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Ramara Quarry

LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT

Brand X Materials and Supply Inc.

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1 Introduction

Tatham Engineering Limited (Tatham) has been retained by Brand X Materials and Supply Inc (Brand X) to prepare a combined Level 1 and Level 2 Hydrogeological Assessment in support of an Aggregate Resources Act (ARA) Class A Quarry Below Water licence application for the proposed Ramara Quarry, located at 6059 Pearl Carrick Road in Ramara, Simcoe County, hereafter referred to as the 'site' or 'Proposed Quarry'. A Site Location Plan is presented as Figure 1.

Tatham has prepared this combined Level 1 and Level 2 Hydrogeological Assessment for the proposed quarry in accordance with the relevant Ministry of Natural Resources (MNR) standards including the *Aggregate Resources of Ontario Technical Reports and Information Standards*, dated August 2020 (Technical Reports Information Standards). This combined Level 1 and Level 2 Hydrogeological Assessment was completed to assess the potential impact to aquifers, surface water features, springs, and discharge areas in the vicinity of the proposed quarry lands and ultimately evaluate potential mitigation measures.

1.1 SITE DESCRIPTION

The site is located at 6059 Pearl Carrick Road in Ramara and is legally defined as Lot 10 and Part Lot 9, Concession C, Geographic Township of Rama, Simcoe County, Ontario.

The site consists of approximately 72.0 ha (177.9 acres) of undeveloped lands consisting of shallow bedrock, woodlands and/or wetlands (Wu-1 through Wu-4) as shown on Figure 1. It is noted towards the northwestern portion of the property there is a small area of exposed bedrock where the thin topsoil has been scraped away.

The site is generally covered by a very thin layer of overburden/topsoil and is fairly flat. Further, the upper bedrock unit is exposed throughout most of the site and is quite weathered and fractured. Surface water entering the site including runoff and precipitation will enter these shallow bedrock fractures within the weathered bedrock unit and flow through the fracture network following the local topography.

Wetland Wu-4 occupies the southeastern portion of the property and extends to the southwest and northeast onto the adjacent properties. The entire wetland is approximately 114 ha in size, with 25.7 ha of the wetland occupying the southern portion of the site. The wetland is underlain by fine grained organic soils which inhibits the infiltration of surface water in this area causing surface water to pond and form the resulting wetland.



This wetland is fed by an external catchment area of 308.9 ha draining overland via a series of intermittent drainage systems entering the site at the southeast corner of the property and feeds the wetland. The wetland collects and stores this external water and eventually when water levels are high enough can spill flow towards the northwest to a low area on the site where water ultimately 'sinks' into the shallow bedrock. Once the surface water enters bedrock fractures within the upper weathered bedrock, on-site monitoring data suggests this surface water then flows through the shallow fracture network within the weathered bedrock unit to the north/northwest following the slope of the upper weathered bedrock unit. The surface water then reappears downstream on the adjacent north property via a series of fractures as the shallow bedrock system is exposed at this location due to the dropping elevation of the existing grades. This system forms part of the Head River upper tributary drainage system.

1.2 STUDY AREA DESCRIPTION

The site is bounded by Donald Carrick Lane and undeveloped wooded/wetland areas to the north, Pearl Carrick Road followed by an existing aggregate operation (ARA Licence No. 3601) to the west, an existing aggregate operation (ARA Licence No. 608542) to the east, and existing residential property and Concession Road B-C followed by undeveloped wooded/wetland areas to the south and an existing aggregate operation (ARA Licence No. 104616) to the southwest.

The area surrounding the site primarily comprises other aggregate operations, and a few rural residential properties. The landscape is primarily shallow bedrock with a thin overburden layer including scattered wetland and woodland areas. The Sweetwater Nature Reserve, which is maintained by the Couchiching Conservancy, is located immediately north of the property.

Properties within the vicinity of the site are serviced by private water supply wells.

1.3 SITE DEVELOPMENT

It is expected all overburden material will be removed prior to initiating quarrying operations. The overburden material will be used for berm construction.

The proposed license boundary includes 43.3 hectares of the site with the proposed area of extraction area covering 34.4 hectares.

Extraction will be completed in three phases to a maximum depth of 15 m in 1 or 2 benches. The benching will be dependent on the geology and quality of rock units encountered. Based on the field investigations to date, the Upper Gull River Formation is present at elevations of 238.1 to 235.0 m asl, with the Lower Gull River Formation extending to the shadow lake formation at an elevation of approximately 233.6 m asl. Both formations will be taken in a single lift, where possible. The underlying unit consists of the Shadow Lake Formation, which will not be extracted.



It is anticipated the final elevation of excavation will be approximately 233.6 m asl, coinciding with the elevation of the Shadow Lake Formation present in BH6.

As the proposed quarry is located between three existing quarrying operations, two of which are licenced to extract below the water table it is anticipated there will be groundwater lowering across the site as a result of the neighboring approved aggregate operations. Further, with the exception of the upper weathered bedrock, which can periodically convey surface water flows, the underlying more competent bedrock has a fairly low permeability which will ultimately limit the amount of groundwater inflow into the quarry. As such, it is not expected significant groundwater inflow will occur at the site, and therefore conventional groundwater management is expected through quarry operation. The focus for water management will be the control and maintenance of the surface water inflow from the surrounding external drainage areas currently conveyed through the site from the wetland located in the south half via a shallow fracture system within the upper weathered bedrock unit. This flow in the shallow weathered bedrock is a contributor to the Head River tributary system originating just north of the site. A water management strategy on-site will be implemented to ensure this surface water system is maintained and continues to function as per existing conditions both during and post quarry activity.

The main site access and truck scales for the proposed quarry will be located in the southwest corner of the proposed licence boundary, as seen in Figure 2. Material will be transported throughout the proposed quarry by rock trucks and/or conveyor belts and it is understood the use of a portable rock crusher with secondary crushing and aggregate washing capabilities is proposed.

It is anticipated processing and storage of aggregate materials will occur within close proximity to the active working faces to reduce off-site impacts.

Groundwater encountered during quarry operations within the extracted areas will be directed to a site sump/pond located in the quarry floor. After remaining in retention for a minimum of 12 hours to ensure the water quality parameters and turbidity levels are met, waters contained within the sump will be intermittently discharged to a constructed infiltration feature proposed along the north property boundary which will introduce water to the fracture network within the upper weather bedrock unit for conveyance off-site to the drainage systems to the north.

1.3.1 Water Management Features

The primary water management required for the site will be to ensure the external surface water flowing currently are conveyed through the site from the existing wetland area on the south half of the site will continue both during and post quarry activity. As described above, under existing conditions this surface flow is primarily conveyed from south to north seasonally through the site



via the shallow bedrock system. To maintain dry operating conditions within the footprint of the proposed quarry, the surface water flowing towards the extraction area from the wetland on the south half of the site is proposed to be collected at the south boundary of the extraction limit and diverted around the extraction area via gravity drainage and a pumping system if necessary. This water will be discharged to an infiltration feature to be constructed along the north limit of the site where it will be connected into the shallow fracture network within the upper weathered bedrock unit. This will ensure surface water will continue to feed the shallow bedrock system contributing flow to the Head River tributary downstream of the site. To ensure the rate of discharge to the shallow bedrock system matches existing conditions, storage of water will be provided on-site via storage pond areas sized to allow for the control and steady release of flows to the downstream system to match existing conditions.

It is also expected some groundwater seepage will occur into the quarry footprint from the deeper aquifers through the exposed bedrock faces. This inflow will be collected in the quarry sump and filtered in the on-site storage ponds then discharged to the same infiltration system proposed along the north boundary for connection to the shallow fracture network within the upper weathered bedrock unit.

The Head River tributary downstream of the site is recognized as a Cool-Water Stream in accordance with the Ontario Stream Assessment Protocol. As such, baseline temperatures ($\pm$ allowing for seasonal variability, etc.) and turbidity are selected to be parameters of note to be maintained throughout the life of the quarry. To achieve this, surface water control structures such as covered culverts/piping and filtering through cooler shallow rock structures will be utilized to strategically re-route the tributary waters in a manner limiting the potential for temperature increases while allowing natural groundwater replenishment to continue.

Specifics of the proposed water management strategies for each phase of extraction are described in the following sections while an assessment of the volume of water to be discharged and potential impacts are described later in this report.

Phase 1

The Phase 1 extraction area is not expected to intercept the shallow fracture network within the weathered bedrock unit which conveys runoff from the wetland to the south across the site. An earth berm will be constructed along the western limit of the Phase 1 extraction area to ensure no intrusion of surface water flow into the active quarry occurs. For the duration of the Phase 1 extraction, it is expected the conveyance of the external drainage through the site will continue in the same manner as it currently does under existing conditions.

Groundwater seepage from the deeper aquifer into the Phase 1 quarry footprint and surface runoff from direct precipitation falling on the Phase 1 extraction area, will be collected in the



quarry sump and discharged to an existing depression storage referred to as WU-01 feature located on-site to allow for the recharge to the shallow bedrock system feeding the Head River tributary. The proposed surface water management measures to be implemented during Phase 1 are illustrated on Figure 3.

Phase 2/3

For the Phase 2 and 3 of extraction, an engineered linear infiltration feature will be constructed along the north limit of the Phase 2 and 3 extraction areas. This feature will consist of a stone filled infiltration trench constructed at a depth sufficient ensure the trench intersects the existing upper shallow fractured bedrock system allowing for the addition of surface water to it for the continued connection to the upper weather bedrock unit which conveys water north off-site to the Head River tributary. The design of this feature will include consideration to line the south limit of the infiltration feature with low permeability soil to prevent water from flowing back into the extraction area.

During these extraction phases the existing shallow bedrock system currently conveying water through the site will be disrupted, therefore, to prevent external flows from the south from entering the Phase 2 and 3 areas a naturalized cutoff swale will be constructed along the south limit of the Phase 2 and 3 extraction areas to redirect external runoff from the upstream wetland and tributaries west towards Pearl Carrick Road. From this location, water will be pumped north to the proposed infiltration feature to be constructed along the north property boundary.

The cutoff swale will be designed with an overflow to allow excess runoff (greater than the volume proposed to be pumped around) to enter the quarry where it will be conveyed to a surface storage feature to be located on the quarry floor. This will allow for the storing and controlled release of surface flow into the infiltration feature which may be needed during periods where surface water flow enters the system in excess of the conveyance capacity of the existing shallow rock fracture system (i.e. during spring freshet and after major storm events). The proposed surface water management measures to be implemented during Phases 2 and 3 are illustrated in Figures 4 and 5.

1.3.2 Site Rehabilitation

Pits and quarries are temporary land use types. Once aggregate extraction has been concluded, the ARA demands pits/quarries undergo rehabilitation. This process involves restoring the land to a safe and stable condition which facilitates the post-extraction use of the land for a variety of needs such as wildlife habitats, wetlands, recreational parks, forestry, agriculture, etc. Following extraction, it is proposed the quarry will be gradually filled with excess soil to allow for progressive naturalization including forested areas, meadow/grassland areas, and a wetland in



order to provide similar wildlife habitats and connectivity to the communities to the north of the property.

The Proposed Quarry will be progressively rehabilitated to achieve pre-extraction grades across the Site. Given the limited overburden on-site, clean off-site materials will be utilized throughout rehabilitation to supplement on-site overburden. Rehabilitation will initiate on the Phase 1 lands once extraction in this Phase is complete. Grades will be returned to pre-extraction grades along the eastern site limits continuing to the west as subsequent Phases are extracted. The phasing of the rehabilitation will recognize some of the quarry area will be used during the later phases of quarrying for interim water storage.

As part of final rehabilitation, the grades will be such that overland flow of surface water will continue through the center of the site from south to the north property line as per existing conditions. This will include the use of select material of appropriate permeability and a rock lined conveyance channel mimicking the current flow of surface water through the shallow fracture network within the weather bedrock unit. The infiltration feature along the north boundary will remain in perpetuity to maintain the connection to from the surface water to the shallow bedrock system.

All equipment and structures will be removed, and all groundwater control features will be modified and/or removed to allow groundwater and surface water to return to near baseline conditions without any active long-term water management. To return the site back to existing conditions, the proposed grades will be designed to allow for water to pond seasonally similar to existing conditions. This along with the proposed infiltration trench will maintain flows to the tributary downstream while minimizing the increase in water temperature and potential impacts to the Head River tributary. The proposed surface water management measures to be implemented during the rehabilitation scenario are illustrated in Figure 6.

1.4 STUDY OBJECTIVES

This investigation was conducted to fulfill the requirements of a Level 1 and Level 2 Hydrogeological Assessment for the licencing of a Class A Quarry Below Water under the ARA.

Level 1 and Level 2 assessment reports were completed concurrently. The purpose of the Level 1 assessment report is to determine any potential impacts which may result from the proposed below water quarry activities on:

- Water wells, including private water wells, municipal/communal/industrial, geothermal and agricultural wells. Where a proposed quarry site is within a Well Head Protection Area (WHPA) for Quantity (Q1 or Q2) as outlined in the applicable Source Water Protection Plan,



the applicable Source Water Protection Policies and mitigation measures are to be incorporated and implemented as part of the proposed site plans;

- Groundwater aquifers;
- Watercourses and surface water bodies;
- Springs; and,
- Discharge areas.

If this high level preliminary screening exercise identifies a potential impact to one of the above receptors, further assessment to quantify the potential impact and ultimately assess the significance and need for mitigation measures will be required. This impact assessment must include:

- A description of the local geology, hydrogeology and surface water systems supported by field and technical data;
- A description of the proposed water diversion, discharge, storage, and/or drainage facilities;
- A water budget outlining how water will be managed on-site and discharged off-site; and,
- A detailed description of the potential impacts to receptors within the zone of influence of the proposed quarry, both negative and positive, and the proposed mitigation measures to reduce or eliminate the potential impacts.

Based on an initial screening, as summarized in Table 1, an assessment to quantify the potential impacts resulting from the proposed extension and an assessment of the significance and need for mitigation measures is required and is presented below.



Table 1: Evaluation of need for Level 2 Hydrogeological Assessment

POTENTIAL GROUNDWATER AND SURFACE WATER FEATURES	INITIAL SCREENING CONSIDERATIONS	NEED TO QUANTIFY IMPACTS
Water Wells	Water wells are located within 250 metres of the proposed extension. The water wells obtain water from dolostone aquifer which is proposed to be extracted.	Further assessment is required to quantify any potential impacts to water wells in the area.
Springs	Springs were not noted within the site limits.	Further assessment is not needed to assess the potential impacts to springs on site, however, the water management strategy should consider the form and function of potential off-site springs to ensure no adverse impacts are a result of the quarry activities.
Groundwater Aquifers	Extraction will occur in the local bedrock aquifer.	Further assessment is required to assess the potential reduction in water levels in the nearby wells (quantity). However, there is limited potential for water quality effects as groundwater dewatering will maintain flow directions into the quarry and no parameters are being introduced in the quarry operation impacting water quality aside from temperature management requirements.
Surface Water Courses and Bodies	A tributary of the Head River feeds the wetland occupying the southwestern portion of the site.	Further assessment is required to assess the potential reduction in this surface water feature as a result of quarry dewatering and flow re-direction.
Discharge to Surface Water	The shallow fracture network within the upper weather bedrock unit through the centre of the site currently acts to convey surface water from the wetland south of the site through the site to the tributary of the Head River to the north.	Assessment is required to evaluate the function and potential impact, if any, as a result of the proposed re-infiltration of the external drainage to the off-site downgradient surface water receiver. This is documented in this report.

POTENTIAL GROUNDWATER AND SURFACE WATER FEATURES	INITIAL SCREENING CONSIDERATIONS	NEED TO QUANTIFY IMPACTS
Water Diversion, Storage and Drainage Facilities On-Site	Water within the wetland to the south will be diverted towards the north of the site and ultimately re-infiltrated into the shallow fracture network within the upper weathered bedrock unit.	Further assessment is required to address alterations to water diversion, storage and drainage facilities. A detailed assessment of site surface water management strategy is included in this report.
Water Balance	There is a potential for the proposed extraction to impact the existing infiltration and/or runoff conditions on-site.	Further assessment is needed to evaluate the potential for changes in the water balance. This will include an assessment of the site-wide and feature-based water balance included as part of this report.
Source Water Protection	There are no municipal water wells within at least a 5.0 km radius. Potable water is supplied by private domestic wells in the vicinity of the site.	Further assessment is not needed as the site does not fall within a WHPA and no municipal water wells are located within at least 5.0 km of the proposed extension lands.

2 Physical Setting

2.1 PHYSIOGRAPHY AND TOPOGRAPHY

The site lies within the physiographic region known as the Carden Plain, comprising primarily Limestone with Sand Plains identified towards the southeastern portion of the site (Chapman and Putnam, 1984), as shown in Figure 7.

Ontario Geological Survey (OGS) quaternary geology mapping indicates the majority of the site is underlain by Paleozoic bedrock while the northwestern portion of the site is underlain by glaciolacustrine deposits of the Pleistocene Epoch comprising sand, gravelly sand, and gravel deposits (OGS, 2000 and 2010), as shown on Figure 8.

The topography within the vicinity of the site is gently sloping, ranging between approximately 240 to 265 m asl, as shown in Figure 9. On-site elevations range from 257 to 242 m asl with grades generally sloping towards the center of the site. Under existing conditions, it is anticipated surface runoff will be captured by the shallow fracture network within the upper weathered bedrock unit at surface and flow within the intricate fracture network. It is anticipated the bedrock fracture network within the upper weather bedrock unit converge towards the center of the site and ultimately flow towards the north to the adjacent property where water captured within the shallow bedrock fracture network within the upper weathered bedrock unit discharged to surface.

2.2 HYDROLOGY

The proposed quarry is located approximately 2.8 km south of the Head River tributary and is within the Head River watershed. The existing drainage patterns on-site are shown on Figure 10.

The large wetland (WU-4) located on the south half of the quarry site is approximately 114 ha in size and has a drainage area of 309 ha (Catchment 100). This catchment area drains to wetland WU-4 filling it seasonally which causes it to overflow to an on-site depression feature where runoff enters the shallow bedrock fracture network within the upper weathered bedrock unit conveying water to the Head River tributary to the north. An additional 100 ha of drainage area (Catchment 101) including the center of the site in addition to external area to the south, also drains to this depression feature before entering the shallow bedrock fracture network within the upper weather bedrock unit and being conveyed north to the Head River tributary. The total drainage area to the on-site depression feature is 409 ha, which includes Catchment 100 and 101. The surface water entering the shallow bedrock fracture network within the upper weathered bedrock unit reappears downstream on the north adjacent property where it is joined by runoff



from Catchment 102 (56 ha) which accepts run-off from the cut above quarry footprint and surrounding area.

Wetland WU-4 is extensive extending to the southwest and northeast onto the adjacent properties. The wetland is underlain by fine grained organic soils which inhibits the infiltration of surface water causing surface water to seasonally pond thus forming the resulting wetland.

2.3 BEDROCK GEOLOGY

The study area is primarily underlain by dolostone/limestone of the Bobcaygeon and/or Gull River Formation overlying sandstones of the Shadow Lake Formation, as summarized in Table 2 (OGS, 2000).

Table 2: Bedrock Stratigraphy

FORMATION	DESCRIPTION
Overburden	
Bobcaygeon Formation	The Bobcaygeon Formation is typically coarser and more fossiliferous when compared to the Gull River Formation. The Bobcaygeon Formation was not present on-site but outcrops have been reported in the vicinity of the site.
Upper Gull River Formation	Grey to brown fine grained dolostone.
Lower Gull River Formation	The Gull River Formation is variability dolomitized, predominantly muddy limestone. The Upper Gull River Formation is characterized by distinctive dolomitic fossiliferous lime mudstone and is characterized by the abundance of chert nodules. The Lower Gull River Formation consists primarily of green-grey to tan argillaceous dolostone, and dolomitic limestones. Fossils are sparse suggesting a sabkha to supra-/upper intertidal depositional environment. This layer is commonly referred to as the green marker bed and typically contains interbedded layers of shale and sandstone.
Shadow Lake Formation	Grey to red sandstone with interbedded layers of shale and/or dolostone. The Shadow Lake formation is a highly permeable water-bearing sandstone unit with large fractures and smoothed stones, indicating a significant water bearing zone



This formation is not considered usable as an aggregate resource due to compositional variability.

Precambrian Grenville Basement
Rocks

Granite bedrock

2.4 HYDROGEOLOGY

2.4.1 Regional Hydrogeology

The regional hydrogeology of an area is controlled by the geometry of the geological features which influence the distribution and movement of groundwater. Groundwater movement within bedrock primarily occurs through discontinuities such as fractures and bedding planes and is controlled by both the topography and hydraulic head potential within the bedrock. The rate of groundwater movement is a function of the hydraulic head potential, hydraulic conductivity, and porosity, which in turn is a function of a fracture's aperture and degree of interconnectivity.

Groundwater resources in the vicinity of the site are supplied from the water bearing fractures within the Gull River dolostone bedrock.

MECP Water Wells

To assess the nature of groundwater resources as well as the history of the well usage in the area, MECP water well records were reviewed for a 1,000 m radius surrounding the site. The approximate MECP water well locations are shown on Figure 11, and a summary of the MECP water well records is provided in Appendix A.

A total of 9 MECP well records were reviewed. Of the records reviewed, four indicated domestic water supply well use, two indicated monitoring well use, one record indicated test hole well use and the remaining two records did not indicate their well use type.

In general, stratigraphy noted from the records indicated sand with variable gravel and clay over limestone bedrock over shale and/or granite. Bedrock was encountered in all records at depths ranging from at surface to 9 m below existing grades. Domestic water wells are anticipated to be screened within the Gull River Formation. Pumping test details were provided for 4 of 9 well records and indicated pumping tests were carried out for 1 to 4 hours and 20 minutes at rates of 3 to 30 GPM (11.4 to 113.6 L/min) with static water levels ranging from 1.2 to 11 m bgs being drawdown to depths of 1.2 to 33 m bgs.



Regulated Groundwater Use: Permit To Take Water

Groundwater takings are governed by the Ontario Water Resource Act (OWRA) Section 34 and O.Reg. 387/04. These regulations state a Permit to Take Water (PTTW) is required if total groundwater takings exceed 50,000 L/day.

A review of the permitted water takings within a 1 km radius of the site was completed. The results indicated there were two active PTTW records in the study area.

A summary of the two active PTTW records within the 1 km radius of the proposed quarry is summarized below:

- P-300-1190403955 (cancels and replaced PTTW No. P-300-1190403955): Issued to 1595479 Ontario Limited (permit holder) located at 7172 Concession Road B-C in Sebright, Ramara, Ontario, approximately 270 m west of the northwestern site limit. The PTTW was issued for quarry dewatering purposes and allows water takings from the quarry sump pond at a rate of up to 1,000 L/min for 24 hours per day, 240 days/year, totaling 1,440,000 L/day or 345,600,000 L/year.
- P-300-9099524560 (Cancels and replaces PTTW No. 2216-A3AJQX, which cancelled and replaced PTTW No. 7614-8C6N8N): Issued to Bot Aggregates Limited for the quarry located at Lot 12 Concession B, Township of Rama, approximately 750m southeast of the southeastern site limit. The PTTW was issued for quarry dewatering purposes and allows water takings from the quarry sump pond at a rate of up to 852 L/min for 24 hours/day, 365 days per year, totaling 1,226,880 L/day or 447,811,200 L/year. The PTTW allows for temporary increases in pumping rates up to 5,351 L/min for a maximum of 7,705,440 L/day for 30 days/year.

2.4.2 Source Water Protection

The Clean Water Act (The Act) was established to provide a baseline for how to conduct drinking water source protection (CWA, S.O. 2006, Chapter 22). The Act was ratified by the Legislative Assembly of Ontario in 2006 and focuses on protecting current and potential future sources of residential drinking water. The Ontario Water Resources Act (OWRA), the Environmental Protection Act (EPA), and other applicable federal/provincial/municipal laws remain the primary legislation for protecting the quality and quantity of all of Ontario's water resources.

The proposed quarry is located within the Lakes Simcoe and Couchiching/Black River Source Protection Area (SPA) and the Black-Severn River watershed. The Black-Severn River watershed spans over three upper-tier municipalities (Simcoe, Muskoka, and Haliburton) and largely consists of rural residential properties with few urban/agricultural areas. The Black-Severn River



watershed has a total drainage area of approximately 277,000 ha and houses merely 54,000 residents (South Georgian Bay Lake Simcoe Region Drinking Water Source Protection, n.d.)

The Lakes Simcoe and Couchiching/Black River SPA includes a total of 107 drinking water systems with 275 municipal wells and 16 surface water intakes, supplying approximately 70% of all residents with their water supply needs. Properties within the vicinity of the site are serviced by private water supply wells.

Intake Protection Zones

An Intake Protection Zone (IPZ) is an area of land or water contributing source water to a municipal surface water intake pipe. The IPZ shows where surface water is coming from to supply a municipal intake pipe as well as how fast it is travelling to the intake pipe. The IPZ's associated with the surface water drinking systems within the Lakes Simcoe and Couchiching/Black River SPA are primarily located along the shore of Lake Simcoe and Lake Couchiching; however, an IPZ 3 has been mapped through the center of the site corresponding with the Head River tributary as shown on Figure 12. An IPZ 3 identifies areas where contaminants may reach a municipal intake pipe during and/or after large storm events.

Well Head Protection Areas

A Well Head Protection Area (WHPA) is the area surrounding a municipal wellhead contributing source water to a drinking water system. A WHPA shows where groundwater is coming from to supply a municipal well, and how fast it is travelling through the ground toward the municipal well. The site does not lie within a WHPA, and the closest municipal wellhead is located approximately 7 km northwest of the site, just north of Rama.

Significant Groundwater Recharge Areas and Highly Vulnerable Aquifers

A Significant Groundwater Recharge Area (SGRA) is defined as a geographical location where a large volume of water readily infiltrates the ground and replenishes an aquifer at a rate significantly higher than the average for the surrounding area. Similarly, a Highly Vulnerable Aquifer (HVA) is an area identified as being susceptible to contamination as a result of surficial activities. SGRAs and HVAs are subject to the rules outlined in the *Technical Rules for Development of an Assessment Report* within The Act. In general, the determination of an SGRA and HVA uses hydrogeological modelling and data from Tier I, II and III water budgets, which account for the geology, soils, land cover and topography in the area.

Portions of the site lie within an SGRA, as shown in Figure 13, and the entirety of the site lies within an HVA, as shown in Figure 14, indicating the ability of water to infiltrate the ground in



the area and the high potential for aquifer contamination due to a rapid flow of water from ground surface to the underlying aquifer.



3 Field Program Methodology

To assess the potential impacts of the proposed quarry on the nearby groundwater and surface water resources, an in-depth understanding of baseline groundwater and surface water characteristics is required. Among the data for analysis are geologic logs, water level data, water quality data, estimates of aquifer properties, and other flows/levels controlling groundwater flow and interaction with surface waters.

This scope of work was designed to build upon the regional geological, hydrological, and hydrogeological setting (refer to Section 2) to provide a comprehensive characterization of the site, which serves as the foundation for our assessment and ultimately guides the design and recommendation of the long-term groundwater monitoring program.

3.1 GROUNDWATER

3.1.1 Borehole Drilling and Monitoring Well Installation

The borehole drilling and monitoring well installation program was designed to allow for a detailed characterization of the groundwater regime.

Five boreholes, designated BH24-1 through BH24-5, were advanced by Pontil Drilling between April 8 and 10, 2024, to depths of 10.1 to 10.6 m below existing grade. Monitoring wells, designated MW24-1 through MW24-5, were installed in all boreholes upon completion and were constructed with 50 mm PVC riser pipe and 3.0 m long slotted screens. Annular space was filled with filter sand surrounding the well screen and 0.3 m above the well screen. The remaining annular space was backfilled with bentonite holeplug. All monitoring wells were finished with monument casings.

An additional borehole designated MW6 was advanced by Walker Drilling Ltd. on March 25, 2025 to a depth of 16.8. A PVC monitoring well, designated MW6, was installed with a 3.0-meter-long screen on March 28, 2025.

Monitoring wells MW24-1 through MW24-5 and MW6 using a Trimble R12i GNSS receiver connected to the CANNET GNSS network via built in GNSS integrated antenna. The receiver is connected to a TSC7 controller using Trimble Access software for data collection. This equipment provides an accuracy of 8 mm horizontally and 15 mm vertically. Elevations provided reference the CGVD28 datum.

The monitoring well locations are presented in Figure 15, construction details are summarized in Table 3, and borehole logs are provided in Appendix B.



Table 3: Groundwater Monitoring Well Construction Details

MONITORING WELL ID	GROUND SURFACE ELEVATION (m asl)	WELL DEPTH (m bgs)	SCREENED INTERVAL (m asl)
MW24-1	247.55	10.1	237.5 – 240.5
MW24-2	247.58	9.0	238.6 – 241.6
MW24-3	245.25	9.7	235.6 – 238.6
MW24-4	246.56	10.0	236.6 – 239.6
MW24-5	245.43	10.0	235.4 – 238.4
MW6	245.69	12.1	233.6 – 236.6

3.1.2 Groundwater Level Monitoring

On-Site Monitoring Wells

Beginning in May 2024, Tatham representatives installed continuously recording data loggers to facilitate continue groundwater level monitoring and collected monthly manual water level measurements from all monitoring wells. A barometric pressure transducer was installed on-site to correct the groundwater level monitoring dataloggers for changes due to fluctuations in atmospheric pressure. The dataloggers were set to a 4-hour sampling frequency. The results of the continuous water level monitoring are provided on individual hydrographs for each monitoring well presented in Appendix C and discussed further in Section 4.2.

The continuous water level data supplements manually collected data and has been used to assess the aquifers response to precipitation events, establish the seasonally high water table elevations, and determine the local groundwater flow direction.

Private Water Wells

When conducting a Level 1 and 2 Hydrogeological Assessment, private water supply wells are typically utilized to monitor water levels and quality in the supply aquifer, ensuring no adverse effects to nearby water users occur as a result of nearby quarry operations.

As previously noted, few rural residential properties are located within the Study Area. The property owner located at 7006 Concession Road B-C, southwest adjacent to the proposed quarry, was asked if they would like to partake in a residential water supply well monitoring program but permission was not granted. As such, private water well monitoring was not completed as part of this Level 1 and 2 Hydrogeological Assessment scope.



3.1.3 Hydraulic Conductivity Testing

Rising Head Tests

Rising head tests were conducted on monitoring wells MW24-1 through MW24-5 on March 28, 2025, to estimate the hydraulic conductivities of the screened bedrock strata. To conduct the tests, static water level measurements were recorded prior to removing a specified volume of water from each well. The water level recovery over time was then manually recorded on regular time intervals as well as via use of an automated datalogger recording on a 1-second sampling frequency. The rising head data was then processed and analyzed using *Aqtesol/v*. Well-specific hydraulic conductivities were estimated via the Hvorslev (1951) solution for fully penetrating well screens (MW24-1, MW24-3, MW24-4, MW24-5) and the Dagan (1978) solution for partially submerged screens (MW24-2). Results are presented in Appendix D and discussed further in Section 4.2

Lugeon Testing

Lugeon testing, known more generally as *packer* testing, is an in-situ method used to measure the hydraulic conductivity (or permeability) of fractured bedrock masses. The primary objective of lugeon testing is to isolate a specific depth/fracture interval and inject high pressure water into the bedrock fractures in order to quantify the rocks response to water movement (i.e. how much water is able to move through fractured bedrock over a given time).

Lugeon testing was carried out on MW6 on March 26, 2025, prior to the installation of MW6. Results are discussed further in Section 4.2

3.1.4 Constant-Rate Pumping Test

Walker Drilling Ltd. conducted a 6-hour pumping test on MW6 on March 27, 2025 following the completion of the Lugeon testing. The well was originally pumped at a rate of 1.5 Gal/min (5.7 L/min) for the first 45 minutes of the test and after 45 minutes the pumping rate was increased to 3 Gal/min (11.4 L/min) where it remained for the duration of the test.

Groundwater levels were manually measured by Tatham representatives before, during, and after the test, and an automatic recording datalogger was installed to measure continuous water levels throughout the test. The results of the pumping test are provided in Appendix E and are discussed further in Section 4.2.



3.1.5 Groundwater Quality Monitoring

The groundwater quality monitoring program provides a baseline of the natural chemical signature of the groundwater beneath the proposed quarry and provides details regarding potential seasonal water quality variabilities.

Water's ability to conduct electricity depends on the concentration of dissolved ions within the water such as sodium, calcium, chloride, sulfate, etc. Groundwater is able to dissolve underground minerals and hold them in solution, resulting in significantly higher electrical conductivity (EC) values than surface water. Conversely, surface water tends to have a lower EC value as few dissolved ions are typically present.

Manual readings of EC, temperature and pH were taken at MW24-1 through MW24-5 from May 2024 to May 2025, and groundwater samples were collected from MW24-1 through MW24-5 by Tatham representatives on April 26 and October 24, 2024.

Samples were submitted to Caduceon Environmental Laboratories, a CALA accredited lab, for the chemical analysis of pH, Conductivity, Total Dissolved Solids (TDS), Alkalinity, Bicarbonate, Carbonate, Major Anions, and Metals.

Laboratory results are presented in Appendix F and discussed further in Section 4.2.

3.2 SURFACE WATER

3.2.1 Surface Water Monitoring

Drive Point/Piezometer Installation

To quantify the groundwater-surface water interaction on-site and to assess the potential effect of quarry dewatering/discharge on the Head River tributary, two streamflow monitoring stations (SW1 and SW2) were installed in May 2024, and a third streamflow monitoring station (SW3) was installed in November 2024, as shown in Figure 15. Automatically recording dataloggers have been installed and are utilized to supplement manual data and allow for continuous surface water monitoring.

It is noted SW3 was installed just downstream of SW1, as the low flow channel at SW1 started bypassing the water level sensor in 2024 and as such the sensor was measuring as dry throughout the 2024 monitoring period. SW3 will be utilized to collect low flow data for the tributary and supplement the data collected at SW1.

Further, three Mini-Piezometers (MP1 through MP3) were installed to provide information about the surface water elevation and groundwater-surface water interactions across the site.

SW1 through SW3 and MP1 through MP3, were surveyed using a Trimble R12i GNSS receiver connected to the CANNET GNSS network via built in GNSS integrated antenna. The receiver is



connected to a TSC7 controller using Trimble Access software for data collection. This equipment provides an accuracy of 8 mm horizontally and 15 mm vertically. Elevations provided reference the CGVD28 datum.

Installation details for SW1 through SW3 and MP1 through MP3 are presented in Table 4.

Table 4: Surface Water Monitor Installation Details

LOCATION ID	UTM COORDINATES (ZONE 17T)	GROUND SURFACE ELEVATION (m asl)
SW1	640818m E 4950040m N	243.95
SW2	640195m E 4950687m N	238.43
SW3	640795m E 4950045m N	244.11
MP1	641080m E 4950176m N	245.96
MP2	640920m E 4949969m N	246.04
MP3	640671m E 4950452 m N	245.15

Water Level Monitoring

Monthly surface water level and streamflow monitoring was initiated at SW1 and SW2 in May 2024, and at SW3 in November 2024 (provided frozen conditions were not encountered). Monitoring included manual measurements of water depth (stage) (referenced to an installed staff gauge), and manual streamflow measurements utilizing a Swoffer Model 3000 Flow Meter and the Velocity-Area method. The collected surface water level and streamflow data were used to develop a stage-discharge curve, allowing for the estimation of flow rates based on measured water depth.

Monthly surface water and groundwater level monitoring was initiated at MP1, MP2 and MP3 in May 2025. Manual water level measurements, both inside and outside the piezometer pipes, were collected on a monthly basis beginning in June 2024. The manual measurements were utilized to determine Vertical Hydraulic Gradients (VHG) between the surface water and shallow groundwater at each monitor.

The results of the continuous water level and streamflow monitoring are provided in Appendix G and discussed further in Section 4.3.



3.2.2 Surface Water Quality Monitoring

Electrical conductivity, temperature and pH measurements were recorded at SW1, SW2, and SW3 during most monitoring events (granted access was feasible), as well as periodically at piezometers MP1 through MP3. The EC values provide insight as to the source of the tested water, whether it be groundwater or surface water origination, while temperature and pH measurements serve as a baseline to compare future conditions to in order to quantify any changes resultant of quarry operations (i.e. increased temperatures, acidification, etc.).

The results of the surface water quality monitoring are discussed further in Section 4.3.



4 Data Assessment and Results

The findings of the field program outlined in Section 3 were utilized to assess the on-site stratigraphy and derive baseline conditions for the groundwater and surface water systems including seasonal high levels, direction of flow, and water quality. The established baseline conditions serve as a benchmark for evaluating future conditions in order to assess and quantify any changes resulting from the proposed quarry.

4.1 STRATIGRAPHY

Stratigraphy at the site was inferred from borehole logs, OGS open-source data, and previously completed reports. The boreholes drilled across the proposed quarry property provide detailed information about the geology and hydrostratigraphic units underlaying the site. There is some variance between/across the boreholes which is to be expected with a large site.

Generally, stratigraphy on-site was described as sparse overburden overlying highly fractured weathered upper Gull River Formation dolostone/limestone at surface to depths of 1 to 2 m where the formation became less fractured ultimately transitioning to the lower Gull River Formation where Green Bed Markers and interbedded layers of shale and sandstone were observed overlying sandstone of the Shadow Lake Formation.

Details of the subsurface conditions are presented in borehole logs within Appendix B and geological cross-sections have been developed showing the various geological layers as present in Cross-Sections A-A' (Northwest-Southeast) and B-B' (Northeast-Southwest), shown on Figures 16 and 17, respectively.

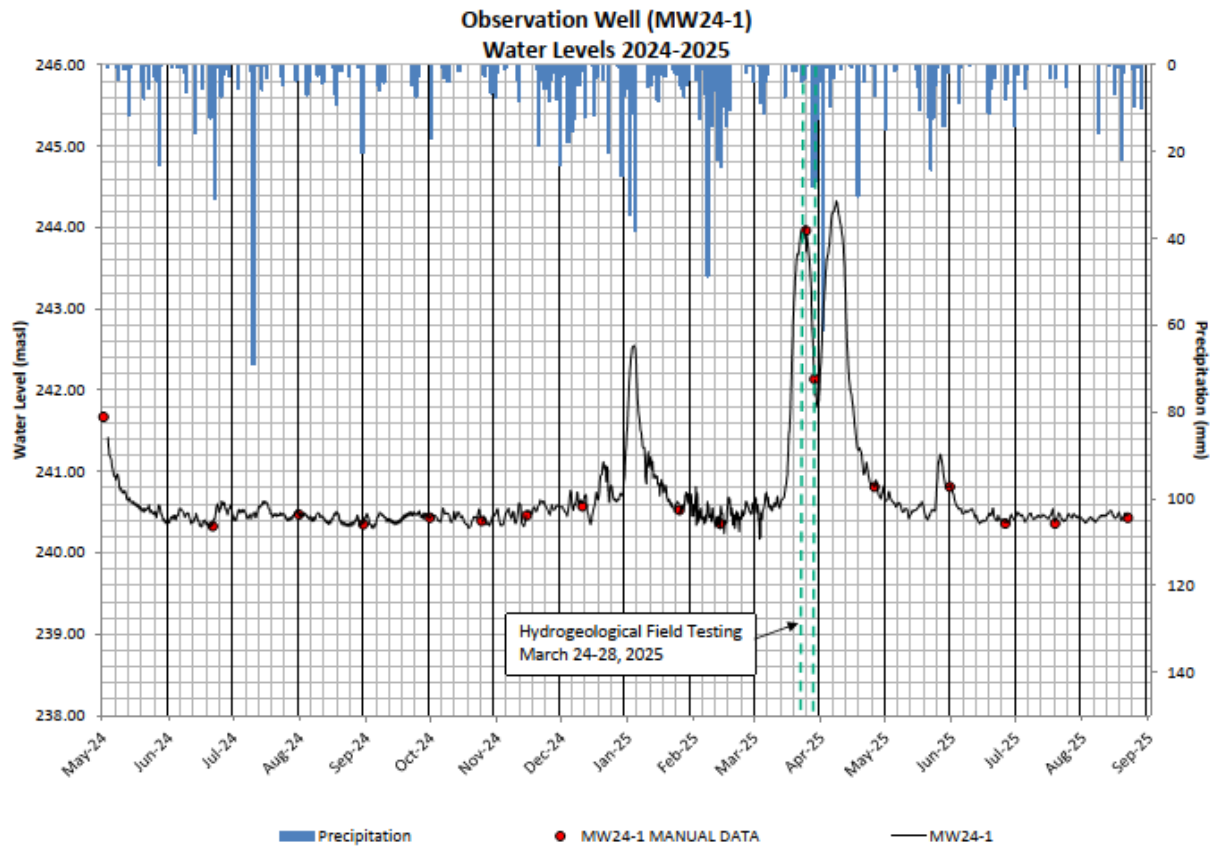
4.2 GROUNDWATER

4.2.1 Groundwater Levels

The results of the continuous water level monitoring are provided on hydrographs for monitoring wells MW24-1, MW24-2, MW24-3, MW24-4, MW24-5 and MW6 presented in Appendix C and discussed below.



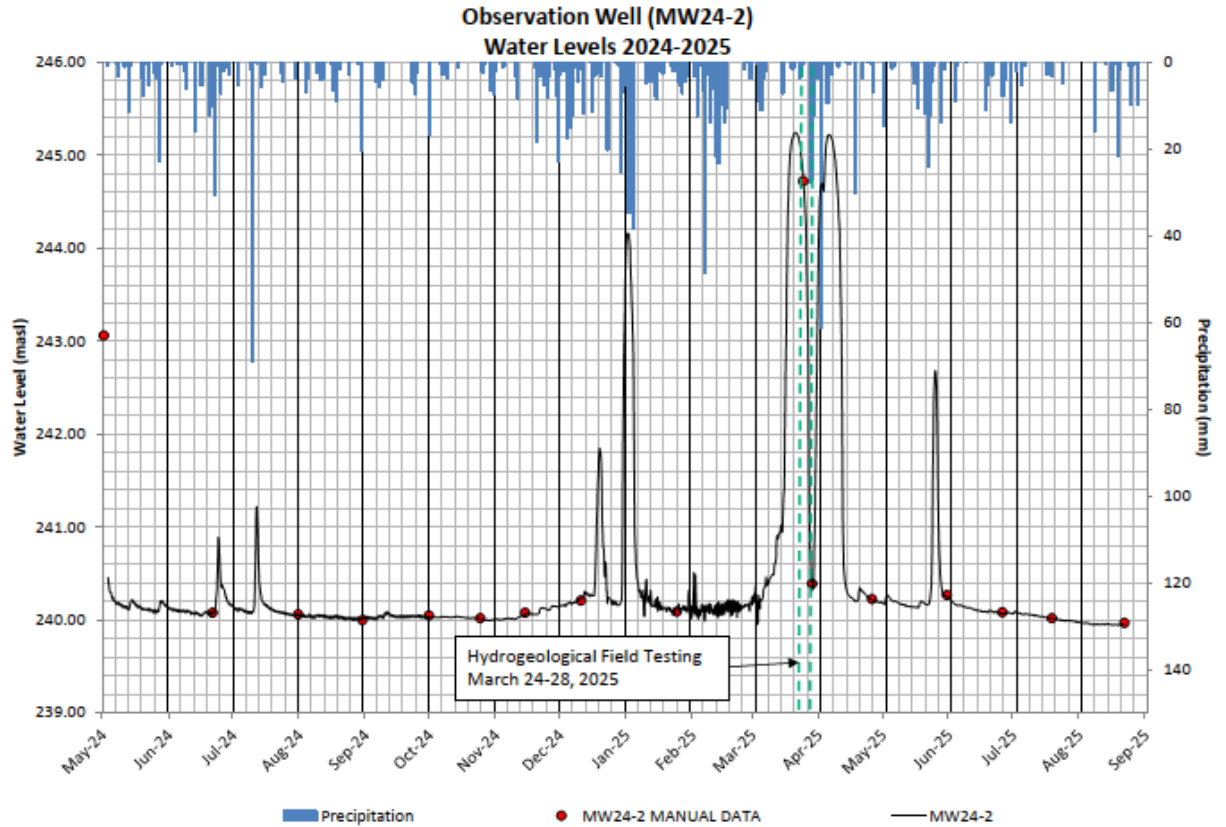
MW24-1



MW24-1 is located in the northwest corner of the site (Figure 15) and is constructed within the Gull River Formation. The water level record shows water levels ranging from 244.33 to 240.17 masl, illustrating high water level responses following precipitation events and snowmelt in the spring. Water levels appear to be fairly consistent during the summer, winter and fall.



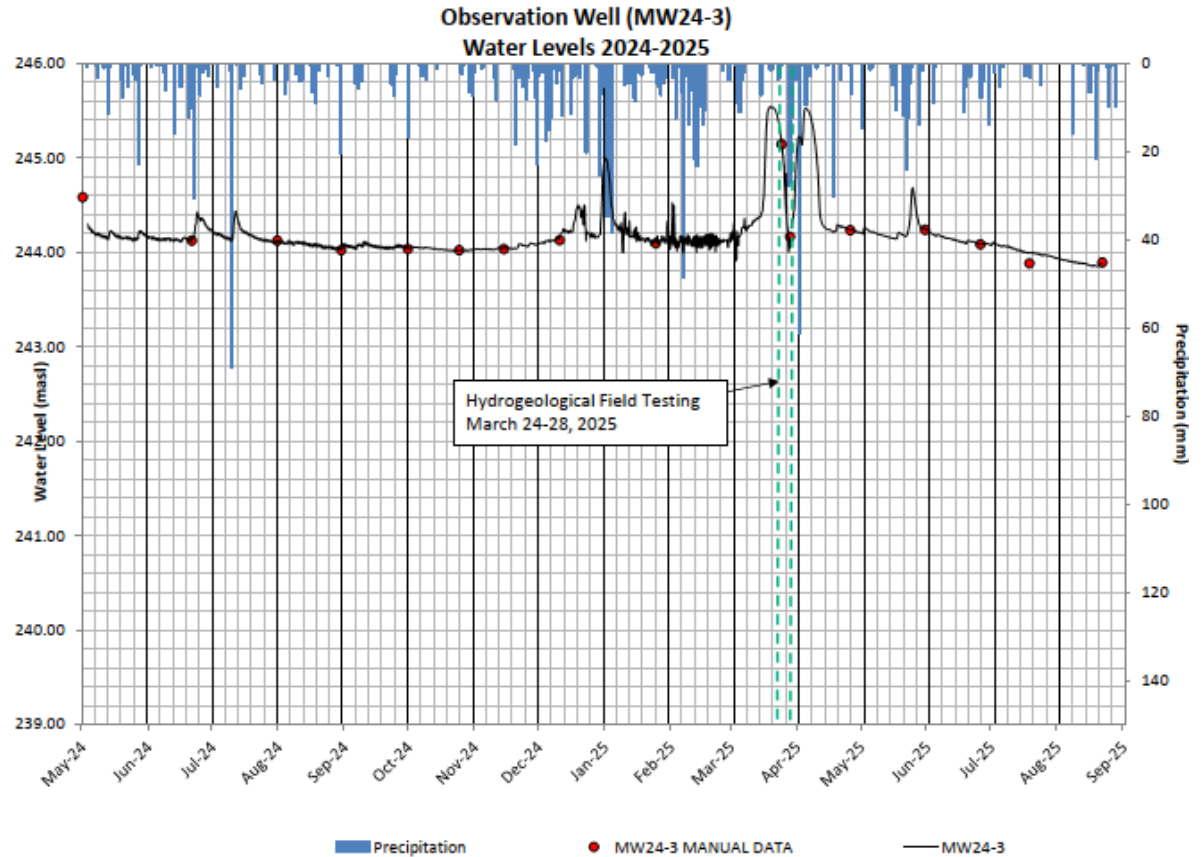
MW24-2



MW24-2 is located in the northeast corner of the site (Figure 15) and is constructed within the Gull River Formation. The water level record shows water levels ranging from 245.28 to 239.98 masl, illustrating high water level responses following precipitation events and snowmelt in the spring. Water levels appear to be fairly consistent during the summer, winter and fall with some evidence of levels dropping in the later portion of 2025 due to drier than typical conditions.



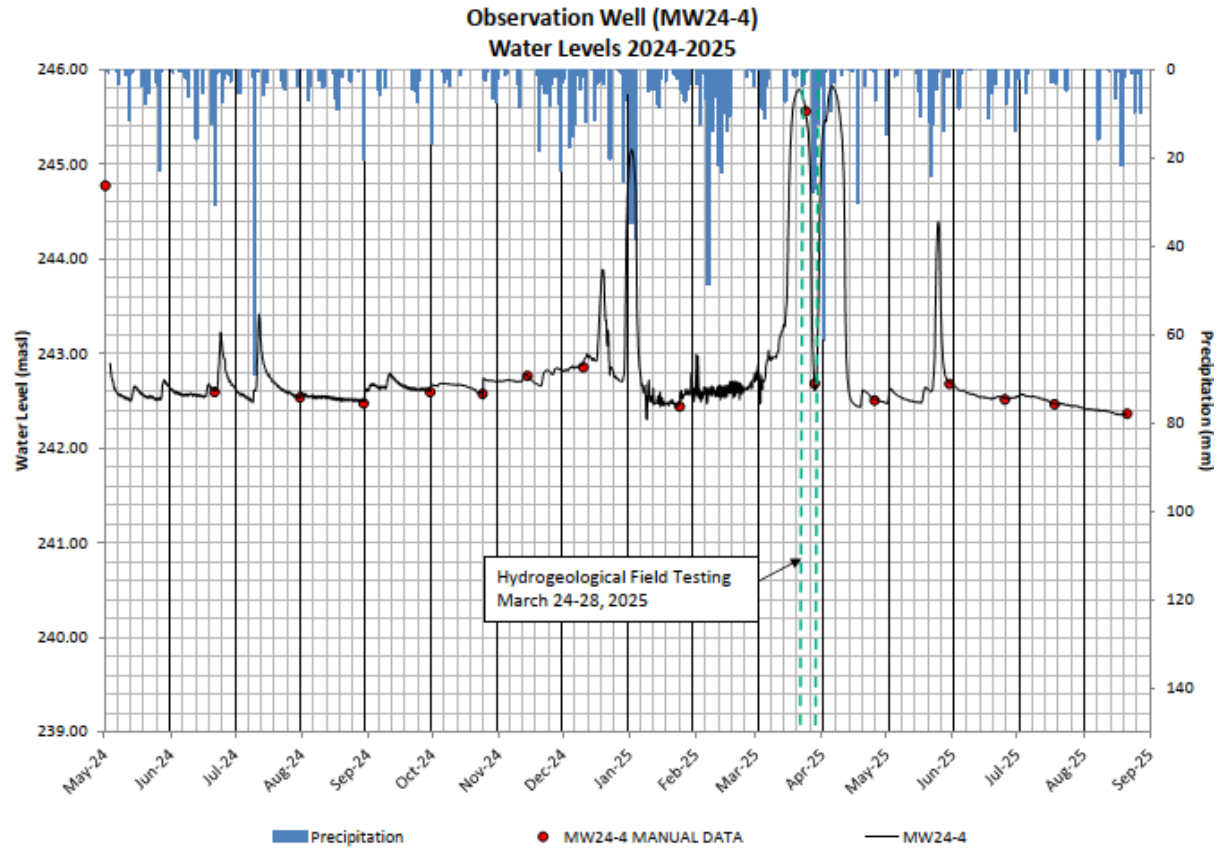
MW24-3



MW24-3 is located in the central portion of the site (Figure 15) and is constructed within the Gull River Formation. The water level record shows water levels ranging from 245.54 to 243.85 m asl, illustrating high water level responses following precipitation events and snowmelt in the spring. Water levels appear to be fairly consistent during the summer, winter and fall with some evidence of levels dropping in the later portion of 2025 due to drier than typical conditions.



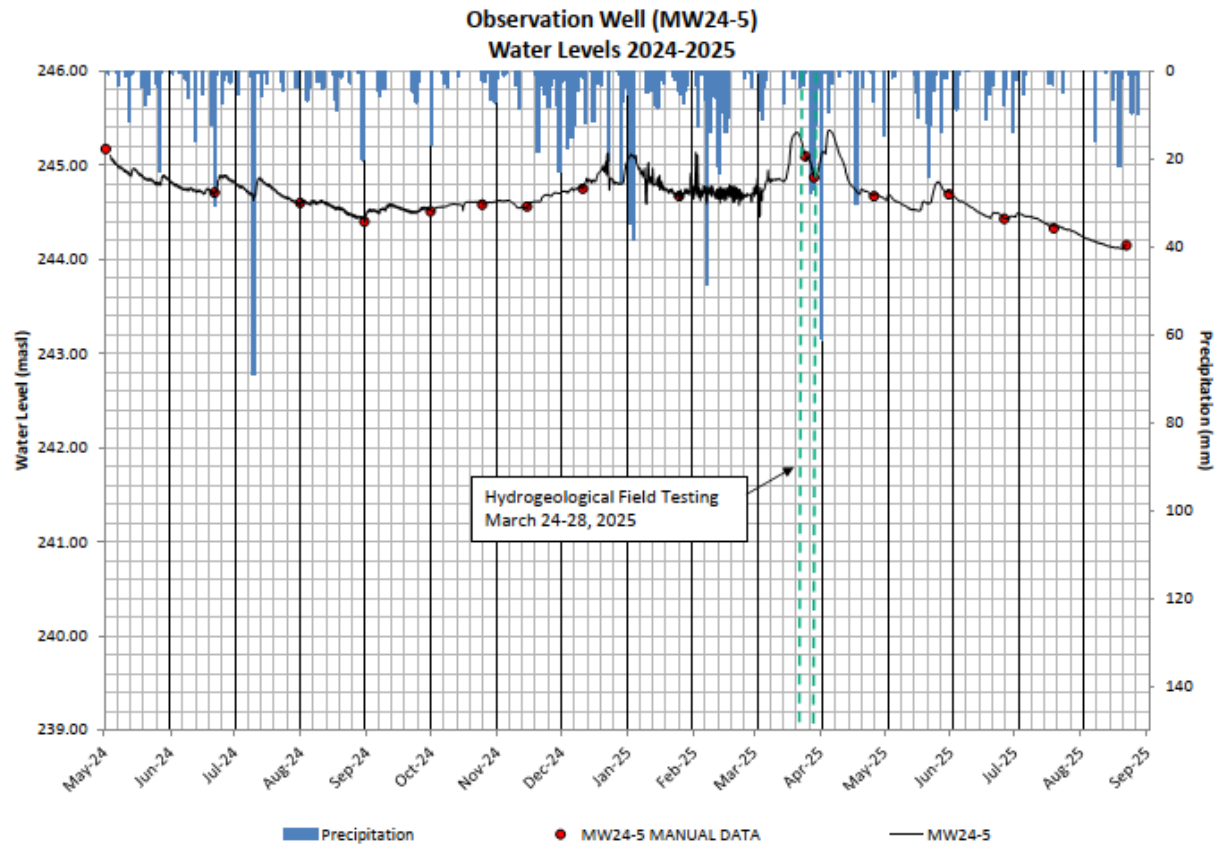
MW24-4



MW24-4 is located in the southeastern portion of the site immediately north of the on-site wetland (Figure 15) and is constructed within the Gull River Formation. The water level record shows water levels ranging from 245.82 to 242.30 masl, illustrating high water level responses following precipitation events and snowmelt in the spring. Water levels appear to be fairly consistent during the summer, winter and fall with some evidence of levels dropping in the later portion of 2025 due to drier than typical conditions.

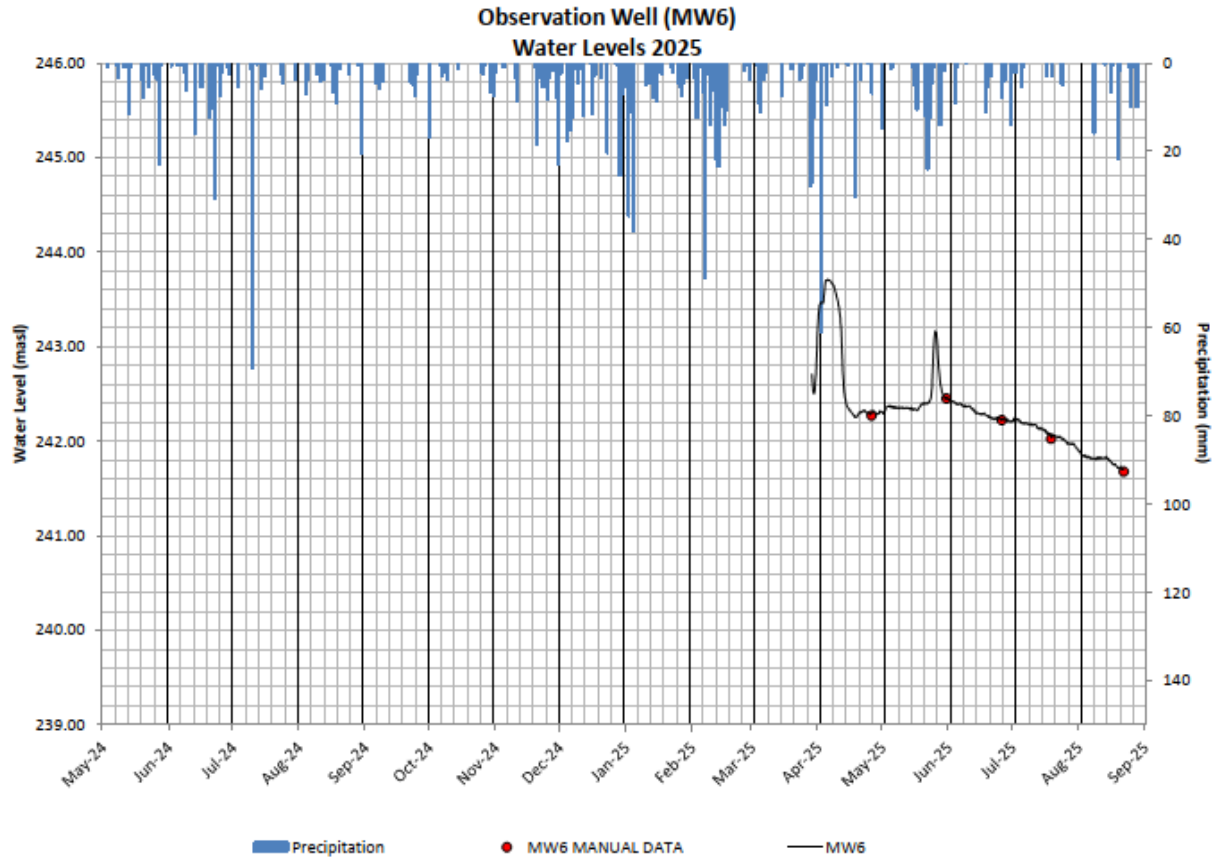


MW24-5



MW24-5 is located in the southwestern portion of the site (Figure 15) and is constructed within the Gull River Formation. The water level record shows water levels ranging from 245.37 to 244.11 masl, illustrating high water level responses following precipitation events and snowmelt in the spring. Water levels appear to be fairly consistent during the summer, winter and fall with some evidence of levels dropping in the later portion of 2025 due to drier than typical conditions.



MW6

MW6 is located in the central portion of the site east of MW24-3 (Figure 15) and is constructed within the Gull River Formation. The water level record shows water levels ranging from 243.72 to 241.70 masl, illustrating high water level responses following precipitation events and snowmelt in the spring. Water levels appear to be fairly consistent during the summer, winter and fall showing a decline for this fall due to the drier than normal conditions later in 2025.

Groundwater Flow

Based on the groundwater monitoring program completed in July and October 2024, and January and April 2025, as presented in Figures 18 through 21. The local groundwater flow direction within the Gull River Formation is to the north. Regional groundwater flow is interpreted to be toward the north/northwest, ultimately flowing toward Mud Lake/Lake St. John/Lake Couchiching.

The neighboring aggregate operations to the west and southeast are permitted to extract below the water table, and an overall lowering of the groundwater levels on-site is possible as a result



of the approved aggregate activities surrounding the site depending on their proposed mitigation measures.

4.2.2 Hydrogeological Conditions

Hydraulic Conductivities

The results of the borehole permeability testing carried out are summarized in Table 5, and are provided in Appendix D.

Table 5: Summary of Hydraulic Conductivities

MONITORING WELL	SCREENED INTERVAL (m asl)	STRATA SCREENED	HYDRAULIC CONDUCTIVITY (m/s)
MW24-1	237.6 – 240.6	Upper and Lower Gull River Dolostone	7.9×10^{-7}
MW24-2	238.6 – 241.6	Upper and Lower Gull River Dolostone	4.5×10^{-6}
MW24-3	235.6 – 238.6	Lower Gull River Dolostone	8.5×10^{-6}
MW24-4	235.5 – 238.5	Upper Gull River Dolostone	2.8×10^{-6}
MW24-5	235.5 – 238.5	Lower Gull River Dolostone	1.5×10^{-5}

A total of 5 test intervals were selected for Lugeon testing, and the lugeon values and interpreted hydraulic conductivity values are summarized in Table 6.

According to Freeze and Cherry (1979), the typical hydraulic conductivities of the screened strata are:

- Unfractured Dolostone/Limestone: 10^{-12} m/s to 10^{-9} m/s
- Fractured Dolostone/Limestone: 10^{-8} m/s to 10^{-2} m/s

Considering both the Lugeon Test and the borehole permeability testing results the estimated hydraulic conductivities of the Gull River Formation ranged from 7.9×10^{-7} to 1.5×10^{-5} m/s. The actual measured hydraulic conductivities of the Gull River Formation illustrate the potential fractured nature of the Gull River dolostone resulting in higher hydraulic conductivities than those anticipated within an unfractured dolostone bedrock.

Further with the Gull River Formation the Lugeon Tests indicate the highest hydraulic conductivities are anticipated within the upper 5.0 m after which the hydraulic conductivities



generally decrease. One test was completed with the Shadow Lake formation indicating higher hydraulic conductivities within the sandstone unit.



Table 6: Lugeon Testing Details

TEST	TEST DEPTH INTERVAL (m bgs)	LUGEON PATTERN		LUGEON VALUE	ESTIATED HYDRAULIC CONDUCTIVITY (m/s)	GEOLOGIC UNIT
1	12.4 - 15.3		Turbulent Flow	43.8	5.7×10^{-6}	Shadow Lake
2	9.3 - 12.2		Turbulent Flow	35.6	4.6×10^{-6}	Gull River
3	6.3 - 9.2		Wash Out	4.3	5.6×10^{-7}	Gull River
4	3.20 - 6.11		Turbulent	29.4	3.8×10^{-6}	Gull River
5	1.98 - 4.89		Turbulent	73.6	9.6×10^{-6}	Gull River

Pumping Test

Results of the constant rate pumping test are presented in Appendix E.

During the pumping test, water levels declined from a static level of 2.0 m bgs to a final level of 4.4 m bgs. After the pump was shut off, water levels recovered to within 5% of the static water level within 9.5 hours.

The results of the pumping test are summarized in Table 7.

Table 7: Summary of Pumping Test

WELL ID	MW6
Well Depth	12.1
Pumping Rate (L/min)	5.7 to 11.4 L/min
Static Water Level (m bgl)	2.0
Final Water level (m bgl)	4.4
Calculated Average Transmissivity (m ² /day) ¹	3.6
Calculated Specific Capacity (m ² /min)	0.0024 to 0.0048

Note:

1. Transmissivities calculated using the Copper-Jacob Straightline Method and considering late time data.

4.2.3 Groundwater Quality

Groundwater quality monitoring was carried out at MW24-1 through MW24-5 monthly from May 2024 to December 2024. The results of the manual groundwater monitoring are summarized in Table 8.

In general, the pH across the monitoring sites ranged from 6.77 to 8.2, the electrical conductivity at MW24-1 and MW24-2 (north portion of the site) ranged from 728 to 2,342 µS/cm compared to MW24-3 through MW24-5 (southern portion of the site near the on-site wetland) ranged from 377 to 968 µS/cm, and temperature ranged from 7.8 to 14.0°C.

As groundwater flows through the subsurface, the interaction of the groundwater with the surrounding soil and rock results in higher concentrations of dissolved minerals and salts which ultimately results in a higher electrical conductivity. As such electrical conductivities can be



reviewed qualitatively to assess whether a surface water feature is receiving groundwater, as the electrical conductivity of groundwater is typically higher.

Further, baseline groundwater quality analysis was completed at MW24-1, MW24-2, MW24-3, MW24-4, and MW24-5 on April 10 and October 24, 2024. The laboratory results are provided in Appendix F.

The groundwater samples indicated compliance as compared to the Ontario Drinking Water Quality Standards (ODWQS) with the exception of:

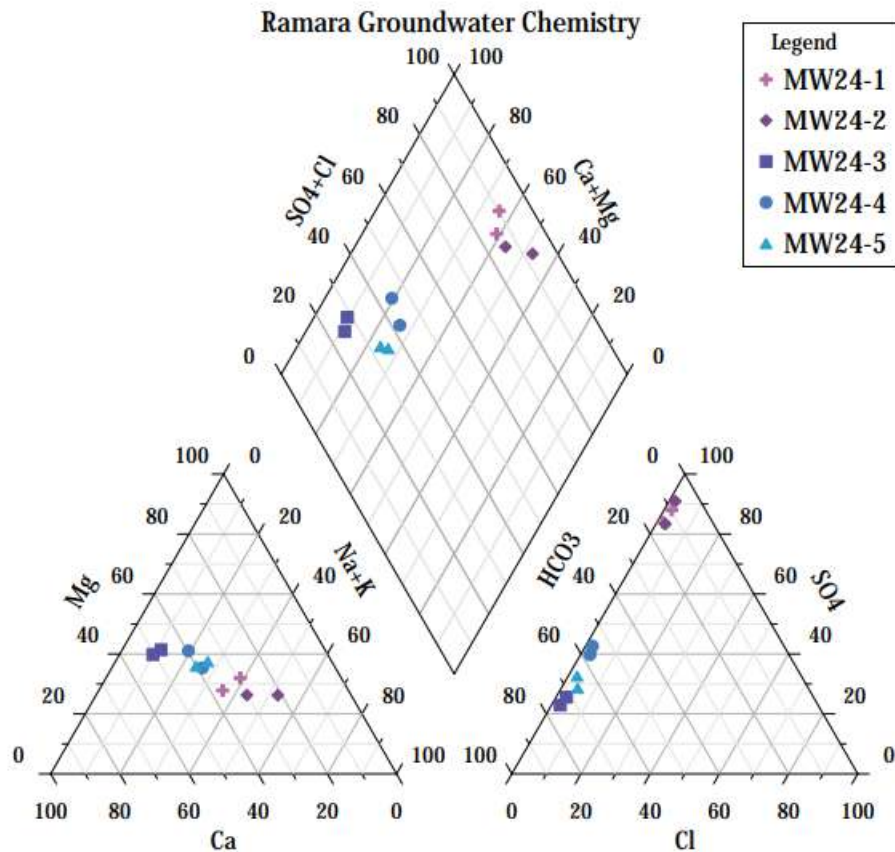
- Elevated Sodium concentrations ranging from 25 to 329 mg/L during the April 2024 sampling event and 25 to 246 mg/L during the October 2024 sampling event compared to the ODWQS Aesthetic Objective (AO) of 20 mg/L and a Maximum Allowable Concentrations (MAC) of 20 mg/L at all locations with the exception of MW24-3. The MAC for sodium in drinking water is 200 mg/L due to any exceedances causing a salty taste. A normal adult consuming more than 10 grams per day of sodium will not lead to any adverse health effects.
- Elevated Hardness concentrations ranging from 179 to 785 mg/L during the April 2024 sampling event and 198 to 935 mg/L during the October 2024 sampling event compared to the ODWQS Operational Guidelines (OG) of 80 to 100 mg/L.
- Elevated Aluminum concentrations in MW24-1 during the April 2024 sampling event with a concentration of 0.16 mg/L compared to an ODWQS OG of 0.1 mg/L.
- Elevated Sulphate concentrations in MW24-1 and MW24-2 during both the April 2024 and October 2024 sampling events with concentrations ranging from 1,050 to 1,230 mg/L at MW24-1 and 913 to 1300 mg/L at MW23-2 compared to a ODWQS AO of 500 mg/L
- Elevated Manganese concentrations in MW24-1 during the April 2024 sampling event with a concentration of 0.066 mg/L and in MW24-2 during the October 2024 sampling event with a concentration of 0.098 mg/L compared to an ODWQS AO of 0.05.
- Elevated Total Dissolved Solids were noted during the October 2024 sampling event with a concentration of 1,370 mg/L compared to an ODWQS AO of 500 mg/L



Table 8: Summary of Manual Groundwater Water Quality

Date	pH / Electrical Conductivity (µs/cm) / Temperature (°C)				
	MW24-1	MW24-2	MW24-3	MW24-4	MW24-5
Apr 26, 2024	7.44 / 2067 / 13.0	7.83 / 2317 / 9.6	7.27 / 847 / 9.3	7.45 / 968 / 8.8	7.84 / 713 / 9.4
Jul 9, 2024	7.69 / 1126 / 12.4	7.42 / 1487 / 11.4	7.29 / 668 / 10.9	7.71 / 734 / 10.3	8.15 / 472 / 12.3
Jul 31, 2024	7.74 / 1956 / 15.0	7.22 / 2164 / 11.1	6.88 / 674 / 12.8	7.05 / 750 / 11.7	7.45 / 505 / 12.8
Aug 30, 2024	7.87 / 1325 / 13.6	7.08 / 2342 / 13.8	7.29 / 695 / 14.0	7.67 / 734 / 14.0	7.84 / 475 / 13.9
Sept 30, 2024	7.50 / 980 / 13.5	6.77 / 1230 / 10.8	6.77 / 615 / 12.3	7.00 / 681 / 10.7	7.24 / 452 / 12.4
Oct 24, 2024	7.49 / 1856 / 11.3	7.68 / 1897 / 10.2	7.38 / 599 / 11.4	7.62 / 592 / 9.9	7.95 / 397 / 11.4
Nov 15, 2024	7.87 / 1792 / 9.6	8.03 / 1583 / 8.6	7.68 / 550 / 10.9	7.85 / 569 / 9.7	8.20 / 397 / 10.8
Dec 10, 2024	8.00 / 1133 / 10.1	-- / 1539 / --	7.41 / 522 / 9.0	7.78 / 572 / 9.1	7.92 / 377 / 8.9
Mar 24, 2025	7.64 / 2211 / 8.4	7.65 / 728 / 7.8	7.25 / 681 / 8.5	7.46 / 793 / 7.8	7.77 / 480 / 8.0

The groundwater quality results have been plotted on a piper plot and the water quality results are considered to be representative of typical bedrock aquifer conditions. Groundwater quality towards the southern portion of the site (MW24-3, MW24-4 and MW24-5) is indicative of calcium bicarbonate waters, compared to the groundwater quality towards the northern portion of the site (MW24-1 and MW24-2) which is indicative of mixed Sodium Chloride and Calcium Sulfate waters.



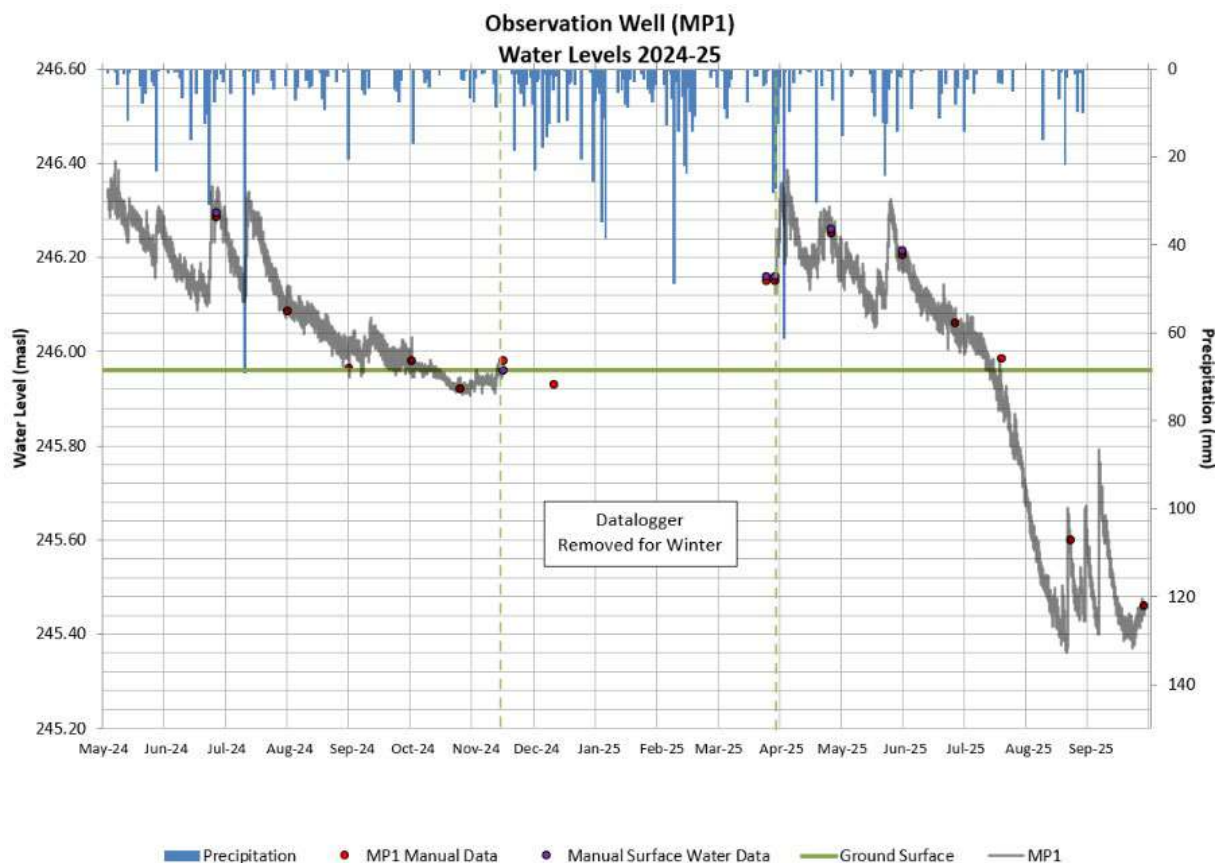
4.3 SURFACE WATER

4.3.1 Wetland Monitors

Individual hydrographs for MP1, MP2 and MP3 prepared utilizing data collected between May 2024 and August 2025 are presented in Appendix G and discussed below.



MP1

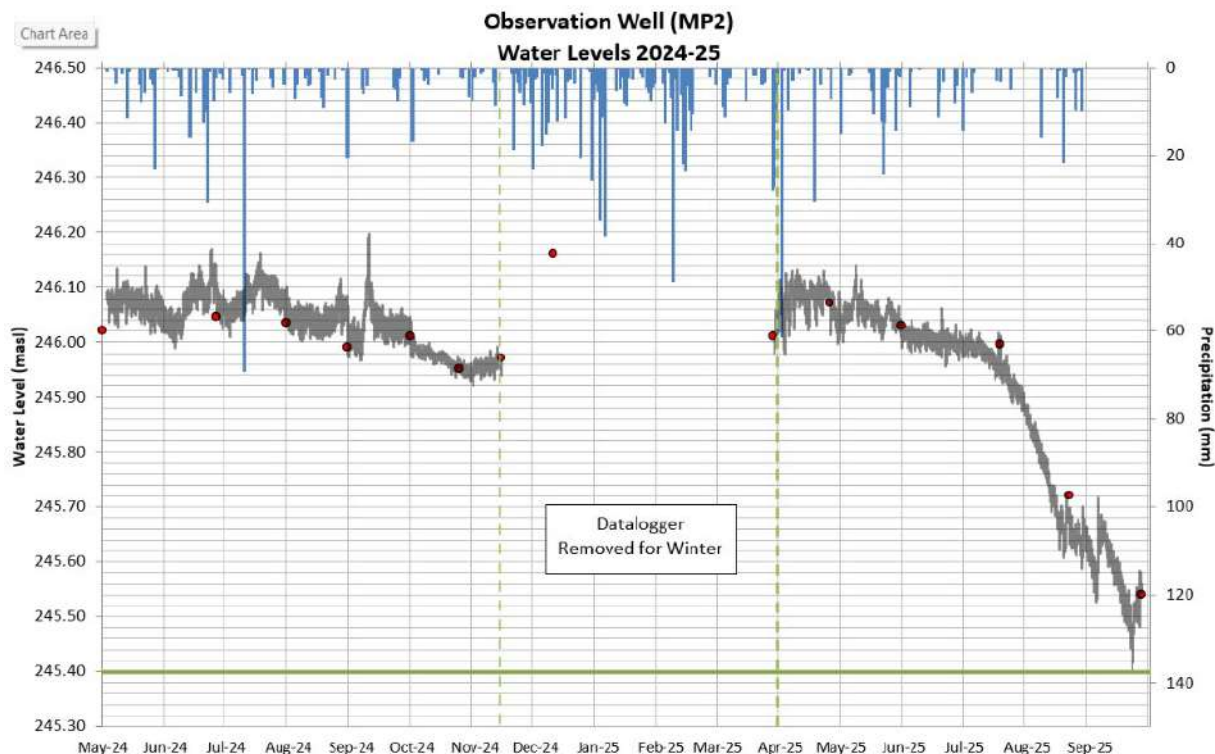


MP1 is located in the east portion of the site along the northern section of wetland feature WU-4 feature (Figure 15). This wetland is hydraulically connected to the main wetland feature on the site (WU-4) and as such generally follows a similar trend to MP2. The water level record shows water levels ranging from 245.4 to 246.4 m asl. The wetland water levels were above or at the ground level for the majority of 2024 but dried up during the summer in 2025 due to below average precipitation from June through August. Generally, water levels are highest during the spring months and the lowest during the late summer and fall, and frozen conditions were observed from January through March. A more significant drop in water levels in the wetland was observed in 2025 when compared to 2024. This is due to the significant dry weather in 2025 as there was 116 mm less rainfall observed from June to August 2025 when compared to 2024.

Based on the groundwater and surface water level measurements taken it appears the wetland is predominantly surface water fed with some contribution from the perched surface water fed overburden aquifer in which the piezometer is installed in. The groundwater levels within the bedrock aquifer generally range from 242.30 m asl to 244.40 (MW24-4) with brief periods when groundwater elevations rise to 245.84 m asl during flooded conditions in the spring. As such, the groundwater in the bedrock aquifer is not anticipated to contribute to this wetland feature.



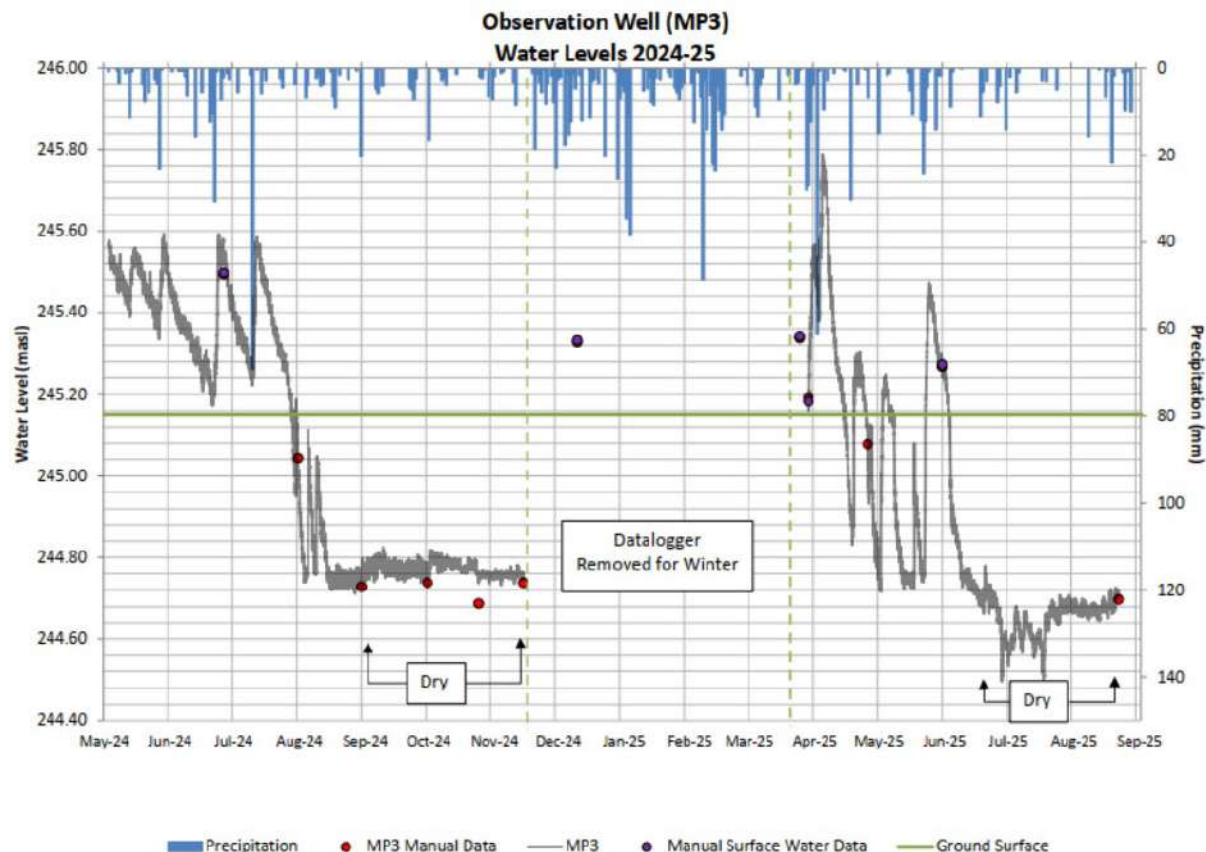
MP2



MP2 is located in the southwest portion of the site along the northern limits of wetland feature (WU-4) (Figure 15). During the monitoring period, the water levels ranged from 245.4 to 246.2 masl and the wetland was not observed to be dry throughout the monitoring period indicating a continuous/year-round hydroperiod. Based on the groundwater and surface water level measurements taken it appears the wetland is predominantly surface water fed with some contribution from the perched surface water fed overburden aquifer in which the piezometer is installed in. The groundwater levels within the bedrock aquifer generally range from 242.85 m asl to 244.40 (MW24-4) with brief periods when groundwater elevations rise to 245.54 m asl during flooded conditions in the spring. As such, the groundwater in the bedrock aquifer is not anticipated to contribute to this wetland feature.



MP3



MP3 is located in the north central portion of the site along the northern property limits (Wu-1) (Figure 15). The water level record shows water levels ranging from 244.6 to 245.8 m asl. Surface levels are observed to be above existing grades during the spring; however, in both 2024 and 2025 the wetland feature was observed to be dry in the summer and fall before filling in the winter indicating the wetland hydroperiod extends from January to May. Based on the groundwater and surface water level measurements taken it appears the wetland is predominantly surface water fed with some contribution from the perched surface water fed overburden aquifer in which the piezometer is installed in. The groundwater levels within the bedrock aquifer generally range from 240.30 m asl to 241.20 m asl at MW24-1 and 240.0 m asl to 240.50 masl at MW24-2 with brief periods when groundwater elevations rise to 244.40 and 245.20 m asl respectively during flooded conditions in the spring. As such, the groundwater in the bedrock aquifer is not anticipated to contribute to this wetland feature.

Surface Water Quality

Surface water quality monitoring was carried out at MP1 through MP3 monthly from May 2024 to December 2024.



The results of the manual surface water monitoring are summarized in Table 9.

Table 9: Summary of Wetland Water Quality

Date	pH / Electrical Conductivity (µS/cm) / Temperature (°C)		
	MP1	MP2	MP3
May 1, 2024	Not Measured	Not Measured	Not Measured
June 26, 2024	Not Measured	Not Measured	Not Measured
July 31, 2024	7.55 / 410 / 28.3	7.68 / 225 / 27.9	7.68 / 335 / 25.8
August 30, 2024	7.44 / 622 / 21.4	7.86 / 366 / 25.4	Not Measured
September 30, 2024	6.67 / 478 / 15.5	6.86 / 366 / 19.9	Not Measured
October 24, 2024	Not Measured	7.38 / 355 / 13.0	Not Measured
November 15, 2024	7.41 / 407 / 5.6	7.81 / 356 / 4.6	Not Measured
December 10, 2024	Not Measured	Not Measured	Not Measured

In general, the pH across the monitoring sites ranged from 6.67 to 7.86, the electrical conductivity ranged from 225 to 622 µS/cm, and temperature ranged from 4.6 to 28.3°C.

4.3.2 Head River Tributary

Utilizing manual streamflow measurements taken from May 2024 to August 2025, rating curves have been developed for each streamflow monitoring location by plotting the manual in-situ streamflow measurements against the manual in-situ water depth measurements collected to create a water depth/streamflow relationship. The rating curves have been used to convert the water depth data collected by the continuously recording pressure transducer and data logger to streamflow and are included in Appendix G for reference.

Individual hydrographs for SW1/3 and SW2 have also been prepared utilizing data collected between May 2024 and August 2025. These hydrographs are discussed in detail in the following sections and have been included in Appendix G for reference.

Streamflow Monitoring

Based on the results of the continuous streamflow monitoring, flow rates within the tributary at SW1/SW3 have varied between 0 and 75 L/s from May 2024 to August 2025. The largest peak flows are generally observed during the spring freshet at this location and have muted responses



to storm events during the summer. This is due to the attenuation provided by the large wetland feature located immediately upstream of this streamflow monitoring location. During both 2024 and 2025 the tributary was observed to be dry during the late summer once the wetland upstream was not full or discharging.

Based on the results of the continuous streamflow monitoring, flow rates within the tributary at SW2 have varied between 0 and 700 L/s from May 2024 to August 2025. The largest peak flows are generally observed during the spring freshet at this location though spikes in streamflows were also noted immediately after significant rain events in both 2024 and 2025. During both 2024 and 2025 the tributary was observed to be dry during the late summer.

During the spring, stream flow volumes at SW1/3 account for as little as 10% of the streamflow measured at SW2. This is due to the significant attenuation provided by the wetland upstream of SW1/3 reducing the streamflow at this location while runoff from the remaining 155 ha of drainage area to SW2 drains freely to SW2 with minimal attenuation. In contrast, the baseflows at SW1/3 during the summer months account for up to 80% of the streamflow at SW2 as the wetland upstream of SW1/3 slowly releases water for an extended period before the water level drops below the wetland outlet. Similarly, both tributaries appear to dry up at a similar point once the wetland upstream of SW1/3 stops discharging.

Surface Water Quality

Surface water quality monitoring was carried out at SW1 through SW3 monthly from July 2024 to December 2024.

The results of the manual surface water monitoring are summarized in Table 10.

Table 10: Summary of Wetland Water Quality

Date	pH / Electrical Conductivity (µs/cm) / Temperature (°C)		
	SW1	SW2	SW3
July 9, 2024	7.34 / 391 / 20.4	7.07 / 363 / 18.8	Not Measured
July 31, 2024	7.60 / 360 / 20.3	7.20 / 344 / --	
August 30, 2024	7.72 / 405 / 18.4	7.83 / 402 / 19.3	
September 30, 2024	6.95 / 391 / 16.0	7.32 / 380 / 15.6	
October 24, 2024	7.54 / 361 / 11.0	7.95 / 346 / 11.8	
November 15, 2024	7.67 / 346 / 7.7	8.24 / 341 / 9.6	
December 10, 2024	Not Measured	7.71 / 319 / 5.0	7.55 / 340 / 2.9



In general, the pH across the monitoring sites ranged from 6.95 to 8.24, the electrical conductivity ranged from 319 to 405 $\mu\text{S}/\text{cm}$, and temperature ranged from 2.9 to 20.4°C.



5 Feature Based Water Balance

A key component of the groundwater and surface water assessment is understanding the influence climatic conditions have during the monitoring period. To assess the potential groundwater impacts of the proposed quarry, a detailed groundwater model has been prepared by Equilibrium Mining and is provide in Appendix I. In addition, a feature-based water balance analysis has been completed to compliment the detailed groundwater model and to evaluate the function of the on-site wetland (WU-4) to consider the potential impacts of the proposed quarry and assist with the sizing of the surface water management features on site. Specifically, the objectives of the feature-based water balance are to:

1. Quantify potential impacts to the on-site south wetland (WU-4) and downstream streamflow at SW2 through the various phases of extraction and in the rehabilitation scenario;
2. Determine target seasonal discharge rates from the quarry to offset potential impacts to the streamflow at SW2 downstream or WU-4; and
3. Calculate the storage volume required on-site to help maintain discharge rates off-site to maintain the water flows off-site in a manner best matching the existing conditions.

5.1 EXISTING CONDITION WATER BALANCE

Existing condition water balances were prepared to predict the existing wetland hydroperiod and outlet runoff volumes at key points of interest. The water balances allow the wetland hydroperiod and outlet runoff volumes to be predicted for periods outside the available monitoring period from the available climatological data for the area, providing a greater period of assessment. The water balances also allow the potential impacts of the proposed extraction and quarry dewatering to be evaluated and quantified using predictive models. A daily water balance was completed to predict the existing wetland hydroperiod and outlet runoff volumes at key points of interest.

5.1.1 Climate Data

For consistency, precipitation and temperature data from 2019 to 2025 from the Orillia Brain Climate Station (I.D. 6115811) was utilized for both the groundwater model and daily water balance. The following three primary datasets were used:

- Precipitation;
- Maximum and minimum daily air temperature; and
- Net incoming solar radiation.



For the daily water balance and the groundwater model, climate datasets were supplemented with saturated vapour pressure based on the mean daily air temperature and the total daylight hours per day for Orillia based on the day of the year (National Research Council Canada). Saturated vapour pressure and the total daylight hours per day are used in the Hamon Equation to calculate the potential evapotranspiration.

5.1.2 Daily Water Balance Methodology

For the wetland and outlet water balances, the daily climate data described previously was used to calculate water balances on a daily time step for the entire period of record to predict the existing wetland hydroperiods and outlet runoff volumes at key points of interest. The daily water balance methodology applied is in spreadsheet form and generally follows the Thornthwaite and Mather methodology as follows:

- A water surplus/deficit has been calculated as the excess of rainfall and snowmelt minus the evapotranspiration.
- Snowmelt has been calculated using the available climate data and the simplified energy balance approach employed in the Guelph All-Weather Sequential-Events Runoff Model (GAWSER).
- Potential evapotranspiration has been calculated using the Hamon equation, a simplified approach to the Penman equation using temperature, saturated vapour pressure and the number of daylight hours to estimate evapotranspiration. The actual quantity is dependant on the quantity of water available as surplus or in soil storage.
- The maximum soil water holding capacity represents the maximum soil storage. The maximum soil water holding capacity has been calculated for each catchment considering the soil type and vegetative cover. The soil storage is adjusted daily depending on the water surplus/deficit. However, the soil storage can never exceed the maximum soil water holding capacity.
- Runoff was calculated using the Soil Conservation Service (SCS) curve number method and consequently the infiltration is calculated as the difference between the runoff and available water. When the soil storage is full, no infiltration occurs and all available water becomes runoff.

For the catchments, the water balance was refined such the wetland areas and non-wetland areas are considered separately to determine the infiltration, runoff and change in storage. Additional storage capacity is available within the wetland areas so runoff calculated from the non-wetland areas is routed to the wetland areas. Furthermore, hydraulic conductivities have been assigned to each wetland from the results of the field investigations and have been added to the water



balance analysis to account for the increase/drawdown of soil storage within the wetlands naturally occurring. This helps predict the hydroperiods of the wetland under certain climate conditions. The water balances were completed for the following locations to provide a representation of the water features potentially impacted by the quarry extraction:

- Monitoring location MP2 (Wetland WU-4);
- SW1/3 (Wetland WU-4 discharge); and
- Monitoring location SW2 (Head River tributary).

Each location has monitoring data from May 2024 to August 2025 to allow for calibration. Additional monitoring data will be collected during the approvals process to verify the wetland hydroperiods and refine the water balance calibration.

5.1.3 Water Balance Calibration/Validation

Monitoring data has been collected since 2024 at the three wetland monitoring locations (MP1, MP2 and MP3) and two streamflow locations (SW1/SW3 and SW2). Sub-catchments have been delineated for MP2 which monitors the large on-site wetland (Wu-4), and SW2 which represents the primary discharge point for the surface water conveyed from the site in the shallow bedrock system. The monitoring data has been used to calibrate the daily water balance for the wetland at MP2 as well as the Head River tributary at SW2. The primary parameters identified for calibration are the hydraulic conductivity of the wetland, the wetland storage volume as well as the estimated discharge curve for the wetland. Adjustments to the wetland storage volume and discharge curves were made to account for the vegetation and topographic variations impacting the volume available for storage. To calibrate the wetland storage, the total wetland volumes were calculated from available LiDAR and field depth measurements of the wetland. The storage volume and discharge curve were then adjusted to fit the water balance results to the corresponding monitoring data.

The focus of the calibration is to have a water balance accurately representing the wetland hydroperiod and surplus volumes observed at SW2 measured to allow for potential impacts to be assessed as conditions change through quarry operations. The variation in water level and the duration of hydroperiods have been calibrated. A graph comparing the water level MP2 against the predicted water balance water level is included in Appendix H for reference and demonstrates the daily water balance is accurately predicting the wetland water levels post-calibration.

In addition, the surplus volume measured at monitoring station SW2 have been compared against the surplus generated from the daily water balance. Due to the limited monitoring data to calibrate against during the spring freshet in 2024, the calibration focused on the spring and summer of 2025. The total volume of water measured at SW2 from April to July 2025 was



1,106,276 m³. Meanwhile, the daily water balance results predict a total volume of 1,147,858 m³ (3.8% more than what was measured at the monitoring location). As such the water balance was deemed to be sufficiently estimating the total surplus at SW2 post-calibration which validates its intended use for further use in assessing potential impacts. It is noted ongoing monitoring will continue through the approvals process, and the calibration/validation will be refined as necessary.

5.1.4 Existing Condition Results

The monthly surface water surplus volumes predicted at SW2 under existing conditions were also calculated using the existing condition water balance and are summarized in Table 11 below. The surplus volumes have been reported seasonally to illustrate the average, minimum and maximum base flows observed during the winter, the spring freshet/early summer, and late summer/early fall at SW2. It is noted the flow rates in the table below are seasonal averages and instantaneous flows regularly reach 0 L/s during the late summer and can exceed 1,000 L/s in response to significant storm events/spring melts.

Table 11: Existing Condition Predicted Seasonal Surface Water Surplus Summary at SW2

YEAR	SEASONAL SURPLUS VOLUMES (m ³)		
	Winter (November - February)	Spring/Summer (March - June)	Summer/Fall (July - October)
2019	-	354,490	125,606
2020	321,406	721,316	117,723
2021	218,805	468,810	100,575
2022	285,333	544,963	29,607
2023	299,061	631,017	146,600
2024	480,481	465,857	38,575
2025	65,211	1,531,460	
Average	278,383 (27)	673,988 (64)	93,114 (9)
Minimum	65,211 (6)	354,490 (34)	29,607 (3)
Maximum	480,481 (46)	1,531,460 (145)	146,600 (14)

Note: Values in *brackets/italics* have been converted from seasonal surplus to L/s.



5.2 PROPOSED CONDITION WATER BALANCE

Proposed condition water balances were prepared to predict the impacts to wetland hydroperiods and outlet runoff volumes at key points of interest. The water balances also allow the potential impacts of the proposed extraction and quarry dewatering to be evaluated and quantified using predictive models. A daily water balance was completed to predict the existing wetland hydroperiod and outlet runoff volumes at key points of interest as well as to establish seasonal discharge rates from the quarry and to size surface storage features on-site.

5.2.1 Phase 1 Extraction Water Balance Results

The existing condition calibrated water balance was updated to account for the land use change occurring with the 8.4 ha Phase 1 extraction area in the northeast portion of the site. The extraction area is represented by Catchment 2001 as illustrated in the Phase 1 Drainage Plan (Figure 22). The results of the Phase 1 Scenario water balance are discussed in the following sections and the potential impacts to the wetland hydroperiods and runoff volumes are discussed in the impact assessment of this report.

Quarry Surface Storage and Discharge Rates

During Phase 1 of extraction, precipitation on and groundwater seepage directly into the extraction area will be stored and discharged to the existing depression feature on-site referred to as WU-1 near the north property limit at the centre of the site. This feature currently accepts and conveys run-off through the shallow fractured network within the upper weathered bedrock unit and conveys drainage to the Head River tributary to the north at SW2. Seasonal discharge rates to this depression feature have been established to minimize impacts to the SW2 flows while ensuring storage of water can be provided within the extraction area to attenuate the peak flows expected in the runoff and groundwater seepage. The maximum seasonal discharge rates from the quarry to the depression feature are predicted as follows:

Table 12: Phase 1 Maximum Instantaneous Discharge Rates Summary (to be used for operational considerations and pump / conveyance sizing)

	MAXIMUM INSTANTANEOUS DISCHARGE RATES (L/s)		
	Winter (November - February)	Spring/Summer (March - June)	Summer/Fall (July - October)
Estimated Groundwater Seepage and Surface Flow into Extraction Area to WU-1	7	20	5



With these maximum discharge rate targets, the Phase 1 extraction area is expected to require a maximum of 18,000 m³ of storage to attenuate peak flows primarily in the spring from runoff and snowmelt. The function and impact of the proposed water management strategy is described in further detail in the impact assessment section of this report.

5.2.2 Phase 2/3 Extraction Water Balance Results

For Phase 2/3 the Phase 1 water balance was updated to include the additional 26.2 ha Phase 2/3 extraction area in the northwest portion of the site. This extraction area is represented by Catchment 3001 as illustrated in the Phase 2/3 Drainage Plan (Figure 23). The results of the Phase 2/3 Scenario water balance are discussed in the following sections and the impacts to the wetland hydroperiod and stream flows are discussed in the impact assessment of this report.

Quarry Surface Storage and Discharge Rates

During Phase 2/3 of extraction, precipitation directly on and groundwater seepage into the extraction area itself will be stored and discharged to a proposed infiltration feature to be constructed along the north limit of the site prior to commencing quarrying of Phase 2/3. This feature will ensure discharging continues to the shallow fracture network within the upper weathered bedrock unit flowing to the north to SW2. In addition, runoff from the external wetland and areas to the south currently can enter the Phase 2/3 area will be cutoff and redirected around the site and discharged directly to the same proposed infiltration feature to maintain existing flow conditions to SW2 and the north.

The streamflow monitoring data at SW2 and water level data at SW1/3 were reviewed to estimate the conveyance capacity of the shallow bedrock fracture network within the upper weathered bedrock unit to help inform the design of the infiltration feature and size subsequent storage requirements. The maximum flow recorded at SW2 during periods where the upstream tributaries were not flooded at SW1/3 was 185 L/s. This includes peak flows from Catchment 102 (56 ha). Prorating this peak flow based on the drainage area to the bedrock fracture network within the upper weather bedrock unit under existing conditions (409 ha) results in an estimated capacity of 160 L/s.

Seasonal discharge rates for the external drainage area feeding WU-4 and will be bypassed around the site have been established to maintain the seasonal average streamflow observed at SW2. Discharge target calculations were then completed to ensure sufficient storage can be provided within the extraction area to attenuate the runoff and snowmelt volume/rate increases to allow for the controlled release and discharge to SW2. The maximum discharge rates from the extraction area as well as the maximum flows bypassed around the extraction area to the infiltration feature have been summarized in Table 13 below.



Table 13: Phase 2/3 Maximum Instantaneous Discharge Rates Summary (to be used for operational considerations and pump / conveyance sizing)

	MAXIMUM INSTANTANEOUS DISCHARGE RATES (L/s)		
	Winter (November - February)	Spring/Summer (March - June)	Summer/Fall (July - October)
Flow from External Drainage Area Bypassing Quarry Direct to Infiltration Gallery	15	55	10
Estimated Groundwater Seepage and Surface Flow into Extraction Area to Infiltration Gallery*	30	105	20
Total	45	160	30

*Assumes Phase2/3 area at full quarry extraction limit

With the above maximum discharge rates for the Phase 2/3 extraction area at full extraction, the water balance has calculated the quarry will ultimately require a total surface storage volume of 70,500 m³ to attenuate peak flows from runoff, snowmelt and groundwater seepage during spring freshet.

The seasonal streamflow rates in the tributary downstream at SW2 predicted by the feature-based water balance under different annual weather conditions (wet year versus dry year) are summarized in the impact assessment section of this report. The function of the drainage system with the mitigation strategy of discharging to the infiltration gallery is also summarized in the impact assessment section of this report.

The Phase 1 extraction area will be used for the initial surface storage area for Phase 2 and 3. As extraction progresses across Phase 2, the storage area will be shifted into the Phase 2 extraction area allowing for the progressive rehabilitation of the Phase 1 area during Phases 2 and 3 of extraction.

5.2.3 Rehabilitation Scenario

Under the rehabilitation scenario, the site will be filled back to its existing grade to replicate existing drainage patterns. As such, the input parameters for the feature-based water balance under the rehabilitation scenario would be identical to the existing conditions water balance with the exception of the change in land use / soil conditions in the quarry itself. Because this is a



relatively small area in proportion to the larger catchment and the overland flow / post rehab land use is intended to be re-instated with a conveyance system moving drainage from the south limit of the site to the north a post rehabilitation a detailed water balance has not been prepared for the rehabilitation scenario. The re-instated surface water flow path through the site to the infiltration trench along the north property boundary will replicate the existing system in a manner matching with existing conditions.



6 Impact Assessment

Two primary methodologies were used to complete the impact assessment specific to surface water and groundwater conditions.

First, an integrated surface water-groundwater model was developed by Equilibrium Mining utilizing the field monitoring data collected on-site, and publicly available regional data to evaluate the existing site conditions, and to assess potential future impacts to the groundwater and domestic wells as a result of the proposed mining plan. The model also provided information aiding in the development of the seasonal feature based water balance referenced in Section 5.0. The model development and calibration details are provided in Appendix I.

For the model the surface water levels and flows, and groundwater levels on-site and within the study area were predicted for the following scenarios:

- **Baseline** which represents the future conditions considering full extraction of the neighbouring aggregate properties as per the current quarry operation licence and no extraction on the site.
- **Full Extraction** which represents the future conditions considering full extraction of the neighbouring aggregate properties as well as the site.
- **Baseline Rehabilitation** which represents the future conditions considering full rehabilitation of the neighboring aggregate properties and full extraction of the site.
- **Rehabilitation** which represents the future conditions considering full rehabilitation of the neighboring aggregate properties as well as the site.

The potential interference with the groundwater and surface water regimes have been considered for each scenario in the following sections.

The groundwater and surface water drawdowns anticipated during the baseline, full extraction, rehabilitation baseline and rehabilitation scenarios are provided in Figures 24 to 35.

Second, as referenced in Section 6.0 a feature-based water balance with a daily time step was used to develop the surface water mitigation strategy. This model and the results were used to assess potential impacts specifically related to the surface water features and patterns noted through monitoring. Results are summarized in Section 6.3 of this report.



6.1 POTENTIAL INTERFERENCE WITH LOCAL GROUNDWATER REGIME

6.1.1 Groundwater Levels

To quantify the changes in groundwater levels throughout site development groundwater drawdown at select locations were reviewed. The changes in groundwater drawdown throughout the site development is summarized in Table 13.

Based on the modelled groundwater influences it is anticipated the zone of influence, or in other words the distance extending from the site where 1 m or less of change in groundwater levels are observed, is estimated to be up to 75 m to the north of the property and 900 m to the west in the weathered bedrock/overburden unit with the most significant drawdowns (>4 m) being limited to within 60 m of the property, and 905 m to the northeast of the property in the Gull River bedrock unit at full extraction with the most significant drawdowns (>4 m) being limited to within 100 m of the property. Following rehabilitation efforts, the zone of influence is estimated to be up to 75 m to the north of the property and 900 m to the west in the weathered bedrock/overburden which is the result of the presence of the existing quarry footprint which extends to 900 m west, however, the most significant drawdowns (>4 m) are limited to within 60 m of the property, and 1,235 m to the northeast and 1,330 m to the southwest in the Gull River bedrock unit with the most significant drawdowns (>4 m) being limited to within 440 m of the property.

6.1.2 Groundwater Quality

The Ontario Stone, Sand, and Gravel Association (OSSGA) supported a literature review study, led by the MNR, to assess the impact of the aggregate industry and associated aggregate lands on source water protection programs. The MNR study, titled *Applied Research on Source Water Protection Issues in the Aggregate Industry*, was prepared by Blackport Hydrogeology Inc. and Golder Associates in 2006. The study ultimately did not provide scientific evidence linking activities of the aggregate industry, such as the extraction and processing of stone, sand, and gravel, to increased threats on drinking water sources.

The study specifically found adverse effects from aggregate extraction below the water table are minimal or localized, leading to negligible impacts on the yield of nearby drinking water supplies. Additionally, the research found little evidence of water quality impacts resulting from typical aggregate extraction and processing activities. No documented instances of municipal water supply well contamination were found to be caused by normal aggregate extraction activities (Blackport Hydrogeology Inc., & Golder Associates, 2006).

As such, it is not anticipated the quarrying activities would have a negative impact on the regional and/or local groundwater quality.



Table 14: Anticipated Groundwater Drawdown

LOCATION	GROUNDWATER ELEVATIONS (m asl)		DRAWDOWN FROM BASELINE TO FULL EXTRACTION (m)	GROUNDWATER ELEVATIONS (m asl)		DRAWDOWN FROM BASELINE TO FULL REHABILITATION (m)
	BASELINE	FULL EXTRACTION		BASELINE REHABILITATION	REHABILITATION	
WEATHERED BEDROCK/OVERBURDEN						
MP1	246.02	246.00	0.02	246.10	246.16	-0.06
MP2	245.95	245.95	0.00	246.02	246.07	-0.05
Wu-1B	245.78	245.75	0.03	245.75	245.76	-0.01
Wu-3	245.19	245.15	0.04	245.18	245.27	-0.09
Wu-4A	245.98	245.97	0.01	246.04	246.09	-0.05
Wu-4B	246.02	246.01	0.01	246.12	246.19	-0.07
Wu-4C	246.02	246.01	0.01	246.12	246.18	-0.06
GULL RIVER BEDROCK						
MW24-4	238.99	233.80	5.19	235.49	245.57	-10.08
MW24-5	234.76	233.10	1.66	237.19	245.13	-7.94
MW6	237.74	231.96	5.78	232.04	245.08	-13.04
7202454	237.07	236.04	1.03	240.95	245.58	-4.63
4605599	237.80	236.80	1.00	241.76	245.82	-4.06

Note:

Negative values (-) represents an increase in groundwater levels
Positive values (+) represent a decrease in groundwater levels

6.2 POTENTIAL INTERFERENCE WITH DOMESTIC WATER WELLS

Water wells in the area are typically installed within the Gull River bedrock, and as previously noted the zone of influence around the site result from the existing and proposed aggregate operations is modelled to extend up to 905 m to the northeast of the property within the Gull River bedrock.

Wells 7202454 and 4605599 are within the zone of influence of the site as well as the adjacent existing licensed below groundwater quarries. The groundwater within the Gull River bedrock is anticipated to be lowered 7.48 and 7.15 m at wells 7202454 and 4605599, respectively, as a result of the existing approved quarries only if no mitigation measures are implemented. The proposed Site development will result in an additional 1.0 m of drawdown at both wells.

Well 7202454 is located immediately southwest of the site on the north side of Concession B-C Road. This 6" diameter well is constructed as an open hole within the limestone bedrock from a depth of 9.8 to 18.3 m. The static water level measured in the well at the time of construction was 1.2 m, resulting in about 17.1 m of available drawdown. Considering the predicted cumulative groundwater drawdown of 8.48 m within the Gull River Bedrock at the time of full extraction it is not anticipated the proposed quarrying operations would impact this well as there is sufficient available drawdown to account for the predicted drawdowns.

Well 4605599 is located south of the site on the south side of Concession B-C immediately west of an existing below groundwater quarry. This 6" diameter well is constructed as an open hole within the limestone bedrock from a depth of 3.4 to 7.3 m. The static water level measured in the well at the time of construction was 1.5 m, resulting in about 5.8 m of available drawdown. Based on a water well survey completed in 2012 by Harden Environmental as part of the Hydrogeological Impact Assessment completed for the neighboring quarry to the west, Well 4605599 had a measured well depth of 10 m and a static water level of 3.31 m bgs resulting in about 6.7 m of available drawdown. The predicted groundwater drawdown, should full development of the proposed quarry and the existing quarries surrounding the site occur on the same timeline, is 8.15 m which exceeds the available drawdown. However, it is noted the predicted drawdown will be lessened should full development of the proposed quarry and the existing quarries surrounding the site were to occur on different timelines and/or groundwater mitigation measures be implemented. Further, Well 4605599 is quite shallow and if necessary, the well could be deepened to provide additional storage and water supplies. Typical wells in this area are installed at depths of 15 to 20 m as observed at Well 7202454. Considering a 20 m well there would be approximately 18.5 m of available drawdown.



6.3 POTENTIAL INTERFERENCE WITH LOCAL SURFACE WATER FEATURES

Three wetlands (WU-1, WU-3 and WU-4) and one watercourse (Head River tributary) have been identified within close proximity to the proposed extraction with a potential to be impacted by the proposed quarry. The feature-based water balance presented in Section 5.0 has been used to quantify the impacts to these locations as discussed in the following sections.

6.3.1 Wetland WU-1

Wetland WU-1 is located within the north portion of the quarry site and under existing conditions is fed primarily seasonally by the movement of water through the shallow bedrock system. For Phase 1, external drainage conveyed to this feature via the shallow bedrock system will continue and only drainage from the small area of the Phase 1 footprint will be removed. To offset this loss groundwater seepage and runoff from the Phase 1 extraction area will be collected in the quarry footprint treated and discharged to WU-1 maintaining its hydroperiod. When the extraction area proceeds into Phase 2/3, the WU-1 wetland will be removed as it is located within the proposed extraction area and as such no mitigation is proposed during Phase 2/3 of extraction.

6.3.2 Wetland WU-3

Wetland WU-3 is located in the southwest corner of the site and under existing conditions is fed by external runoff from the southwest upstream of the extraction footprint. The proposed extraction area remains downstream of Wetland WU-3's drainage area and as such no change in runoff volume directed to this wetland is expected. Similarly, as this wetland is perched and receives minimal input from the groundwater within the extraction footprint thus no reduction in groundwater discharge/recharge is expected at this location. As the surface and groundwater inputs to Wetland WU-3 will remain consistent with existing conditions, no impacts are expected to this wetland.

6.3.3 Wetland WU-4 Hydroperiod

Wetland WU-4 is a large feature as described previously in the report with a total area in excess of 100 Ha and total drainage area of in excess of 300 Ha. The proposed extraction at the site will slightly reduce the total drainage area to wetland WU-4 by 0.6% (1.8 ha). The proposed condition water balance was run from 2019 to 2025 and graphs illustrating the predicted water levels in the wetland are included in Appendix H for reference. Overall, the change in drainage area to the wetland appears to have a negligible effect on the water level and hydroperiod, and as such, no mitigation measures are recommended.



6.3.4 Head River Tributary Base Flow (SW2)

The total drainage area feeding the Head River tributary to the north (SW2) will be reduced by 34.4 ha (9%) with the proposed full extraction before rehabilitation (Phases 1, 2 and 3). The reduction will be mitigated by pumping the precipitation/runoff falling directly on the extraction area and the groundwater seeping into the extraction area to a proposed infiltration feature along the north limit of the site which be designed to connect to the areas shallow bedrock system ultimately conveys runoff to the Head River tributary at SW2.

In addition, as documented in Section 5.0, the flows from the external drainage lands to the south of WU-4 currently flowing through the shallow subsurface bedrock on the quarry site to the north will be temporarily interrupted and bypassed around the quarry footprint during the quarrying of Phase 2 and 3. The flow by-pass will be re-introduced to the shallow bedrock system via an infiltration trench proposed along the north limit of the site to ensure a quantity of water is introduced to the shallow bedrock system to ensure the recharge of this system occurs thus maintaining baseflows at SW2.

Considering both mitigation measures the minimum/average/maximum seasonal base flows expected under existing, full extraction unmitigated, Phase 1 mitigated and Phase 2/3 mitigated are summarized in Table 17 through 19.



Table 15: Average Seasonal Base Flow Targets at SW-2

YEAR	AVERAGE SEASONAL BASEFLOW (L/s)		
	Winter (November - February)	Spring/Summer (March - June)	Summer/Fall (July - October)
Existing Condition	27	64	9
Full Extraction (Unmitigated)	19	39	5
Phase 1 Extraction	33	73	16
Phase 2/3 Extraction	45	94	24

Table 16: Maximum Seasonal Base Flow

YEAR	EXPECTED MAXIMUM SEASONAL BASEFLOW (L/s)		
	Winter (November - February)	Spring/Summer (March - June)	Summer/Fall (July - October)
Existing Condition	46	145	14
Full Extraction (Unmitigated)	35	82	8
Phase 1 Extraction	53	153	22
Phase 2/3 Extraction	62	164	31

Table 17: Minimum Seasonal Base Flow

YEAR	EXPECTED MINIMUM SEASONAL BASEFLOW (L/s)		
	Winter (November - February)	Spring/Summer (March - June)	Summer/Fall (July - October)
Existing Condition	6	34	3
Full Extraction (Unmitigated)	4	15	3
Phase 1 Extraction	12	42	9
Phase 2/3 Extraction	15	62	13



The additional discharge from the proposed extraction area is sufficient to offset the decrease in baseflows predicted without any additional mitigation measures. The seasonal baseflows being discharged to the shallow bedrock system are expected to increase slightly during extraction due to groundwater entering the active quarry areas need to be managed; however, the increase is significantly lower than the peak flow of 800 L/s observed during the 2025 monitoring period (approximately 3%). It is also expected some of this additional flow will re-infiltrate into the deeper aquifer as it would currently. Mitigation measures are available such as promoting direct re-infiltration to the lower aquifer or rehabilitating portions of the quarry footprint for the purposes of preventing groundwater inflow is possible should it be determined limiting groundwater inflow would be of benefit. Regardless, the water management strategy and potential for an increase in flow to the shallow bedrock system is not expected to have negative impacts on flooding downstream.

6.3.5 Head River Tributary (SW2) Water Quality and Temperature

The Head River tributary downstream of the site is recognized as a Cool-Water Stream as per the Ontario Stream Assessment Protocol. As such, baseline temperatures ($\pm$ allowing for seasonal variability, etc.) and water quality (turbidity) are selected to be a parameter of note to be maintained throughout the life of the quarry. To mitigate impacts to the temperature of runoff being diverted around the quarry from the south, external drainage entering the site will be cut-off and diverted directly to the infiltration feature along the north property boundary. Design features to prevent the channel from being exposed to direct sunlight will be included in the bypass channel design. These include additional rip-rap to allow for subsurface low flow through the rocks for temperature and filtration benefits, and pole plating / bio-engineering to shade the channel to ensure further temperature mitigation will occur. In addition, best efforts will be taken to limit the area of disturbance in the area of the cutoff swale to maintain existing tree cover and shade for the swale. No quality changes are expected from the external flow to be bypassed around the site.

Runoff from the quarry itself will be treated for turbidity in a storage pond and be held for 12 hours prior to discharging to the infiltration gallery to allow any suspended sediments to settle. In addition, the pumped outflow to the infiltration gallery will be via a bottom draw to protect temperature profile of the discharge. To further mitigate this temperature increase, the runoff will be mixed with groundwater seepage within the quarry prior to discharging. The groundwater temperatures in this area ranged from 9 to 11°C during 2025 and will assist in maintaining existing baseline temperatures in the tributary downstream. The infiltration feature itself will also be designed to mitigate temperature increases by bringing the quarry discharge in contact with underground stone which will lower water temperatures through cooling contact between the discharge and the cool sub-surface rock to best mimic how the system currently operates. Using



an average groundwater temperature (10.0°C) from the deeper aquifer groundwater seeping into quarry, the proposed infiltration feature is expected to cool external runoff by 1.0°C during the summer months from the current summer high temperature value of 20°C. Calculations quantifying the potential cooling effect of this feature have been included in Appendix H for reference.

A sampling program will also be developed for the discharge of water from the quarry which includes samples at the discharge point and at SW2 with threshold values set for Provincial Water Quality Objectives (PWQO) such as total suspended solids, pH, oil and grease and various dissolved metals/nutrients. Prior to extraction, a baseline sampling program will be completed to establish baseline water quality signatures of both the shallow and deep groundwater in the area, as well as in the Head River Tributary. Having an accurate understanding of the baseline water quality in the area will assist in setting water quality thresholds for various parameters during extraction.



7 Proposed Complaints Response Procedure

A comprehensive response program has been established for the purpose of responding to water well interference complaints for well users in the vicinity of the proposed quarry. The proposed quarry will be situated below the water table and may require dewatering to maintain dry operating conditions. As previously stated, groundwater quantity reductions sufficient to result in a water well complaint are not anticipated, nor concerns with water quality; however, this procedure has been prepared for the unlikely event well interference complaints are received. The program includes the following:

- Following receipt of a complaint from a water well user, the licensee will notify the MECP within 24 hours and provide mitigative actions to be taken.
- The Licensee will hire a licensed water well technician to complete a well inspection including a review of the pump, well condition, pump depth and condition, plumbing, etc. to confirm the well complaint is not resultant of well-specific issues.
- If determined to not be resultant of well-specific issues, the licensee will provide potable water to the well user within 24 hours of the well inspection.
- The licensee will retain a hydrogeologist to review the water well inspection data, water level/quality data, and on-going operations at the quarry to provide an assessment of the cause of the complaint. The hydrogeologist will prepare an opinion on the likelihood the well complaint received, can be attributed to quarry operations.
- If deemed the well interference complaint is legitimately resultant of quarry dewatering operations, the licensee will initiate a water supply restoration program, consisting of:
 - Step 1: Well system rehabilitation:
Replacement or lowering of pumps, flushing the pump lines, well deepening, etc.
 - Step 2: Well Replacements:
If system rehabilitation is not an option, the well could be replaced.
 - Step 3: Water treatment considerations:
Appropriate water treatment will be incorporated into any restored water supply.



- The results of the water supply restoration program must be acceptable to both the water well user(s) and the licensee, and the licensee may bear all of the cost associated with the program.
- If deemed the well interference complaint is not resultant of dewatering operations at the quarry, the licensee will provide a letter report summarizing the results of the investigation to the well user(s). Further, the licensee will continue to supply potable water to the well user(s) for an additional 24 hours to allow the user(s) to make alternate water supply arrangements



8 Proposed Groundwater and Surface Water Monitoring Program

The proposed ARA monitoring program was designed to assess potential impacts to groundwater and surface water resources as a result of aggregate extraction activities

8.1 ON-SITE GROUNDWATER MONITORING

The groundwater monitoring wells outside of the proposed limits of extraction (MW24-4, MW24-5 and MW6) and the quarry sump discharge have been incorporated into the long-term groundwater monitoring program, consisting of continuous (via datalogger) and monthly manual water level measurements, for calibration purposes, and semi-annual (spring and fall) water quality monitoring. Samples will be analyzed for pH, Conductivity, Alkalinity, Bicarbonate, Chloride, Metals (Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Cobalt, Copper, Lead, Iron, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Selenium, Sodium, Silver, Strontium, Sulfur, Thallium, Thorium, Tin, Titanium, Tungsten, Uranium, Vanadium, Zinc), Nitrate/Nitrite, and Sulphate.

During the fall water quality sampling program samples will be analyzed for Petroleum Hydrocarbons (PHC), Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX), and Oil & Grease.

It is noted, as quarry operations advance MW24-1, MW24-2 and MW24-3 will need to be decommissioned in accordance with O.Reg.903 as these locations are within the footprint of the proposed quarry.

The specific groundwater monitoring requirements are provided in Section 11.

8.2 PRIVATE WATER WELL MONITORING

Two water well locations (7202454 and 4605599) have been incorporated into the long-term groundwater monitoring program, consisting of continuous (via datalogger) and monthly manual water level measurements, for calibration purposes, and annual (fall) water quality monitoring. Samples will be analyzed for pH, conductivity, total dissolved solids (TDS), sodium, chloride, potassium, magnesium, sulphate, iron, manganese, cadmium, copper, lead, zinc, and phenolics.

The specific private water well monitoring requirements are provided in Section 11.

8.3 SURFACE WATER MONITORING

Streamflow monitors (SWA, a replacement of SW1/3 which are within the quarry footprint, and SW2) and piezometers (MP1, MP2, and MP3, and new monitors Wu-1B, Wu-3, Wu-4A, Wu-4B



and Wu-4C) have been incorporated into the long-term surface water monitoring program, consisting of continuous (via datalogger) and monthly manual water level measurements (both inside and outside the piezometer pipe) and flow measurements (where possible). Manual surface water Dissolved Oxygen, Conductivity, pH, and Temperature measurements will also be recorded.

The specific surface water monitoring requirements are provided in Section 11.

8.4 SUMP MONITORING

As previously mentioned, incidental waters from across the quarry footprint will be collected within the quarry sump and be periodically discharged to the north infiltration trench. As such, monthly water quality samples will be collected from the sump and will be analyzed for TSS, pH, oil and grease, dissolved metals, and nutrients and compared to the Provincial Water Quality Objectives (PWQO) to assess compliance. Monthly sampling will occur for the first 2 years of quarry operations. If favorable results are consistently received, sampling will be reduced to semi-annual frequency.

The specific sump monitoring requirements are provided in Section 11.



9 Summary and Conclusions

Tatham has prepared this combined Level 1 and 2 Hydrogeological Assessment in support of an ARA Class A Quarry Below Water licence application for the proposed Ramara Quarry, located at 6059 Pearl Carrick Road in Ramara, legally defined as Lot 10 and Part Lot 9, Concession C in the Geographic Township of Rama, County of Simcoe, Ontario.

This investigation was completed to assess the potential impact to aquifers, surface water features, springs, and discharge areas in the vicinity of the proposed quarry lands and ultimately evaluate potential mitigation measures. The conclusions are presented below:

- The site consists of approximately 72.0 ha (177.9 acres) of undeveloped lands consisting of shallow bedrock, woodlands and/or wetlands (Wu-1 through Wu-4); however, towards the northwestern portion of the property there is a small area of exposed bedrock where the thin topsoil soil has been scraped away.
- Wetland Wu-4 occupies the southeastern portion of the property and extends to the southwest and northeast onto the adjacent properties. The wetland is approximately 114 ha in size, with 25.7 ha of the wetland occupying the southern portion of the site. The wetland is underlain by fine grained organic soils which inhibits the infiltration of surface water in this area causing surface water to pond and form the resulting wetland. Wetland Wu-4 is fed by an external drainage area of 308.9 ha draining overland via a series of intermittent drainage systems entering the site at the southeast corner of the property and feeds the wetland. The wetland collects and stores this external water and eventually when water levels are high enough can spill flow towards the northwest to a low area on the site where water ultimately 'sinks' into the shallow bedrock. Once the surface water enters bedrock fractures within the upper weathered bedrock, on-site monitoring data suggests this surface water then flows through the shallow fracture network within the weathered bedrock unit to the north/northwest following the slope of the upper weathered bedrock unit. The surface water then reappears downstream on the adjacent north property via a series of fractures as the shallow bedrock system is exposed at this location due to the grades dropping. This system forms part of the Head River upper tributary drainage system. The area surrounding the site primarily comprise other aggregate operations, and a few rural residential properties. The landscape is primarily shallow bedrock with a thin overburden layer including scattered wetland and woodland areas. The Sweetwater Nature Reserve, which is maintained by the Couchiching Conservancy, is located immediately north of the property.
- The site lies within the physiographic region known as the Carden Plain, comprising primarily Limestone with Sand Plains identified towards the southeastern portion of the site (Chapman



and Putnam, 1984). OGS quaternary geology mapping indicates the majority of the site is underlain by Paleozoic bedrock while the northwestern portion of the site is underlain by glaciolacustrine deposits of the Pleistocene Epoch comprising sand, gravelly sand, and gravel deposits (OGS, 2000 and 2010).

- The study area is primarily underlain by dolostone/limestone of the Bobcaygeon and/or Gull River Formation overlying sandstones of the Shadow Lake Formation.
- The landscape within the vicinity of the site is gently sloping, ranging between approximately 240 to 265 m asl. On-site elevations range from 257 to 242 m asl with grades generally sloping towards the center of the site. Under existing conditions, it is anticipated surface runoff will be captured by the shallow fracture network within the upper weather bedrock unit at surface and flow within the intricate fracture network. It is anticipated the bedrock fracture network within the upper weather bedrock unit will converge towards the center of the site and ultimately flow towards the north to the adjacent property where water captured by the bedrock system is discharged to surface. The proposed quarry is located approximately 2.8 km south of the Head River and is within the Head River watershed. The large wetland (WU-4) located on the south half of the quarry site is approximately 114 ha in size and has a drainage area of 309 ha (Catchment 100). This catchment area drains to wetland WU-4 filling it seasonally which causes it to overflow to an on-site depression feature where runoff enters the shallow bedrock fracture network within the upper weathered bedrock unit conveying water to the Head River tributary to the north. An additional 100 ha of drainage area (Catchment 101) including the center of the site in addition to external area to the south, also drains to this depression feature before entering the shallow bedrock fracture network within the upper weather bedrock unit and being conveyed north to the Head River tributary. The total drainage area to the on-site depression feature is 409 ha, which includes Catchment 100 and 101. The surface water entering the shallow bedrock fracture network within the upper weathered bedrock unit reappears downstream on the north adjacent property where it is joined by runoff from Catchment 102 (56 ha) which accepts run-off from the cut above quarry footprint and surrounding area. Wetland WU-4, is extensive extending to the southwest and northeast onto the adjacent properties. The wetland is underlain by fine grained organic soils which inhibits the infiltration of surface water causing surface water to seasonally pond thus forming the resulting wetland. The external drainage can also cause the depression area near the extraction limit to surcharge and seasonally flood surface water overland across the site and across Pearl Carrick Road during extreme spring freshet events.
- The proposed quarry is located within the Lakes Simcoe and Couchiching/Black River SPA and the Black-Severn River watershed. The IPZ's associated with the surface water drinking



systems within the Lakes Simcoe and Couchiching/Black River SPA are primarily located along the shore of Lake Simcoe and Lake Couchiching; however, an IPZ 3 has been mapped through the center of the site corresponding with the Head River tributary.

- The site does not lie within a WHPA as the closest municipal wellhead is located approximately 7 km northwest of the site, just north of Rama, Ontario. Portions of the site, however, lie within an SGRA, and the entirety of the site lies within an HVA
- A total of 9 MECP well records were reviewed. Of the records reviewed, four indicated domestic water supply well use, two indicated monitoring well use, one record indicated test hole well use and the remaining two records did not indicate their well use type. In general, stratigraphy noted from the records indicated sand with variable gravel and clay over limestone bedrock over shale and/or granite. Bedrock was encountered in all records at depths ranging from at surface to 9 m below existing grades. Domestic water wells are anticipated to be screened within the Gull River Formation. Pumping test details were provided for 4 of 9 well records and indicated pumping tests were carried out for 1 to 4 hours and 20 minutes at rates of 3 to 30 GPM (11.4 to 113.6 L/min) with static water levels ranging from 1.2 to 11 m bgs being drawdown to depths of 1.2 to 33 m bgs.
- Stratigraphy on-site was described as sparse overburden and/or limestone bedrock at surface overlying highly fractured upper Gull River Formation limestone to depths of 1 to 2 m where the formation became less fractured, ultimately transitioning to the lower Gull River Formation. Green Bed Markers and interbedded layers of shale and sandstone were observed overlying sandstone of the Shadow Lake Formation.
- Seasonal fluctuations were noted in all on-site monitoring wells with peaks occurring during the Spring freshet. The seasonally high groundwater table was established at each monitoring well and ranged between 241.7 to 245.2 m asl.
- The local groundwater flow direction within the Gull River Formation is to the north. Regional groundwater flow is interpreted to be toward the north/northwest, ultimately flowing toward Mud Lake/Lake St. John/Lake Couchiching.
- Groundwater quality towards the southern portion of the site (MW24-3, MW24-4 and MW24-5) is indicative of calcium bicarbonate waters, compared to the groundwater quality towards the northern portion of the site (MW1 and MW2) which is indicative of mixed Sodium Chloride and Calcium Sulfate waters
- Groundwater levels within the wetland are lowest during the summer months and remain high throughout the late summer and fall. Frozen conditions were observed at MP1 from January through March. Based on the groundwater and surface water level measurements recorded at MP1 through MP3, it appears the wetlands on-site are predominantly surface



water fed with some contribution from the perched overburden aquifer in which the piezometers are installed.

- The continuous streamflow monitoring data shows flow rates at SW1/SW3 have ranged between 0 to 75 L/s and flow rates at SW2 have ranged between 0 to 800 L/s from May 2024 to August 2025.
- Based on the modelled groundwater influences it is anticipated the zone of influence, or in other words the distance extending from the site where 1 m or less of change in groundwater levels are observed, is estimated to be up to 75 m to the north of the property and 900 m to the west in the weathered bedrock/overburden unit and 905 m to the northeast of the property in the Gull River bedrock unit at full extraction. Following rehabilitation efforts the zone of influence is estimated to be up to 75 m to the north of the property and 900 m to the west in the weathered bedrock/overburden and 1,235 m to the northeast and 1,330 m to the southwest in the Gull River bedrock unit.
- As a result of the proposed extraction, the drainage area to the Head River tributary is marginally reduced. The reduction in drainage area will be mitigated with continuous discharge from the quarry resulting in a minor increase in baseflows ranging from 9 to 30 L/s seasonally.
- Based on the predicted groundwater levels within the Gull River bedrock at the time of full extraction on-site it is not anticipated the proposed quarrying operations would impact nearby water well 7202454. Well 4605599 is significantly shallower than 7202454 and the predicted groundwater drawdown should full development of the proposed quarry and the existing quarries surrounding the site occur on the same timeline exceed the available drawdown. However, the predicted drawdown will be lessened should full development of the proposed quarry and the existing quarries surrounding the site were to occur on different timelines. Further, if necessary, well 4605599 could be deepened to provide additional storage and water supplies. Typical wells in this area are installed at depths of 15 to 20 m as observed at Well 7202454. Considering a 20 m well there would be approximately 18.5 m of available drawdown.
- The drainage area to Wetland WU-1 will be maintained by the construction of an infiltration feature along the north edge of the site which will continuously recharge the shallow groundwater, and subsequently, Wetland WU-1.
- There are no changes to the surface runoff or groundwater contribution to Wetland WU-3 and as such, no impacts are expected to the water levels or hydroperiod of this wetland.



- There is a very minor decrease in the drainage area to Wetland WU-4 (<2%) under proposed conditions. Due to large drainage area under existing conditions, the feature-based water balance predicts negligible impacts to both water levels and hydroperiod.

Based on the findings of this assessment, no negative impacts to the groundwater and surface water resources and their users are anticipated as a result of the proposed quarry operations and rehabilitation.



10 Site Plan Recommendations

Based on the above findings the following conditions are to be included on the Aggregate Resources Act site plan for the Ramra Quarry:

- Water levels shall be collected continuously with automatic water level transducers, with manual measurements collected monthly at the following groundwater monitors: MW24-4, MW24-5, MW6, MP1, MP2 and MP3. The MP3 monitoring location shall be relocated north of the proposed limits of extraction once Phase Two operations commence.
- Water levels shall be collected continuously with automatic water level transducers, with manual measurements collected monthly subject to landowner permission/access being granted at the following: Wu-1B.
- Three years prior to extraction extending below the groundwater table, baseline groundwater level conditions shall be established for MW24-4, MW24-5, MW6, MP1, MP2 and Wu-1B.
- If water levels change more than the established thresholds developed for the Phases 1 through 3, and Rehabilitation conditions considering the predicted groundwater levels and established baseline conditions, a detailed investigation shall be undertaken in regards to the potential impacts to the local groundwater system. This investigation shall include a review of current quarry activities, a review of on-site and off-site groundwater levels, and a review of climate data. Should quarry activities be found to be responsible for the change the licensee shall discuss options with the MNR and consider the following:
 1. Suspension of below water table activities.
 2. Moving mining to a different phase.
 3. Conducting a detailed investigation including installing more observation wells
- Water levels and streamflow shall be collected continuously with automatic water level transducers March through December, with monthly manual measurements collected during the same period at the following surface water monitors: SWA.
- Water levels and streamflow shall be collected continuously with automatic water level transducers March through December, with monthly manual measurements collected subject to landowner permission/access being granted at the following: SW2
- Three years prior to extraction extending below the groundwater table, baseline base flow conditions via a threshold shall be established for SWA and SW2.



- If base flows change more than the established thresholds for this location developed for the Phases One through Three, and Rehabilitation conditions, a detailed investigation shall be undertaken with regard to the potential impacts to the local groundwater-surface water system. This investigation shall include a review of current quarry activities, a review of on-site and off-site groundwater and surface water flows at other monitoring locations, and a review of climate data. Should quarry activities be found to be responsible for the change the licensee shall discuss options with the MNR and consider the following:
 1. Suspension of below water table activities.
 2. Moving mining to a different phase.
 3. Conducting a detailed investigation including installing more observation wells or surface water monitoring locations
- Water levels shall be collected continuously with automatic water level transducers, with manual measurements to be collected monthly subject to landowner permission/access being granted at the following private water wells: 7202454 and 4605599.
- Annual water quality sampling for pH, conductivity, total dissolved solids (TDS), sodium, chloride, potassium, magnesium, sulphate, iron, manganese, cadmium, copper, lead, zinc, phenolics, shall be conducted at the following groundwater monitors: MW24-4, MW24-5 and MW6.
- Semi-annual water quality sampling for pH, Conductivity, Alkalinity, Bicarbonate, Chloride, Metals (Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Cobalt, Copper, Lead, Iron, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Selenium, Sodium, Silver, Strontium, Sulfur, Thallium, Thorium, Tin, Titanium, Tungsten, Uranium, Vanadium, Zinc), Nitrate/Nitrite, and Sulphate, shall be conducted at the following monitors: MW24-4, MW24-5, and MW6.
- Monthly water quality sampling for total suspended solids, pH, oil and grease and various dissolved metals/nutrients shall be conducted at the following monitors: quarry sump.
- Annual water quality sampling for Petroleum Hydrocarbons Fractions F1 to F4, Benzene, Toluene, Ethylbenzene and Xylenes, and Oil and Grease shall be conducted at the following monitors: MW24-4, MW24-5, MW6, and the quarry sump discharge.
- Semi annual water quality sampling for Dissolved Oxygen, Conductivity, pH, and Temperature shall be conducted at the following surface water monitors: SWA, quarry sump discharge, Wu-3. Wu-4A, Wu-4B and Wu-4C.



- Semi annual water quality sampling for Dissolved Oxygen, Conductivity, pH, and Temperature shall be conducted at the following surface water monitors subject to landowner permission/access being granted at the following location: SW2 and Wu-1B.
- Annual water quality sampling for pH, conductivity, total dissolved solids (TDS), sodium, chloride, potassium, magnesium, sulphate, iron, manganese, cadmium, copper, lead, zinc, and phenolics shall be conducted subject to landowner permission/access being granted at the following private water wells: 7202454 and 4605599.
- If a water well complaint is received by the licensee, the following actions shall be taken by the licensee:
 - The licensee shall notify the MECP within 24 hours and provide mitigative actions to be taken.
 - The Licensee shall hire a licensed water well technician to complete a well inspection including a review of the pump, well condition, pump depth and condition, plumbing, etc. to confirm the well complaint is not resultant of well-specific issues.
 - If determined to not be resultant of well-specific issues, the licensee shall provide potable water to the well user within 24 hours of the well inspection.
 - The licensee shall retain a hydrogeologist to review the water well inspection data, water level/quality data, and on-going operations at the quarry to provide an assessment of the cause of the complaint. The hydrogeologist shall prepare an opinion on the likelihood the well complaint received can be attributed to quarry operations.
 - If deemed the well interference complaint is legitimately resultant of quarry dewatering operations, The licensee shall initiate a water supply restoration program, consisting of:
 - Step 1: Well system rehabilitation: Replacement or lowering of pumps, flushing the pump lines, well deepening, etc.
 - Step 2: Well Replacements: If system rehabilitation is not an option, the well could be replaced.
 - Step 3: Water treatment considerations: Appropriate water treatment shall be incorporated into any restored water supply.
 - The results of the water supply restoration program must be acceptable to both the water well user(s) and the licensee, and the licensee shall bear all of the cost associated with the program.
 - If deemed the well interference complaint is not resultant of dewatering operations at the quarry, the licensee shall provide a letter report summarizing the results of the



investigation to the well user(s). Further, the licensee shall continue to supply potable water to the well user(s) for an additional 24 hours to allow the user(s) to make alternate water supply arrangements

- A low earth berm (maximum height of 1.0 m) shall be constructed along the western limits of Phase 1 to limit overland flow into the quarry, as shown on Figure 3.
- During Phase 1 of extraction, the quarry shall have a surface storage volume of 18,000 m³ to provide attenuation for runoff from the extraction area and groundwater seepage into the quarry.
- Runoff and groundwater seepage into the active quarry area shall be treated by a settling pond prior to discharging to the existing WU-1 depression feature (during Phase 1) and to the proposed infiltration feature (during Phases 2 and 3).
- A linear infiltration feature constructed with an estimated depth of up to 3.0 m depth and a slope of 1% (to be confirmed at detailed design) shall be constructed along the northern limits of the Phase 2 and 3 extraction areas. The linear infiltration feature is to bisect the shallow fracture system. An impermeable liner along the south edge of the feature shall be considered in the design of this feature to restrict groundwater flow from the feature south towards the extraction area. A naturalized rip-rap cutoff swale shall be constructed along the south boundary of the Phase 2 and 3 extraction areas to collect runoff from the wetland and tributaries to the south and convey runoff west towards Pearl Carricks Road. The cutoff swale shall be constructed prior to Phase 2 of extraction.
- A pump and forcemain or gravity drain system where feasible shall be installed along Pearl Carricks Road to pump runoff from the external drainage area to the south, around the extraction area and to the proposed infiltration feature along the north boundary of the site.
- An overflow swale shall be constructed from the cut off swale to the Phase 2 and 3 extraction area to convey runoff in excess of the capacity of the bypass swale/pump to the surface storage feature within the extraction which will provide attenuation prior to being pumped into the infiltration feature along the north property boundary.
- The surface water storage feature capable of containing 70,500 m³ of overflow water shall be provided on the quarry floor during Phase 2 and 3 of extraction. The storage feature shall initially be located within the Phase 1 extraction area and shall be relocated into Phases 2 and 3 as extraction progresses and Phase 1 is rehabilitated.
- During rehabilitation, the western section of the naturalized cutoff swale shall be disconnected, and a natural channel shall be constructed to convey flow north similar to existing conditions.



- The section of the naturalized cutoff swale between the two tributaries to the south shall be left as is during rehabilitation to minimize disturbance to the fish habitat in this area.
- A linear conveyance channel shall be constructed as part of rehabilitation to convey runoff from the south extraction limit / cutoff swale underground to the infiltration feature along the north boundary of the site. The channel shall consist of an approximate 3.0 m deep trench filled with 150 mm diameter rip/rap/clearstone. The clearstone shall be graded with a 0.3 m deep channel at surface to convey larger flows overland during large storm events and the spring freshet.
- Water from the quarry sump or clean water pond shall be discharged to the north infiltration trench necessary to maintain dry operating conditions in the Quarry as shown on Figure 4. No process water shall be discharged from the Quarry directly prior to being treated. There shall be no direct discharge of water off-site.
- Excess soil to be utilized for berm construction and rehabilitation shall be imported to site in accordance with Ontario Regulation 244/97 under the Aggregate Resources Act.
- As part of final rehabilitation of the site, the monitoring wells shall be decommissioned in accordance with O.Reg.903.
- The licensee shall operate in accordance with the Environmental Compliance Approval (ECA) and Permit to Take Water (PTTW) requirements.
- The operation and rehabilitation of this site will not impact a Wellhead Protection Area or a Surface Water Intake Protection Zone and therefore, source water protection policies do not apply for this licence.



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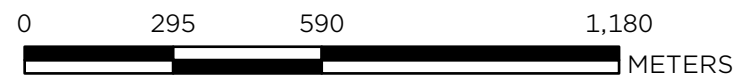
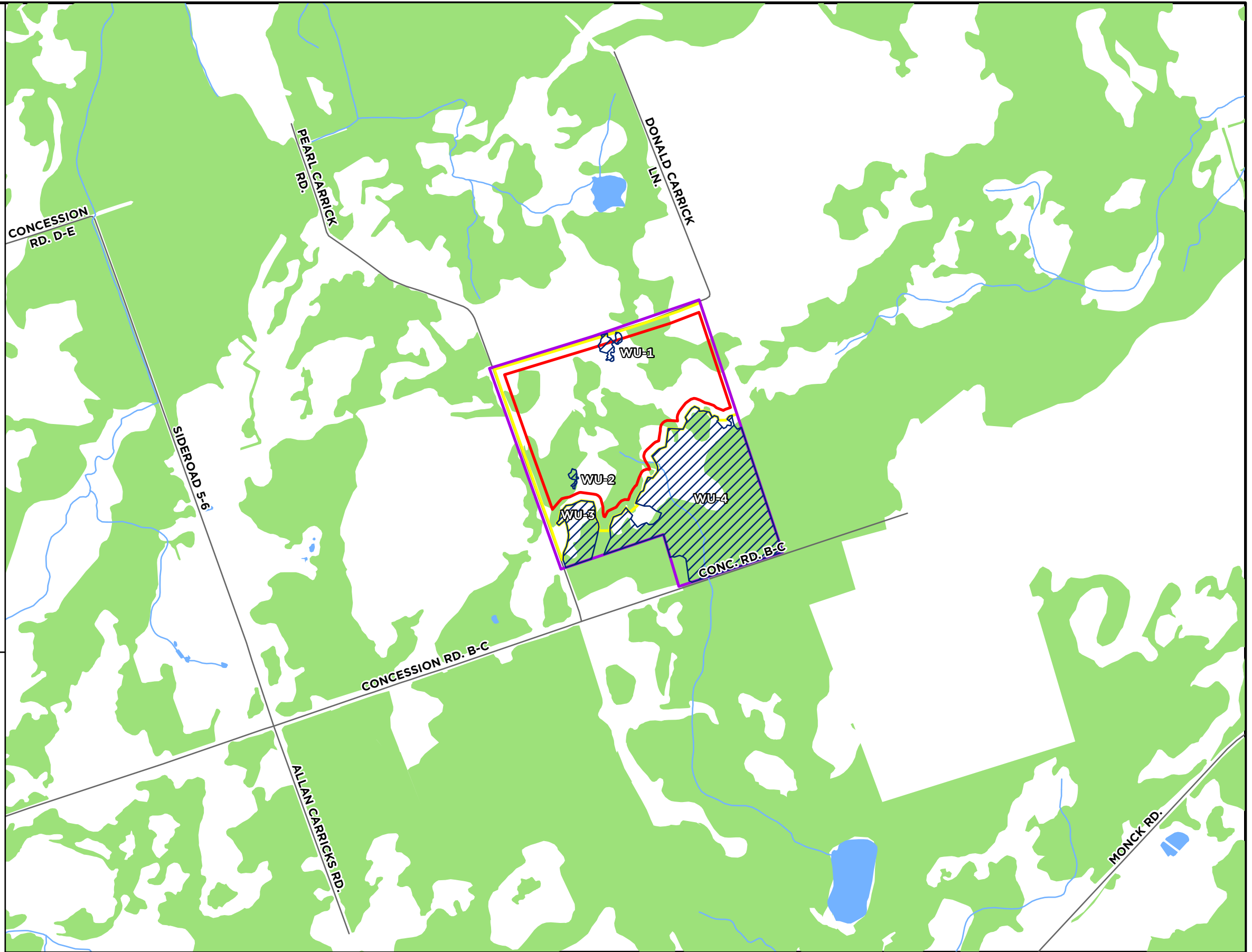


NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

-  PROPERTY BOUNDARY
-  PROPOSED LICENCE BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  ROADS
-  WATERCOURSE
-  WOODLANDS
-  WATERBODY
-  WETLAND



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
SITE LOCATION PLAN

DWG. No.
FIG-1

SCALE: 1:15,000	DRAWN: AO	DATE: DEC. 2025	JOB NO. 424371
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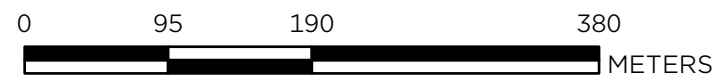
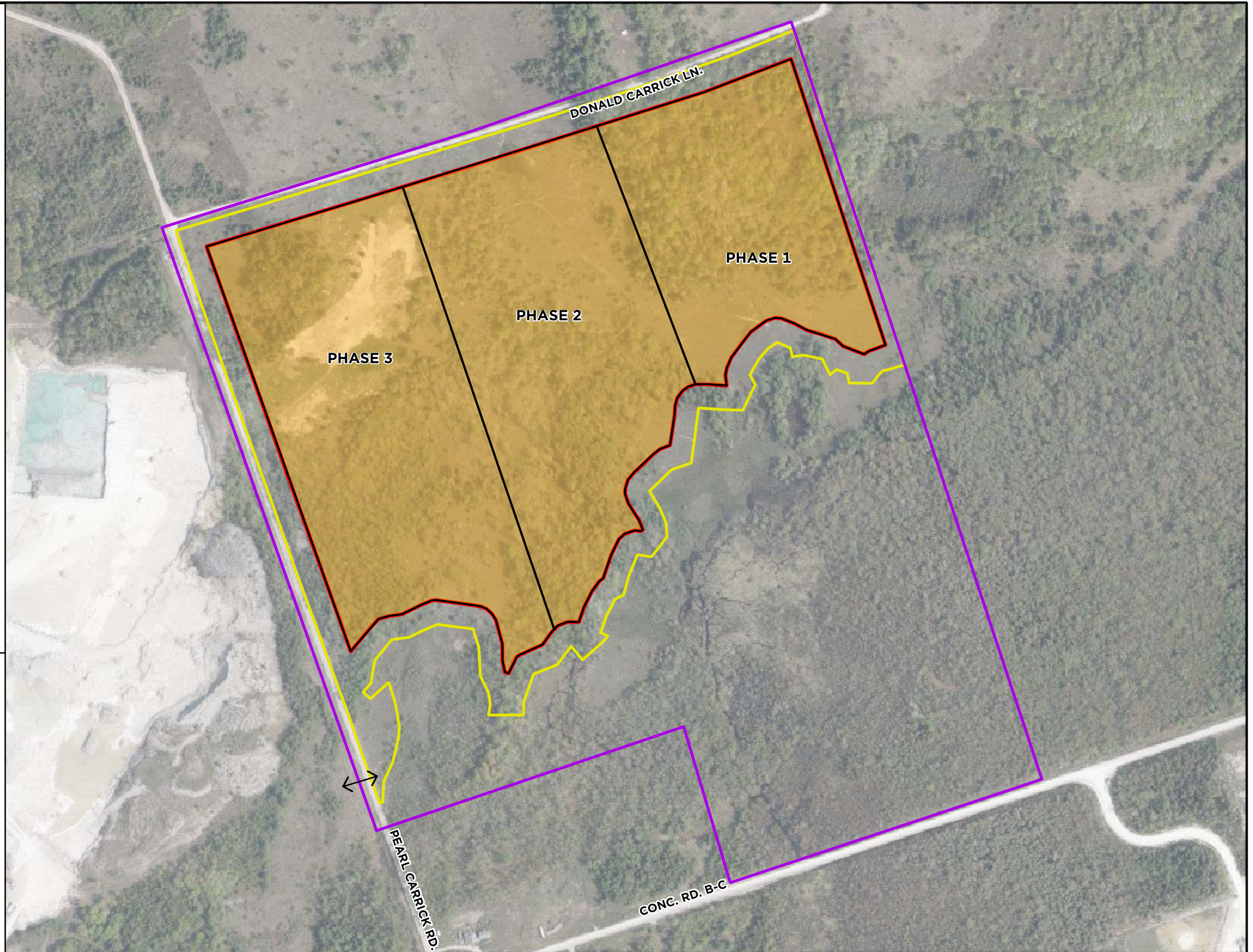


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LEGEND

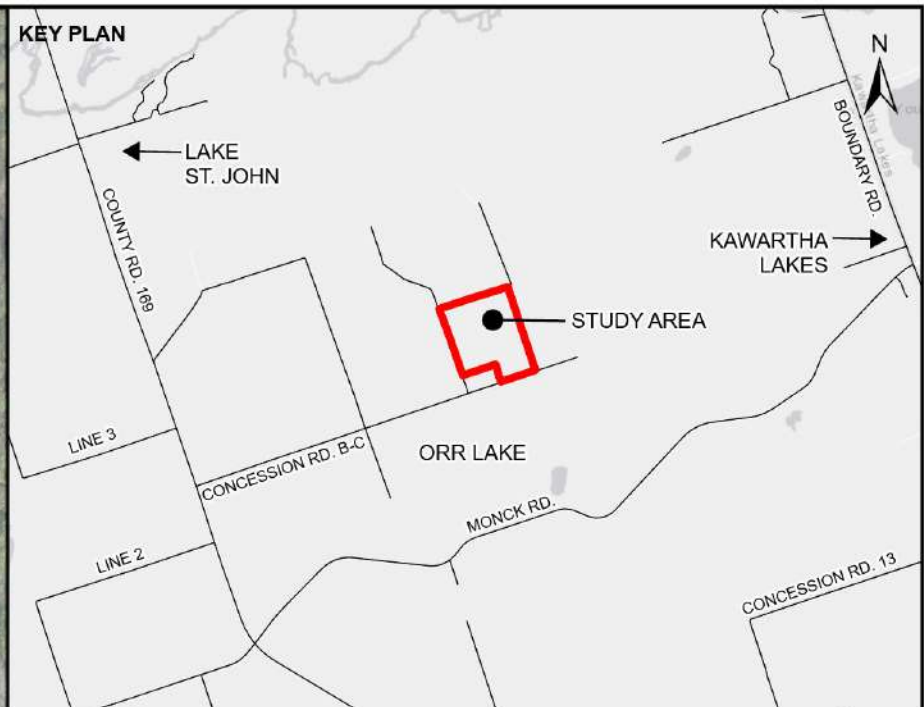
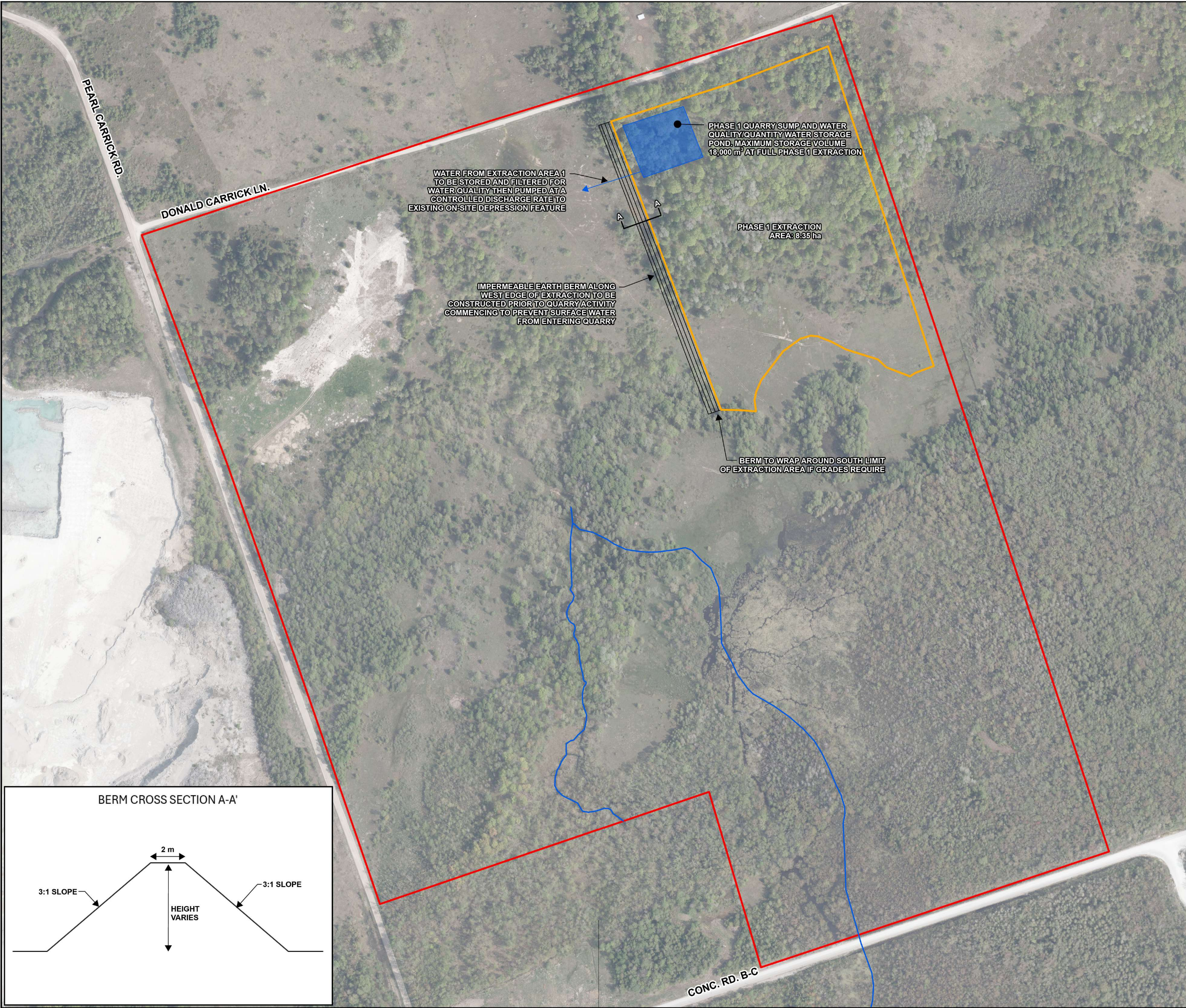
-  PROPERTY BOUNDARY
-  PROPOSED LICENCE BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  EXTRACTION PHASING
-  PROPOSED ENTRANCE/EXIT LOCATION



**RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
MINING PHASING PLAN**

DWG. No.
FIG-2

SCALE: 1:5,000	DRAWN: AO	DATE: DEC. 2025	JOB NO. 424371
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LEGEND	
	SITE
	EXTRACTION PHASING
	WATERCOURSE
	SUMP
	BERM

NOTES
PHASE 1 QUARRY SUMP TO BE UNLINED WITH 1:1 SIDE SLOPES. DIMENSIONS/ LOCATION OF SUMP WILL VARY AS EXTRACTION PROGRESSES

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VERSION	DATE
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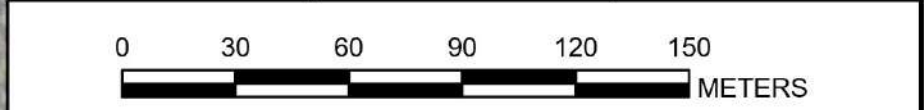
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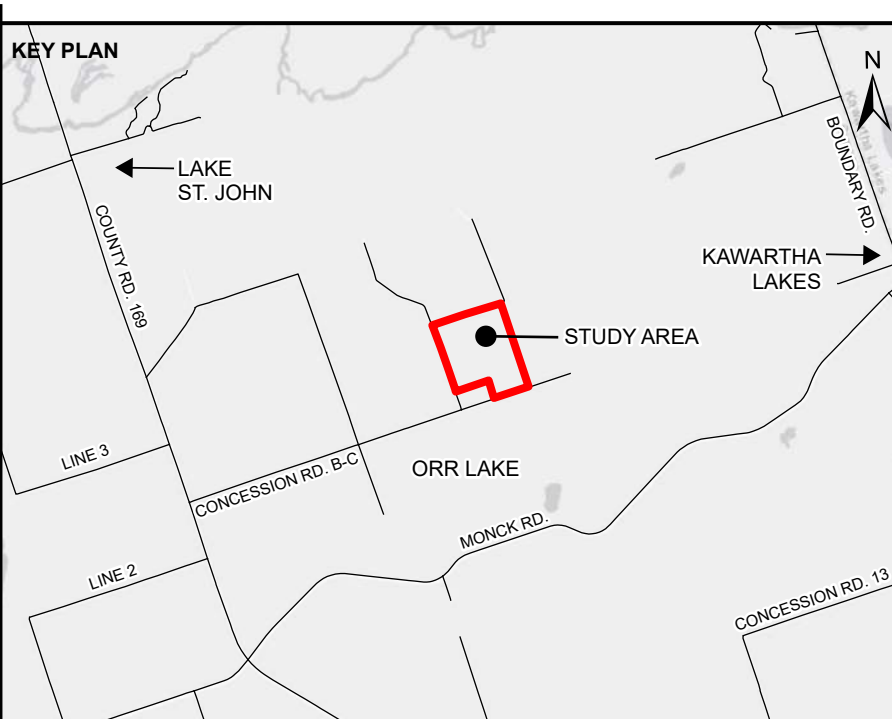
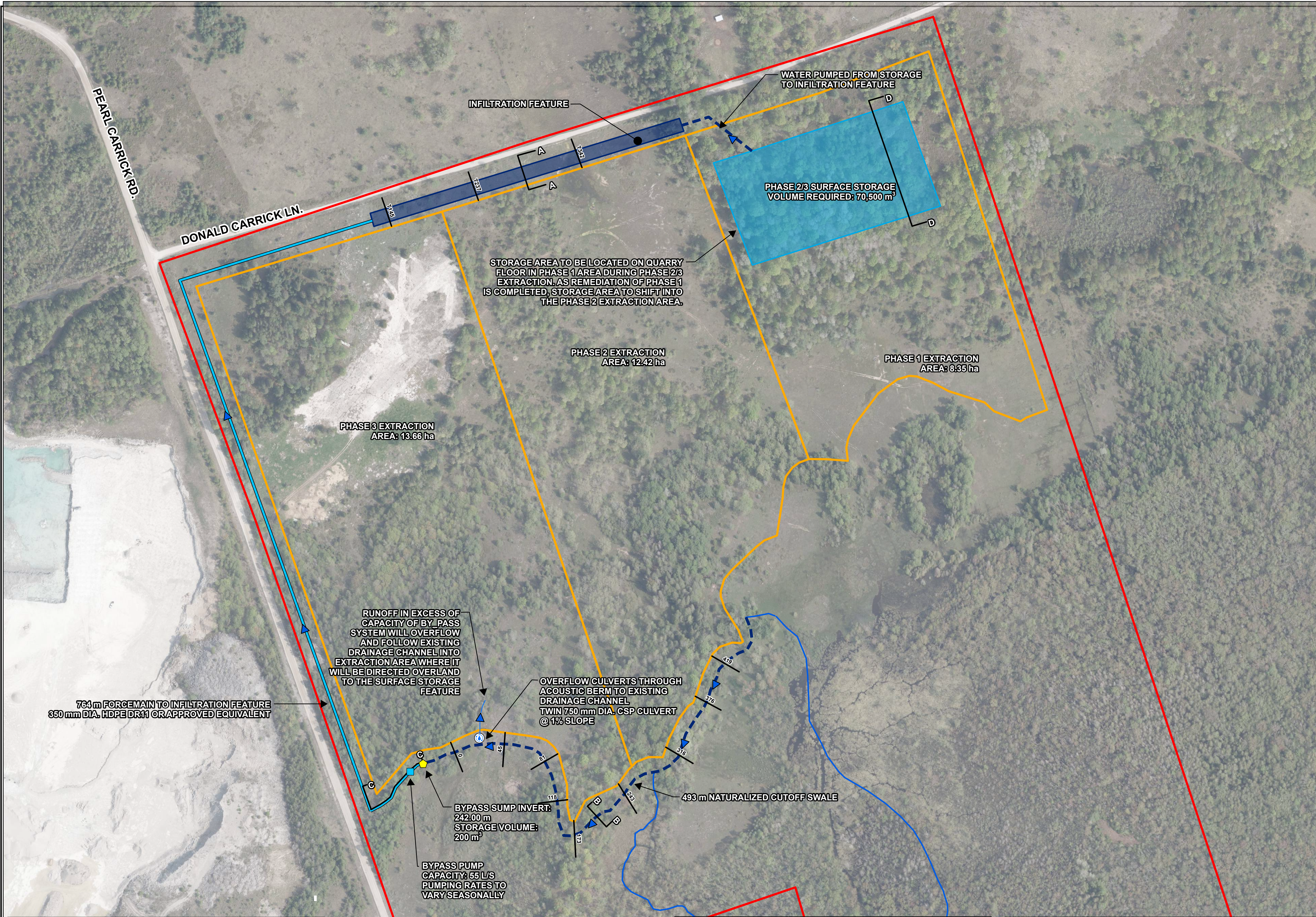


PROJECT TITLE
SARJEANTS RAMARA QUARRY

DRAWING TITLE
PHASE 1 SURFACE WATER MANAGEMENT PLAN

PROJECT	SCALE	DRAWING
424371	1:2,000	FIG.3





- LEGEND**
- SITE
 - EXTRACTION PHASING
 - INFILTRATION FEATURE
 - FORCEMAIN
 - SWALE
 - SURFACE STORAGE FEATURE
 - BYPASS SUMP
 - OVERFLOW CULVERTS
 - PUMP LOCATION
 - WATERCOURSE
 - CROSS-SECTIONS

NOTES

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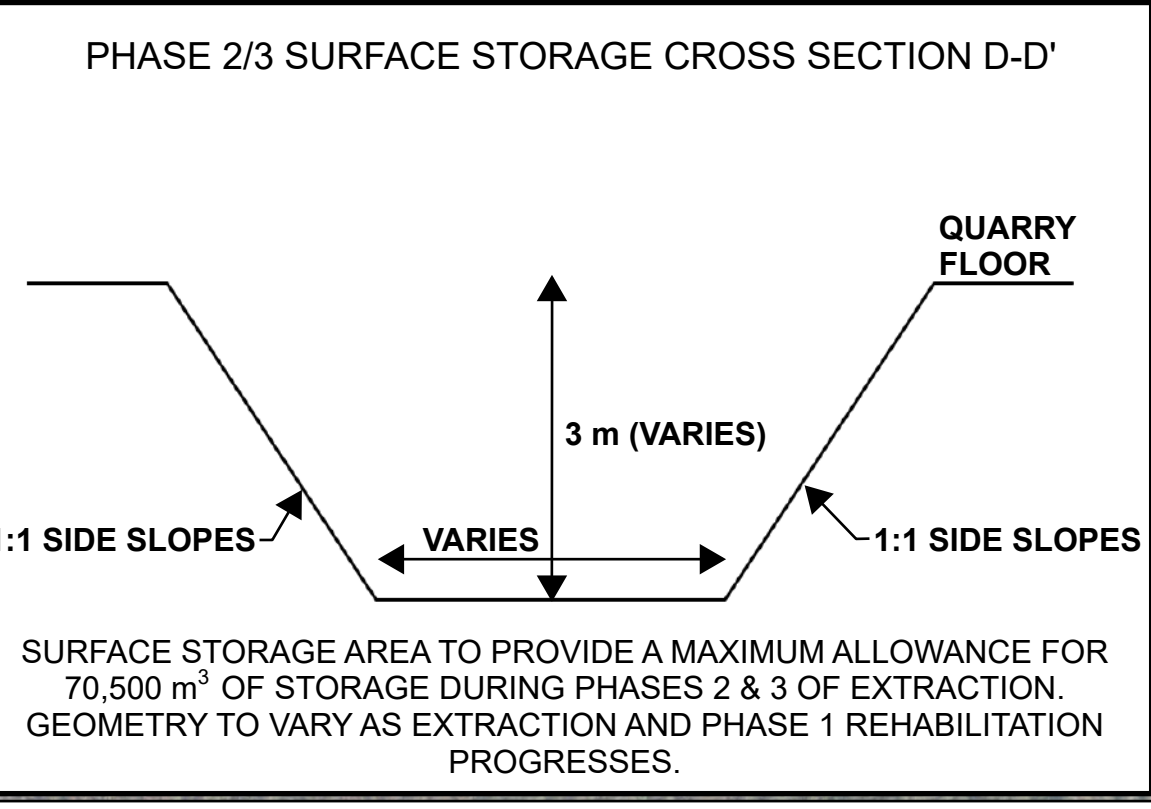
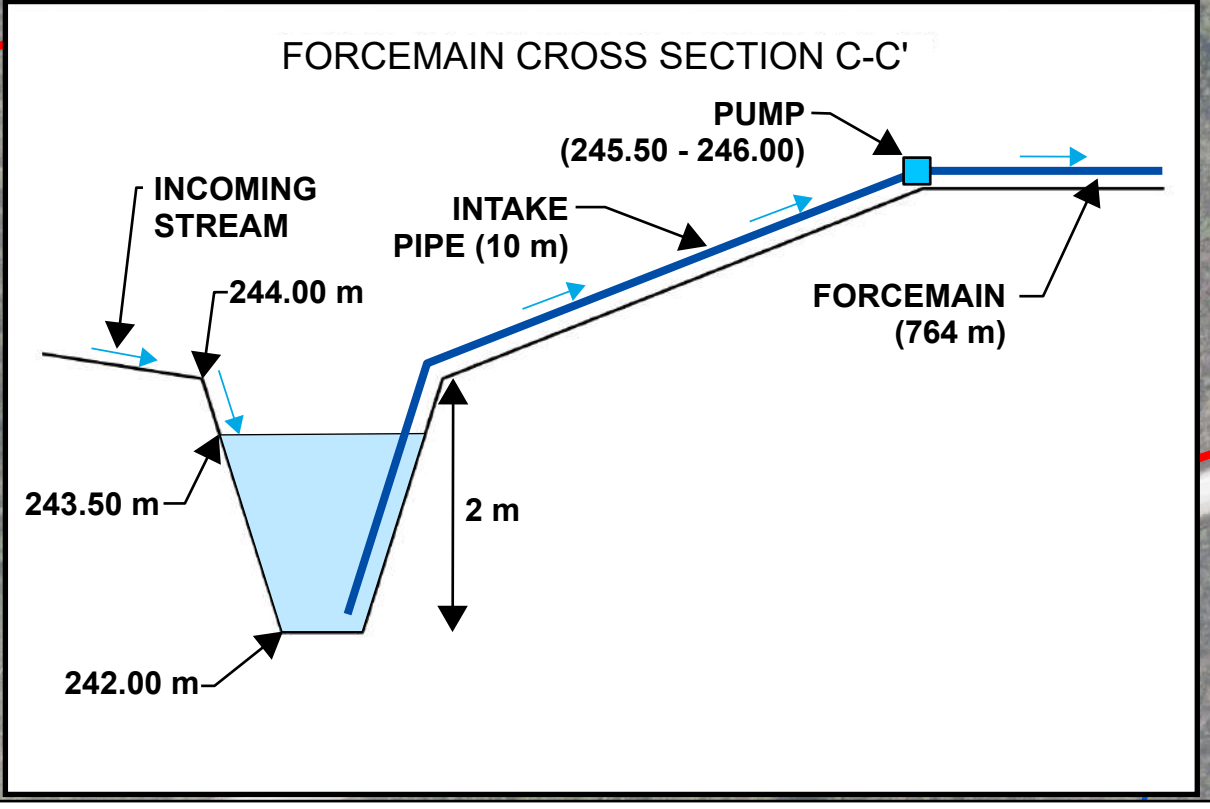
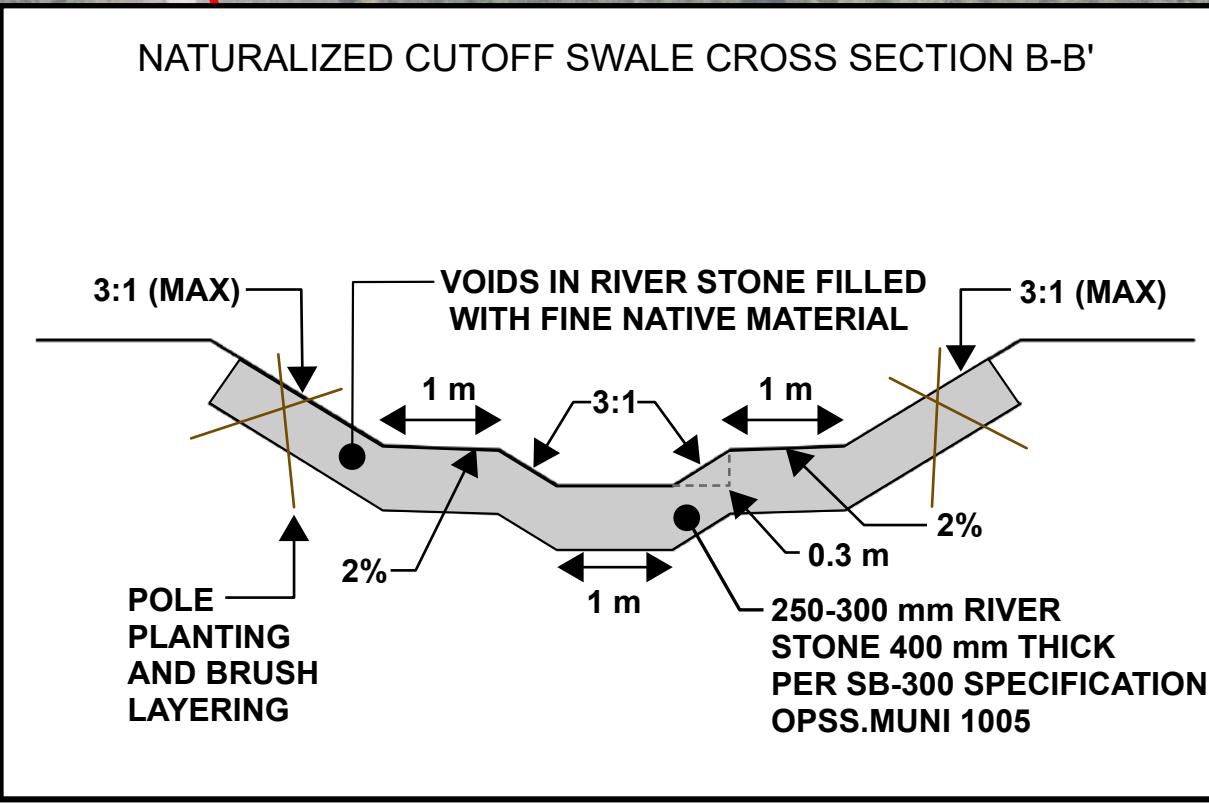
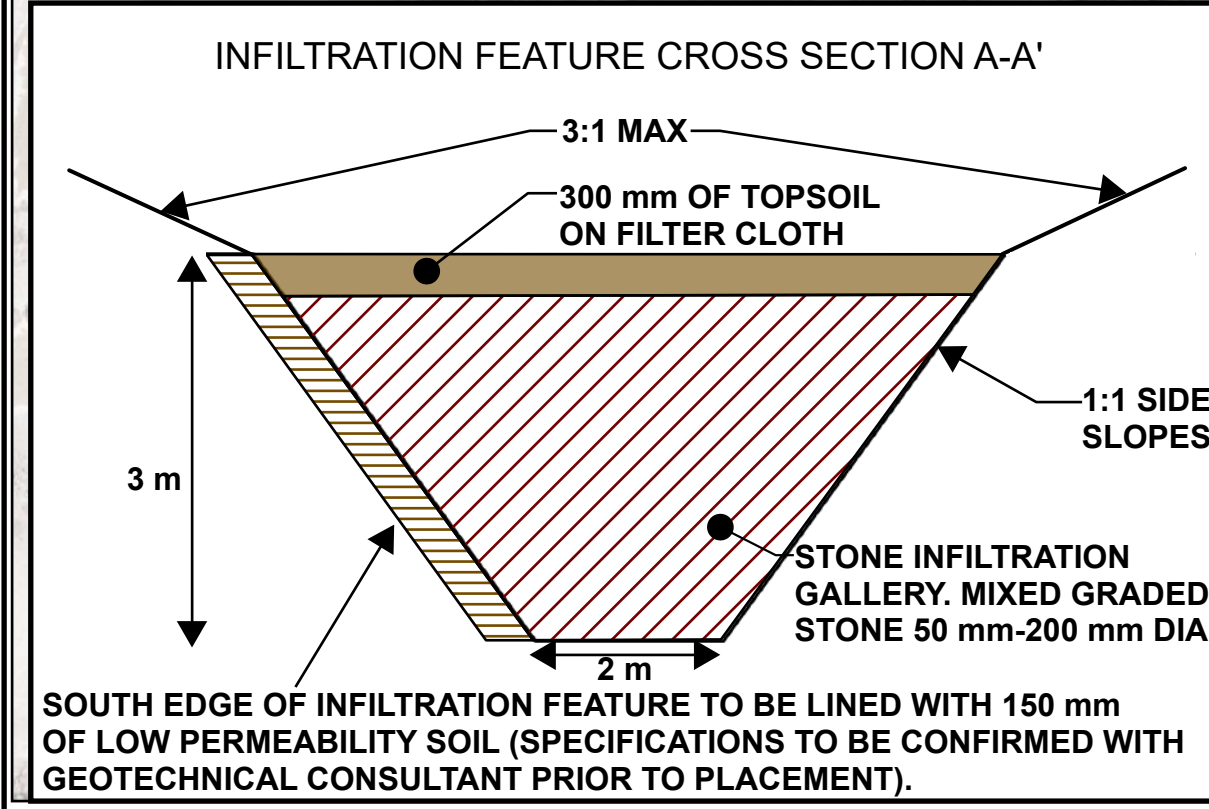
PROJECT TITLE

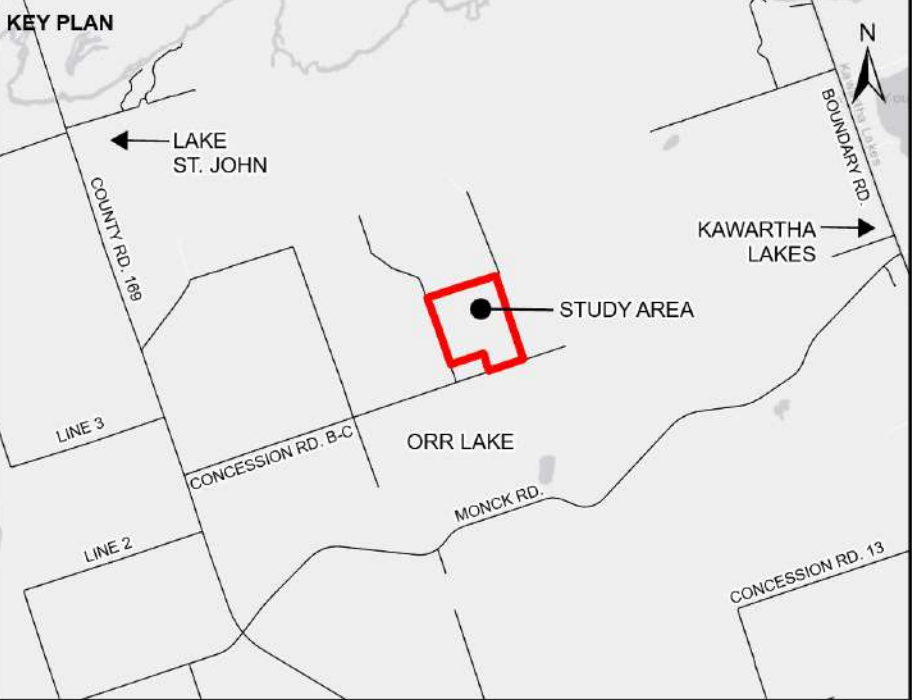
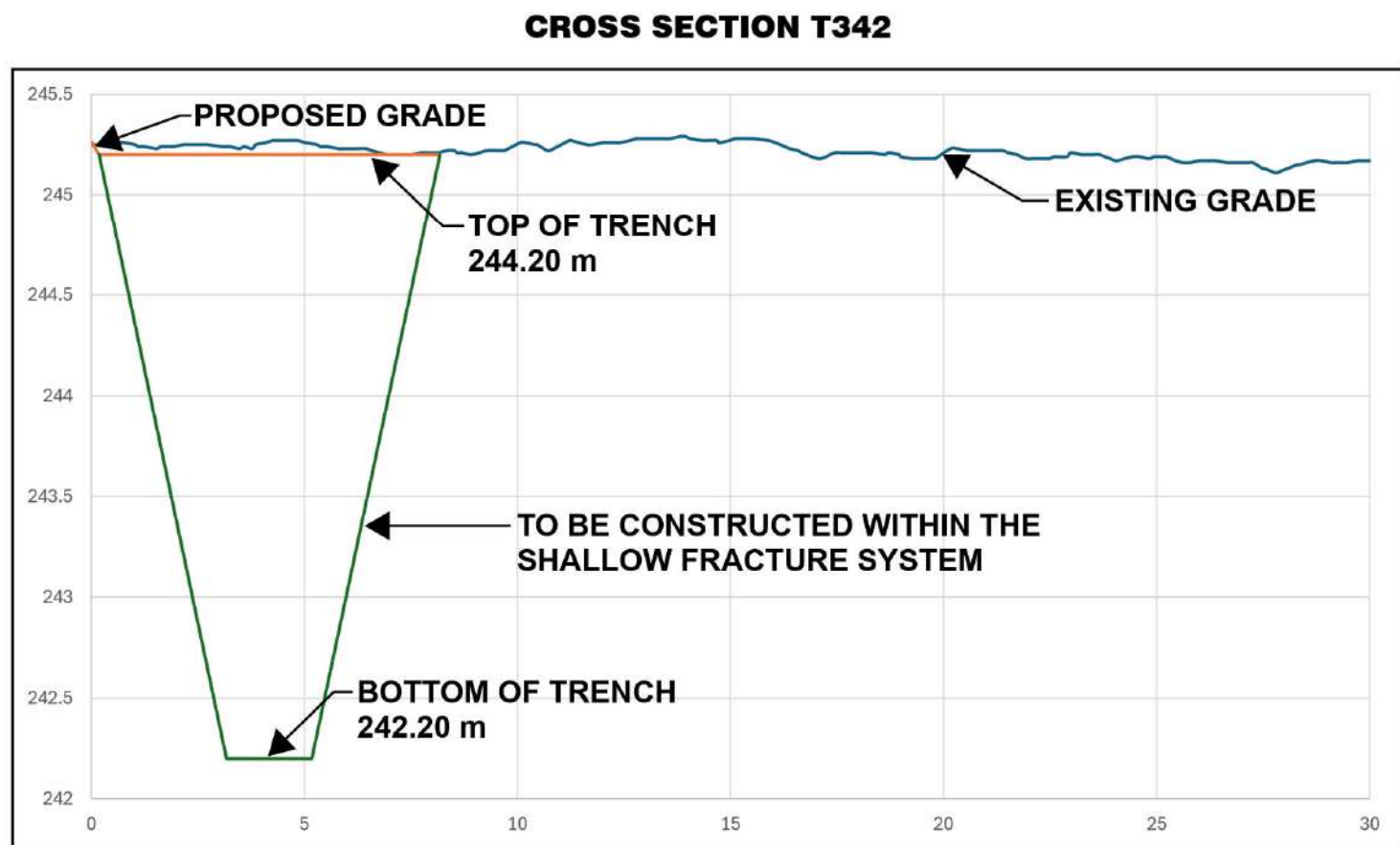
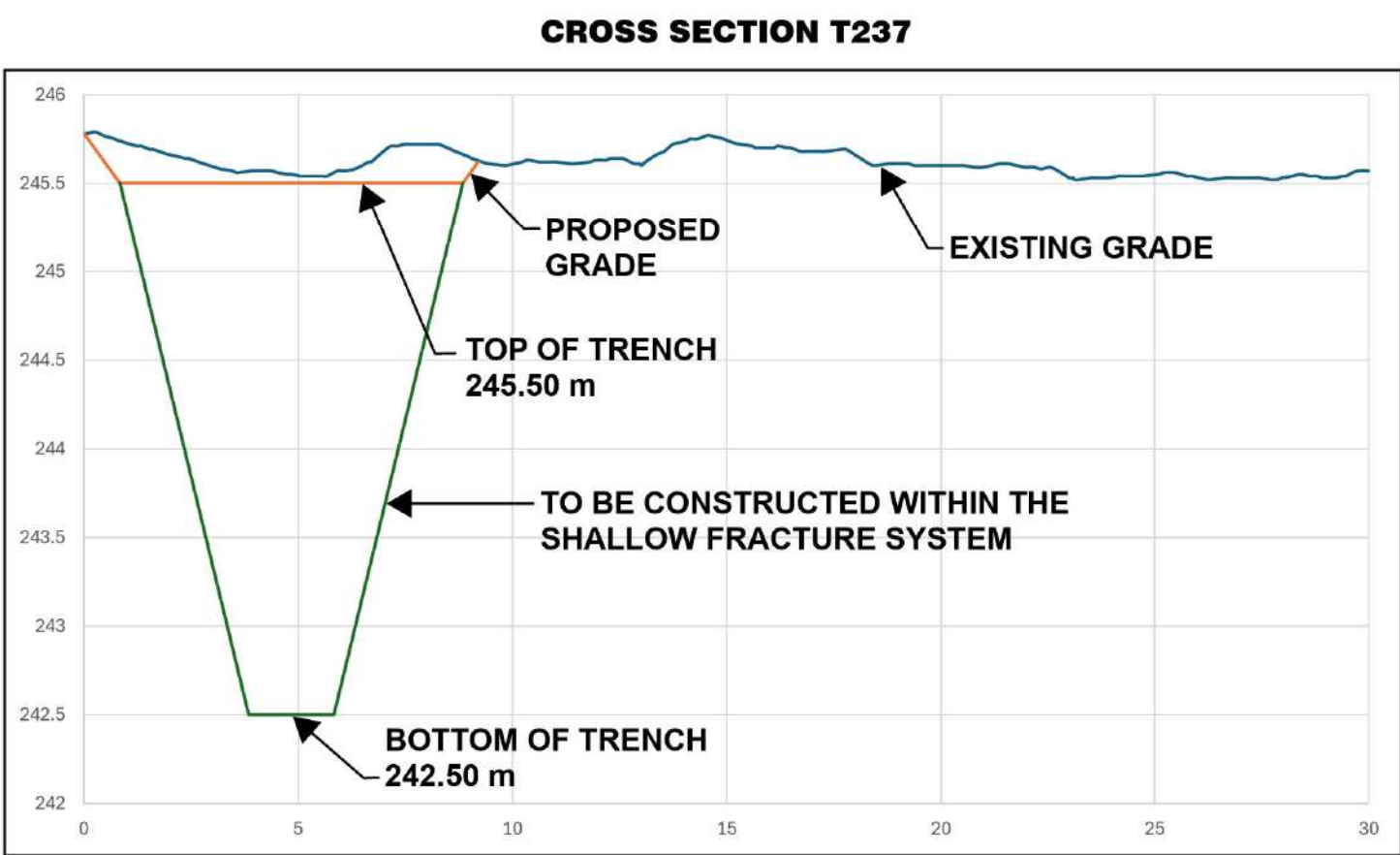
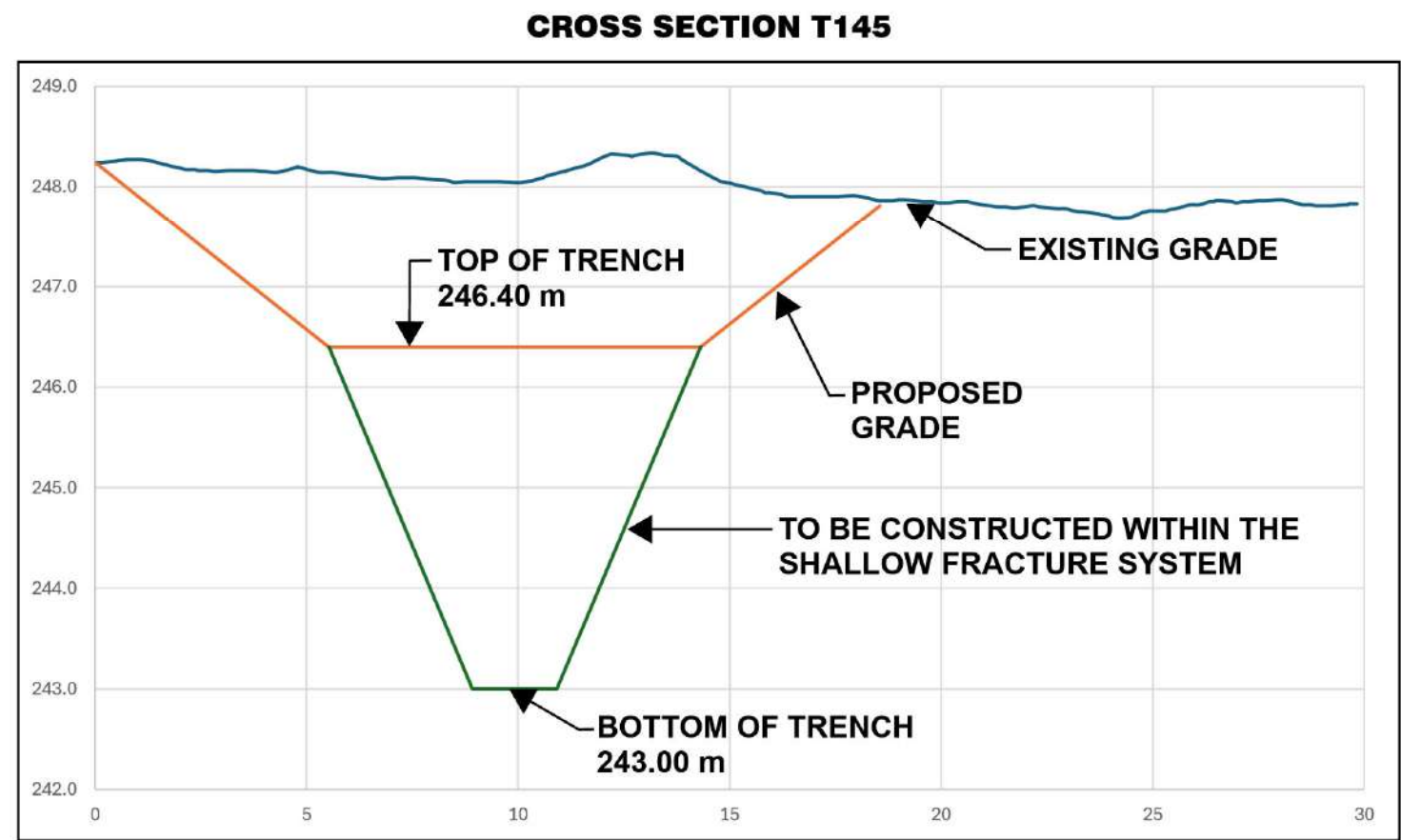
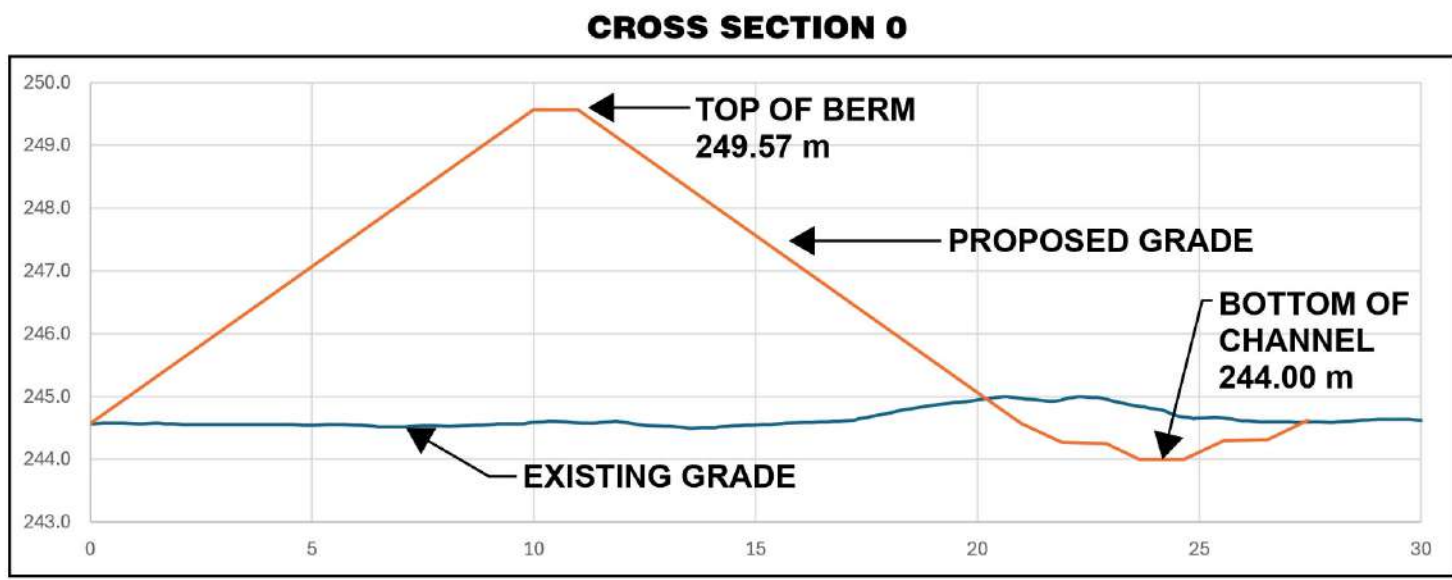
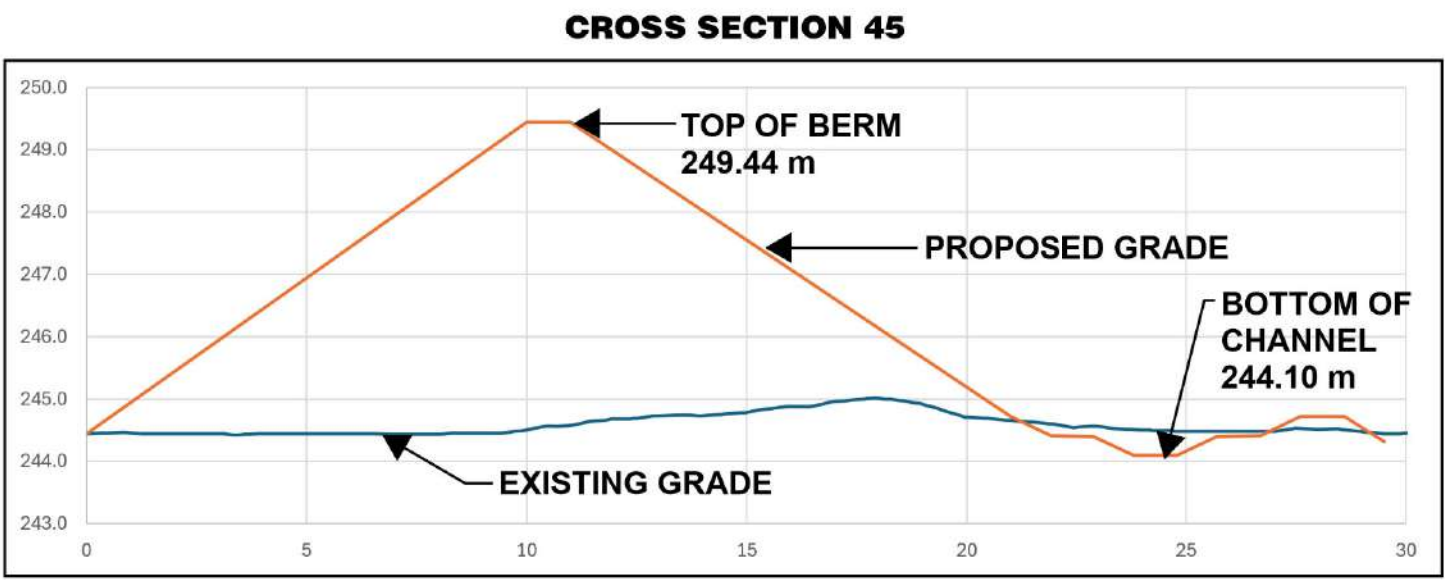
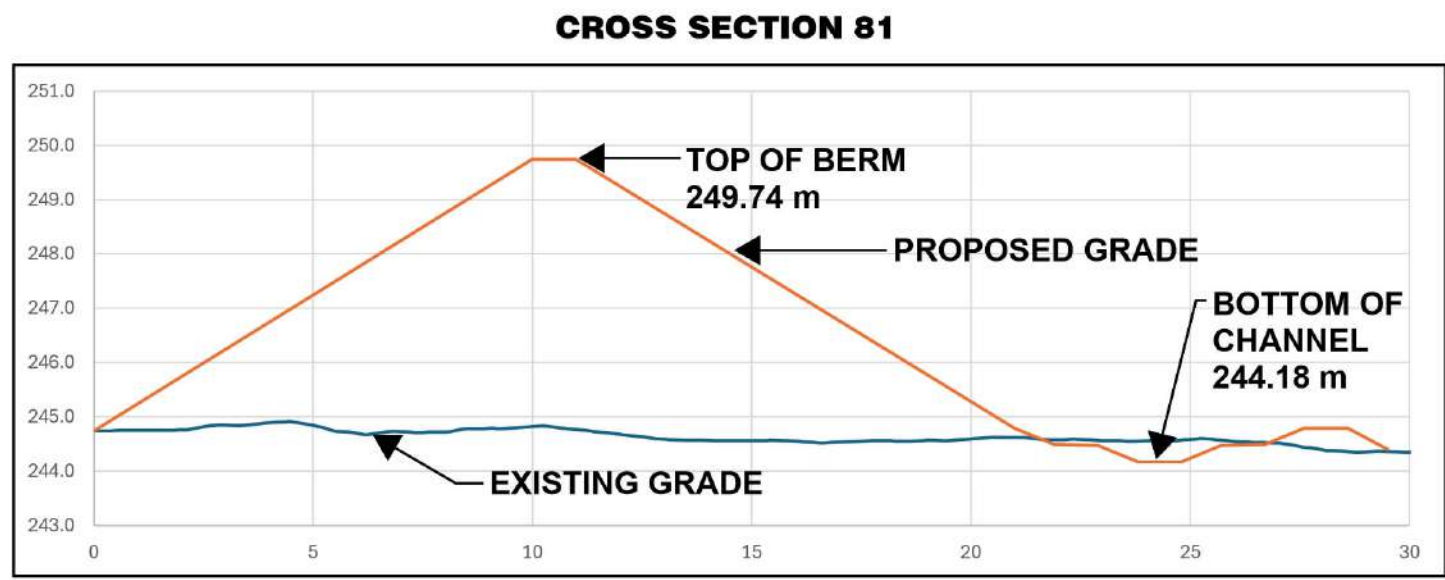
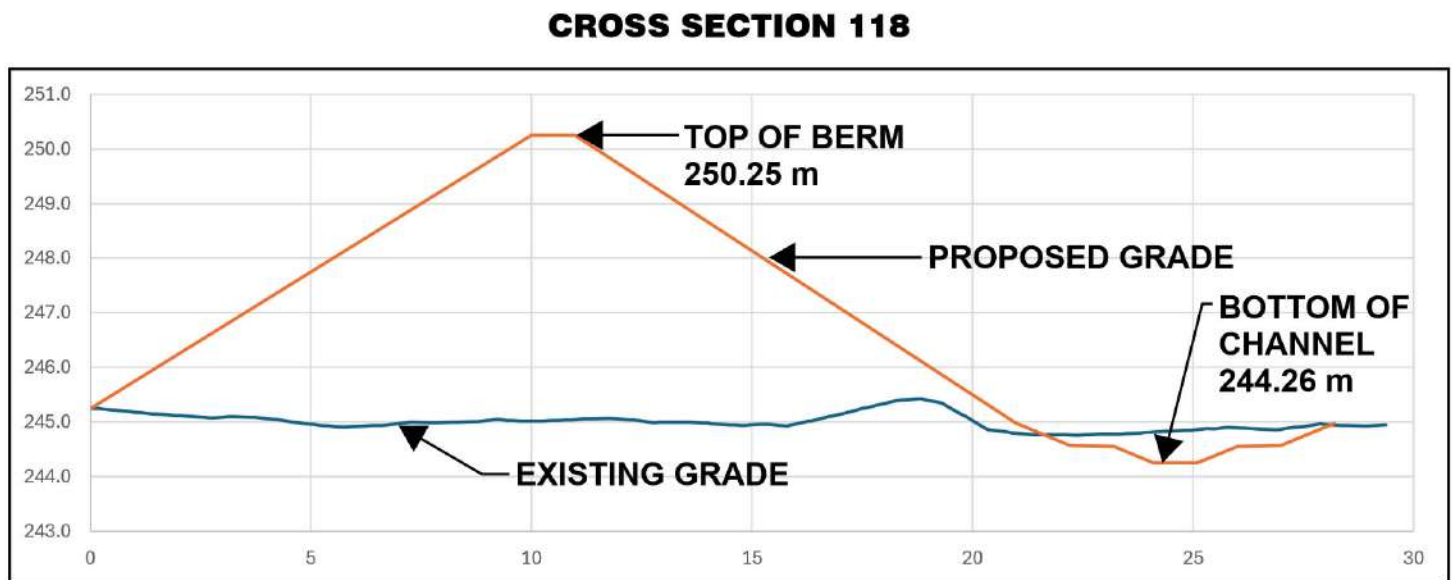
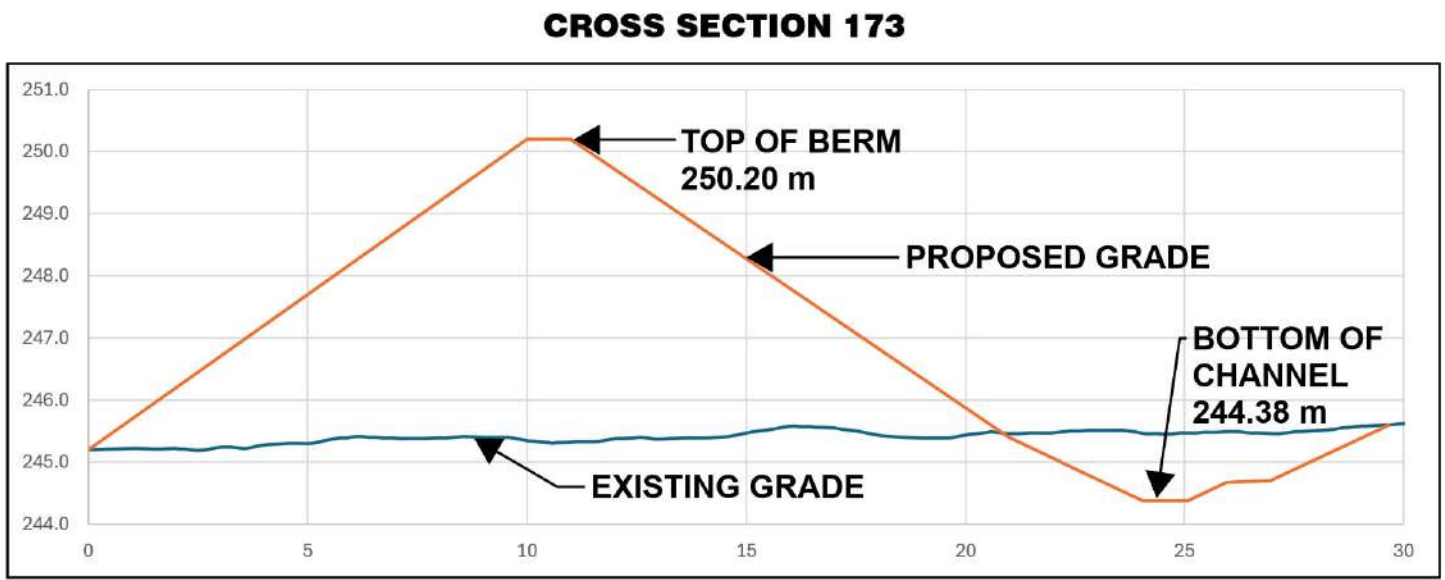
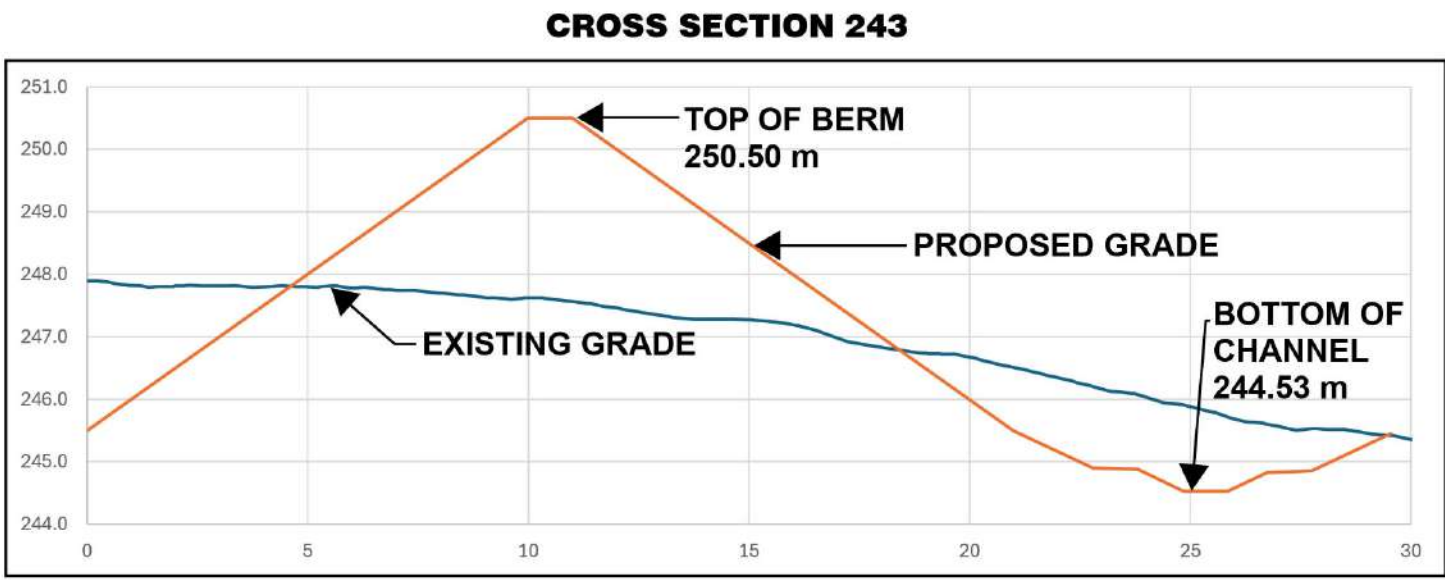
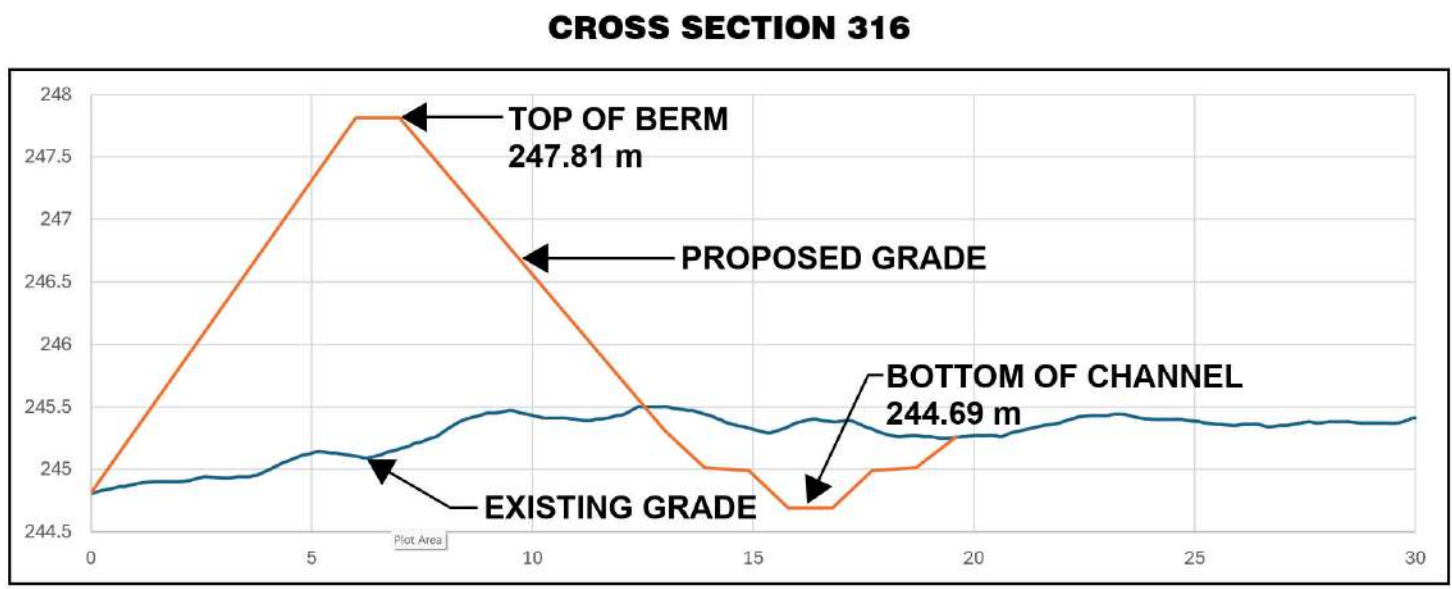
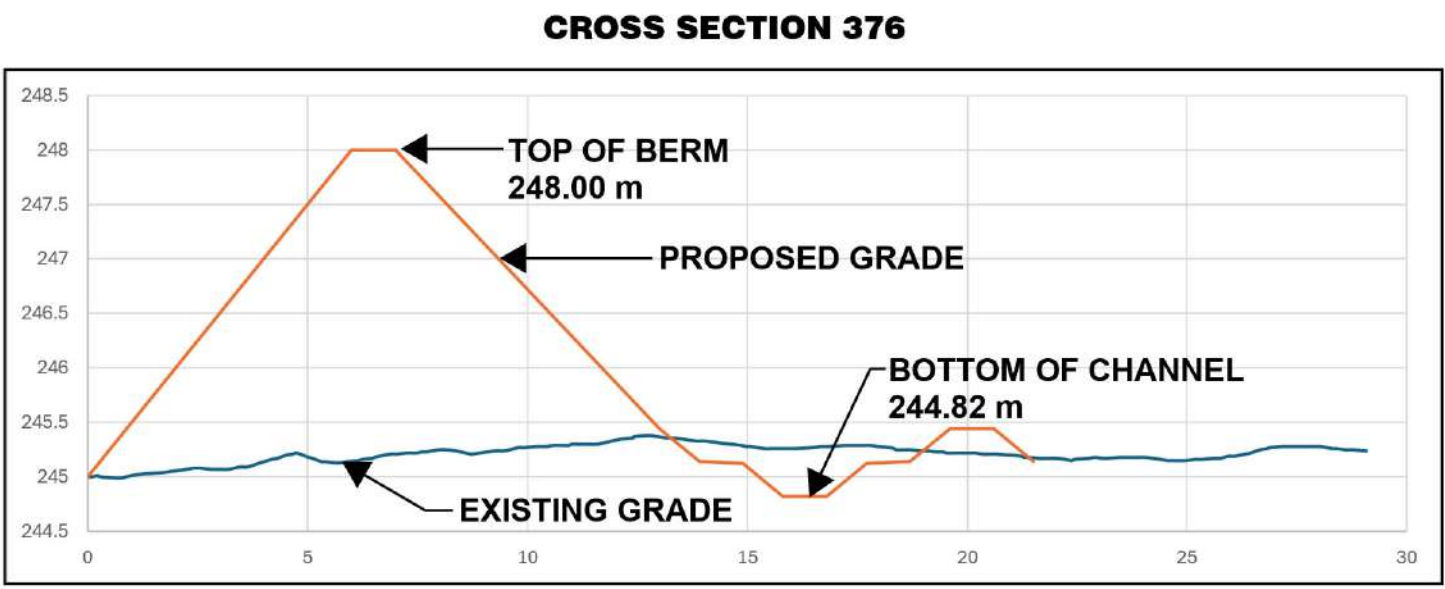
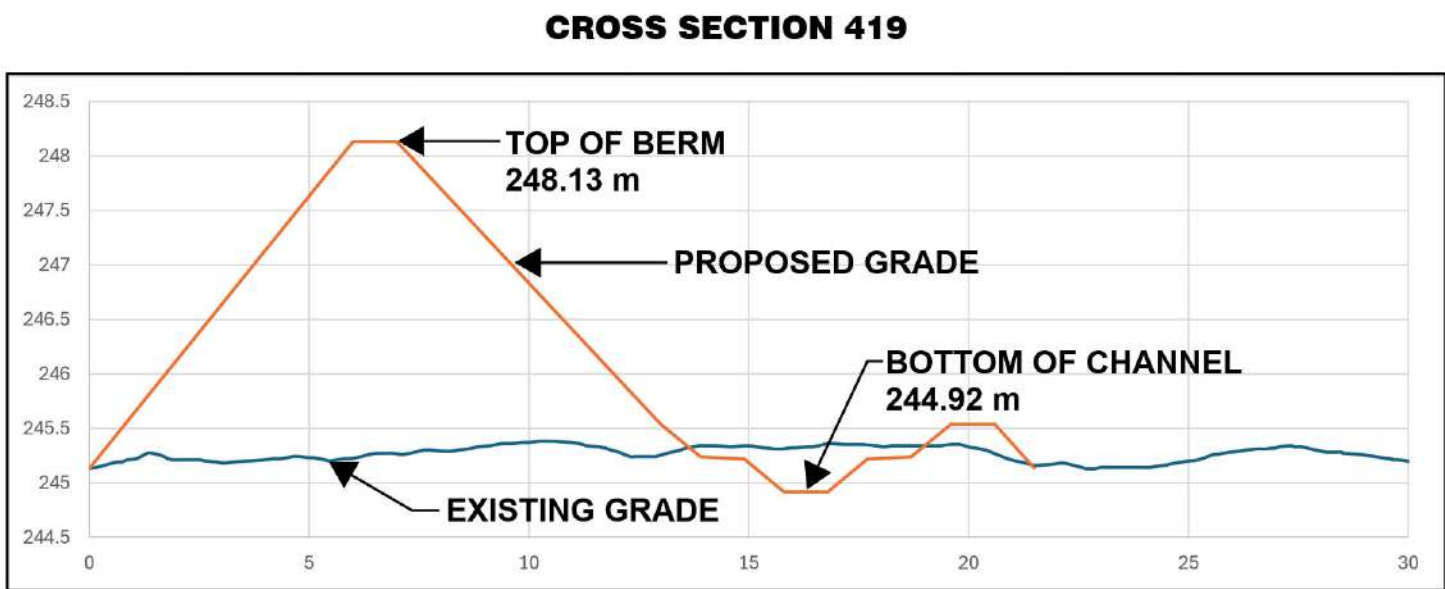
SARJEANTS RAMARA QUARRY

DRAWING TITLE

PHASE 2/3 SURFACE WATER MANAGEMENT PLAN

PROJECT	SCALE	DRAWING
424371	1:2,000	FIG.4





NOTES

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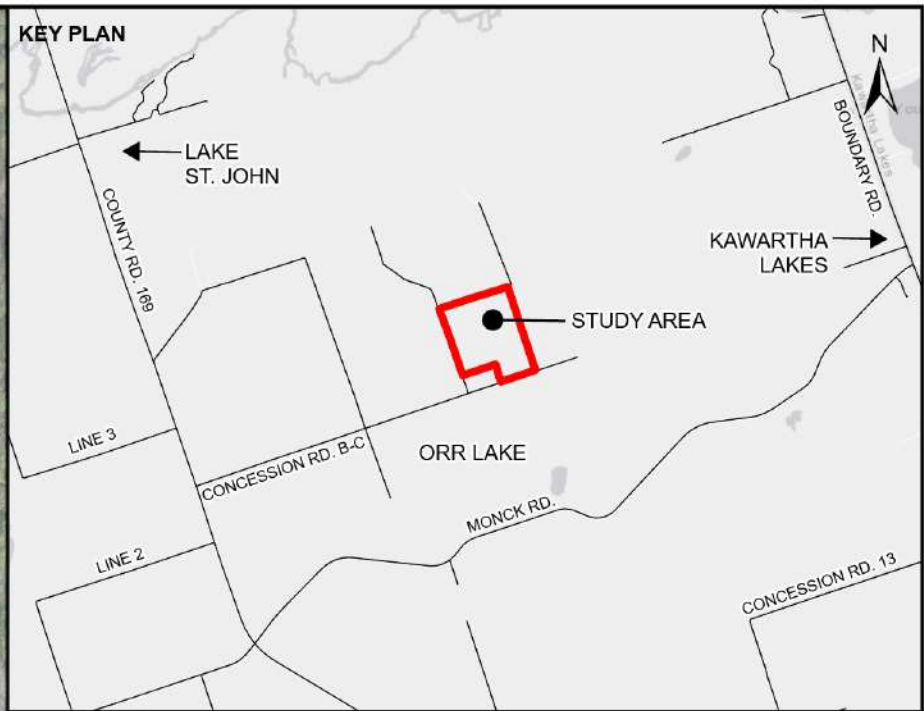
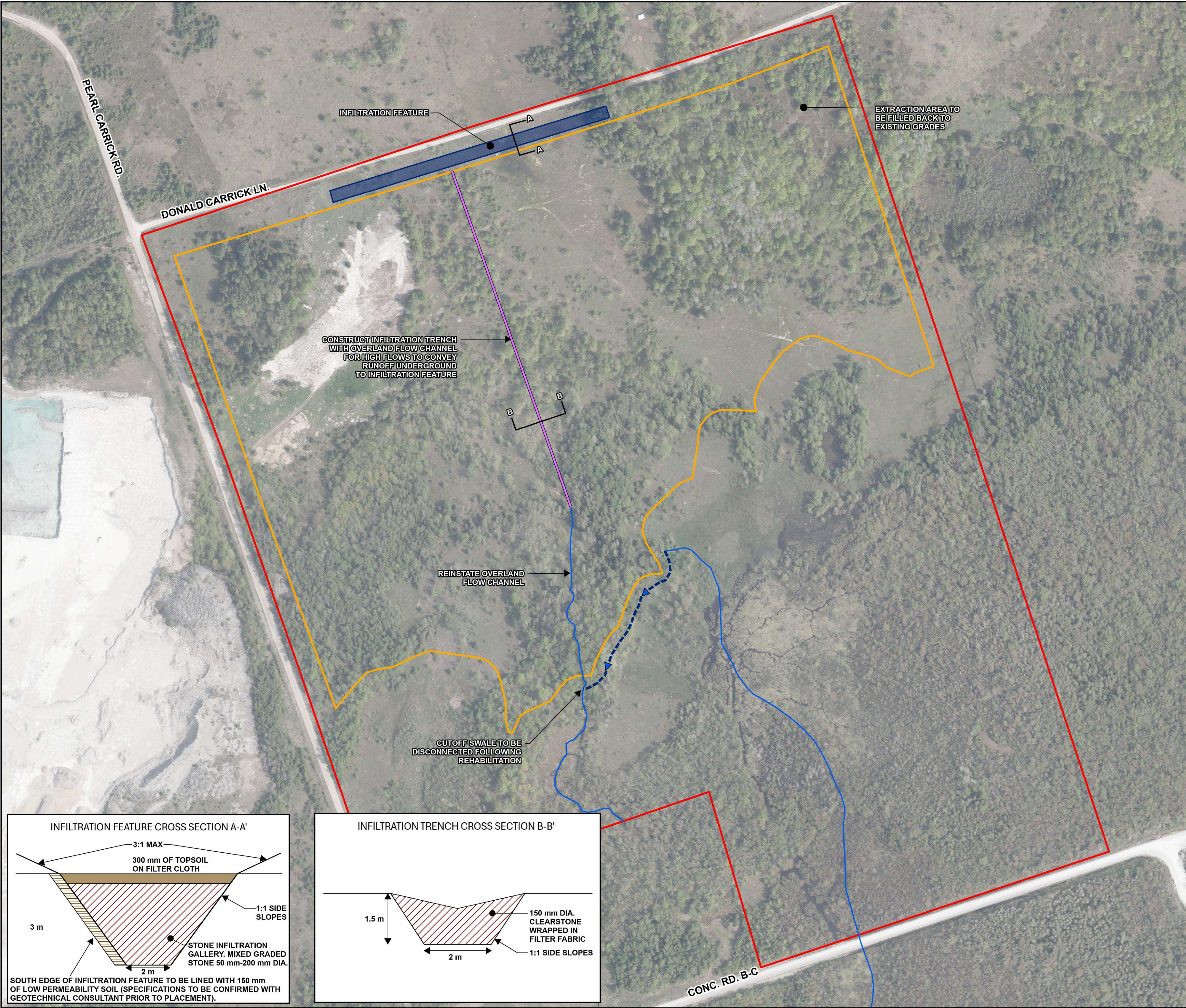
PROJECT TITLE

SARJEANTS RAMARA QUARRY

DRAWING TITLE

**REHABILITATION SURFACE
WATER MANAGEMENT PLAN**

PROJECT	SCALE	DRAWING
424371		FIG.5



LEGEND	
▭	SITE
▭	PROPOSED LIMIT OF EXTRACTION
▭	INFILTRATION FEATURE
▭	TRENCH
▬	SWALE
▬	WATERCOURSE

NOTES	

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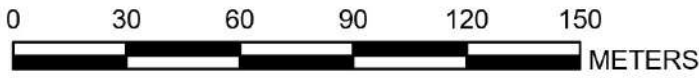
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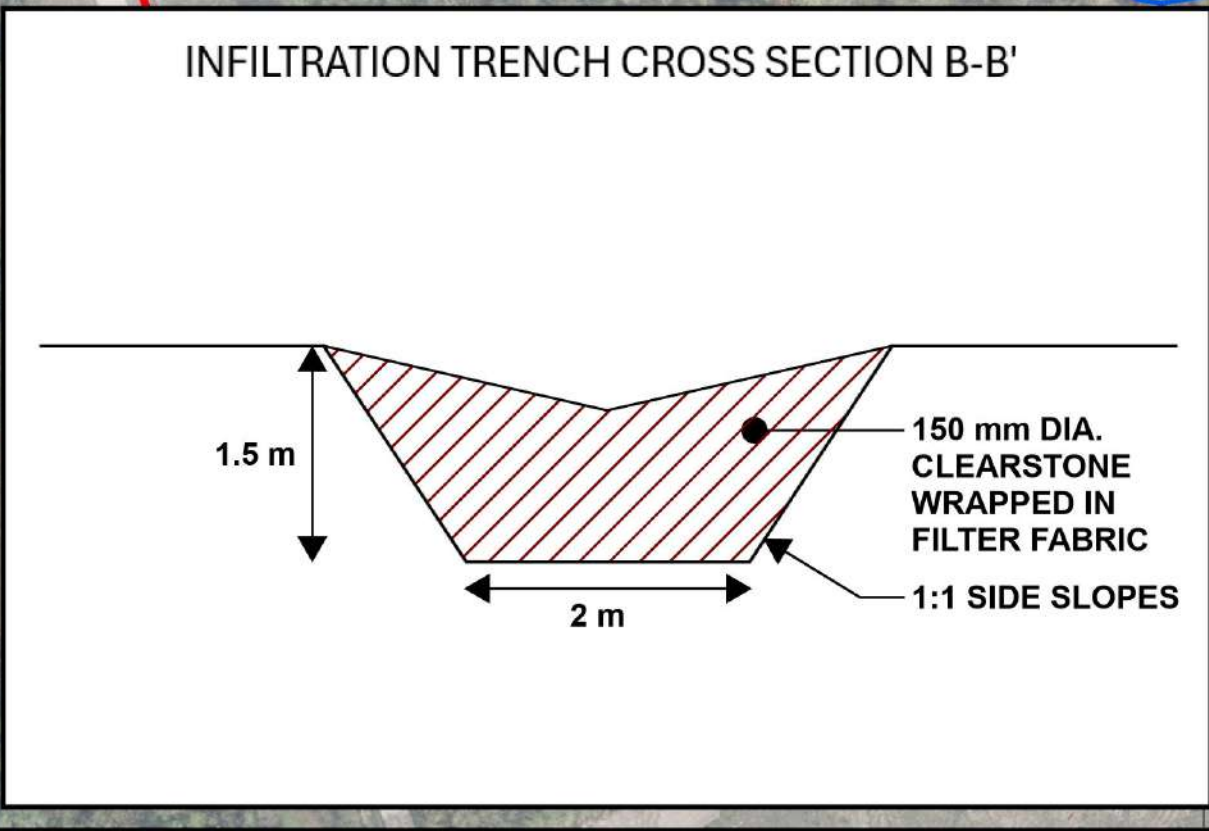
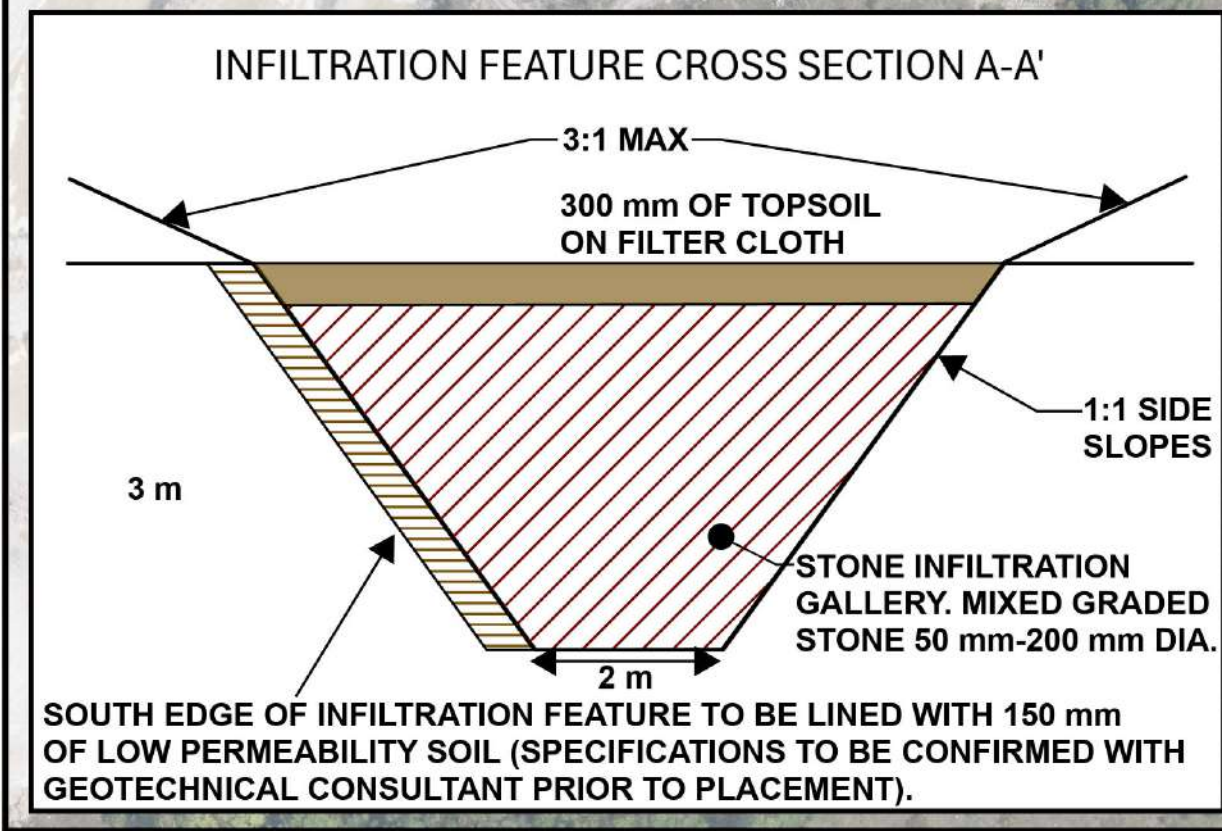
SARJEANTS RAMARA QUARRY

DRAWING TITLE

**REHABILITATION SURFACE
WATER MANAGEMENT PLAN**

PROJECT	SCALE	DRAWING
424371	1:2,000	FIG.6



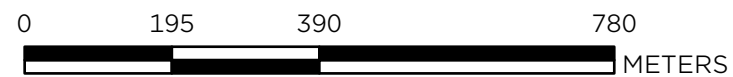
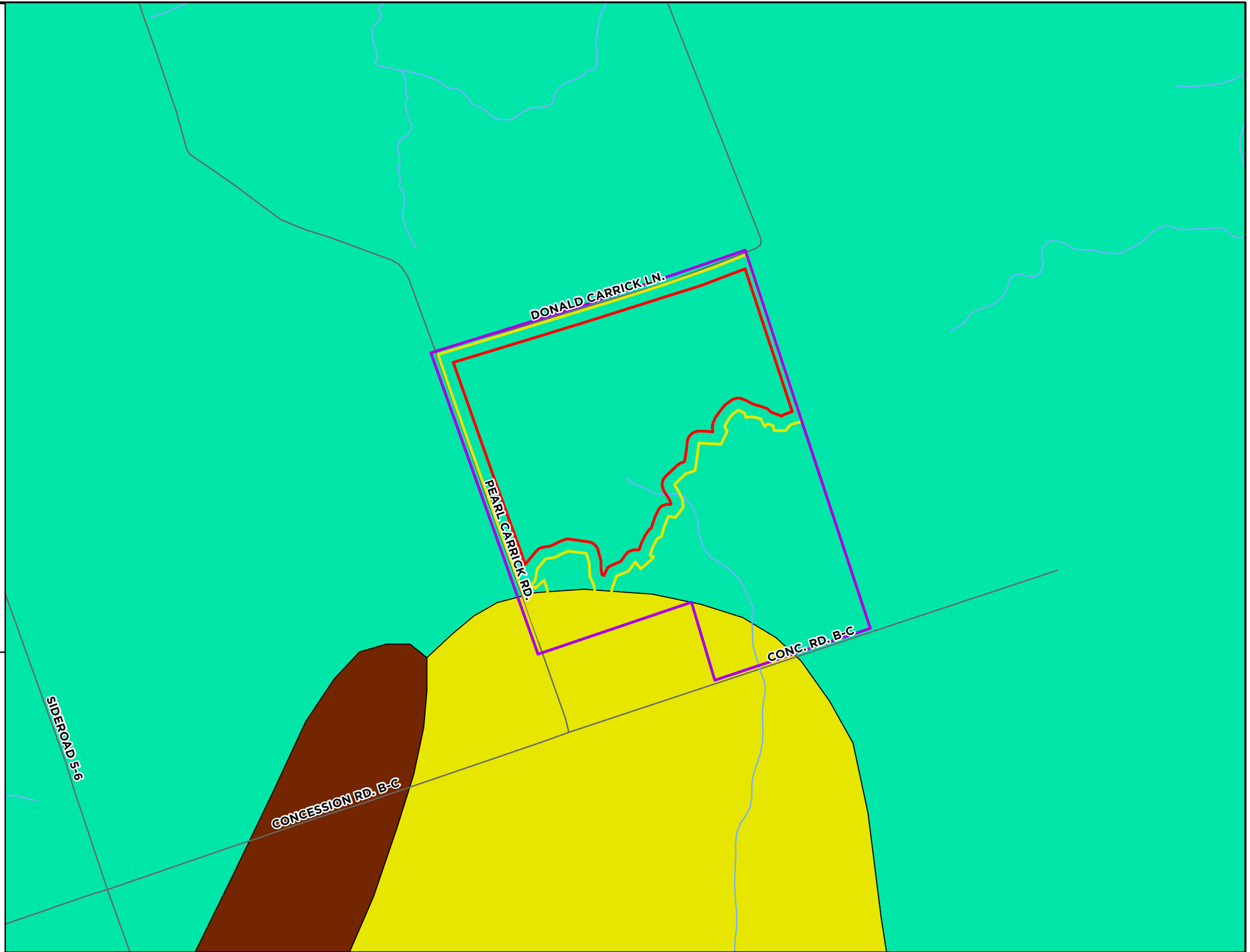




NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM
ZONE 17N
2. CONTAINS INFORMATION LICENSED
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ONTARIO.

LEGEND

-  PROPERTY BOUNDARY
-  PROPOSED LICENCE BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  WATERCOURSE
-  ROADS
- PHYSIOGRAPHY
-  DRUMLINS
-  LIMESTONE PLAINS
-  SAND PLAINS



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
PHYSIOGRAPHY MAPPING

DWG. No.
FIG-7

SCALE: 1:10,000	DRAWN: AO	DATE: DEC. 2025	JOB NO. 424371
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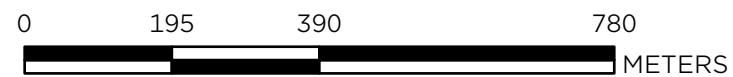
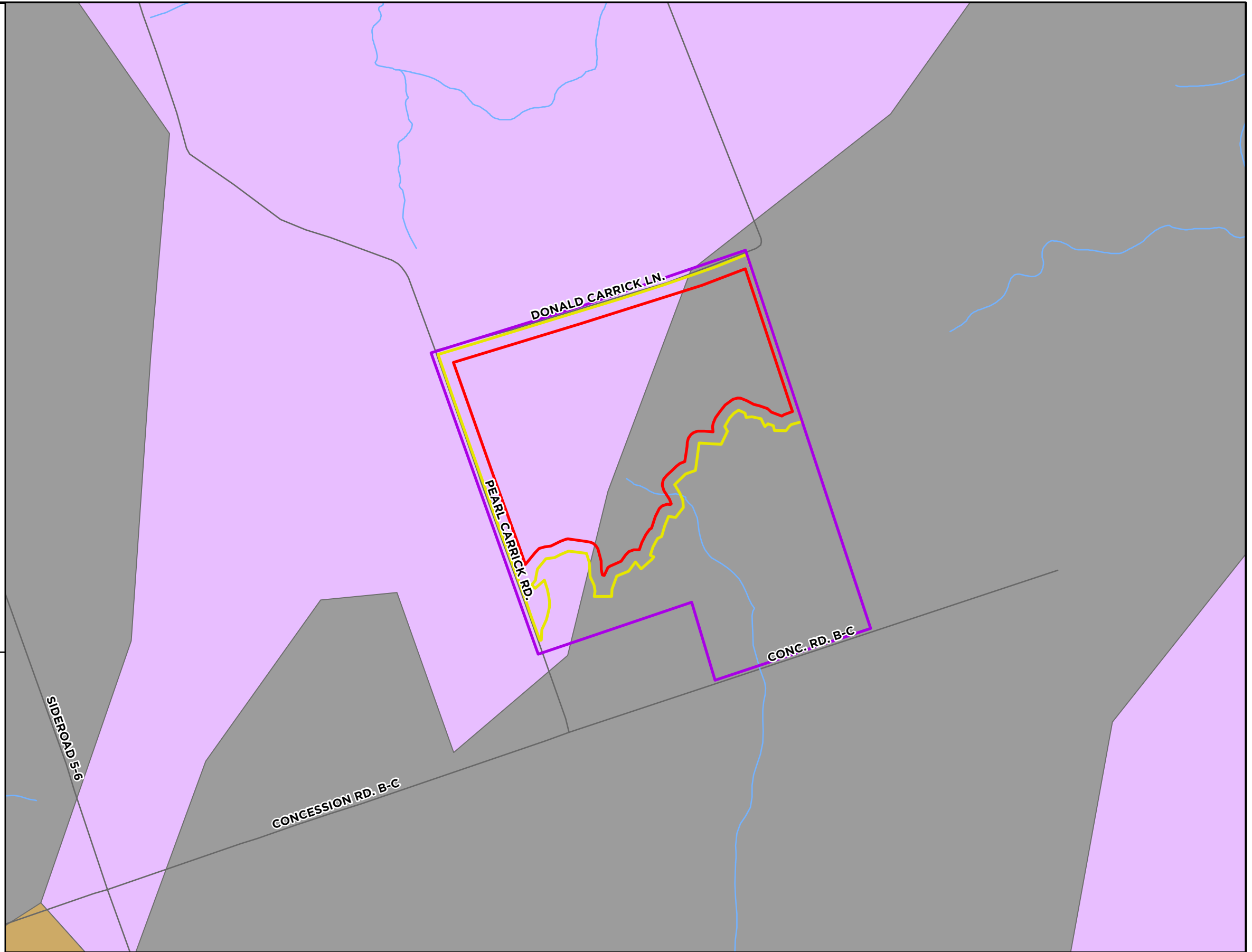


NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

-  PROPERTY BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  PROPOSED LICENCE BOUNDARY
-  WATERCOURSE
-  ROADS
- QUATERNARY GEOLOGY
 -  BEDROCK
 -  GLACIOLACUSTRINE DEPOSITS
 -  TILL



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
QUATERNARY GEOLOGY MAPPING

DWG. No.
FIG-8

SCALE: 1:10,000	DRAWN: AO	DATE: DEC. 2025	JOB NO. 424371
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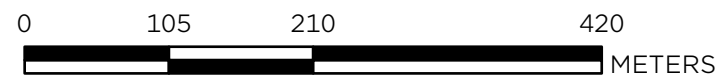
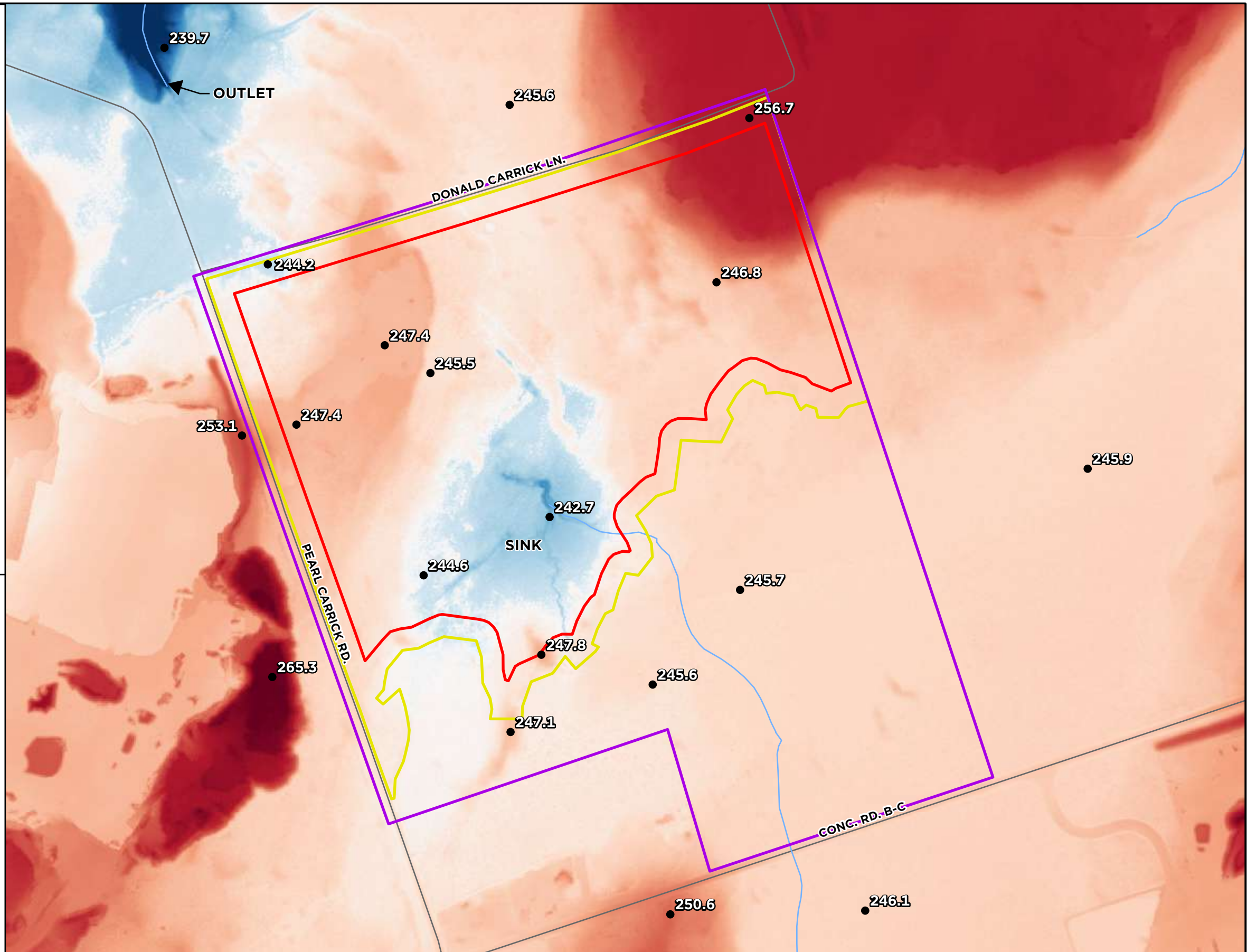
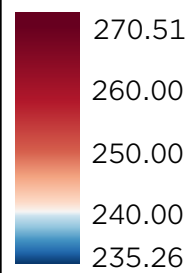
NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- WATERCOURSE
- ROADS
- SPOT ELEVATIONS

ELEVATION (M)



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
TOPOGRAPHY AND DRAINAGE

SCALE: 1:5,500

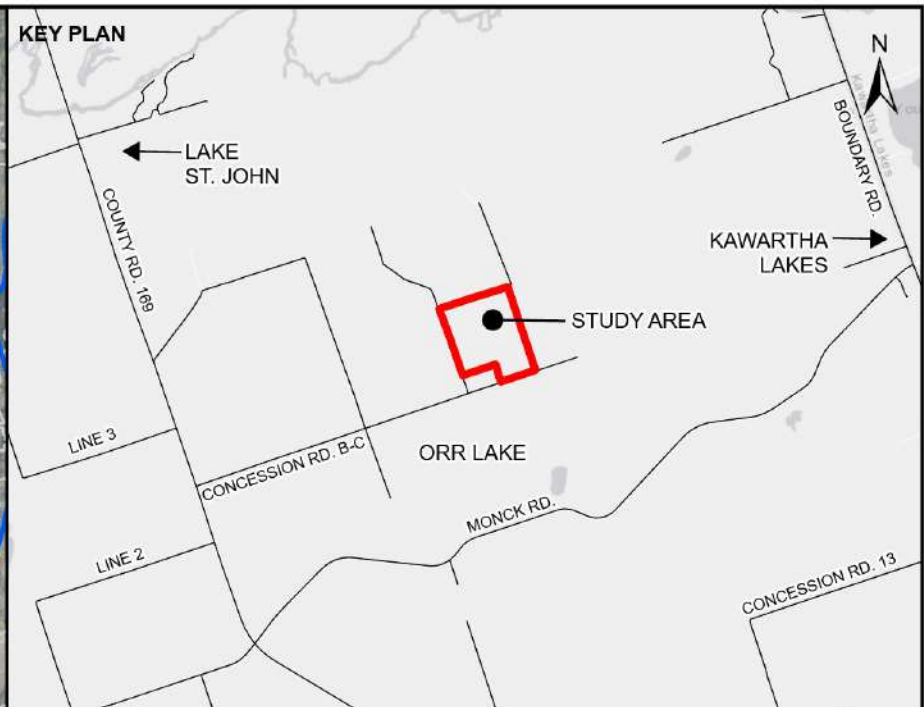
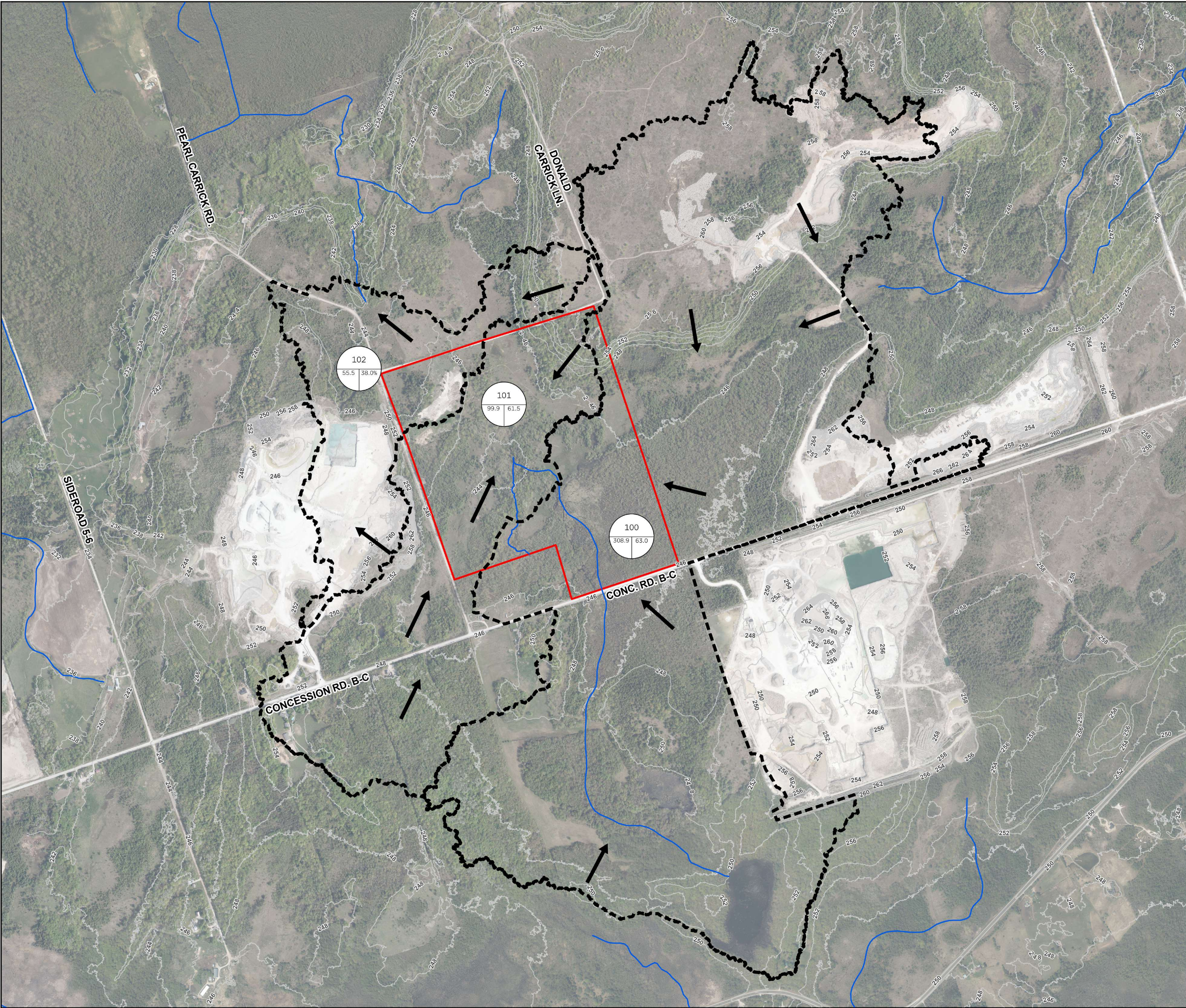
DRAWN: AO

DATE: DEC. 2025

DWG. No.

FIG-9

JOB NO. 424371



LEGEND

- SITE
- CATCHMENT BOUNDARY
- WATERCOURSE
- CONTOURS

100

308.9

63.0

CATCHMENT ID

CN NUMBER / % IMPERVIOUS

CATCHMENT AREA (ha)

NOTES

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PROJECT TITLE

SARJEANTS RAMARA QUARRY

DRAWING TITLE

**DRAINAGE PLAN
EXISTING CONDITIONS**

PROJECT	SCALE	DRAWING
424371	1:6,500	FIG.10

0110220330440550

METERS

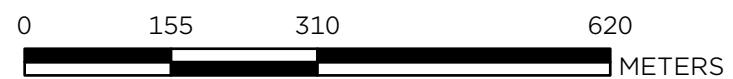
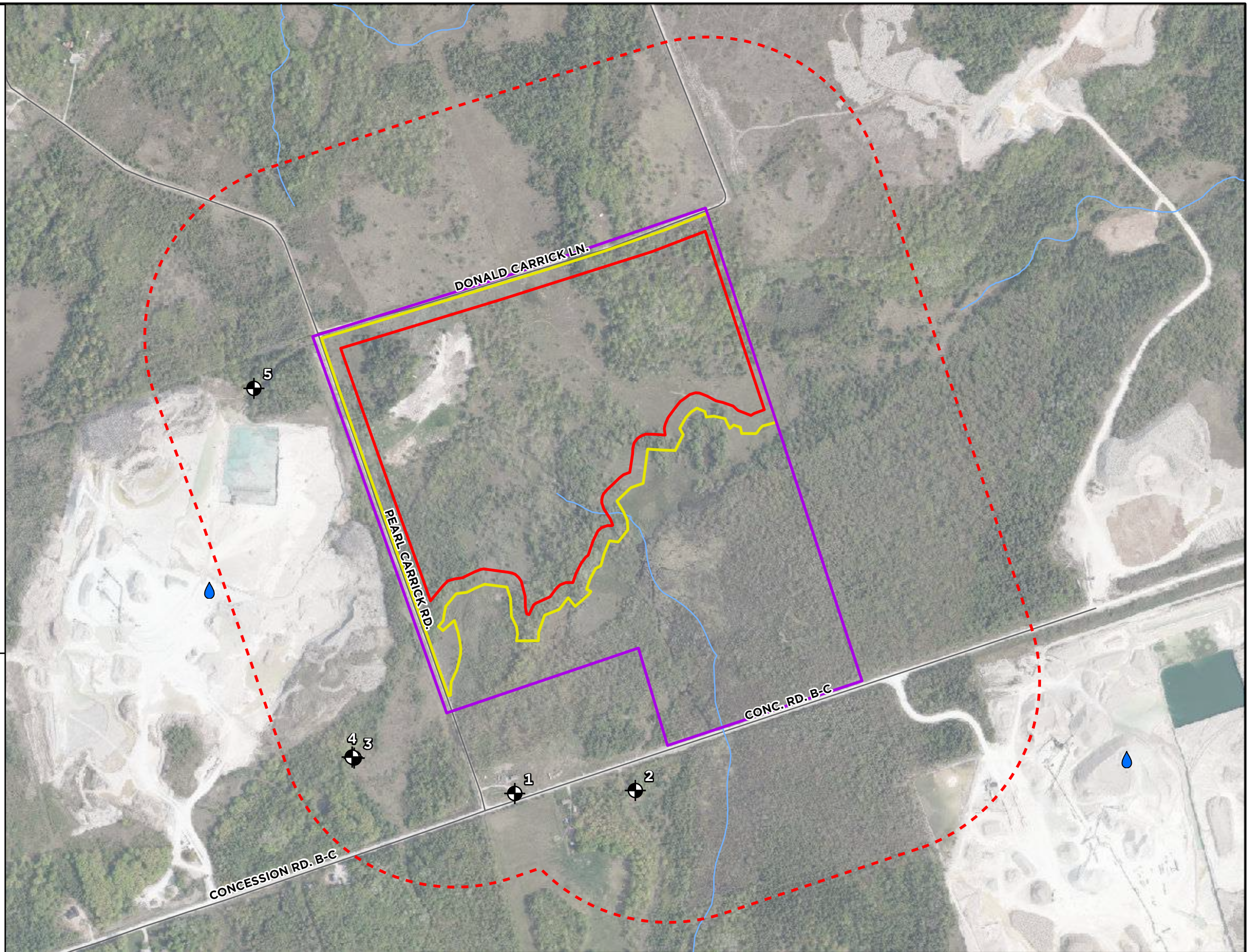


NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- STUDY AREA (500 M)
- ROADS
- WATERCOURSE
- MECP WATER WELL
- ACTIVE PTTW



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
MECP WATER WELL RECORDS

DWG. No.

FIG-11

SCALE: 1:8,000

DRAWN: AO

DATE: DEC. 2025

JOB NO. 424371

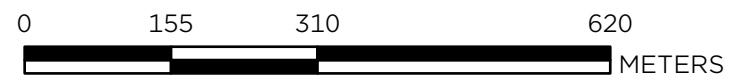
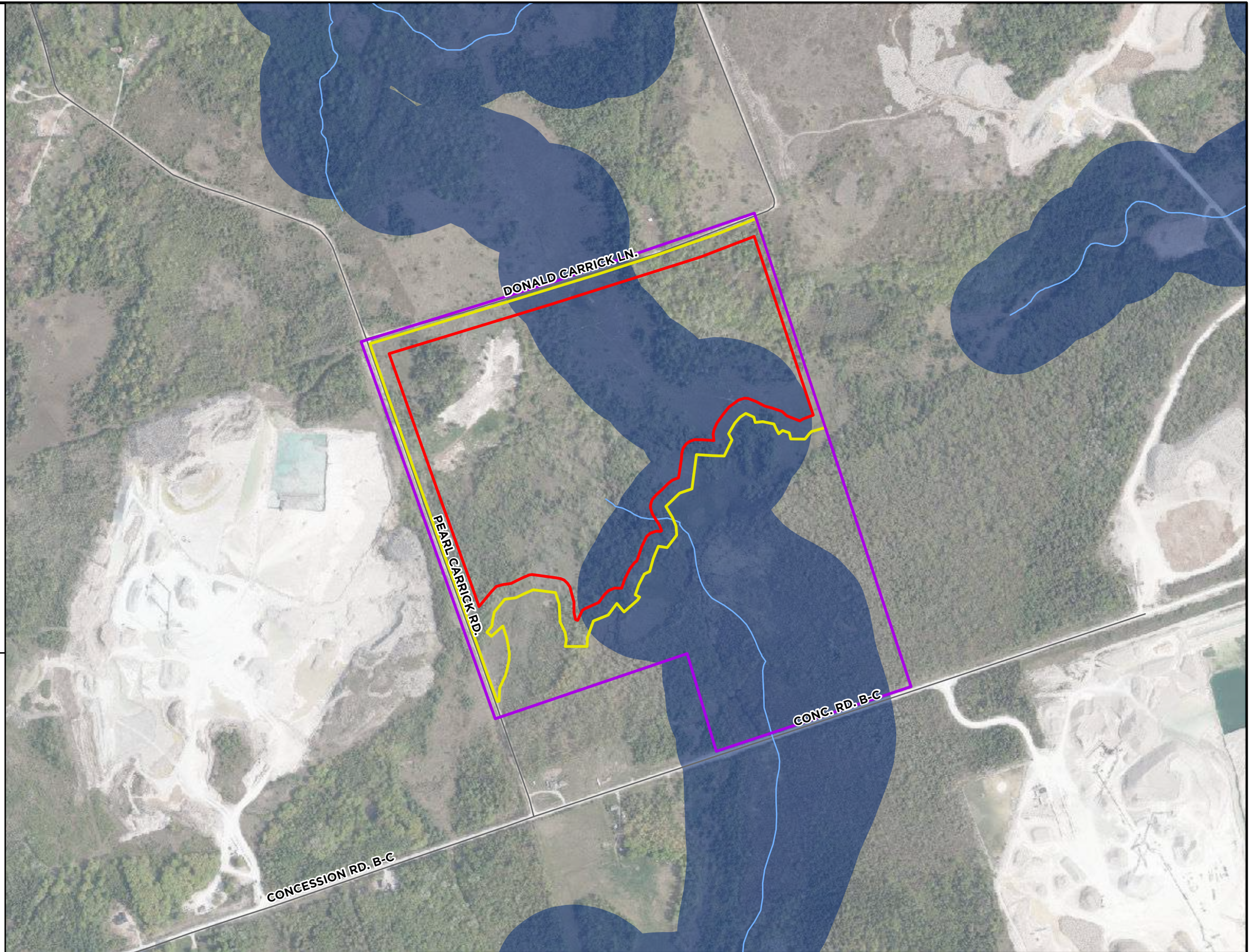


NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

-  PROPERTY BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  PROPOSED LICENCE BOUNDARY
-  INTAKE PROTECTION ZONE
-  ROADS
-  WATERCOURSE



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
INTAKE PROTECTION ZONES

DWG. No.

FIG-12

SCALE: 1:8,000

DRAWN: AO

DATE: DEC. 2025

JOB NO. 424371

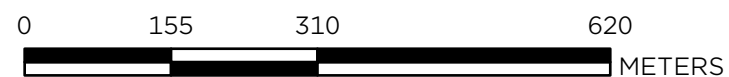
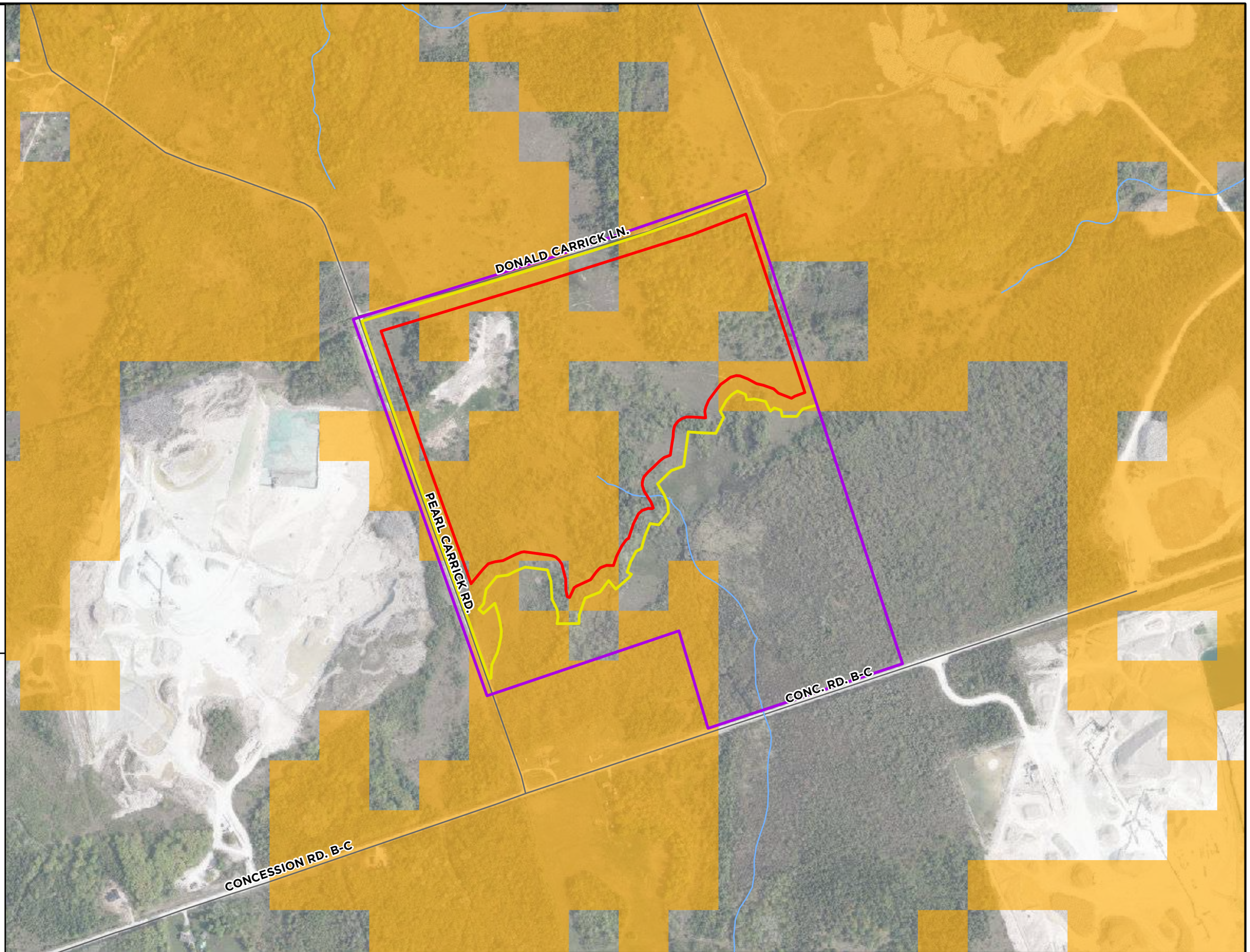


NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

-  PROPERTY BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  PROPOSED LICENCE BOUNDARY
-  SIGNIFIGANT GROUNDWATER RECHARGE AREA
-  ROADS
-  WATERCOURSE



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
SIGNIFICANT GROUNDWATER RECHARGE AREA

SCALE: 1:8,000

DRAWN: AO

DATE: DEC. 2025

DWG. No.

FIG-13

JOB NO. 424371

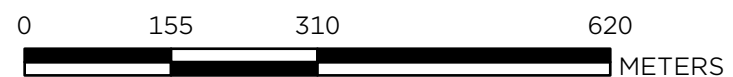
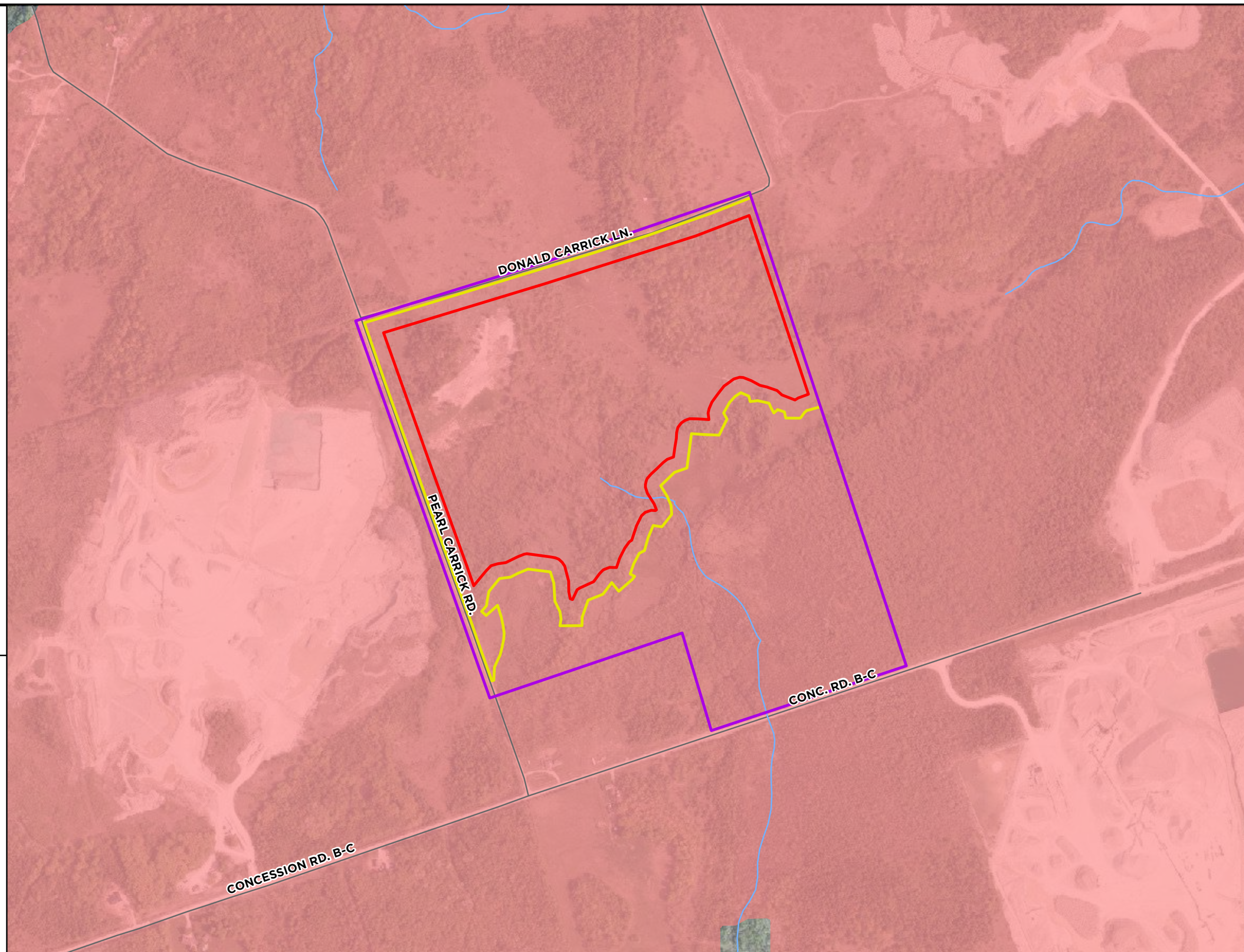


NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

-  PROPERTY BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  PROPOSED LICENCE BOUNDARY
-  HIGHLY VULNERABLE AQUIFER
-  ROADS
-  WATERCOURSE



**RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
HIGHLY VULNERABLE AQUIFER**

SCALE: 1:8,000

DRAWN: AO

DATE: DEC. 2025

DWG. No.

FIG-14

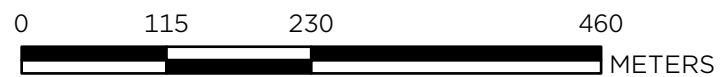
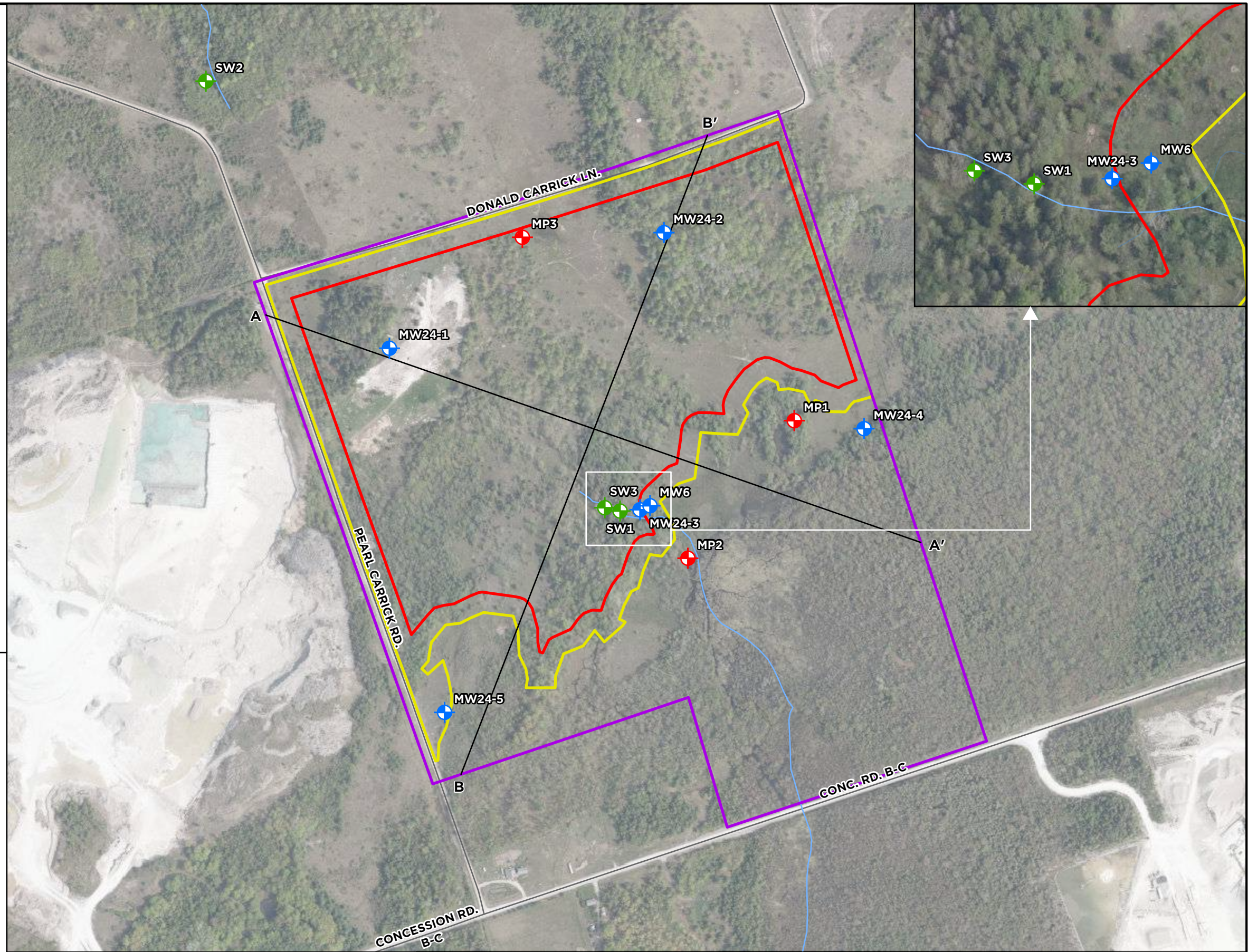
JOB NO. 424371



NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

-  PROPERTY BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  PROPOSED LICENCE BOUNDARY
-  PIEZOMETER
-  MONITORING WELL
-  STREAMFLOW MONITORING LOCATIONS
-  ROADS
-  WATERCOURSE
-  CROSS-SECTIONS



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
SITE MONITORING LOCATION PLAN

SCALE: 1:6,000 DRAWN: AO DATE: DEC. 2025

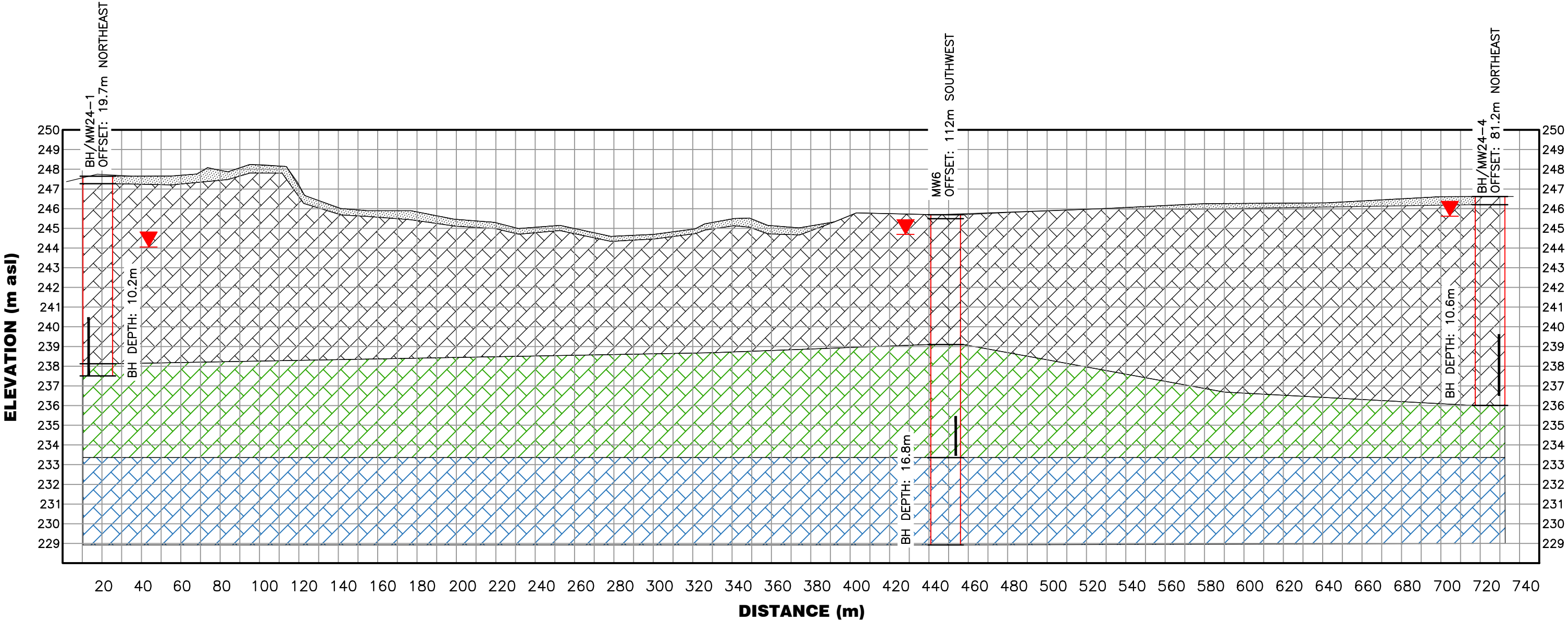
DWG. No.

FIG-15

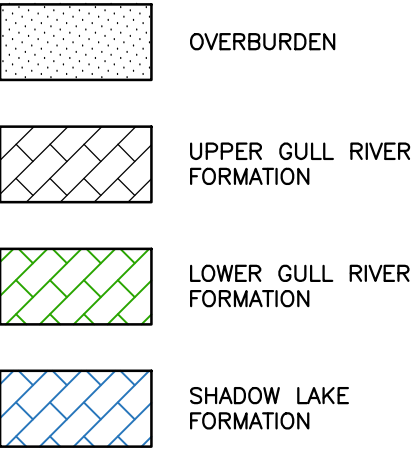
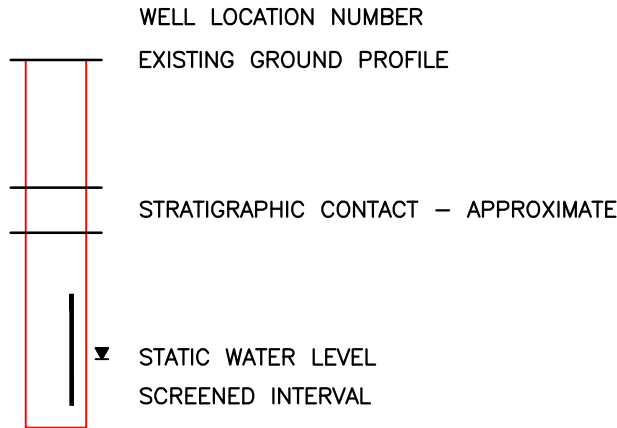
JOB NO. 424371

NORTHWEST

SOUTHEAST



LEGEND



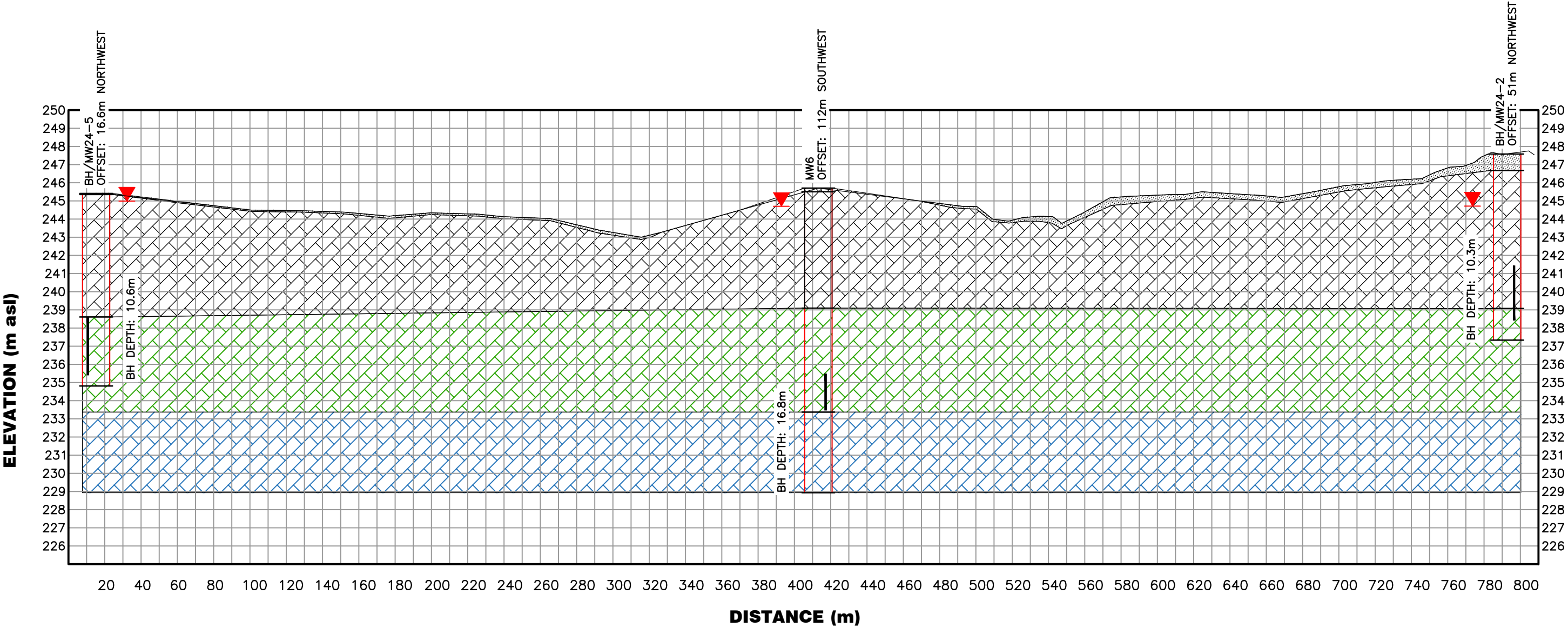
RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
CROSS-SECTION A-A'

SCALE: AS NOTED | DRAWN: HDY | DATE: DEC 2025 | JOB NO. 424371

No.
FIG-16

SOUTHWEST

NORTHEAST



LEGEND

WELL LOCATION NUMBER

EXISTING GROUND PROFILE

STRATIGRAPHIC CONTACT – APPROXIMATE

▼ STATIC WATER LEVEL

SCREENED INTERVAL

OVERBURDEN

UPPER GULL RIVER FORMATION

LOWER GULL RIVER FORMATION

SHADOW LAKE FORMATION

HORIZONTAL SCALE: 1:2250
VERTICAL SCALE: 1:225
VERTICAL EXAGGERATION: 10X



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
CROSS-SECTION B-B'

No.
FIG-17

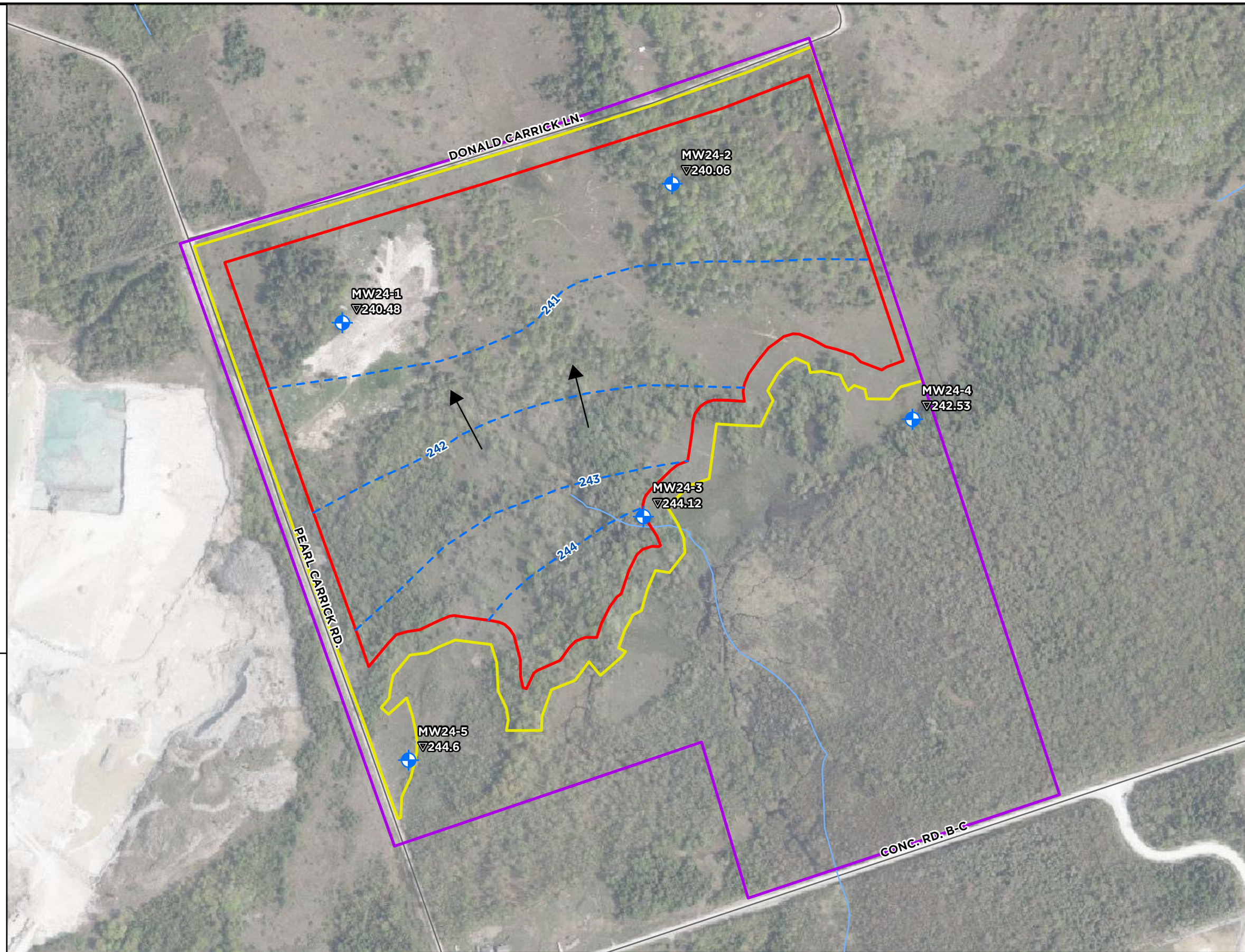
SCALE: AS NOTED | DRAWN: HDY | DATE: DEC 2025 | JOB NO. 424371



NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- ▬ PROPOSED LICENCE BOUNDARY
- ▬ PROPOSED LIMIT OF EXTRACTION
- ▬ PROPERTY BOUNDARY
- ⊕ MONITORING WELL
- WATERCOURSE
- ROADS
- - - GROUNDWATER CONTOUR
- ▽ GROUNDWATER ELEVATION (MEASURED JULY 2024)
- GROUNDWATER FLOW DIRECTION



0 95 190 380
METERS

TATHAM
ENGINEERING

RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER CONTOUR SUMMER (JULY 2024)

SCALE: 1:5,000

DRAWN: AO

DATE: DEC. 2025

DWG. No.

FIG-18

JOB NO. 424371

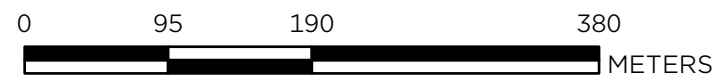
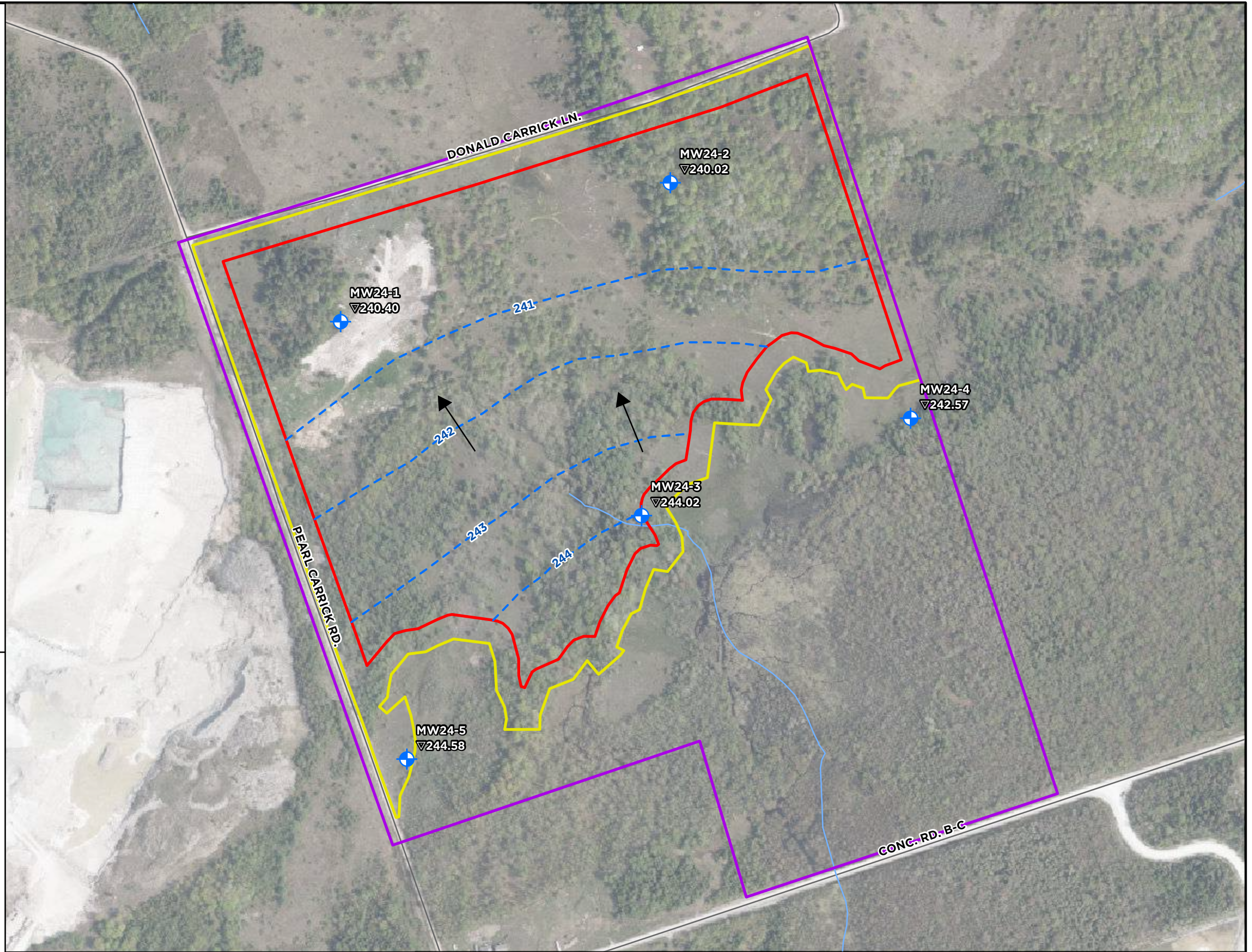


NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- MONITORING WELL
- ROADS
- WATERCOURSE
- GROUNDWATER CONTOUR
- GROUNDWATER ELEVATION (MEASURED OCTOBER 2024)
- GROUNDWATER FLOW DIRECTION



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER CONTOUR FALL (OCTOBER 2024)

SCALE: 1:5,000

DRAWN: AO

DATE: DEC. 2025

DWG. No.

FIG-19

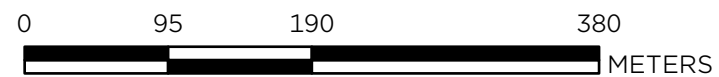
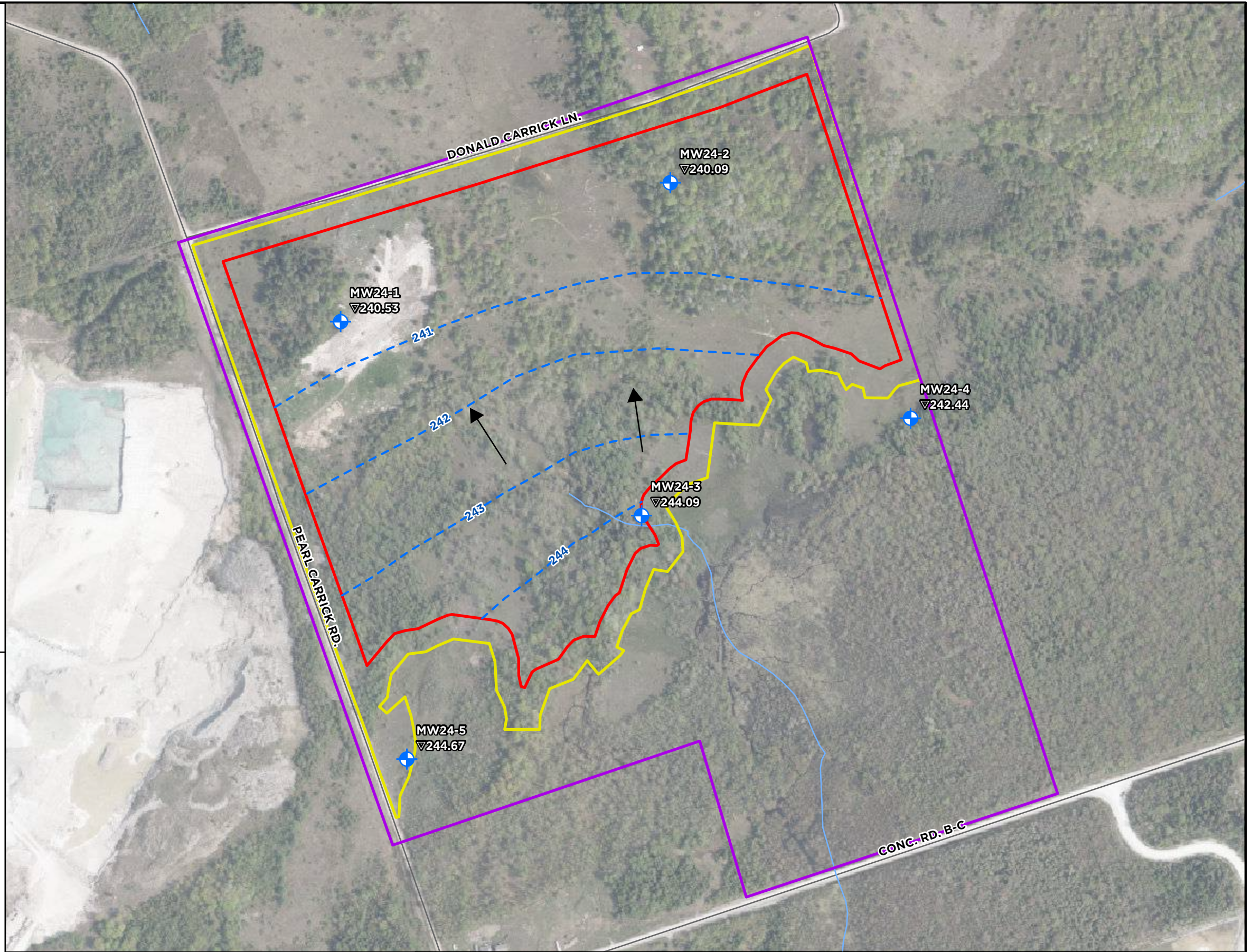
JOB NO. 424371



NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

-  PROPERTY BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  PROPOSED LICENCE BOUNDARY
-  MONITORING WELL
-  ROADS
-  WATERCOURSE
-  GROUNDWATER CONTOUR
-  GROUNDWATER ELEVATION (MEASURED JANUARY 2025)
-  GROUNDWATER FLOW DIRECTION



RAMARA QUARRY LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT GROUNDWATER CONTOUR WINTER (JANUARY 2025)			DWG. No.
SCALE: 1:5,000			FIG-20
DRAWN: AO	DATE: DEC. 2025	JOB NO. 424371	

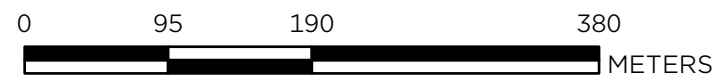
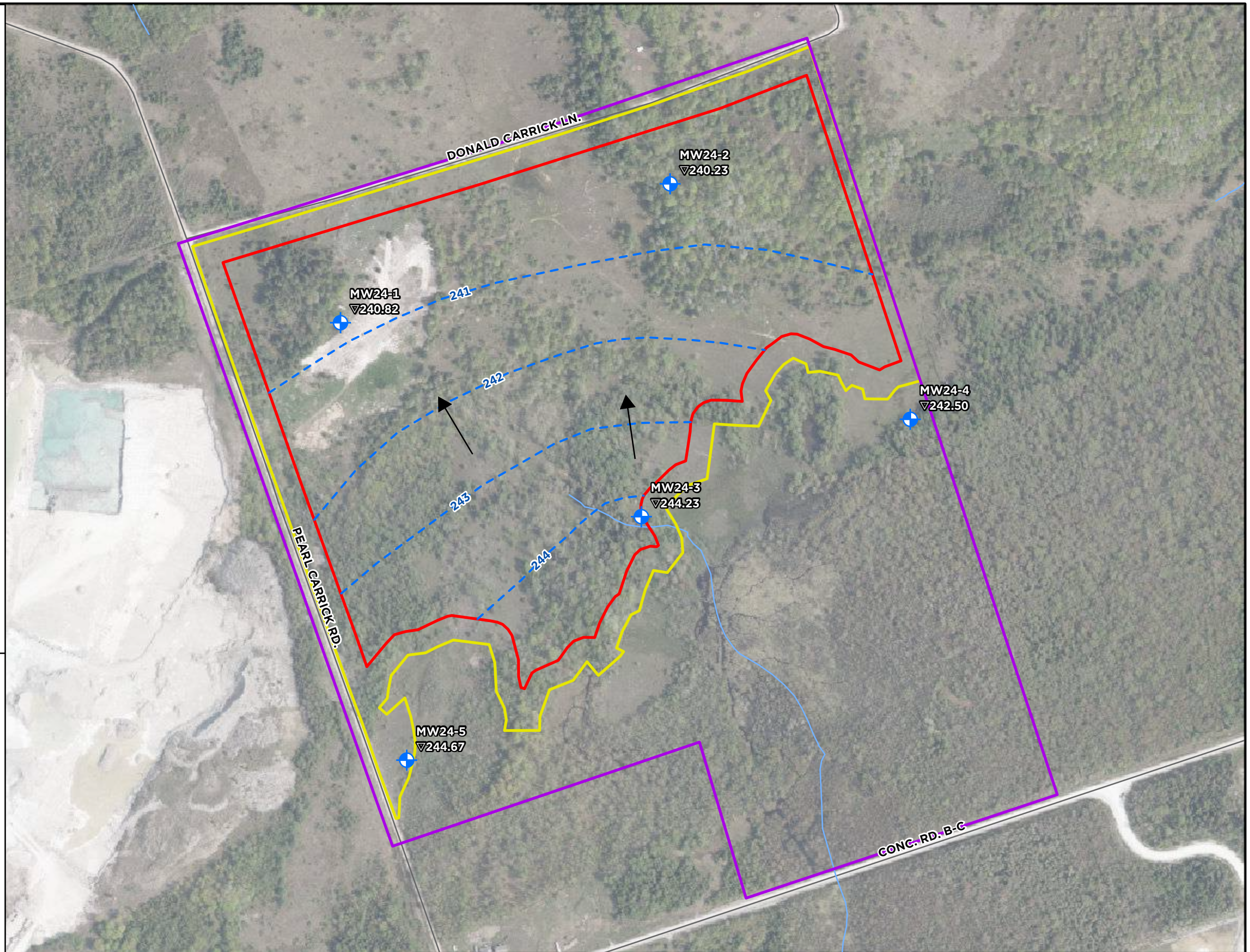


NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

-  MONITORING WELL
-  GROUNDWATER CONTOUR_ APRIL 25
-  PROPERTY BOUNDARY
-  PROPOSED LIMIT OF EXTRACTION
-  PROPOSED LICENCE BOUNDARY
-  WATERCOURSE
-  ROADS
-  GROUNDWATER ELEVATION (MEASURED APRIL 2025)
-  GROUNDWATER FLOW DIRECTION



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER CONTOUR SPRING (APRIL 2025)

SCALE: 1:5,000

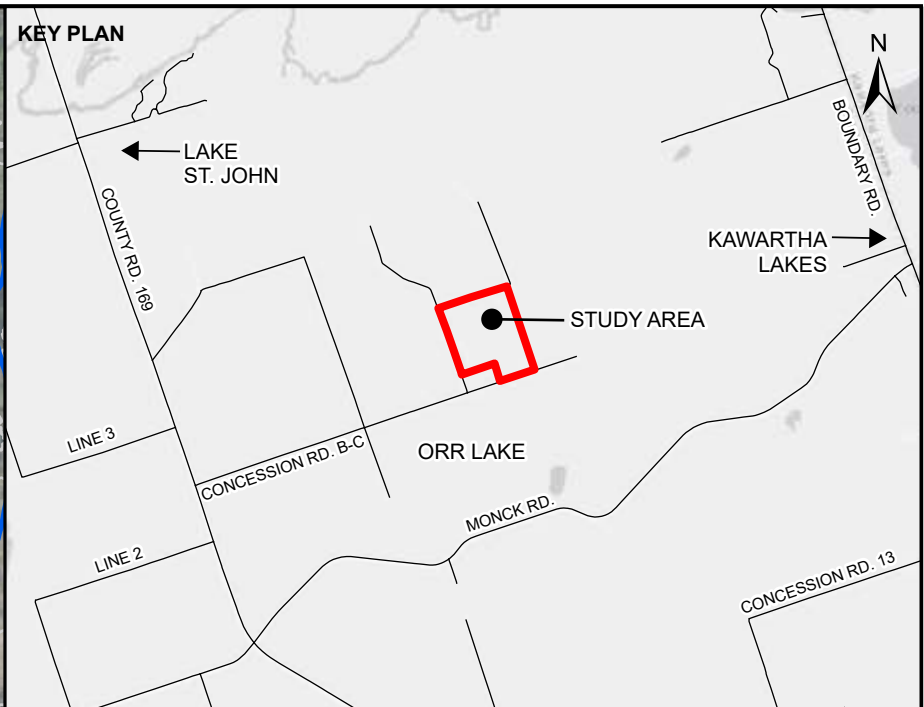
DRAWN: AO

DATE: DEC. 2025

DWG. No.

FIG-21

JOB NO. 424371



LEGEND

- SITE
- CATCHMENT BOUNDARY
- WATERCOURSE
- CONTOURS

200

307.2

63.0

CATCHMENT ID

CN NUMBER / % IMPERVIOUS

CATCHMENT AREA (ha)

NOTES

DISCLAIMER & COPYRIGHT
CONTRACTOR MUST VERIFY ALL DIMENSIONS AND BE RESPONSIBLE FOR SAME. ANY DISCREPANCIES MUST BE REPORTED TO THE ENGINEER BEFORE COMMENCING WORK. DRAWINGS ARE NOT TO BE SCALED.
TATHAM ENGINEERING LIMITED CLAIMS COPYRIGHT TO THIS DRAWING WHICH MAY NOT BE USED FOR ANY PURPOSE OTHER THAN THAT PROVIDED IN THE CONTRACT BETWEEN THE OWNER/CLIENT AND THE ENGINEER WITHOUT THE EXPRESS CONSENT OF TATHAM ENGINEERING LIMITED.

VERSION	DATE
1 FIRST SUBMISSION	OCT. 2025

DESIGN BY: JP	DRAWN BY: ASO	CHECKED BY: JTG	DATE: DEC. 2025
---------------	---------------	-----------------	-----------------

STAMP

TATHAM

ENGINEERING

COLLINGWOOD - BRACEBRIDGE - ORILLIA - BARRIE - OTTAWA - GUELPH

PROJECT TITLE

SARJEANTS RAMARA QUARRY

DRAWING TITLE

DRAINAGE PLAN
PROPOSED EXTRACTION PHASE 1

PROJECT

424371

SCALE

1:6,500

DRAWING

FIG.22

0

110

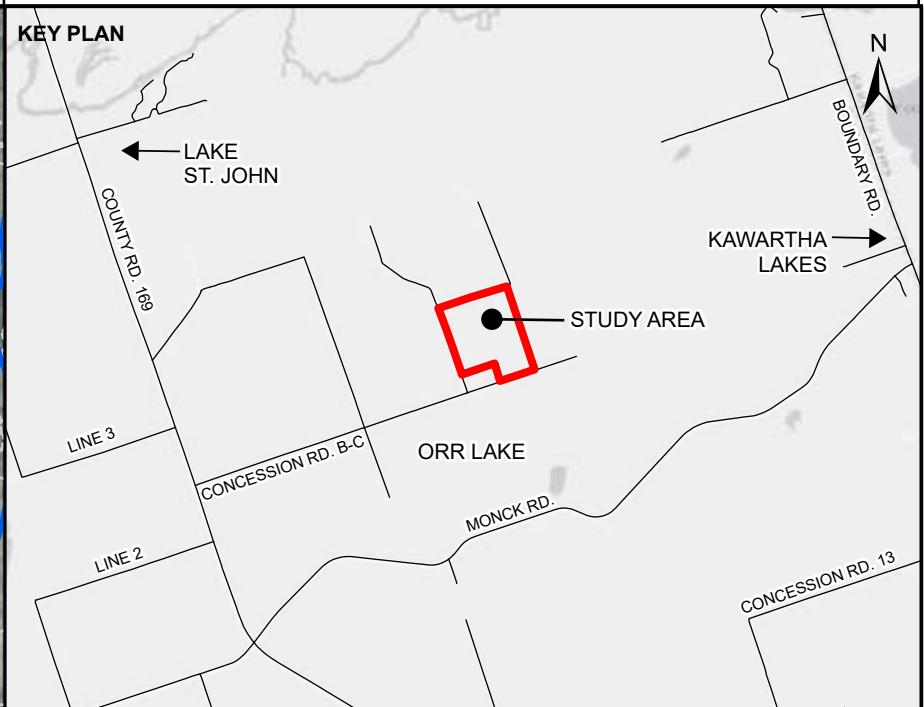
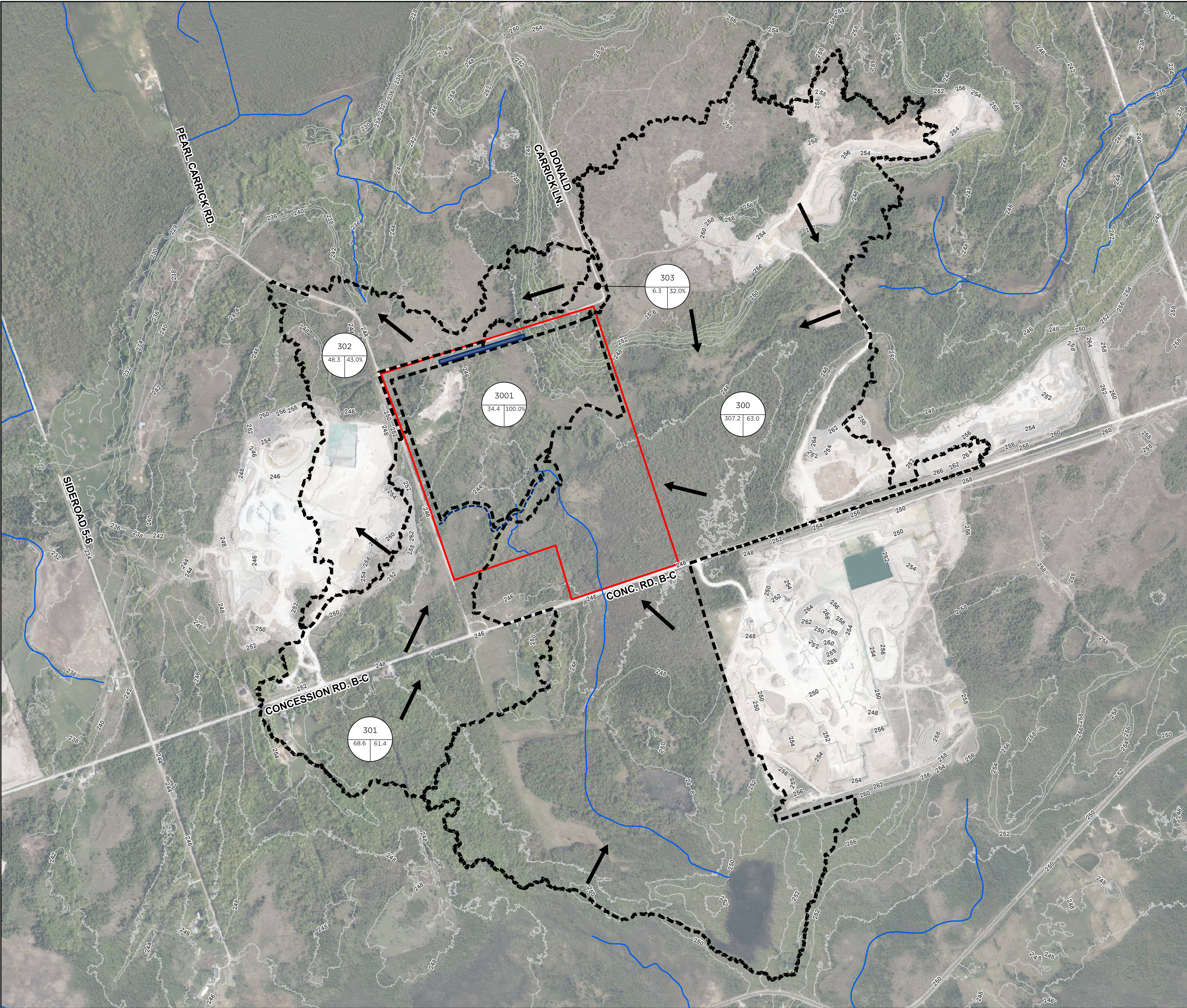
220

330

440

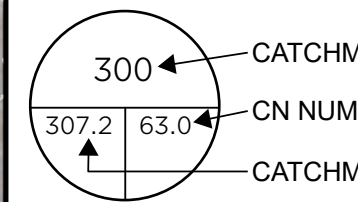
550

METERS



LEGEND

- SITE
- CATCHMENT BOUNDARY
- WATERCOURSE
- CONTOURS
- SWALE
- FORCEMAIN
- INFILTRATION FEATURE



CATCHMENT ID
CN NUMBER / % IMPERVIOUS
CATCHMENT AREA (ha)

NOTES

DISCLAIMER & COPYRIGHT
CONTRACTOR MUST VERIFY ALL DIMENSIONS AND BE RESPONSIBLE FOR SAME. ANY DISCREPANCIES MUST BE REPORTED TO THE ENGINEER BEFORE COMMENCING WORK. DRAWINGS ARE NOT TO BE SCALED.
TATHAM ENGINEERING LIMITED CLAIMS COPYRIGHT TO THIS DRAWING WHICH MAY NOT BE USED FOR ANY PURPOSE OTHER THAN THAT PROVIDED IN THE CONTRACT BETWEEN THE OWNER/CLIENT AND THE ENGINEER WITHOUT THE EXPRESS CONSENT OF TATHAM ENGINEERING LIMITED.

VERSION	DATE
1 FIRST SUBMISSION	OCT. 2025

DESIGN BY: JP	DRAWN BY: ASO	CHECKED BY: JTG	DATE: DEC. 2025
---------------	---------------	-----------------	-----------------

STAMP


COLLINGWOOD - BRACEBRIDGE - ORILLIA - BARRIE - OTTAWA - GUELPH

PROJECT TITLE
SARJEANTS RAMARA QUARRY

DRAWING TITLE
**DRAINAGE PLAN
PROPOSED EXTRACTION PHASE 2/3**

PROJECT 424371	SCALE 1:6,500	DRAWING FIG.23
--------------------------	-------------------------	--------------------------

0 110 220 330 440 550 METERS



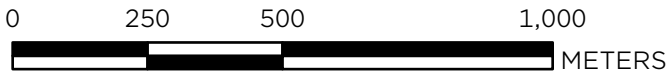
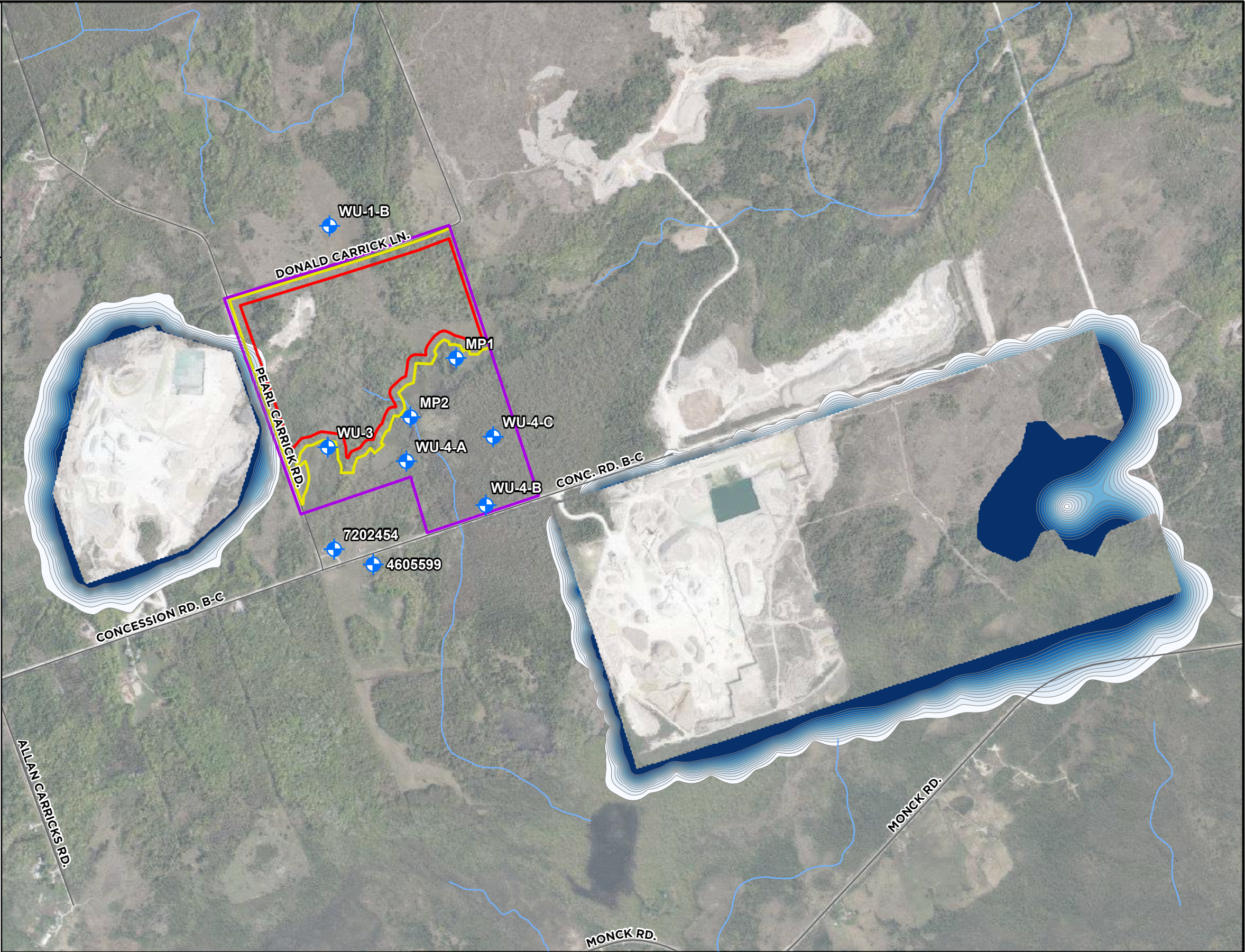
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 13.00
- 13.01 - 14.00
- 14.01 - 15.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN WEATHERED
BEDROCK/OVERBURDEN (BASELINE)

SCALE: 1:14,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371

DWG. No.
FIG-24



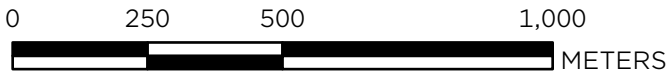
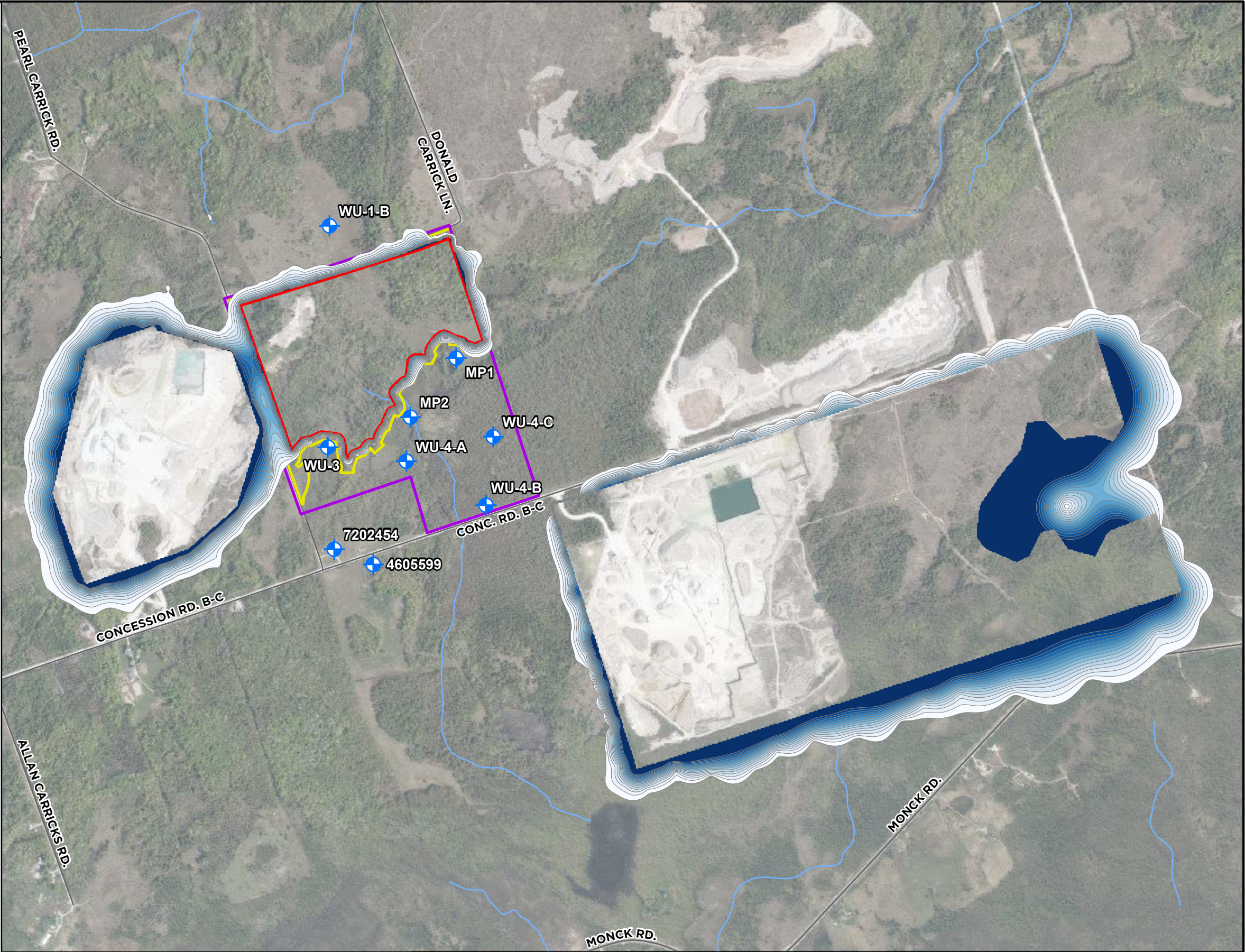
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 13.00
- 13.01 - 14.00
- 14.01 - 15.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN WEATHERED
BEDROCK/OVERBURDEN (FULL EXTRACTION)

SCALE: 1:14,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371

DWG. No.
FIG-25



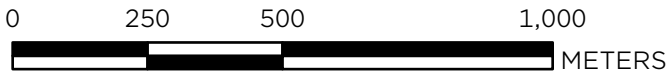
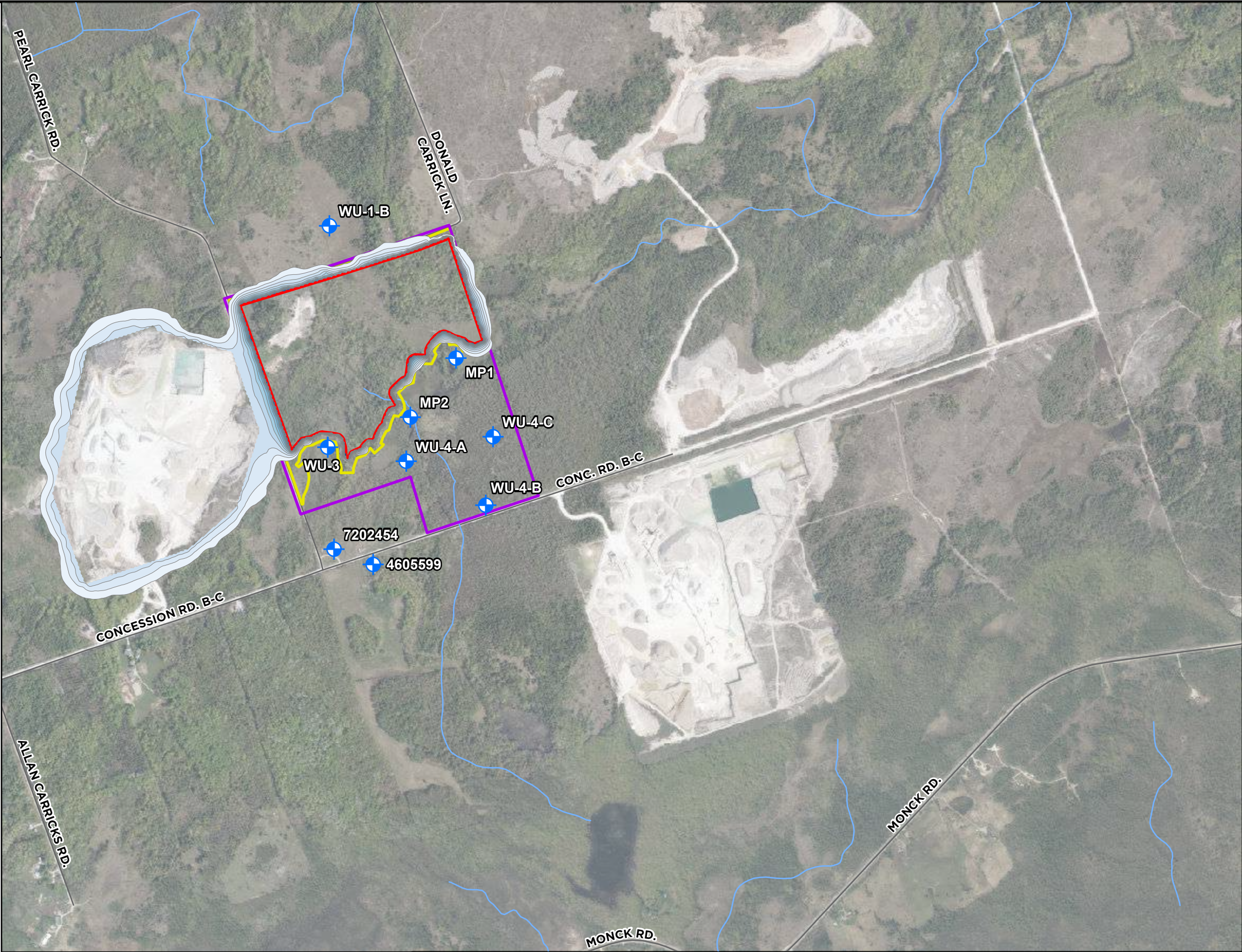
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 13.00
- 13.01 - 14.00
- 14.01 - 15.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN WEATHERED
BEDROCK/OVERBURDEN (INCREMENTAL)

DWG. No.
FIG-26

SCALE: 1:14,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371



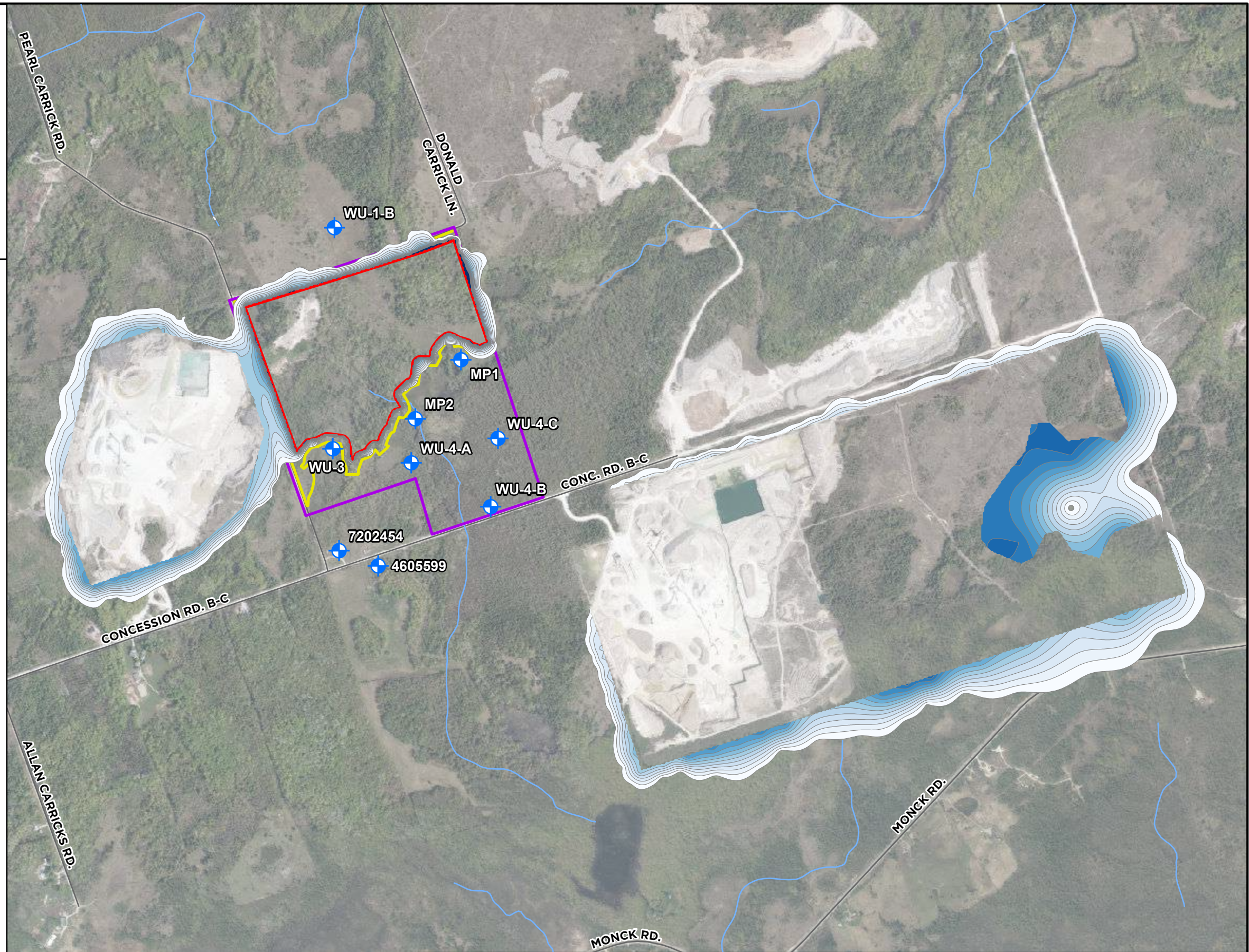
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 13.00
- 13.01 - 14.00
- 14.01 - 15.00



0 250 500 1,000
METERS

TATHAM
ENGINEERING

RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN WEATHERED BEDROCK
/OVERBURDEN (REHABILITATION BASELINE)

SCALE: 1:14,000 DRAWN: AO DATE: DEC. 2025 JOB NO. 424371

DWG. No.
FIG-27



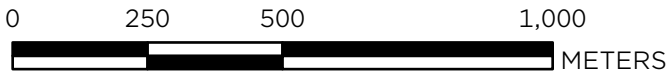
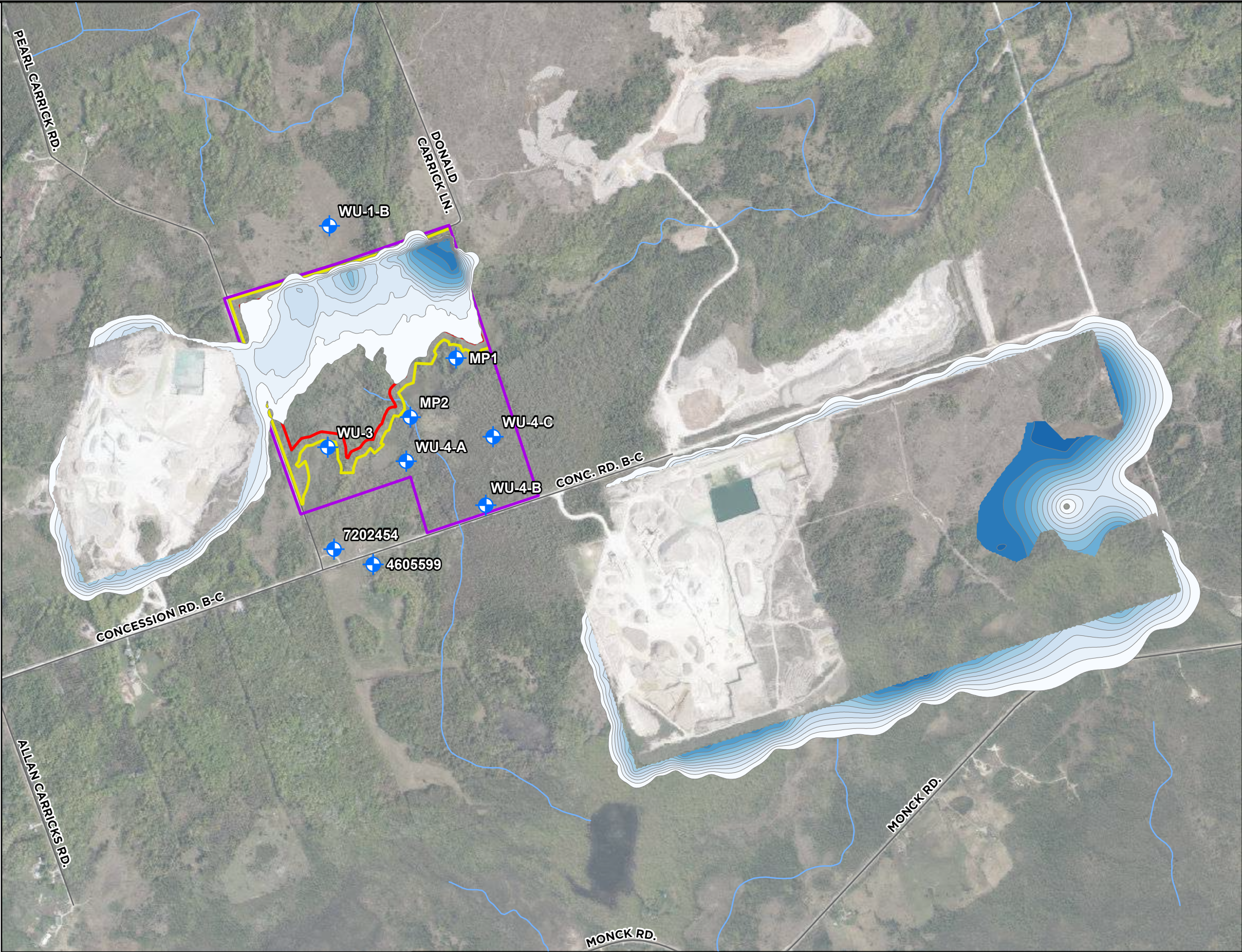
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 13.00
- 13.01 - 14.00
- 14.01 - 15.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN WEATHERED
BEDROCK OVERBURDEN (REHABILITATION)

SCALE: 1:14,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371

DWG. No.
FIG-28



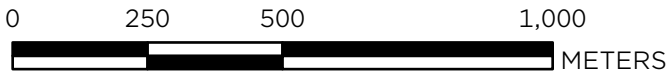
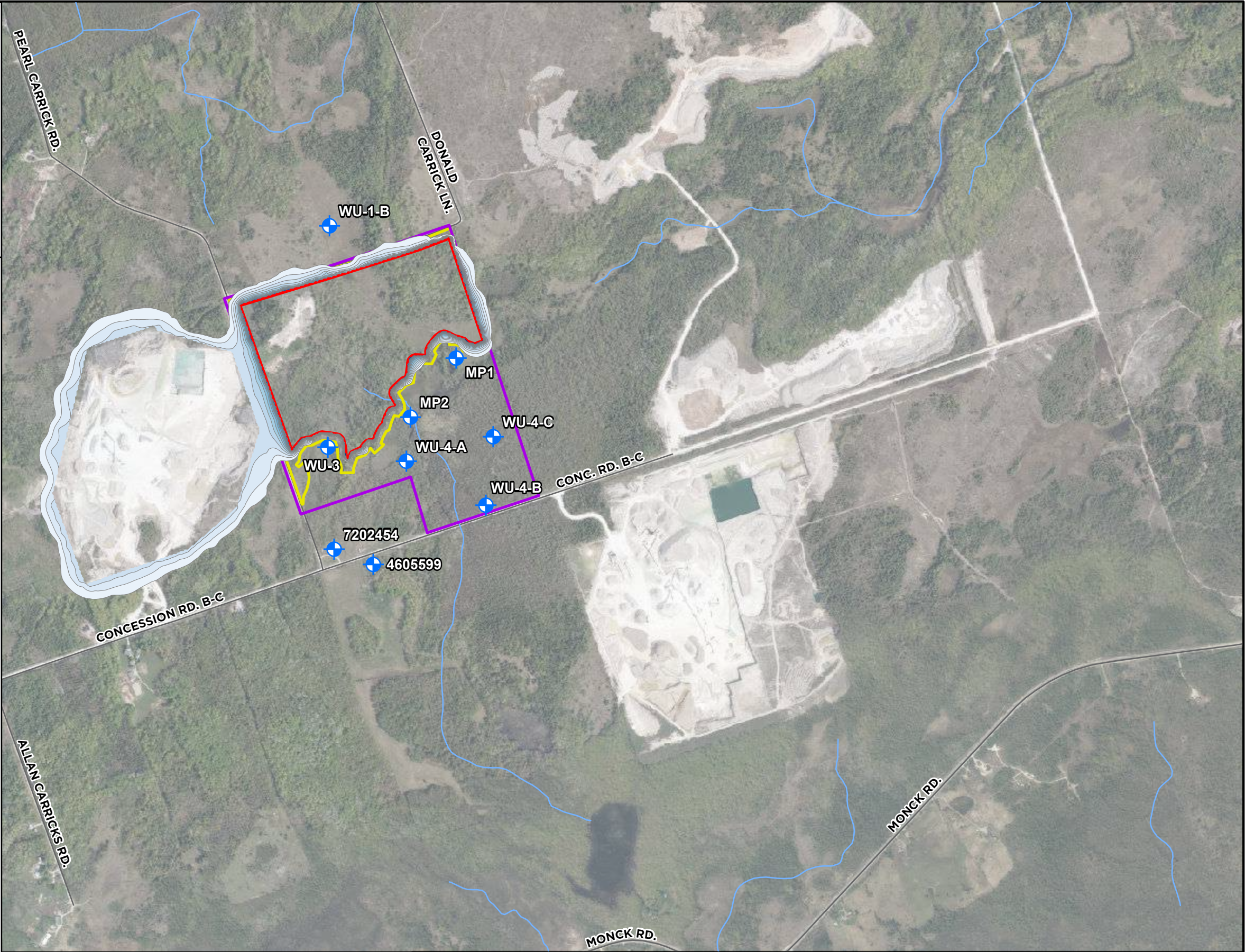
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 13.00
- 13.01 - 14.00
- 14.01 - 15.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN WEATHER BEDROCK
OVERBURDEN (INCREMENTAL REHABILITATION)

SCALE: 1:14,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371

DWG. No.
FIG-29



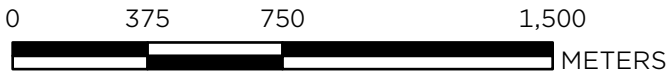
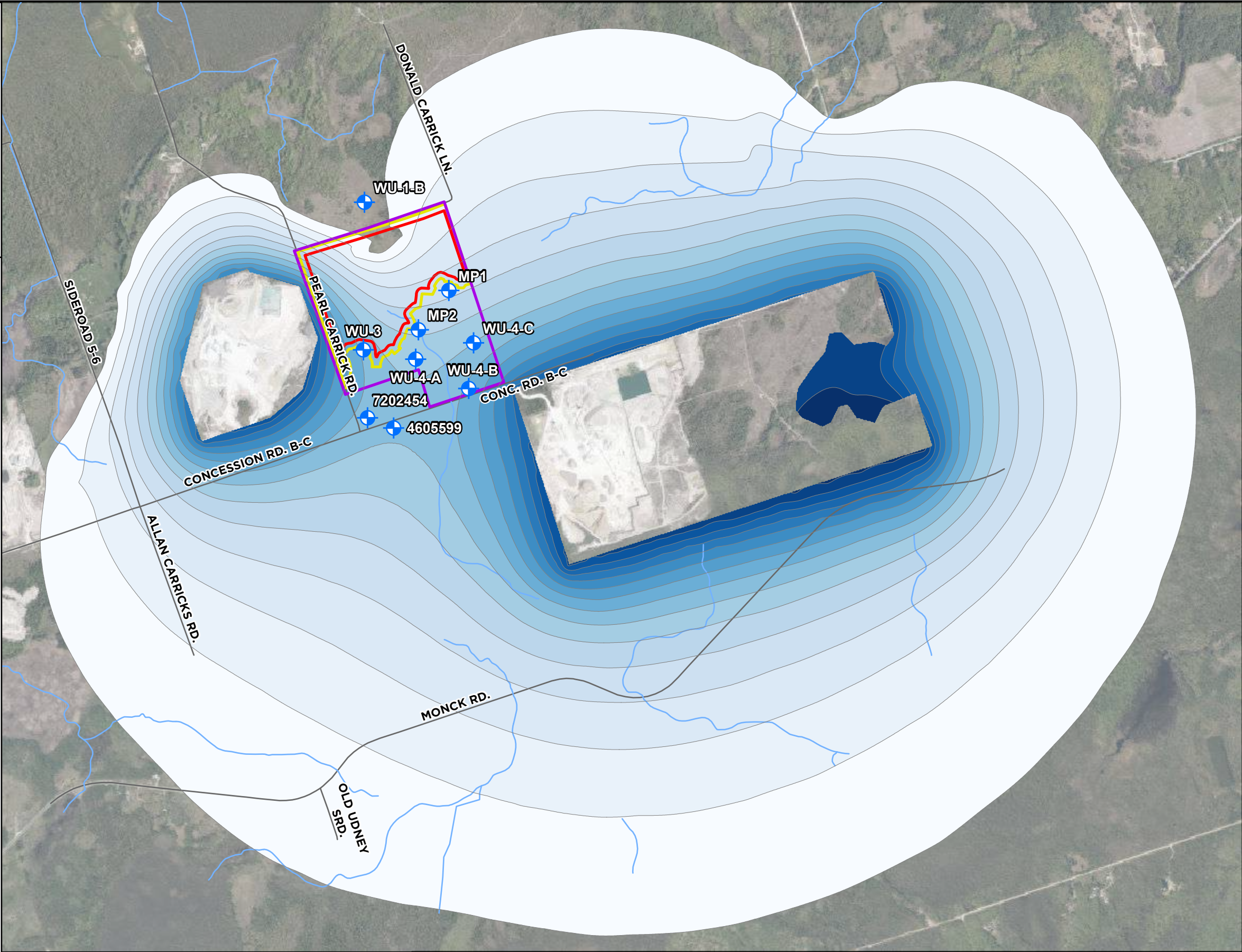
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 13.00
- 13.01 - 14.00
- 14.01 - 15.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN GULL
RIVER BEDROCK (BASELINE)

SCALE: 1:21,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371

DWG. No.
FIG-30



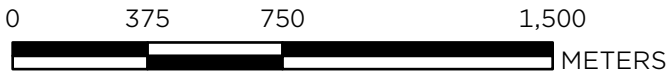
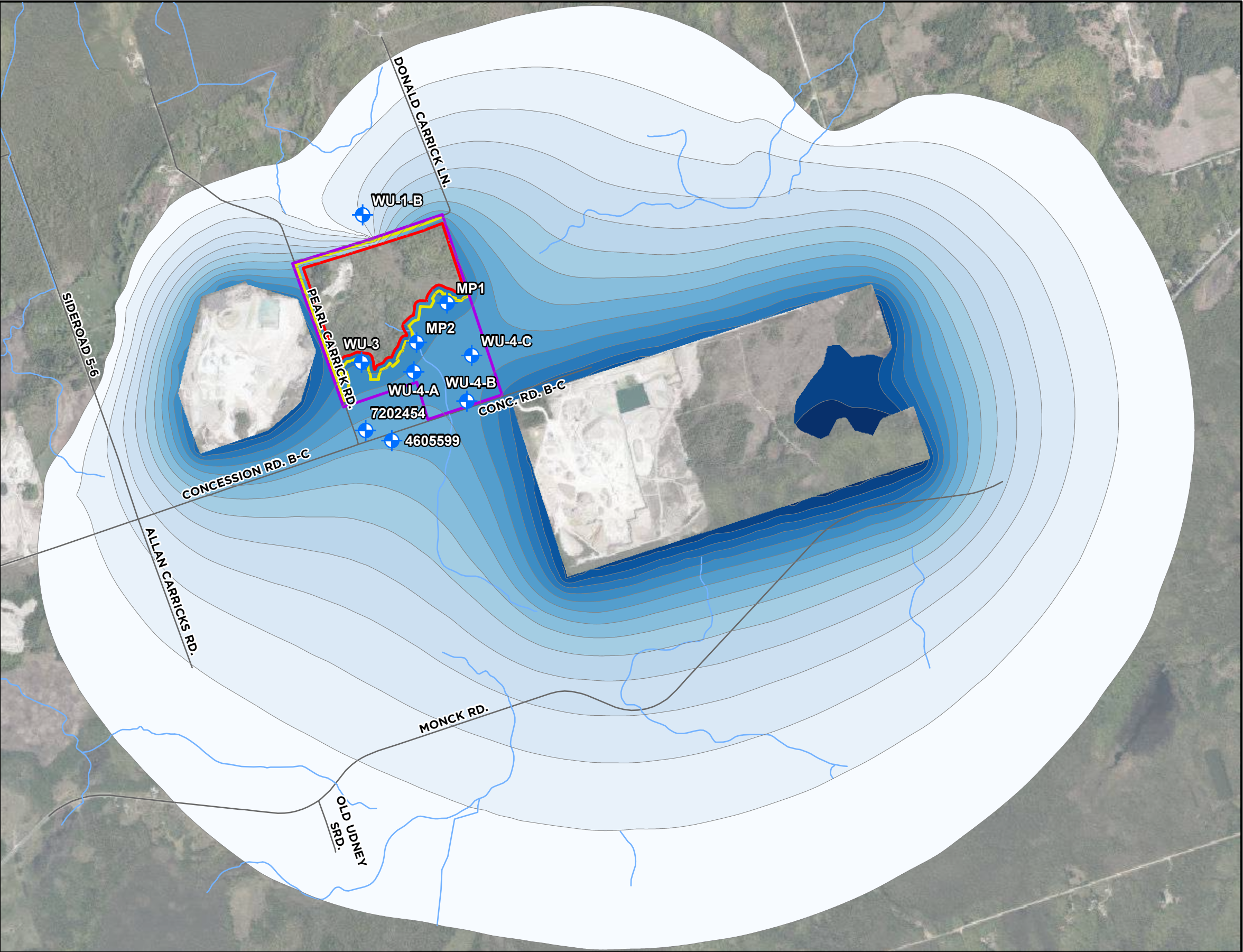
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 13.00
- 13.01 - 14.00
- 14.01 - 15.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN GULL
RIVER BEDROCK (FULL EXTRACTION)

SCALE: 1:21,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371

DWG. No.
FIG-31



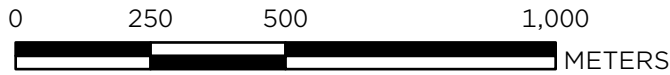
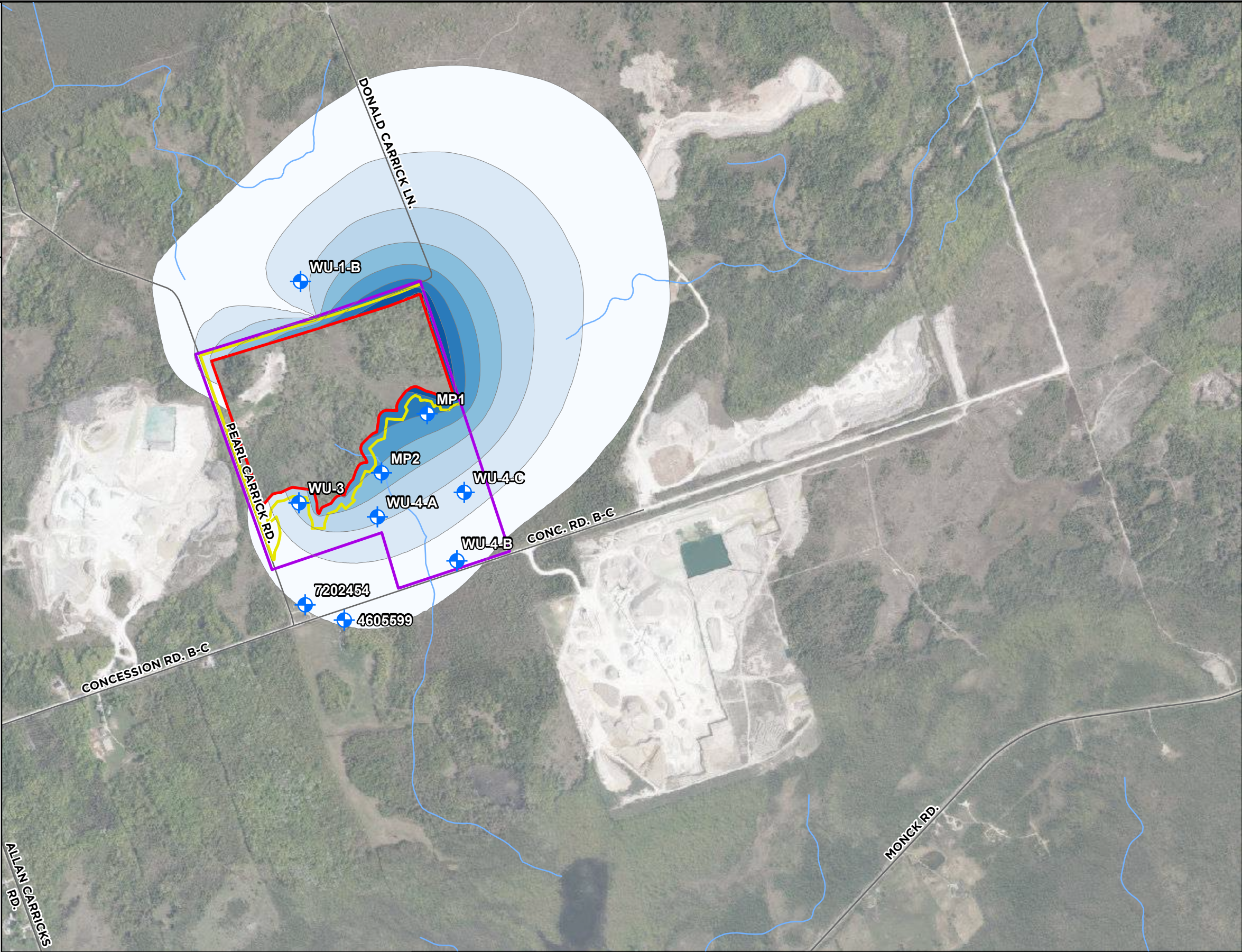
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN GULL
RIVER BEDROCK (INCREMENTAL)

DWG. No.
FIG-32

SCALE: 1:14,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371



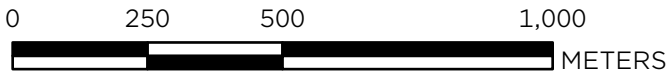
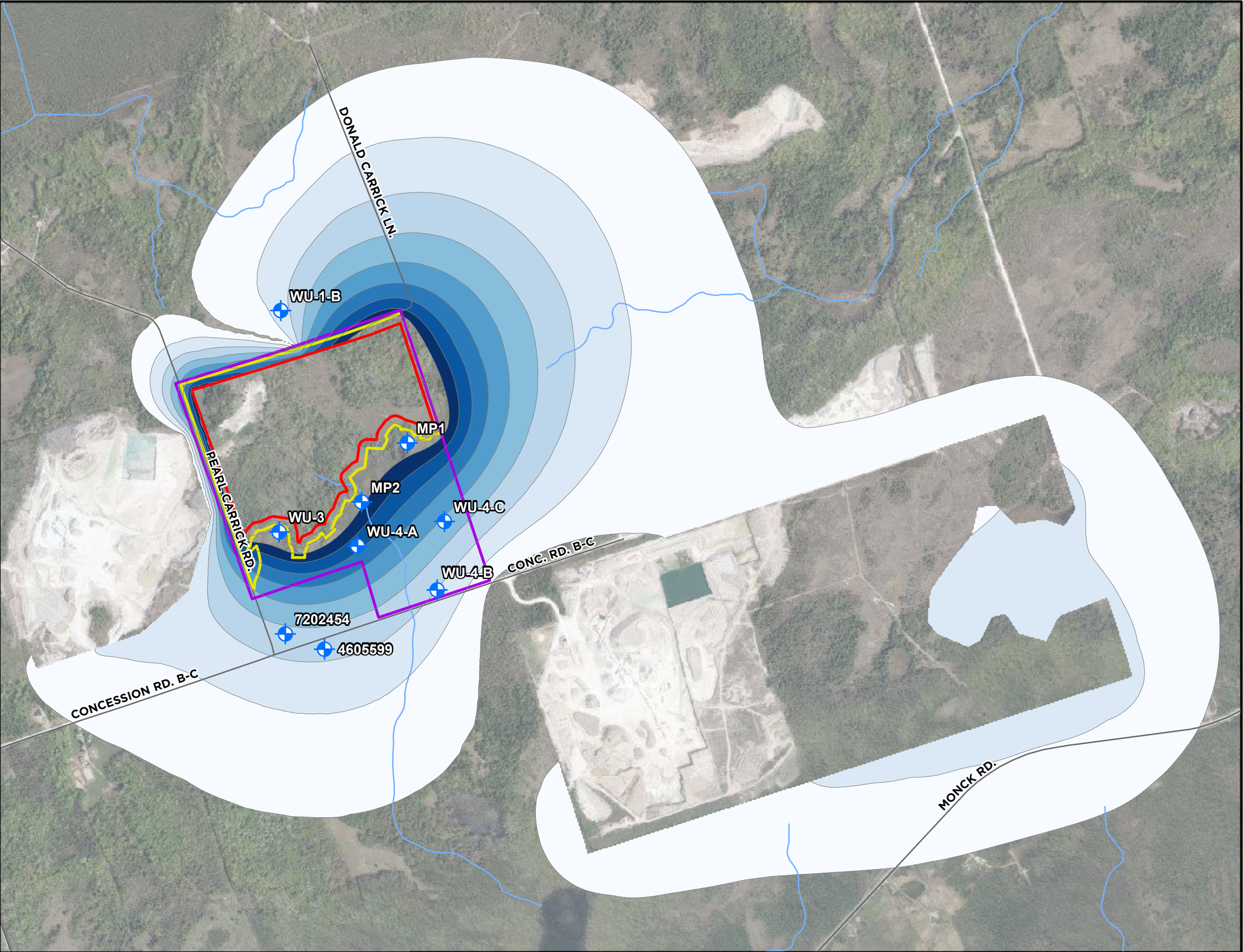
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN GULL
RIVER BEDROCK (REHABILITATION BASELINE)

SCALE: 1:14,000 DRAWN: AO DATE: DEC. 2025 JOB NO. 424371

DWG. No.
FIG-33



NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

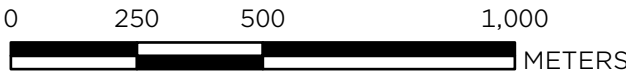
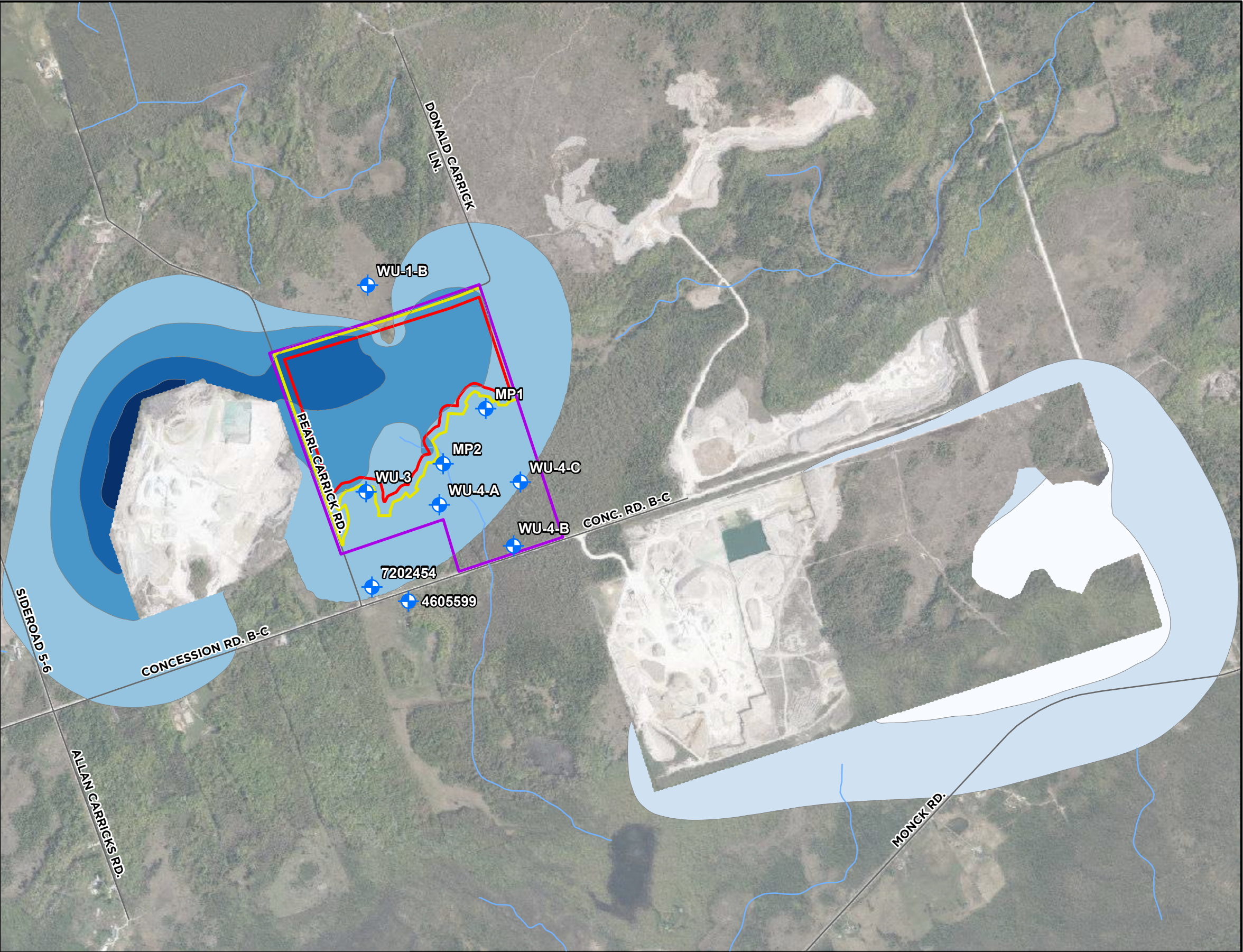
LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 2.00
- 1.99 - -1.00
- 0.99 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00

* -2.00 DENOTES 2 METRES ABOVE GROUND



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN
GULL RIVER BEDROCK (REHABILITATION)

SCALE: 1:15,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371

DWG. No.
FIG-34



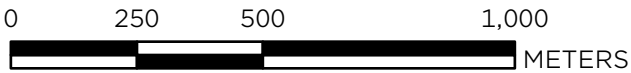
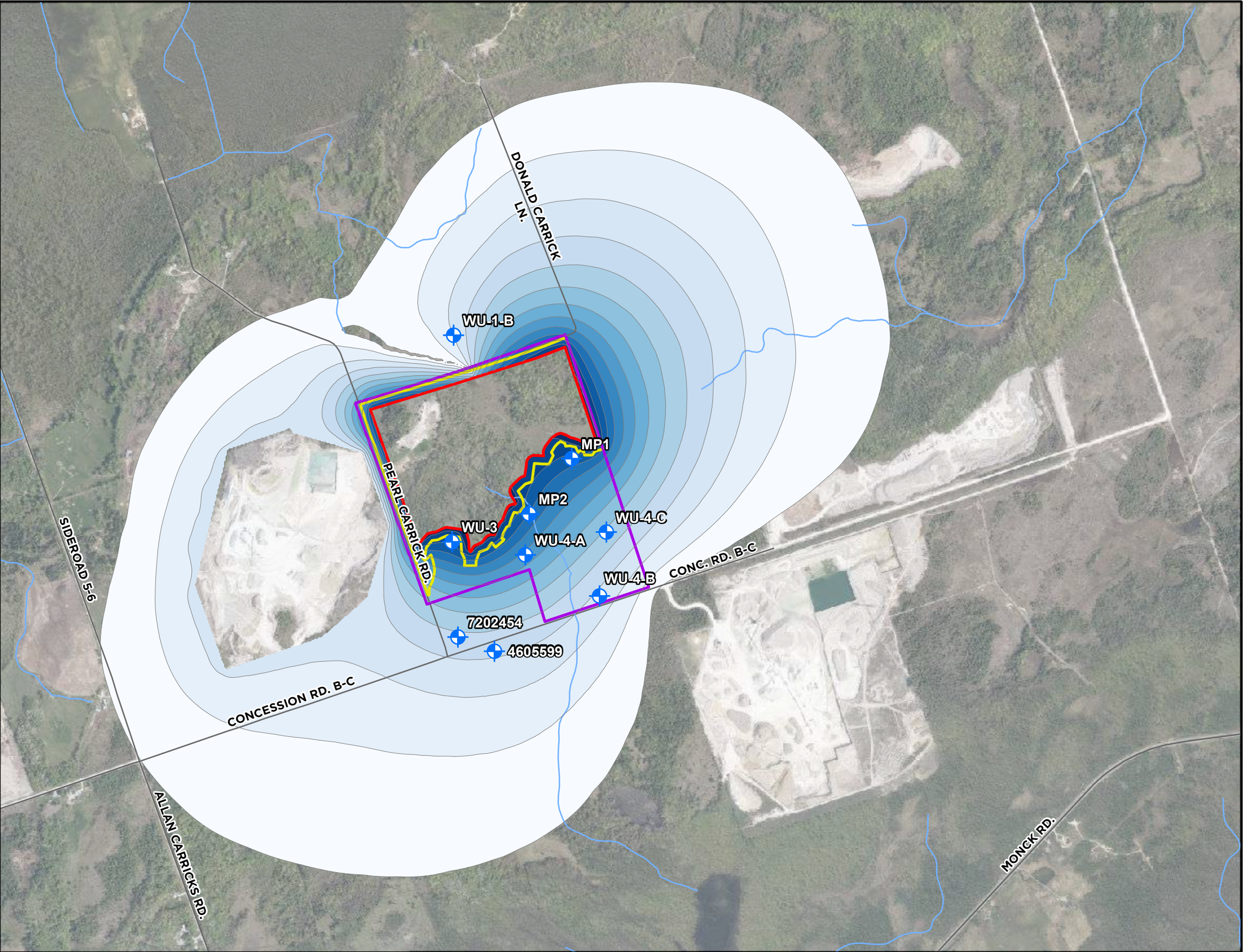
NOTES:
1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N
2. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO.

LEGEND

- PROPERTY BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- PROPOSED LICENCE BOUNDARY
- REFERENCE POINT
- ROADS
- WATERCOURSE
- DRAWDOWN CONTOUR (M)

DRAWDOWN DEPTH (M)

- 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 13.00
- 13.01 - 14.00



RAMARA QUARRY
LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT
GROUNDWATER DRAWDOWN GULL RIVER
BEDROCK (INCREMENTAL REHABILITATION)

SCALE: 1:15,000 | DRAWN: AO | DATE: DEC. 2025 | JOB NO. 424371

DWG. No.
FIG-35

Appendix A: MECP Water Well Records

Township Con Lot	UTM	Date Centr	Casing Dia	Water	Pump Test	Well Use	Screen Depth	Well	Formation
RAMA TOWNSHIP	17 640068 4949599 W	2012/09 7075	6.11			MO		7192301 (Z136096) A135770	GREY LMSN HARD 0067 RED LMSN SOFT 0068
RAMA TOWNSHIP	17 640008 4949353 W	2012/09 7075	6.11	UT 0269	35/107/3/1:	DO MO		7192302 (Z144477) A135769	GREY LMSN HARD 0056 RED LMSN SOFT 0063 GREY GRNT HARD 0300
RAMA TOWNSHIP	17 639932 4949243 W	2018/09 7238	4 3.75	UT 0009		MO		7320304 (Z293029) A243491	SAND GRVL 0002 GREY SAND SLTY SOFT 0011 GREY LMSN ROCK 0061 RED SHLE ROCK 0066
RAMA TOWNSHIP	17 640351 4949539 W	2018/09 7238	2				0010 5	7320305 (Z293028) A237269	LMSN ROCK 0015
RAMA TOWNSHIP	17 640150 4950280 W	2018/09 7238	4 3.5	UT 0004				7320303 (Z293030) A243492	LOAM 0001 BRWN CLAY SLTY SOFT 0003 LMSN ROCK 0045 SHLE ROCK 0066
RAMA TOWNSHIP CON B 009	17 640915 4949474 W	1973/10 2517	6 6	UK 0020	5/15/30/4:20	DO		4605599 ()	BLCK LOAM 0002 GREY CLAY BLDR 0006 GREY LMSN ROCK 0024
RAMA TOWNSHIP CON C 008	17 640347 4949541 W	2014/06 7075	2			TH	0040 10	7227979 (Z144478) A135667	GREY LMSN HARD 0042 GREN LMSN HARD 0050

Township Con Lot	UTM	Date Centr	Casing Dia	Water	Pump Test	Well Use	Screen Depth	Well	Formation
RAMA TOWNSHIP CON C 009	17 640673 4949468 W	2013/02 1312	6.25	UT 0055	4/4/5/1:	DO		7202454 (Z153253) A133796	GREY FILL PCKD 0004 GREY CLAY 0010 BRWN SAND GRVL 0030 GREY LMSN 0060
RAMA TOWNSHIP CON D 008	17 639865 4950974 W	1981/01 2653	6	FR 0066	20//10/1:0	DO		5717931 ()	HPAN 0005 LMSN 0039 GRNT 0066

UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
 DATE CNTR: Date Work Completed and Well Contractor Licence Number
 CASING DIA: Casing diameter in inches
 WATER: Unit of Depth in Feet. See Table 4 for meanign of code.
 PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hr : Min
 WELL USE: See Table 3 for Meaning of Code
 SCREEN: Screen Depth and Length in feet
 WELL: WEL (AUDIT #) Well Tag. A: Abandonment; P: Partial Data Entry Only
 FORMATION: See Table 1 and 2 for Meaning of Code

Table 1: Core Material and Descriptive Terms

BLDR BOULDERS	FCRD FRACTURED	IRFM IRON FORMATION	PORS POROUS	SOFT SOFT
BSLT BASALT	FGRD FINE-GRAINED	LIMY LIMY	PRDG PREVIOUSLY DUG	SPST SOAPSTONE
CGRD COARSE-GRAINED	FGVL FINE GRAVEL	LMSN LIMESTONE	PRDR PREV. DRILLED	STKY STICKY
CGVL COARSE GRAVEL	FILL FILL	LOAM TOPSOIL	QRTZ QUARTZITE	STNS STONES
CHRT CHERT	FLDS FELDSPAR	LOOS LOOSE	QSND QUICKSAND	STNY STONEY
CLAY CLAY	FLNT FLINT	LTCL LIGHT-COLOURED	QTZ QUARTZ	THIK THICK
CLN CLEAN	FOSS FOSILIFEROUS	LYRD LAYERED	ROCK ROCK	THIN THIN
CLYY CLAYEY	FSND FINE SAND	MARL MARL	SAND SAND	TILL TILL
CMTD CEMENTED	GNIS GNEISS	MGRD MEDIUM-GRAINED	SHLE SHALE	UNKN UNKNOWN TYPE
CONG CONGLOMERATE	GRNT GRANITE	MGVL MEDIUM GRAVEL	SHLY SHALY	VERY VERY
CRYS CRYSTALLINE	GRSN GREENSTONE	MRBL MARBLE	SHRP SHARP	WBRG WATER-BEARING
CSND COARSE SAND	GRVL GRAVEL	MSND MEDIUM SAND	SHST SCHIST	WDFR WOOD FRAGMENTS
DKCL DARK-COLOURED	GRWK GREYWACKE	MUCK MUCK	SILT SILT	WTHD WEATHERED
DLMT DOLOMITE	GVLY GRAVELLY	OBDN OVERBURDEN	SLTE SLATE	
DNSE DENSE	GYPS GYPSUM	PCKD PACKED	SLTY SILTY	
DRTY DIRTY	HARD HARD	PEAT PEAT	SND S SANDSTONE	
DRY DRY	HPAN HARDPAN	PGVL PEA GRAVEL	SNDY SANDY OAPSTONE	

Table 2: Core Color

WHIT WHITE
 GREY GREY
 BLUE BLUE
 GREN GREEN
 YLLW YELLOW
 BRWN BROWN
 RED RED
 BLCK BLACK
 BLGY BLUE-GREY

Table 3: Well Use

DO Domestic
 ST Livestock
 IR Irrigation
 IN Industrial
 CO Commercial
 MN Municipal
 PS Public
 AC Cooling And A/C
 NU Not Used
 OT Other
 TH Test Hole
 DE Dewatering
 MO Monitoring
 MT Monitoring TestHole

Table 4: Water Detail

FR Fresh
 SA Salty
 SU Sulphur
 MN Mineral
 UK Unknown
 GS Gas
 IR Iron

Appendix B: Borehole Logs



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Telephone: 7057339037

WELL NUMBER MW24-1

PAGE 1 OF 1

CLIENT Brand X Materials and Supply Inc.

PROJECT NAME Proposed Ramara Quarry

PROJECT NUMBER 424371

PROJECT LOCATION 6059 Pearl Carrick Road, Ramara, Ontario

DATE STARTED 4/8/24 COMPLETED 4/8/24

UTM COORDINATES: 4950285 m N, 640471.3 m E

DRILLING CONTRACTOR Pontil Drilling

GROUND ELEVATION 247.55 m HOLE SIZE 3.78"

DRILLING METHOD Coring

GROUND WATER LEVELS:

LOGGED BY SDP CHECKED BY AK

AT TIME OF DRILLING Water used in drilling

AT END OF DRILLING Water used in drilling

NOTES Stick-up = 0.74 m

▼ AFTER DRILLING 7.22 m / Elev 240.34 m

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
					Monument Casing
	RC 1	Upper Gull River Formation		0.38 SAND: Brown, sand, some silt, trace organics, moist 247.18	
2	RC 2			GULL RIVER FORMATION: Grey to brown, fine grained dolostone, moist The Gull River Formation is a variably dolomitized, predominantly muddy limestone. This formation is subdivided into two informal members, lower and upper. The upper unit is characterized by a distinctive dolomitic, fossiliferous lime mudstone and is characterized by the abundance of chert nodules. The lower part of the Formation consists primarily of green-grey to tan, argillaceous dolostone, and dolomitic limestones. Fossils are sparse suggesting a sabkha to supra- / upper intertidal depositional environment.	
4	RC 3				
6	RC 4				
8	RC 5				
10	RC 6				
	RC 7	Lower Gull River Formation		9.52 Layers of green shale observed 238.03	
				10.14 237.41	Bentonite holeplug Filter sand and 50 mm diameter slotted screen

Bottom of hole at 10.14 m.



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WELL NUMBER MW24-2

CLIENT Brand X Materials and Supply Inc.
PROJECT NUMBER 424371
DATE STARTED 4/8/24 COMPLETED 4/8/24
DRILLING CONTRACTOR Pontil Drilling
DRILLING METHOD Coring
LOGGED BY SDP CHECKED BY AK
NOTES Stick-up = 0.92 m

PROJECT NAME Proposed Ramara Quarry
PROJECT LOCATION 6059 Pearl Carrick Road, Ramara, Ontario
UTM COORDINATES: 4950458.6 m N, 640883.9 m E
GROUND ELEVATION 247.58 m HOLE SIZE 3.78"
GROUND WATER LEVELS:
AT TIME OF DRILLING Water used in drilling
AT TIME OF DRILLING Water used in drilling
AFTER DRILLING 7.50 m / Elev 240.08 m

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
				SILTY SAND: Brown, silty sand, wet	Monument Casing
			0.90		246.68
2	RC 1	Upper Gull River Formation		GULL RIVER FORMATION: Grey, fine grained dolostone, wet The Gull River Formation is a variably dolomitized, predominantly muddy limestone. This formation is subdivided into two informal members, lower and upper. The upper unit is characterized by a distinctive dolomitic, fossiliferous lime mudstone and is characterized by the abundance of chert nodules. The lower part of the Formation consists primarily of green-grey to tan, argillaceous dolostone, and dolomitic limestones. Fossils are sparse suggesting a sabkha to supra- / upper intertidal depositional environment.	
	RC 2				
	RC 3				
4	RC 4				
	RC 5				
6	RC 6				
	RC 7				
8					
	RC 8	Lower Gull River Formation	8.50	Layers of green shale observed	239.08
10			10.25		237.33

Bottom of hole at 10.25 m.



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WELL NUMBER MW24-3

PAGE 1 OF 1

CLIENT Brand X Materials and Supply Inc.

PROJECT NAME Proposed Ramara Quarry

PROJECT NUMBER 424371

PROJECT LOCATION 6059 Pearl Carrick Road, Ramara, Ontario

DATE STARTED 4/9/24 COMPLETED 4/9/24

UTM COORDINATES: 4950041.9 m N, 640847.9 m E

DRILLING CONTRACTOR Pontil Drilling

GROUND ELEVATION 245.25 m HOLE SIZE 3.78"

DRILLING METHOD Coring

GROUND WATER LEVELS:

LOGGED BY SDP CHECKED BY AK

AT TIME OF DRILLING Water used in drilling

AT END OF DRILLING Water used in drilling

NOTES Stick-up = 0.95 m

▼ AFTER DRILLING 0.91 m / Elev 244.34 m

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
					Monument Casing
	RC 1	Upper Gull River Formation		SAND: Brown, sand, trace organics, moist GULL RIVER FORMATION: Grey, fine grained dolostone, wet	
2	RC 2			The Gull River Formation is a variably dolomitized, predominantly muddy limestone. This formation is subdivided into two informal members, lower and upper.	
	RC 3			The upper unit is characterized by a distinctive dolomitic, fossiliferous lime mudstone and is characterized by the abundance of chert nodules.	
4	RC 4			The lower part of the Formation consists primarily of green-grey to tan, argillaceous dolostone, and dolomitic limestones. Fossils are sparse suggesting a sabkha to supra- / upper intertidal depositional environment.	
6	RC 5				
	RC 6	Lower Gull River Formation		Layers of green shale observed	Bentonite holeplug
8	RC 7				
10	RC 8				Filter sand and 50 mm diameter slotted screen
				Bottom of hole at 10.54 m.	



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WELL NUMBER MW24-4

PAGE 1 OF 1

CLIENT Brand X Materials and Supply Inc.

PROJECT NAME Proposed Ramara Quarry

PROJECT NUMBER 424371

PROJECT LOCATION 6059 Pearl Carrick Road, Ramara, Ontario

DATE STARTED 4/10/24 COMPLETED 4/10/24

UTM COORDINATES: 4950163.9 m N, 641184.5 m E

DRILLING CONTRACTOR Pontil Drilling

GROUND ELEVATION 246.56 m HOLE SIZE 3.78"

DRILLING METHOD Coring

GROUND WATER LEVELS:

LOGGED BY SDP CHECKED BY AK

AT TIME OF DRILLING Water used in drilling

AT END OF DRILLING Water used in drilling

NOTES Stick-up = 1.04 m

▼ AFTER DRILLING 3.97 m / Elev 242.59 m

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
					Monument Casing
			0.33	SAND: Brown, sand, some silt, wet	246.23
				GULL RIVER FORMATION: Fine grained dolostone, wet	
		Upper Gull River Formation		The Gull River Formation is a variably dolomitized, predominantly muddy limestone. This formation is subdivided into two informal members, lower and upper.	
				The upper unit is characterized by a distinctive dolomitic, fossiliferous lime mudstone and is characterized by the abundance of chert nodules.	
				The lower part of the Formation consists primarily of green-grey to tan, argillaceous dolostone, and dolomitic limestones. Fossils are sparse suggesting a sabkha to supra- / upper intertidal depositional environment.	
					Bentonite holeplug
					Filter sand and 50 mm diameter slotted screen
			10.59		235.97

Bottom of hole at 10.59 m.



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WELL NUMBER MW24-5

PAGE 1 OF 1

CLIENT Brand X Materials and Supply Inc.
PROJECT NUMBER 424371
DATE STARTED 4/11/24 COMPLETED 4/11/24
DRILLING CONTRACTOR Pontil Drilling
DRILLING METHOD Coring
LOGGED BY SDP CHECKED BY AK
NOTES Stick-up = 0.93 m

PROJECT NAME Proposed Ramara Quarry
PROJECT LOCATION 6059 Pearl Carrick Road, Ramara, Ontario
UTM COORDINATES: 4949736.8 m N, 640553.9 m E
GROUND ELEVATION 245.43 m HOLE SIZE 3.78"
GROUND WATER LEVELS:
AT TIME OF DRILLING Water used in drilling
AT END OF DRILLING Water used in drilling
AFTER DRILLING 0.81 m / Elev 244.62 m

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM	
					Monument Casing	
	RC 1	Upper Gull River Formation		0.05 SAND: Brown, sand, some silt, trace organics, moist 245.38 GULL RIVER FORMATION: Grey, fine grained dolostone, moist	Bentonite holeplug	
	RC 2			The Gull River Formation is a variably dolomitized, predominantly muddy limestone. This formation is subdivided into two informal members, lower and upper.		
2	RC 3					The upper unit is characterized by a distinctive dolomitic, fossiliferous lime mudstone and is characterized by the abundance of chert nodules.
	RC 4					
4	RC 5					
6	RC 6	Lower Gull River Formation		6.80 Layers of green shale observed 238.63	Filter sand and 50 mm diameter slotted screen	
8	RC 7					
10	RC 8					
				10.60 234.83		

Bottom of hole at 10.60 m.

GENERAL BH / TP / WELL 424371 DRAFT CORE LOGS.GPJ GINT STD CANADA LAB GDT 9/22/25



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WELL NUMBER MW6

PAGE 1 OF 1

CLIENT Brand X Materials and Supply Inc.

PROJECT NAME Proposed Ramara Quarry

PROJECT NUMBER 424371

PROJECT LOCATION 6059 Pearl Carrick Road, Ramara, Ontario

DATE STARTED 3/25/25 COMPLETED 3/28/25

UTM COORDINATES: 4950047.7 m N, 640862.9 m E

DRILLING CONTRACTOR Walker Drilling

GROUND ELEVATION 245.69 m HOLE SIZE 4.8"

DRILLING METHOD Coring

GROUND WATER LEVELS:

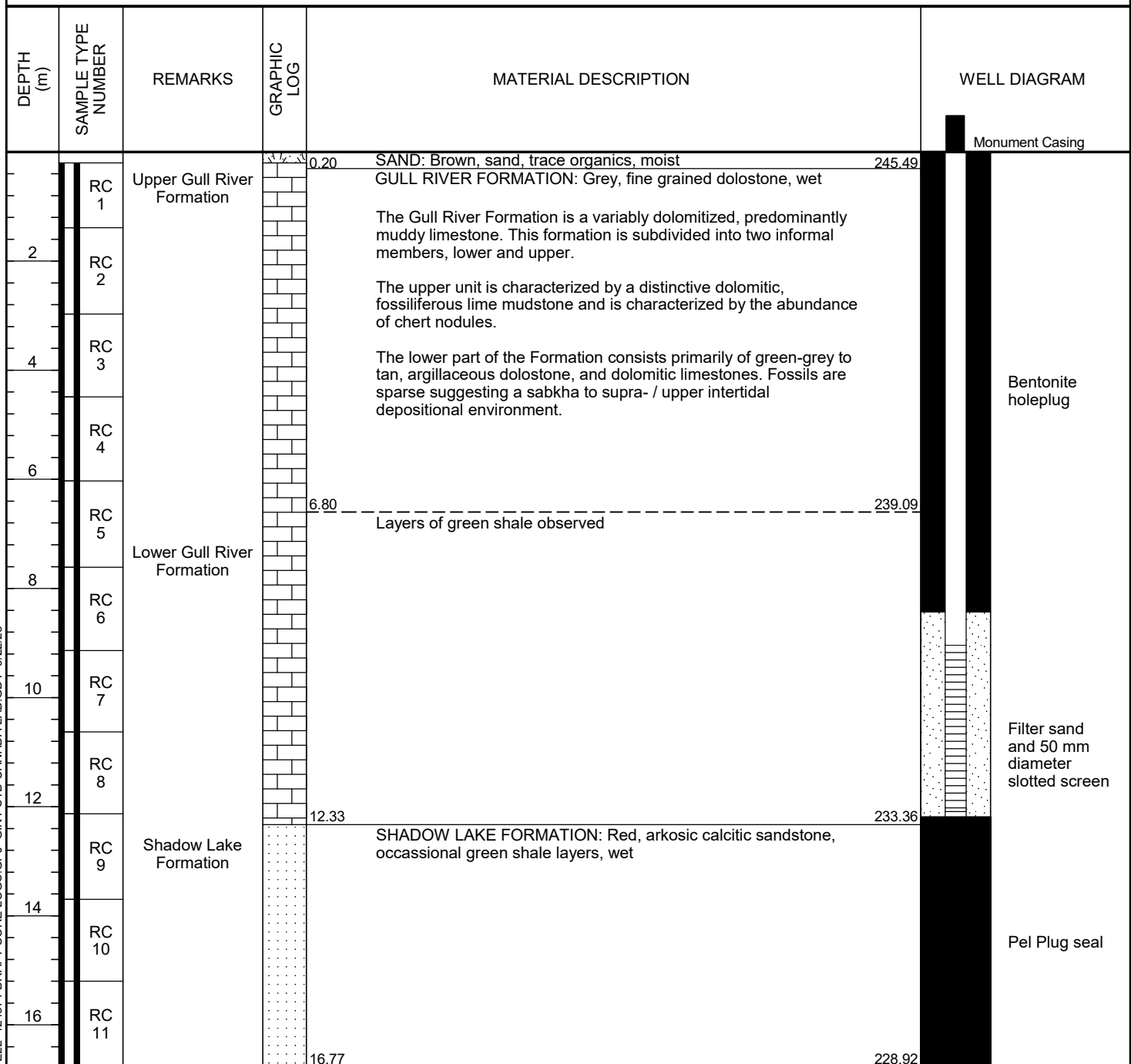
LOGGED BY SDP CHECKED BY AK

AT TIME OF DRILLING Water used in drilling

AT END OF DRILLING Water used in drilling

NOTES Stick-up = 0.77 m

▼ AFTER DRILLING 1.15 m / Elev 244.54 m

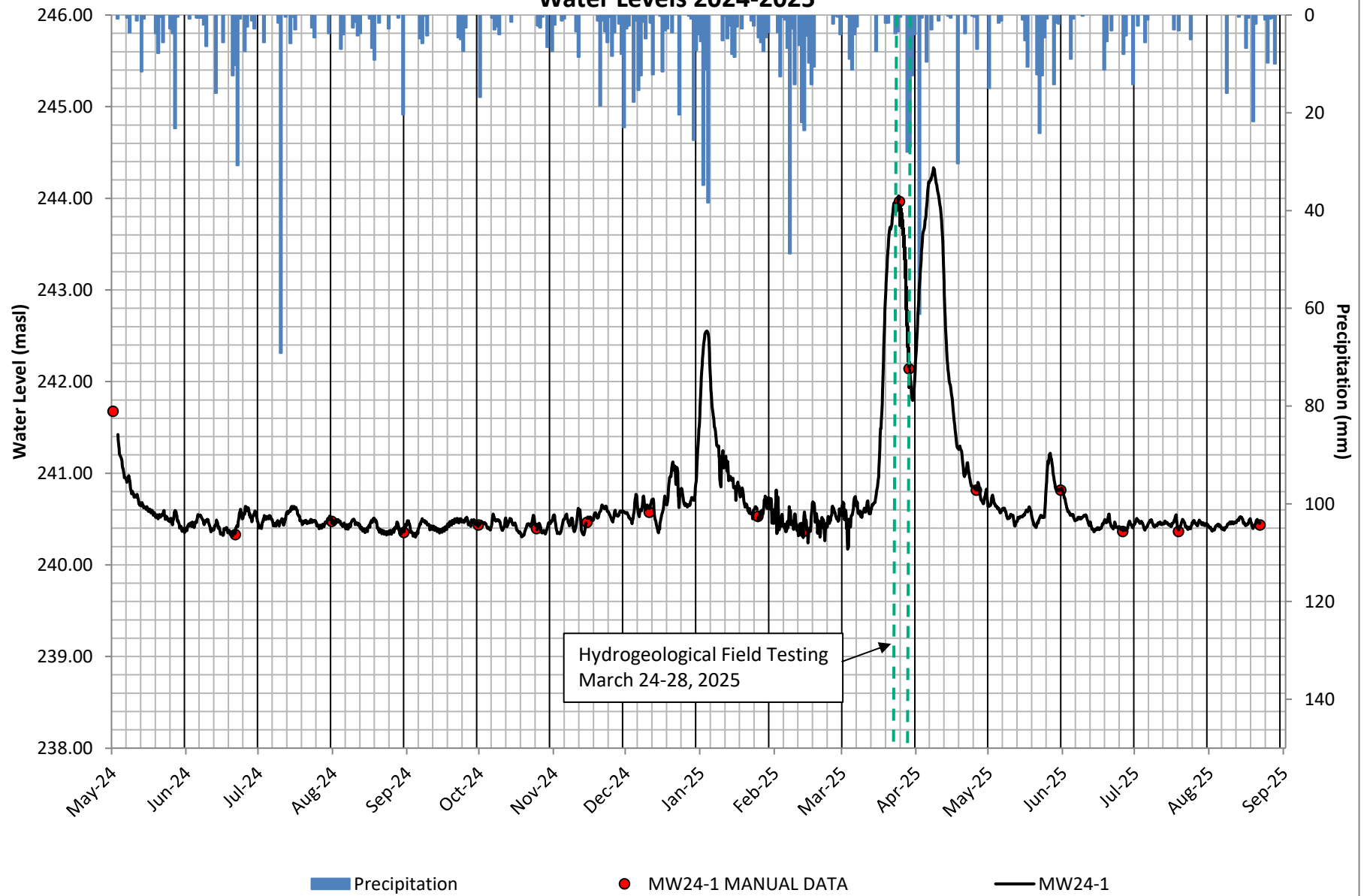


Bottom of hole at 16.77 m.

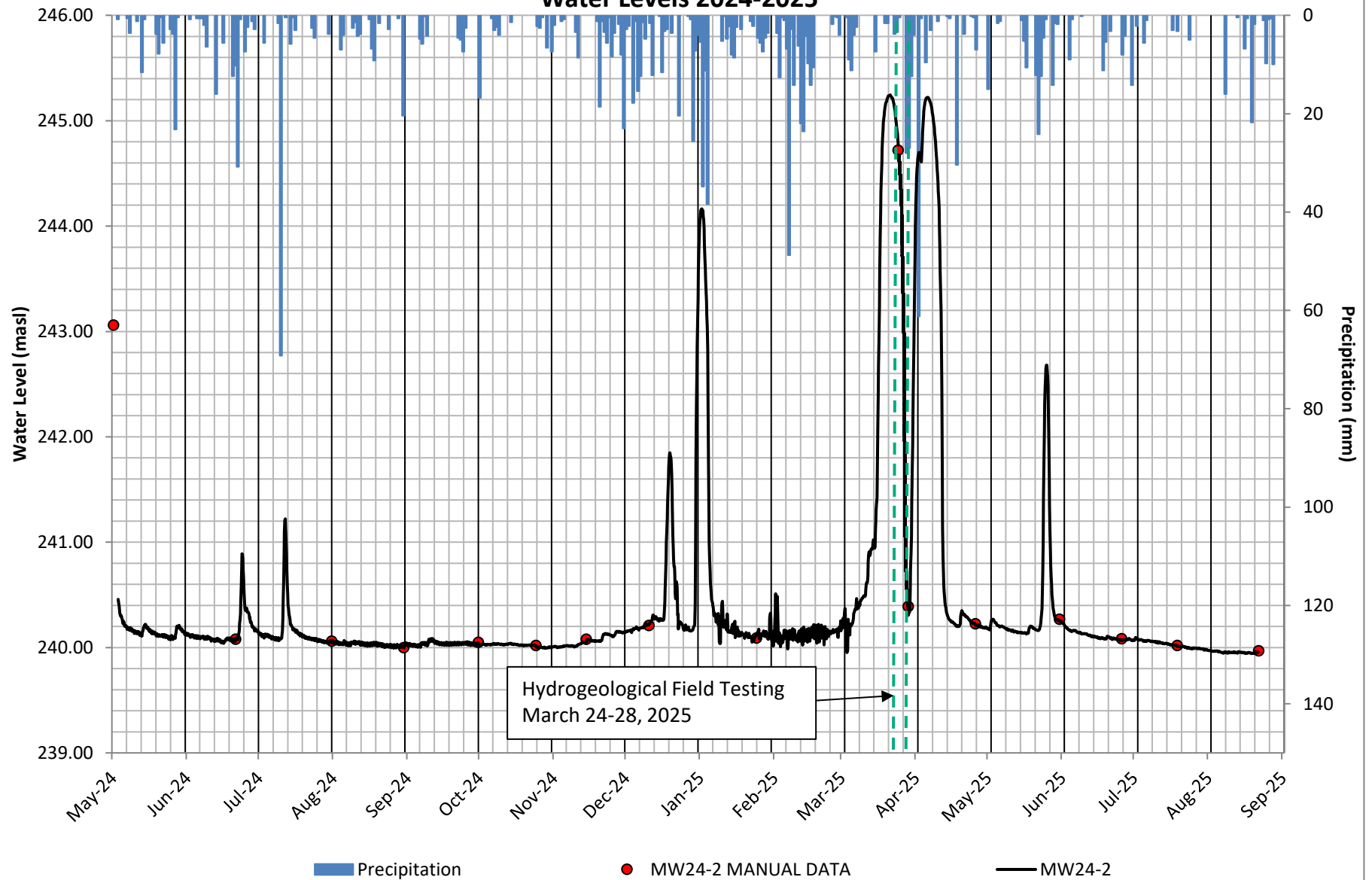
GENERAL BH / TP / WELL 424371 DRAFT CORE LOGS.GPJ GINT STD CANADA LAB GDT 9/22/25

Appendix C: Individual Hydrographs

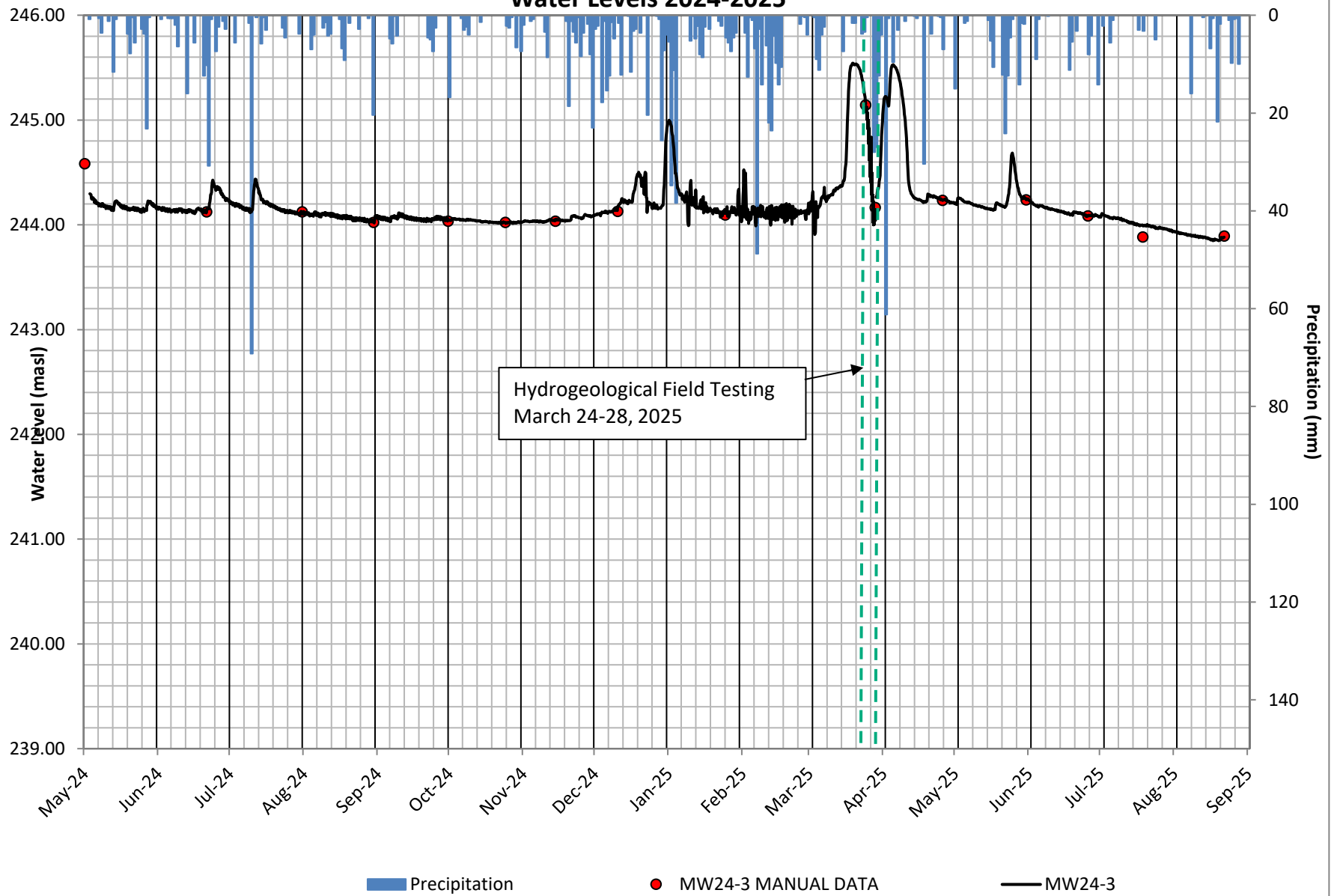
Observation Well (MW24-1) Water Levels 2024-2025



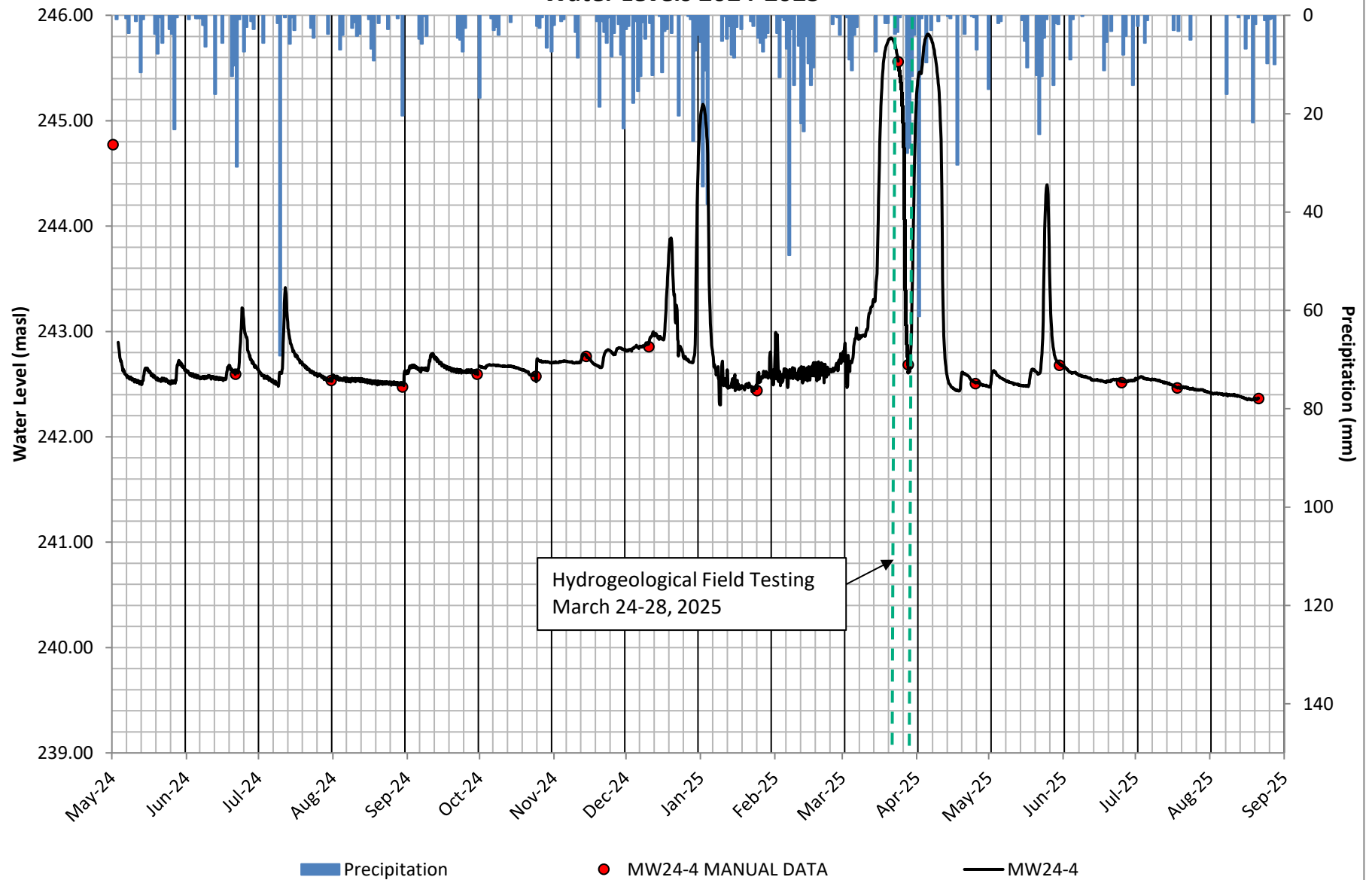
Observation Well (MW24-2) Water Levels 2024-2025



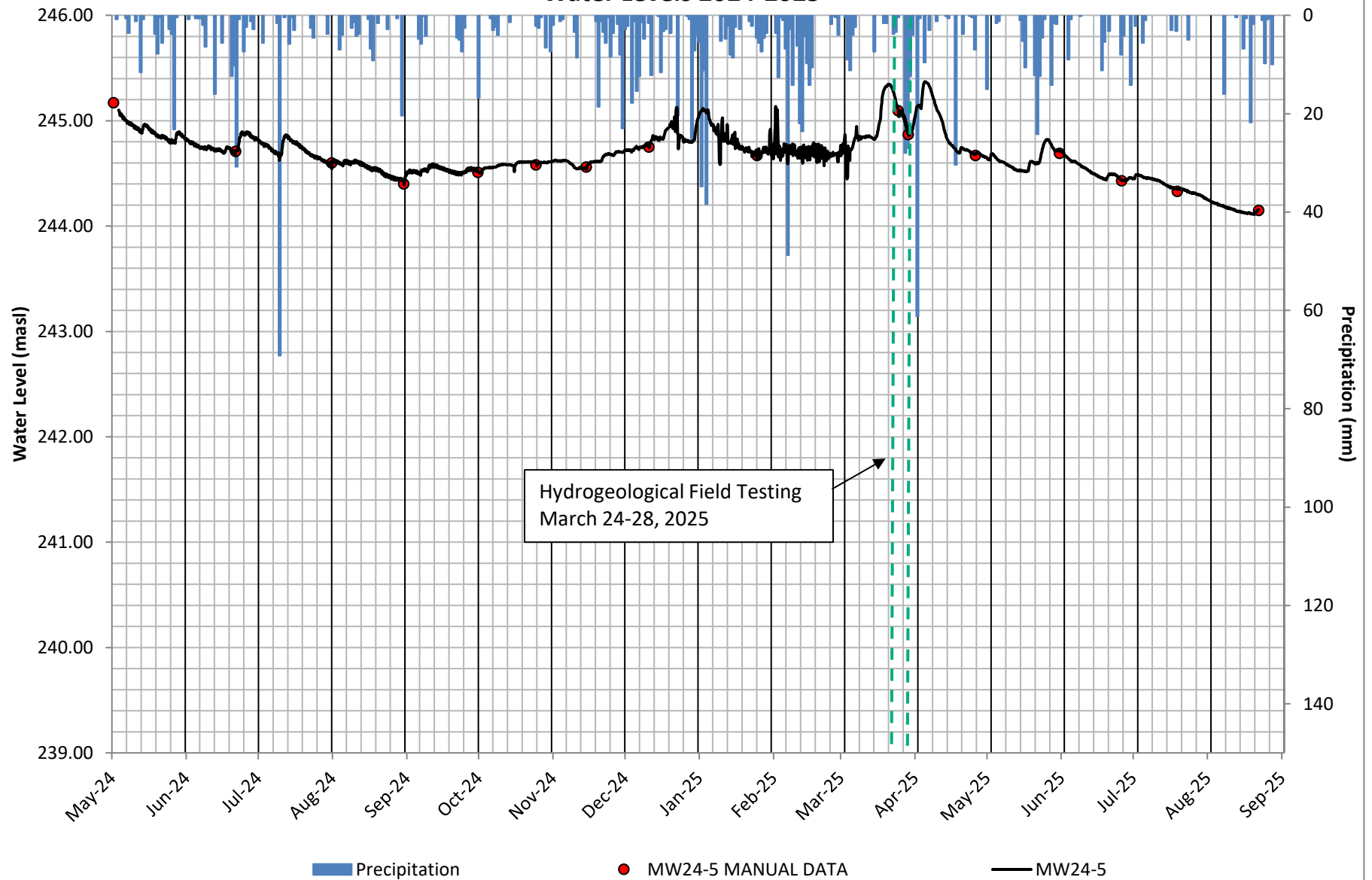
Observation Well (MW24-3) Water Levels 2024-2025



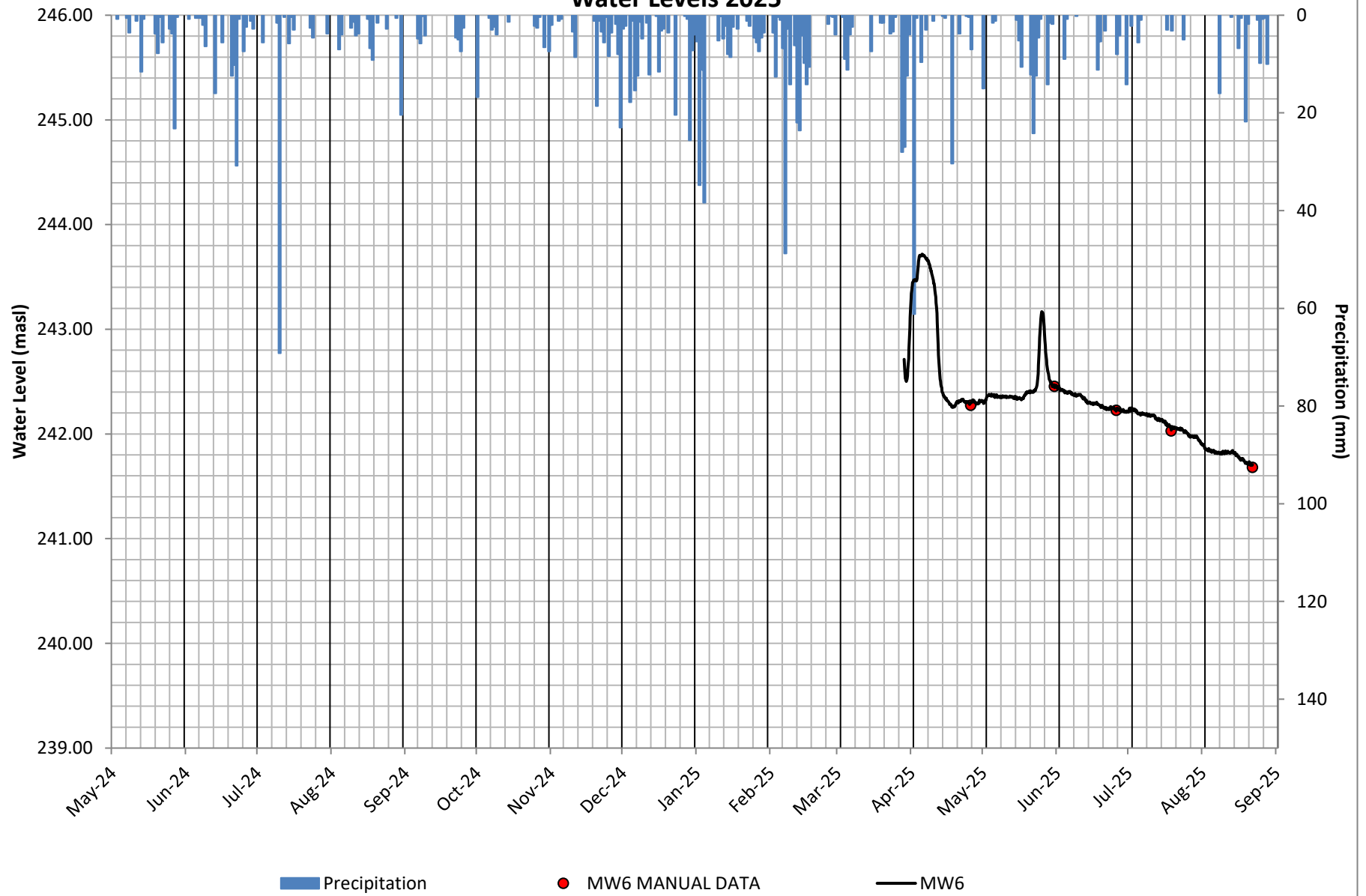
Observation Well (MW24-4) Water Levels 2024-2025



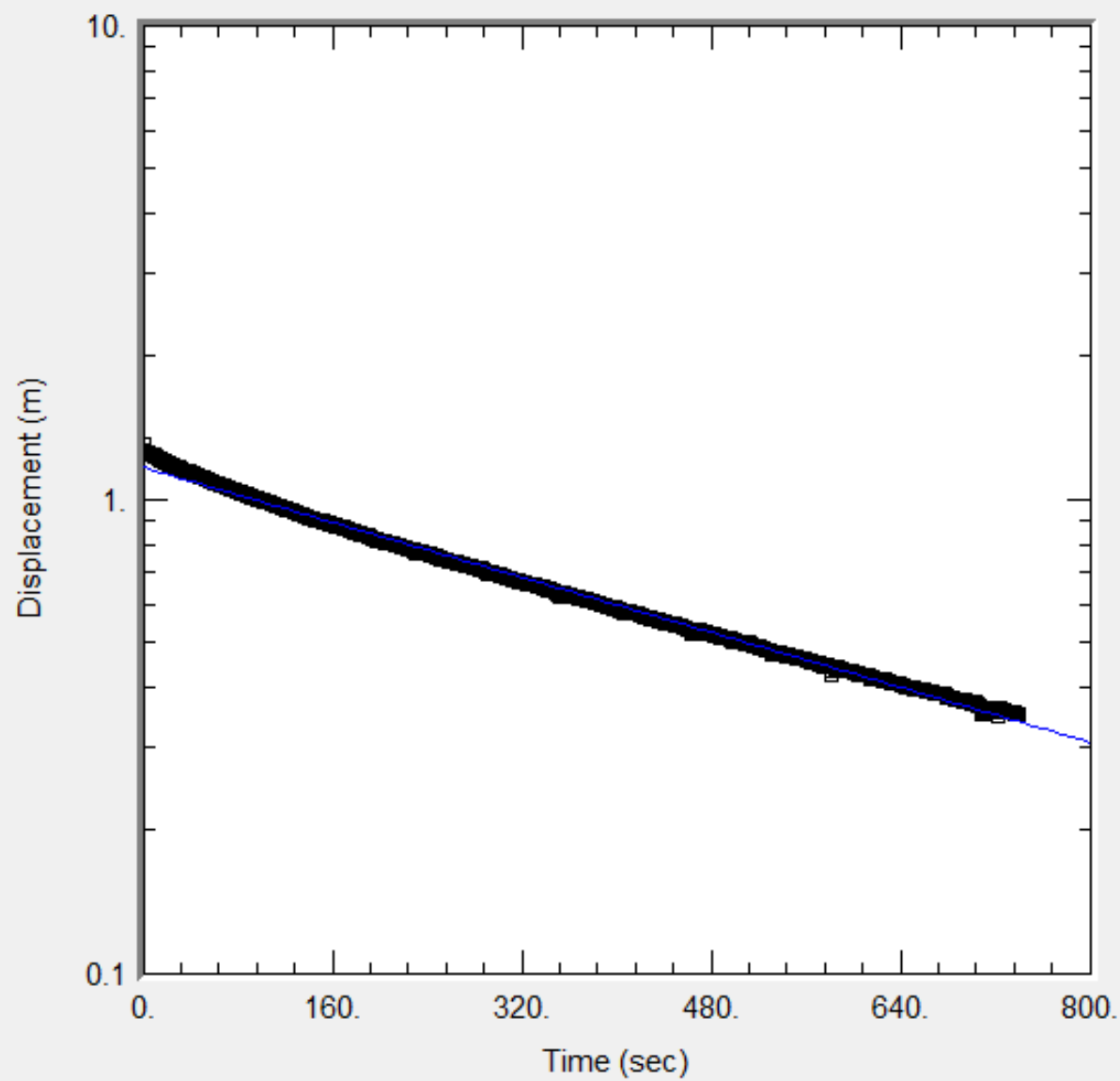
Observation Well (MW24-5) Water Levels 2024-2025



Observation Well (MW6) Water Levels 2025



Appendix D: Hydraulic Conductivity Testing



Obs. Wells

□ MW1

Aquifer Model

Unconfined

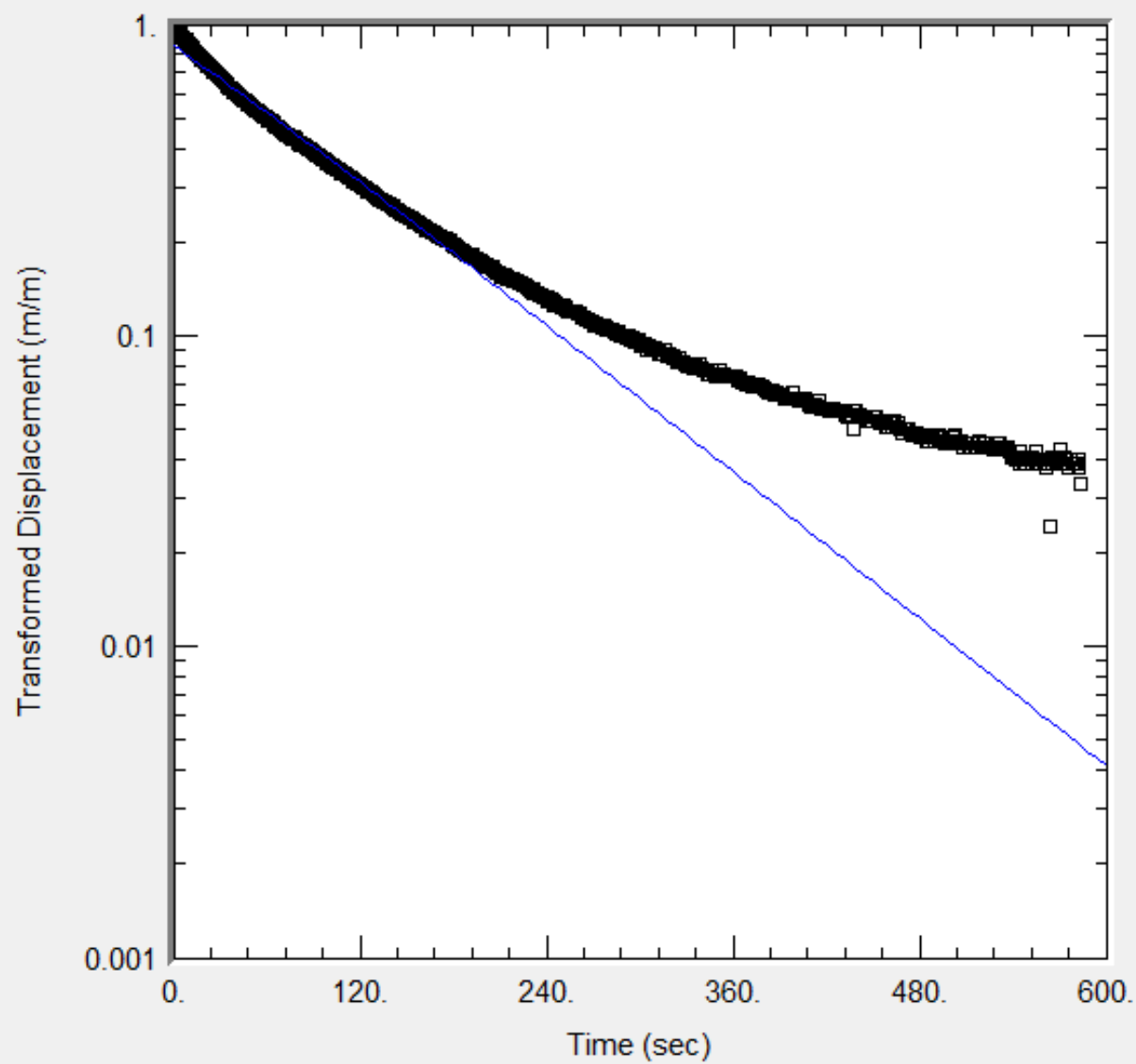
Solution

Hvorslev

Parameters

$K = 7.851\text{E-}7 \text{ m/sec}$

$y_0 = 1.166 \text{ m}$



Obs. Wells

□ MW2

Aquifer Model

Unconfined

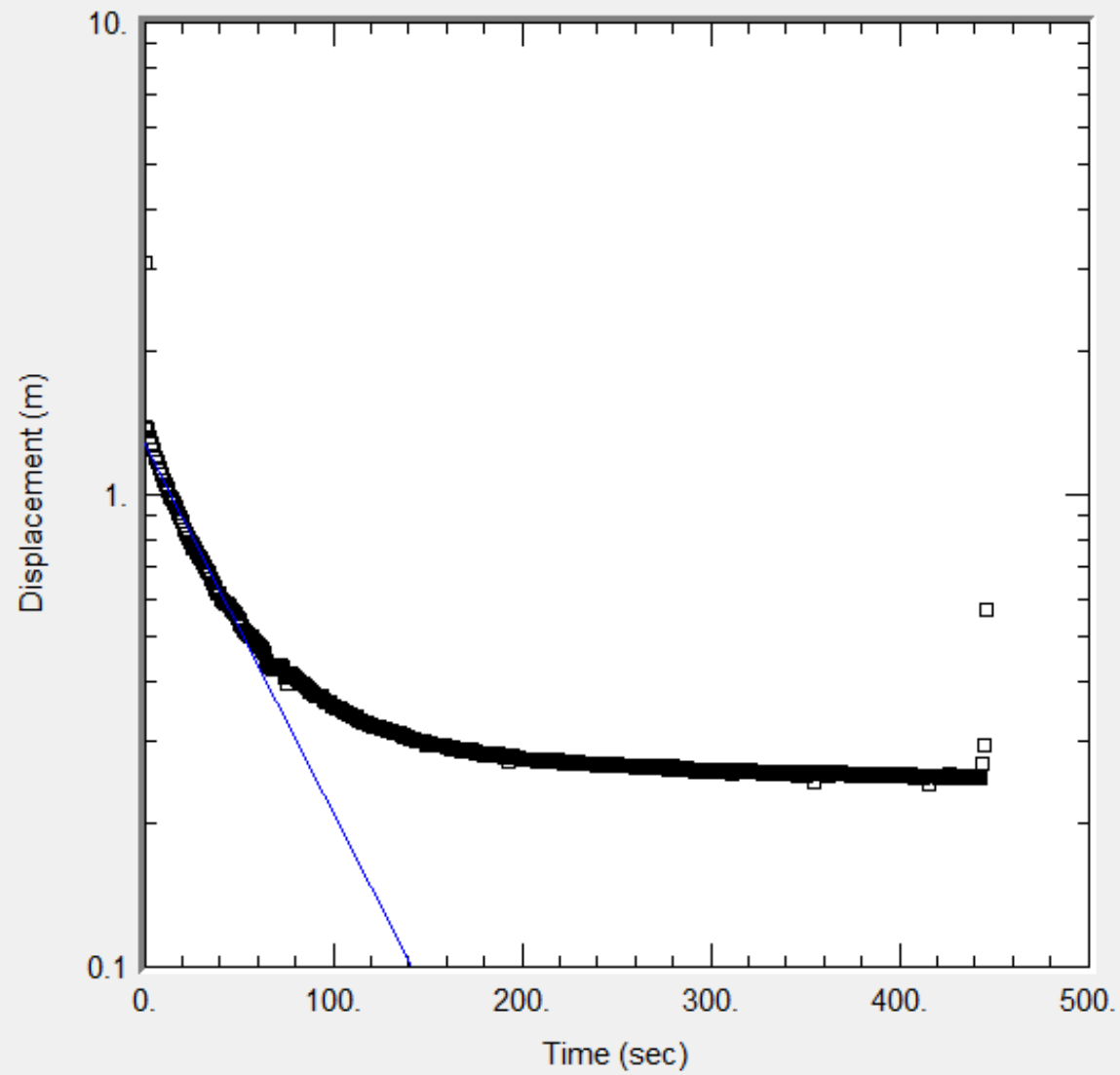
Solution

Dagan

Parameters

$K = 4.524\text{E-}6 \text{ m/sec}$

$y_0 = 0.9371 \text{ m}$



Obs. Wells

□ MW3

Aquifer Model

Unconfined

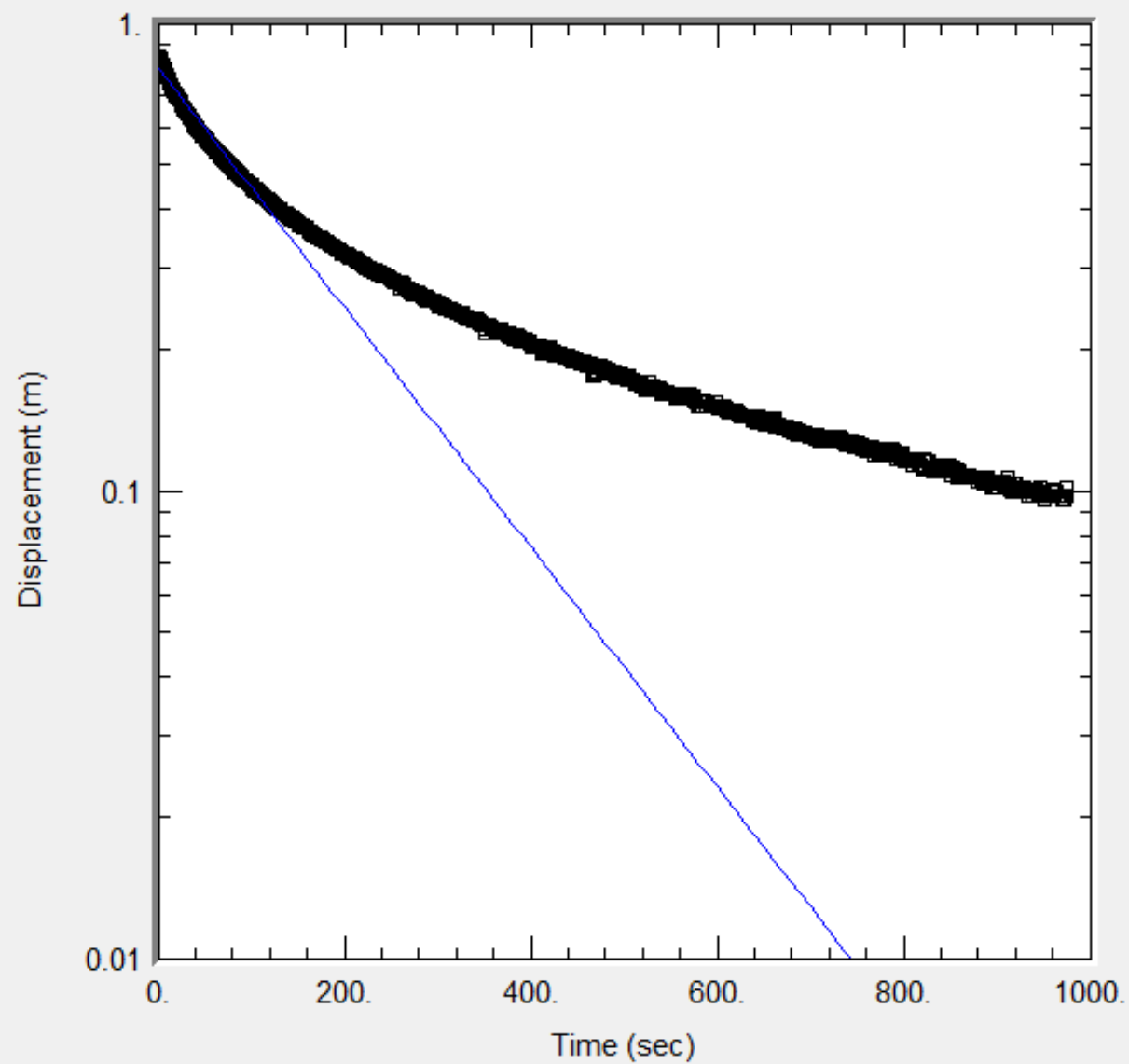
Solution

Hvorslev

Parameters

$K = 8.464E-6$ m/sec

$y_0 = 1.277$ m



Obs. Wells

□ MW4

Aquifer Model

Unconfined

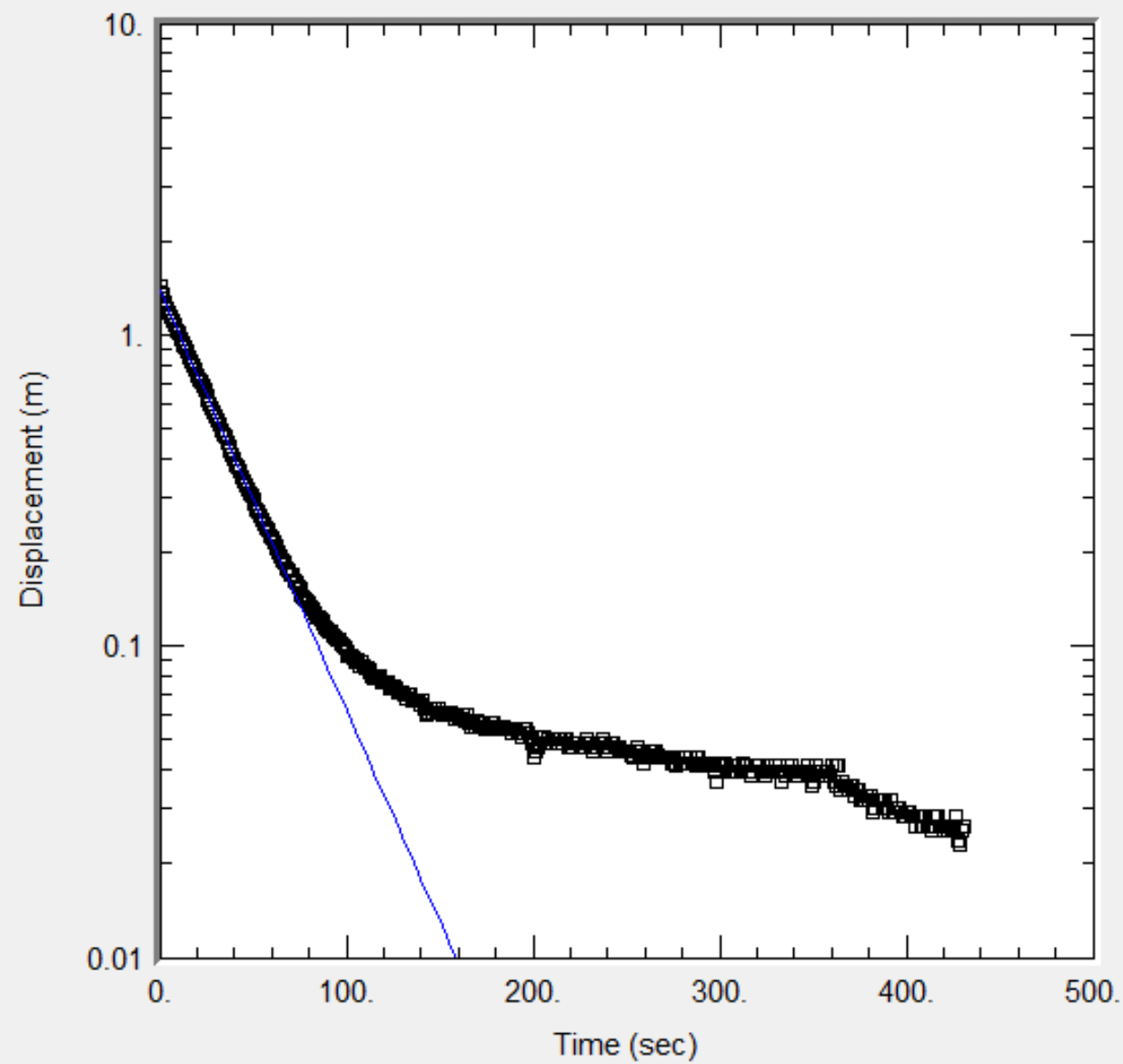
Solution

Hvorslev

Parameters

$K = 2.772E-6$ m/sec

$y_0 = 0.8023$ m



Obs. Wells

□ MW5

Aquifer Model

Unconfined

Solution

Hvorslev

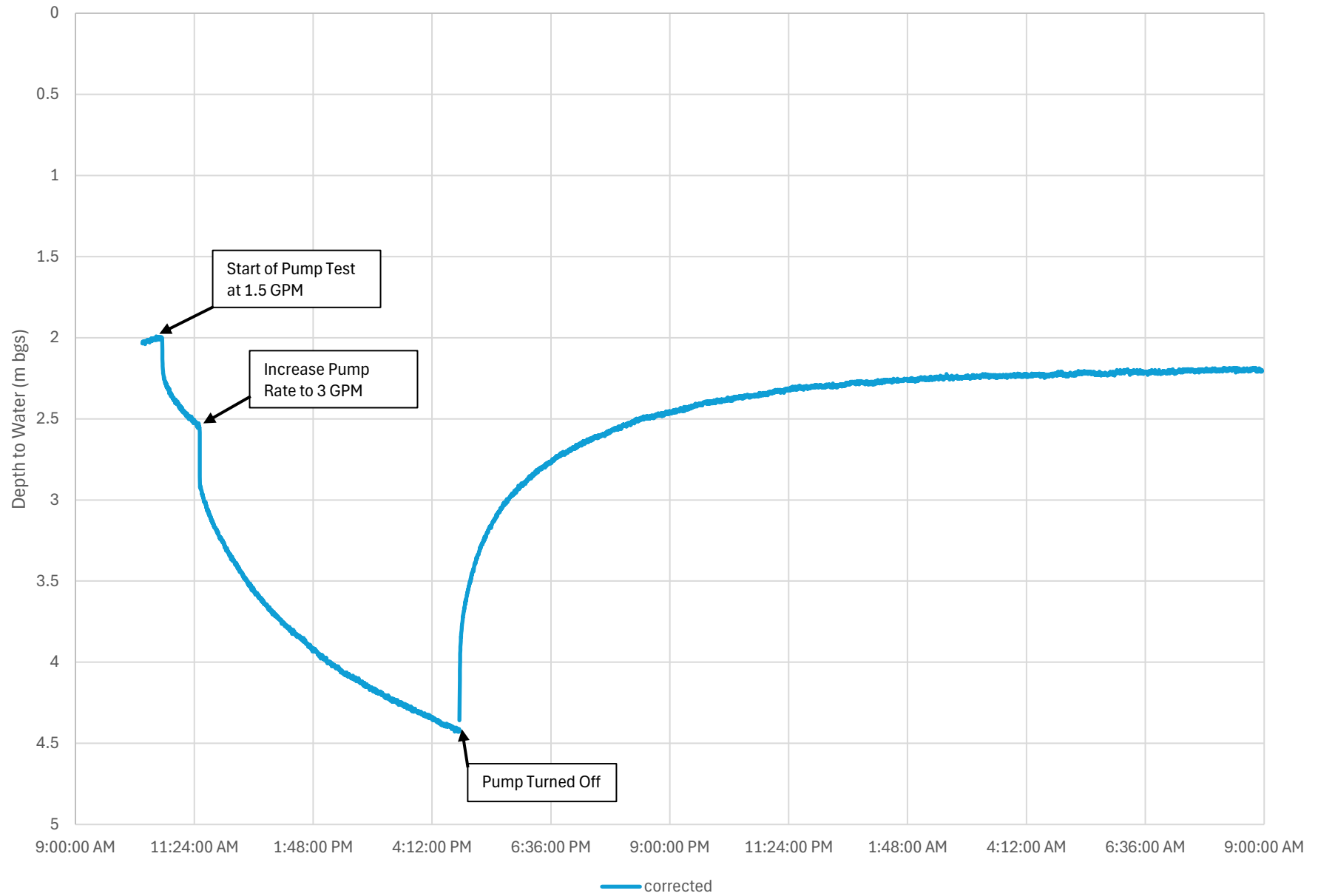
Parameters

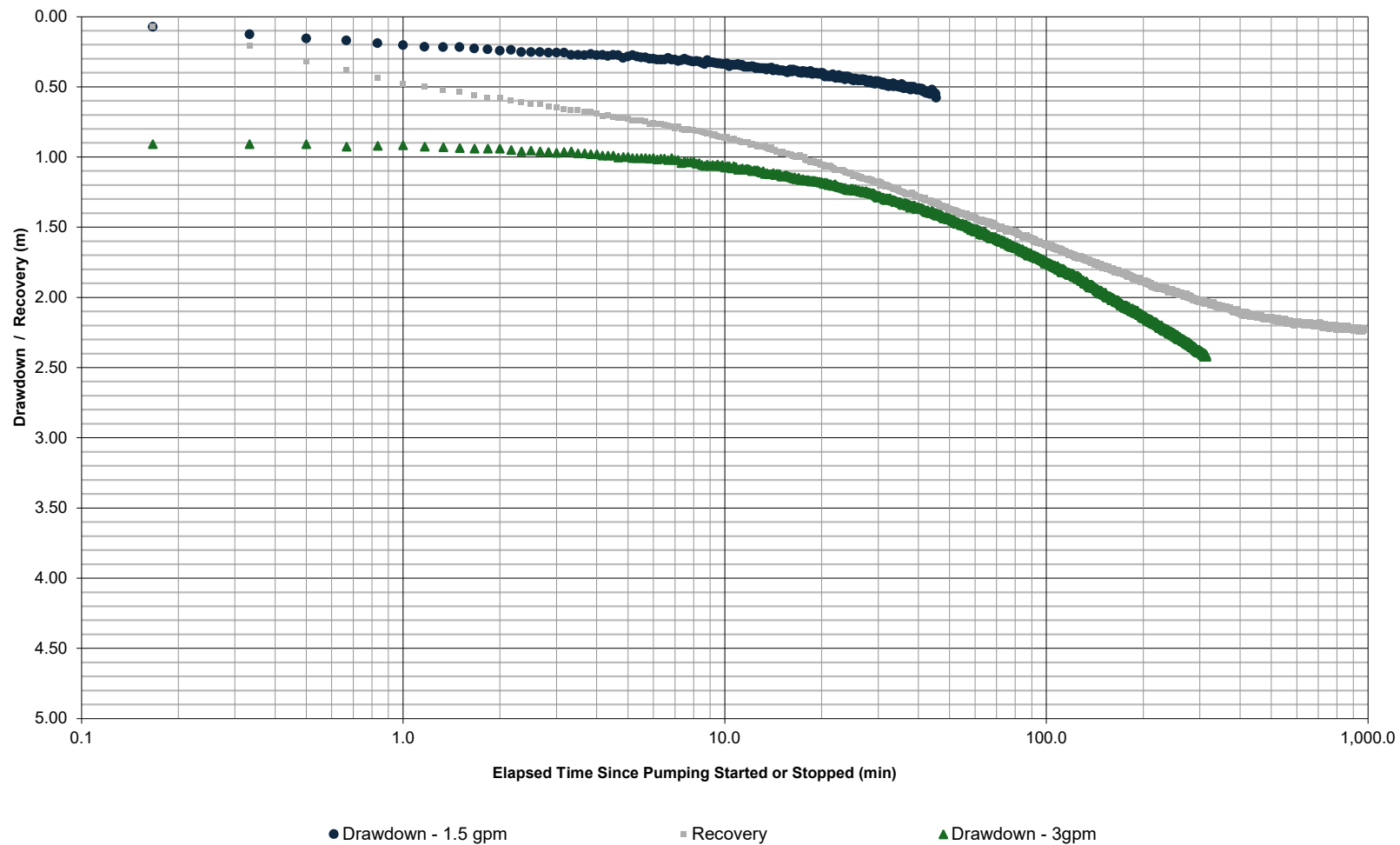
$K = 1.46E-5$ m/sec

$y_0 = 1.395$ m

Appendix E: Constant Rate Pumping Test Results

MW6 6-Hour Pumping Test





Record of TAG #		CONSULTANT	YYYY-MM-DD	2025/01/15	PROJECT	MW6			
Static Water Level (mbmp)	2.0		PREPARED	2025/01/15	TITLE	6 hour pumping test			
Pumping Level (mbmp)	4.4		DESIGN	SM					
Q of Pumping Well	1.5 GPM to 3.0 GPM		REVIEW		PROJECT No.	Phase	Rev	FIGURE	
			APPROVED		424371				

Appendix F: Lab Results

C.O.C.: G113824

REPORT No: 24-011644 - Rev. 0

Report To:

Tatham Engineering
115 Sandford Fleming Drive
Suite 200
Collingwood, ON L9Y 5A6

CADUCEON Environmental Laboratories

112 Commerce Park Dr Unit L
Barrie, ON L4N 8W8

Attention: Scott Patrick

DATE RECEIVED: 2024-Apr-29
DATE REPORTED: 2024-May-03
SAMPLE MATRIX: Ground Water

CUSTOMER PROJECT: 424371
P.O. NUMBER:

Analyses	Qty	Site Analyzed	Authorized	Date Analyzed	Lab Method	Reference Method
Anions (Liquid)	5	OTTAWA	PCURIEL	2024-Apr-30	A-IC-01	SM 4110B
Cond/pH/Alk Auto (Liquid)	5	OTTAWA	SBOUDREAU	2024-May-01	COND-02/PH-02/A LK-02	SM 2510B/4500H/ 2320B
ICP/MS (Liquid)	5	OTTAWA	AOZKAYMAK	2024-May-03	D-ICPMS-01	EPA 200.8
ICP/OES (Liquid)	5	OTTAWA	NHOGAN	2024-May-02	D-ICP-01	SM 3120B

R.L. = Reporting Limit

NC = Not Calculated

Test methods may be modified from specified reference method unless indicated by an *



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Data Specialist

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REPORT No: 24-011644 - Rev. 0

					Client I.D.	MW 1	MW 2	MW 3	MW 4
					Sample I.D.	24-011644-1	24-011644-2	24-011644-3	24-011644-4
					Date Collected	2024-Apr-26	2024-Apr-26	2024-Apr-26	2024-Apr-26
Parameter	Units	R.L.	Limits	DWG		-	-	-	-
Alkalinity(CaCO3) to pH4.5	mg/L	5	500	OG		228	132	289	266
Bicarbonate (as CaCO3)	mg/L	5				228	132	289	266
Conductivity @25°C	uS/cm	1				2330	2670	695	823
pH @25°C	pH units	-	8.5	OG		8.00	7.95	7.84	7.94
Chloride	mg/L	0.5	250	AO		16.2	18.8	5.7	5.6
Nitrate (N)	mg/L	0.05	10.0	MAC		<0.40	<0.40	<0.05	<0.05
Nitrite (N)	mg/L	0.05	1.0	MAC		<0.40	<0.40	<0.05	<0.05
Sulphate	mg/L	1	500	AO		1050	1300	70	161
Hardness (as CaCO3)	mg/L as CaCO3	0.02	100	OG		785	658	297	330
Aluminum	mg/L	0.01	0.1	OG		0.16	0.05	0.04	0.03
Barium	mg/L	0.001	1	MAC		0.028	0.055	0.009	0.012
Bismuth	mg/L	0.02				<0.02	<0.02	<0.02	<0.02
Boron	mg/L	0.005	5	MAC		2.09	4.06	0.981	1.85
Calcium	mg/L	0.02				150	118	63.4	65.0
Iron	mg/L	0.005	0.3	AO		0.120	<0.005	0.024	0.027
Lithium	mg/L	0.005				0.105	0.264	0.027	0.064
Magnesium	mg/L	0.02				99.7	88.5	33.6	40.8
Manganese	mg/L	0.001	0.05	AO		0.066	0.045	0.006	0.019
Phosphorus	mg/L	0.1				<0.1	<0.1	<0.1	<0.1
Potassium	mg/L	0.1				15.8	11.1	6.0	8.7
Silicon	mg/L	0.01				4.75	3.54	4.19	4.91



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					Client I.D.	MW 1	MW 2	MW 3	MW 4
					Sample I.D.	24-011644-1	24-011644-2	24-011644-3	24-011644-4
					Date Collected	2024-Apr-26	2024-Apr-26	2024-Apr-26	2024-Apr-26
Parameter	Units	R.L.	Limits	DWG		-	-	-	-
Silica	mg/L	0.02				10.2	7.58	8.97	10.5
Sodium	mg/L	0.2	200, 20, 20	AO, WL, MAC		220	329	13.7	31.2
Strontium	mg/L	0.001				5.34	5.08	3.54	4.15
Tin	mg/L	0.05				<0.05	<0.05	<0.05	<0.05
Titanium	mg/L	0.005				<0.005	<0.005	<0.005	<0.005
Tungsten	mg/L	0.01				0.31	0.09	0.02	0.02
Zinc	mg/L	0.005	5	AO		<0.005	<0.005	<0.005	<0.005
Zirconium	mg/L	0.003				<0.003	<0.003	<0.003	<0.003
Antimony	mg/L	0.0001	0.006	MAC		0.0019	0.0002	<0.0001	0.0001
Arsenic	mg/L	0.0001	0.01	MAC		0.0025	0.0004	0.0001	0.0006
Beryllium	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001
Cadmium	mg/L	0.000015	0.005	MAC		0.000124	<0.000015	<0.000015	<0.000015
Chromium	mg/L	0.001	0.05	MAC		<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.0001				0.0033	0.0005	0.0001	0.0005
Copper	mg/L	0.0001	1	AO		0.0049	0.0026	0.0004	0.0003
Lead	mg/L	0.00002	0.010	MAC		0.00011	<0.00004	<0.00002	<0.00002
Molybdenum	mg/L	0.0001				0.0863	0.0055	<0.0001	0.0004
Nickel	mg/L	0.0002				0.0072	0.0015	0.0006	0.0009
Selenium	mg/L	0.001	0.05	MAC		0.002	<0.001	<0.001	<0.001
Silver	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001
Thallium	mg/L	0.00005				<0.00005	<0.00005	<0.00005	<0.00005



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					Client I.D.	MW 1	MW 2	MW 3	MW 4
					Sample I.D.	24-011644-1	24-011644-2	24-011644-3	24-011644-4
					Date Collected	2024-Apr-26	2024-Apr-26	2024-Apr-26	2024-Apr-26
					DWG	-	-	-	-
Parameter	Units	R.L.	Limits						
Uranium	mg/L	0.00005	0.02		MAC	0.00162	0.00038	<0.00005	0.00013
Vanadium	mg/L	0.0001				0.0008	0.0003	<0.0001	<0.0001



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					Client I.D.
					MW 5
					Sample I.D.
					24-011644-5
					Date Collected
					2024-Apr-26
Parameter	Units	R.L.	Limits	DWG	
Alkalinity(CaCO3) to pH4.5	mg/L	5	500	OG	184
Bicarbonate (as CaCO3)	mg/L	5			184
Conductivity @25°C	uS/cm	1			515
pH @25°C	pH units	-	8.5	OG	8.05
Chloride	mg/L	0.5	250	AO	4.2
Nitrate (N)	mg/L	0.05	10.0	MAC	<0.05
Nitrite (N)	mg/L	0.05	1.0	MAC	<0.05
Sulphate	mg/L	1	500	AO	73
Hardness (as CaCO3)	mg/L as CaCO3	0.02	100	OG	179
Aluminum	mg/L	0.01	0.1	OG	0.01
Barium	mg/L	0.001	1	MAC	0.015
Bismuth	mg/L	0.02			<0.02
Boron	mg/L	0.005	5	MAC	1.24
Calcium	mg/L	0.02			35.0
Iron	mg/L	0.005	0.3	AO	0.009
Lithium	mg/L	0.005			0.032
Magnesium	mg/L	0.02			22.2
Manganese	mg/L	0.001	0.05	AO	0.009
Phosphorus	mg/L	0.1			<0.1
Potassium	mg/L	0.1			6.1
Silicon	mg/L	0.01			4.26



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					Client I.D.
					MW 5
					Sample I.D.
					24-011644-5
					Date Collected
					2024-Apr-26
Parameter	Units	R.L.	Limits	DWG	
Silica	mg/L	0.02			9.12
Sodium	mg/L	0.2	200, 20, 20	AO, WL, MAC	26.3
Strontium	mg/L	0.001			2.53
Tin	mg/L	0.05			<0.05
Titanium	mg/L	0.005			<0.005
Tungsten	mg/L	0.01			0.04
Zinc	mg/L	0.005	5	AO	<0.005
Zirconium	mg/L	0.003			<0.003
Antimony	mg/L	0.0001	0.006	MAC	0.0007
Arsenic	mg/L	0.0001	0.01	MAC	0.0019
Beryllium	mg/L	0.0001			<0.0001
Cadmium	mg/L	0.000015	0.005	MAC	<0.000015
Chromium	mg/L	0.001	0.05	MAC	<0.001
Cobalt	mg/L	0.0001			0.0012
Copper	mg/L	0.0001	1	AO	0.0003
Lead	mg/L	0.00002	0.010	MAC	<0.00002
Molybdenum	mg/L	0.0001			0.0019
Nickel	mg/L	0.0002			0.0008
Selenium	mg/L	0.001	0.05	MAC	<0.001
Silver	mg/L	0.0001			<0.0001
Thallium	mg/L	0.00005			<0.00005



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REPORT No: 24-011644 - Rev. 0

					Client I.D.	MW 5
					Sample I.D.	24-011644-5
					Date Collected	2024-Apr-26
Parameter	Units	R.L.	Limits	DWG		
Uranium	mg/L	0.00005	0.02	MAC	0.00020	
Vanadium	mg/L	0.0001			0.0002	

DWG - Drinking Water Guidelines

ODWS - Ontario Drinking Water Standards

AO - Aesthetic Objectives

IMAC - Interim Maximum Acceptable Concentration

MAC - Maximum Acceptable Concentration

ODWO - D-5-5 Objective

OG - Operational Guidelines

WL - Warning Level - Sodium Restricted Diets



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Summary of Exceedances		
Aesthetic Objectives		
MW 1	Found Value	Limit
Sulphate	1050	500
Manganese	0.066	0.05
Sodium	220	200
MW 2	Found Value	Limit
Sulphate	1300	500
Sodium	329	200
Maximum Acceptable Concentration		
MW 1	Found Value	Limit
Sodium	220	20
MW 2	Found Value	Limit
Sodium	329	20
MW 4	Found Value	Limit
Sodium	31.2	20
MW 5	Found Value	Limit
Sodium	26.3	20
Operational Guidelines		
MW 1	Found Value	Limit
Hardness (as CaCO ₃)	785	100
Aluminum	0.16	0.1
MW 2	Found Value	Limit
Hardness (as CaCO ₃)	658	100
MW 3	Found Value	Limit
Hardness (as CaCO ₃)	297	100
MW 4	Found Value	Limit
Hardness (as CaCO ₃)	330	100
MW 5	Found Value	Limit
Hardness (as CaCO ₃)	179	100
Warning Level - Sodium Restricted Diets		
MW 1	Found Value	Limit
Sodium	220	20
MW 2	Found Value	Limit
Sodium	329	20
MW 4	Found Value	Limit
Sodium	31.2	20
MW 5	Found Value	Limit
Sodium	26.3	20



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C.O.C.: G114027

REPORT No: 24-033607 - Rev. 0

Report To:

Tatham Engineering
115 Sandford Fleming Drive
Suite 200
Collingwood, ON L9Y 5A6

CADUCEON Environmental Laboratories

112 Commerce Park Dr Unit L
Barrie, ON L4N 8W8

Attention: Scott Patrick

DATE RECEIVED: 2024-Oct-25
DATE REPORTED: 2024-Nov-01
SAMPLE MATRIX: Ground Water

CUSTOMER PROJECT: 424371
P.O. NUMBER:

Analyses	Qty	Site Analyzed	Authorized	Date Analyzed	Lab Method	Reference Method
Anions (Liquid)	5	OTTAWA	PCURIEL	2024-Oct-29	A-IC-01	SM 4110B
Cond/pH/Alk Auto (Liquid)	5	OTTAWA	SBOUDREAU	2024-Oct-28	COND-02/PH-02/A LK-02	SM 2510B/4500H/ 2320B
ICP/MS (Liquid)	5	OTTAWA	AOZKAYMAK	2024-Oct-31	D-ICPMS-01	EPA 200.8
ICP/OES (Liquid)	5	OTTAWA	APRUDYVUS	2024-Oct-29	D-ICP-01	SM 3120B

R.L. = Reporting Limit

NC = Not Calculated

Test methods may be modified from specified reference method unless indicated by an *



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REPORT No: 24-033607 - Rev. 0

					Client I.D.	MW24-1	MW24-2	MW24-3	MW24-4
					Sample I.D.	24-033607-1	24-033607-2	24-033607-3	24-033607-4
					Date Collected	2024-Oct-24	2024-Oct-24	2024-Oct-24	2024-Oct-24
Parameter	Units	R.L.	Limits	DWG		-	-	-	-
Alkalinity(CaCO3) to pH4.5	mg/L	5	500	OG		173	194	298	252
Bicarbonate (as CaCO3)	mg/L	5				173	194	298	252
Carbonate (as CaCO3)	mg/L	5				<5	<5	<5	<5
TDS (Calc. from Cond.)	mg/L	3	500	AO		1370	1210	381	394
Conductivity @25°C	uS/cm	1				2460	2180	731	753
pH @25°C	pH units	-	8.5	OG		8.05	8.08	8.01	8.11
Bromide	mg/L	0.4				<1.0	<1.0	<0.4	<0.4
Fluoride	mg/L	0.1	1.5	MAC		<0.7	<0.7	0.6	1.2
Chloride	mg/L	0.5	250	AO		22.8	21.9	7.3	6.9
Nitrate (N)	mg/L	0.05	10.0	MAC		0.68	0.72	<0.05	<0.05
Nitrite (N)	mg/L	0.05	1.0	MAC		<0.40	<0.40	<0.05	<0.05
Sulphate	mg/L	1	500	AO		1230	913	84	137
Hardness (as CaCO3)	mg/L as CaCO3	0.02	100	OG		935	710	370	309
Aluminum	mg/L	0.01	0.1	OG		0.06	0.05	0.03	0.02
Bismuth	mg/L	0.02				<0.02	<0.02	<0.02	<0.02
Boron	mg/L	0.005	5	MAC		2.71	3.57	1.04	1.94
Calcium	mg/L	0.02				212	152	82.9	64.6
Iron	mg/L	0.005	0.3	AO		<0.005	0.010	0.014	0.074
Lithium	mg/L	0.005				0.159	0.210	0.027	0.067
Magnesium	mg/L	0.02				98.4	80.4	39.6	36.0
Manganese	mg/L	0.001	0.05	AO		0.037	0.098	0.007	0.010



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					Client I.D.	MW24-1	MW24-2	MW24-3	MW24-4
					Sample I.D.	24-033607-1	24-033607-2	24-033607-3	24-033607-4
					Date Collected	2024-Oct-24	2024-Oct-24	2024-Oct-24	2024-Oct-24
Parameter	Units	R.L.	Limits	DWG		-	-	-	-
Phosphorus	mg/L	0.1				<0.1	<0.1	<0.1	<0.1
Potassium	mg/L	0.1				11.4	10.6	7.4	8.5
Silicon	mg/L	0.01				4.09	4.02	4.29	5.02
Silica	mg/L	0.02				8.75	8.61	9.17	10.7
Sodium	mg/L	0.2	200, 20, 20	AO, WL, MAC		233	246	13.8	45.4
Strontium	mg/L	0.001				5.64	7.43	4.26	3.94
Tin	mg/L	0.05				<0.05	<0.05	<0.05	<0.05
Titanium	mg/L	0.005				<0.005	<0.005	<0.005	<0.005
Tungsten	mg/L	0.01				0.08	0.01	<0.01	<0.01
Zinc	mg/L	0.005	5	AO		<0.005	<0.005	<0.005	<0.005
Zirconium	mg/L	0.003				<0.003	0.004	<0.003	<0.003
Antimony	mg/L	0.0001	0.006	MAC		0.0011	0.0001	<0.0001	<0.0001
Arsenic	mg/L	0.0001	0.01	MAC		0.0012	0.0004	<0.0001	0.0003
Beryllium	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001
Cadmium	mg/L	0.000015	0.005	MAC		0.000016	<0.000015	<0.000015	<0.000015
Chromium	mg/L	0.001	0.05	MAC		<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.0001				0.0020	0.0004	0.0002	<0.0001
Copper	mg/L	0.0001	1	AO		0.0005	0.0004	0.0001	0.0004
Lead	mg/L	0.00002	0.010	MAC		<0.00004	0.00004	0.00002	0.00002
Molybdenum	mg/L	0.0001				0.0108	0.0030	<0.0001	<0.0001
Nickel	mg/L	0.0002				0.0037	0.0011	0.0003	<0.0002



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					Client I.D.	MW24-1	MW24-2	MW24-3	MW24-4
					Sample I.D.	24-033607-1	24-033607-2	24-033607-3	24-033607-4
					Date Collected	2024-Oct-24	2024-Oct-24	2024-Oct-24	2024-Oct-24
Parameter	Units	R.L.	Limits	DWG		-	-	-	-
Selenium	mg/L	0.001	0.05	MAC		<0.001	<0.001	<0.001	<0.001
Silver	mg/L	0.0001				<0.0001	<0.0001	<0.0001	<0.0001
Uranium	mg/L	0.00005	0.02	MAC		0.00341	0.00022	<0.00005	<0.00005
Vanadium	mg/L	0.0001				0.0005	0.0002	0.0001	<0.0001



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REPORT No: 24-033607 - Rev. 0

					Client I.D.
					MW24-5
					Sample I.D.
					24-033607-5
					Date Collected
					2024-Oct-24
Parameter	Units	R.L.	Limits	DWG	
Alkalinity(CaCO ₃) to pH4.5	mg/L	5	500	OG	181
Bicarbonate (as CaCO ₃)	mg/L	5			181
Carbonate (as CaCO ₃)	mg/L	5			<5
TDS (Calc. from Cond.)	mg/L	3	500	AO	257
Conductivity @25°C	uS/cm	1			496
pH @25°C	pH units	-	8.5	OG	8.23
Bromide	mg/L	0.4			<0.4
Fluoride	mg/L	0.1	1.5	MAC	1.4
Chloride	mg/L	0.5	250	AO	7.5
Nitrate (N)	mg/L	0.05	10.0	MAC	<0.05
Nitrite (N)	mg/L	0.05	1.0	MAC	<0.05
Sulphate	mg/L	1	500	AO	61
Hardness (as CaCO ₃)	mg/L as CaCO ₃	0.02	100	OG	198
Aluminum	mg/L	0.01	0.1	OG	0.02
Bismuth	mg/L	0.02			<0.02
Boron	mg/L	0.005	5	MAC	1.41
Calcium	mg/L	0.02			41.7
Iron	mg/L	0.005	0.3	AO	0.073
Lithium	mg/L	0.005			0.032
Magnesium	mg/L	0.02			22.7
Manganese	mg/L	0.001	0.05	AO	0.007



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REPORT No: 24-033607 - Rev. 0

					Client I.D.
					MW24-5
					Sample I.D.
					24-033607-5
					Date Collected
					2024-Oct-24
Parameter	Units	R.L.	Limits	DWG	
Phosphorus	mg/L	0.1			<0.1
Potassium	mg/L	0.1			6.4
Silicon	mg/L	0.01			4.40
Silica	mg/L	0.02			9.42
Sodium	mg/L	0.2	200, 20, 20	AO, WL, MAC	25.0
Strontium	mg/L	0.001			2.65
Tin	mg/L	0.05			<0.05
Titanium	mg/L	0.005			<0.005
Tungsten	mg/L	0.01			<0.01
Zinc	mg/L	0.005	5	AO	<0.005
Zirconium	mg/L	0.003			<0.003
Antimony	mg/L	0.0001	0.006	MAC	<0.0001
Arsenic	mg/L	0.0001	0.01	MAC	0.0013
Beryllium	mg/L	0.0001			<0.0001
Cadmium	mg/L	0.000015	0.005	MAC	<0.000015
Chromium	mg/L	0.001	0.05	MAC	<0.001
Cobalt	mg/L	0.0001			0.0001
Copper	mg/L	0.0001	1	AO	0.0005
Lead	mg/L	0.00002	0.010	MAC	0.00002
Molybdenum	mg/L	0.0001			0.0004
Nickel	mg/L	0.0002			<0.0002



Michelle Dubien
Data Specialist

The analytical results reported herein refer to the samples as received and relate only to the items tested. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

CADUCEON Environmental Laboratories Certificate of Analysis

Final Report
REPORT No: 24-033607 - Rev. 0

					Client I.D.
					MW24-5
					Sample I.D.
					24-033607-5
					Date Collected
					2024-Oct-24
Parameter	Units	R.L.	Limits	DWG	
Selenium	mg/L	0.001	0.05	MAC	<0.001
Silver	mg/L	0.0001			<0.0001
Uranium	mg/L	0.00005	0.02	MAC	0.00008
Vanadium	mg/L	0.0001			<0.0001

Sample 24-033607-1 filtered from unpreserved for metals analysis due to sediment in the metals bottle.
Elevated RLs due to sample matrix interferences

DWG - Drinking Water Guidelines

ODWS - Ontario Drinking Water Standards

AO - Aesthetic Objectives

IMAC - Interim Maximum Acceptable Concentration

MAC - Maximum Acceptable Concentration

ODWO - D-5-5 Objective

OG - Operational Guidelines

WL - Warning Level - Sodium Restricted Diets



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Data Specialist

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Summary of Exceedances		
Aesthetic Objectives		
MW24-1	Found Value	Limit
TDS (Calc. from Cond.)	1370	500
Sulphate	1230	500
Sodium	233	200
MW24-2	Found Value	Limit
TDS (Calc. from Cond.)	1210	500
Sulphate	913	500
Manganese	0.098	0.05
Sodium	246	200
Maximum Acceptable Concentration		
MW24-1	Found Value	Limit
Sodium	233	20
MW24-2	Found Value	Limit
Sodium	246	20
MW24-4	Found Value	Limit
Sodium	45.4	20
MW24-5	Found Value	Limit
Sodium	25.0	20
Operational Guidelines		
MW24-1	Found Value	Limit
Hardness (as CaCO ₃)	935	100
MW24-2	Found Value	Limit
Hardness (as CaCO ₃)	710	100
MW24-3	Found Value	Limit
Hardness (as CaCO ₃)	370	100
MW24-4	Found Value	Limit
Hardness (as CaCO ₃)	309	100
MW24-5	Found Value	Limit
Hardness (as CaCO ₃)	198	100
Warning Level - Sodium Restricted Diets		
MW24-1	Found Value	Limit
Sodium	233	20
MW24-2	Found Value	Limit
Sodium	246	20
MW24-4	Found Value	Limit
Sodium	45.4	20
MW24-5	Found Value	Limit



Michelle Dubien
Data Specialist

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Final Report

REPORT No: 24-033607 - Rev. 0

Sodium	25.0	20
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Michelle Dubien
Data Specialist

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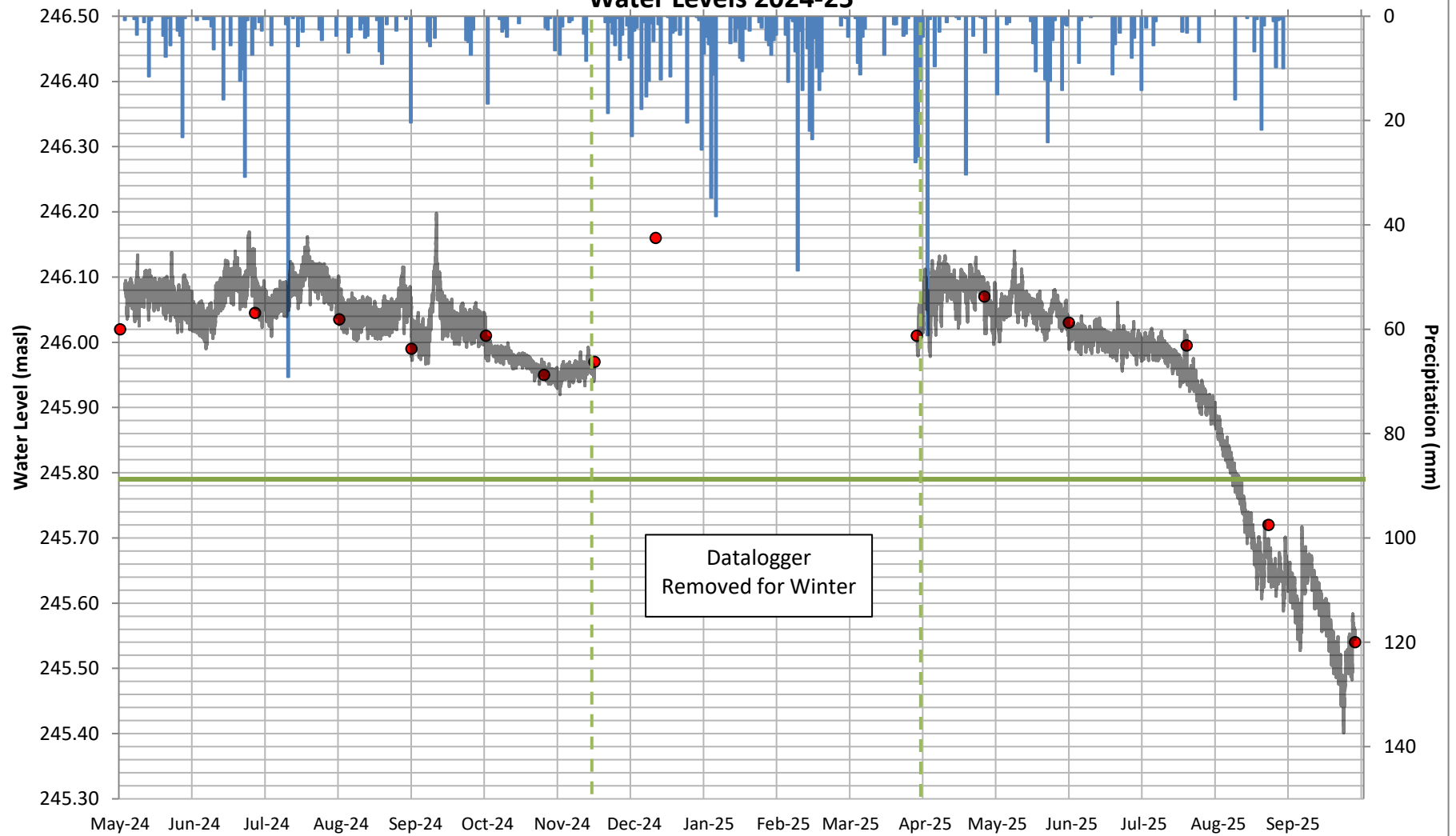
Appendix G: Wetland and Surface Water Hydrographs/Ratings Curves

Observation Well (MP1) Water Levels 2024-25



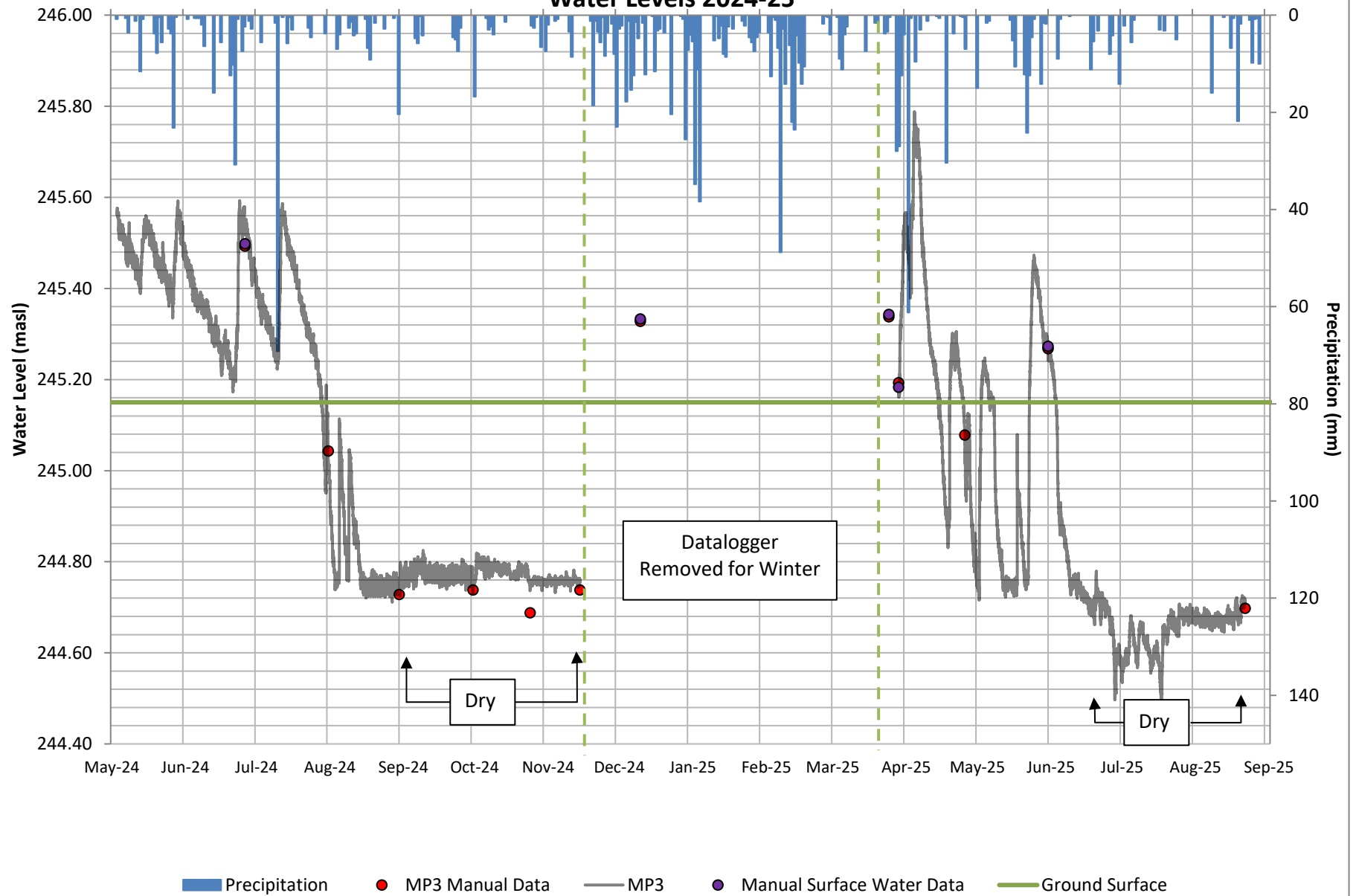
Precipitation MP1 Manual Data Manual Surface Water Data Ground Surface MP1

Observation Well (MP2) Water Levels 2024-25

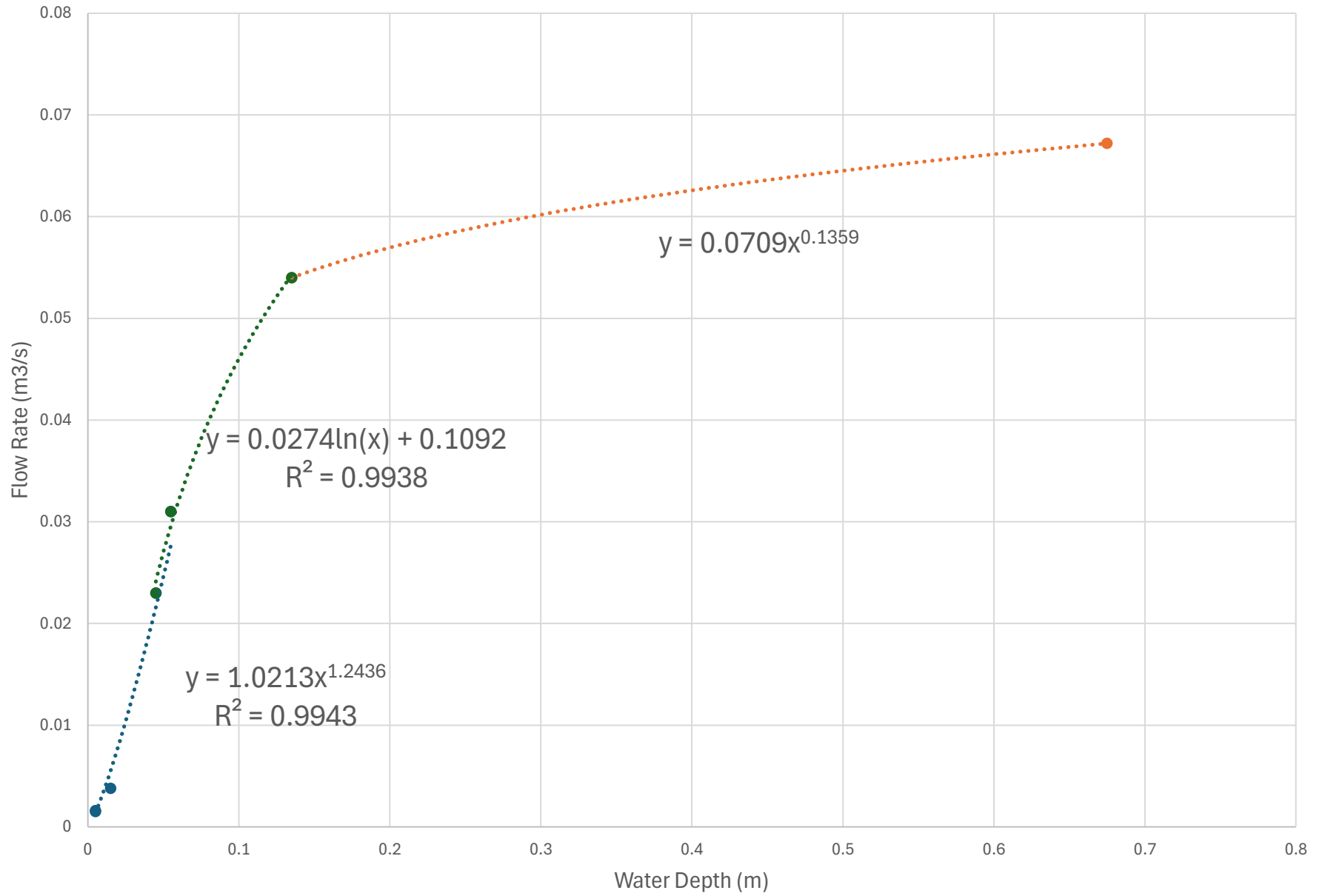


Precipitation MP2 Manual Data MP2 Manual Surface Water Data Ground Surface

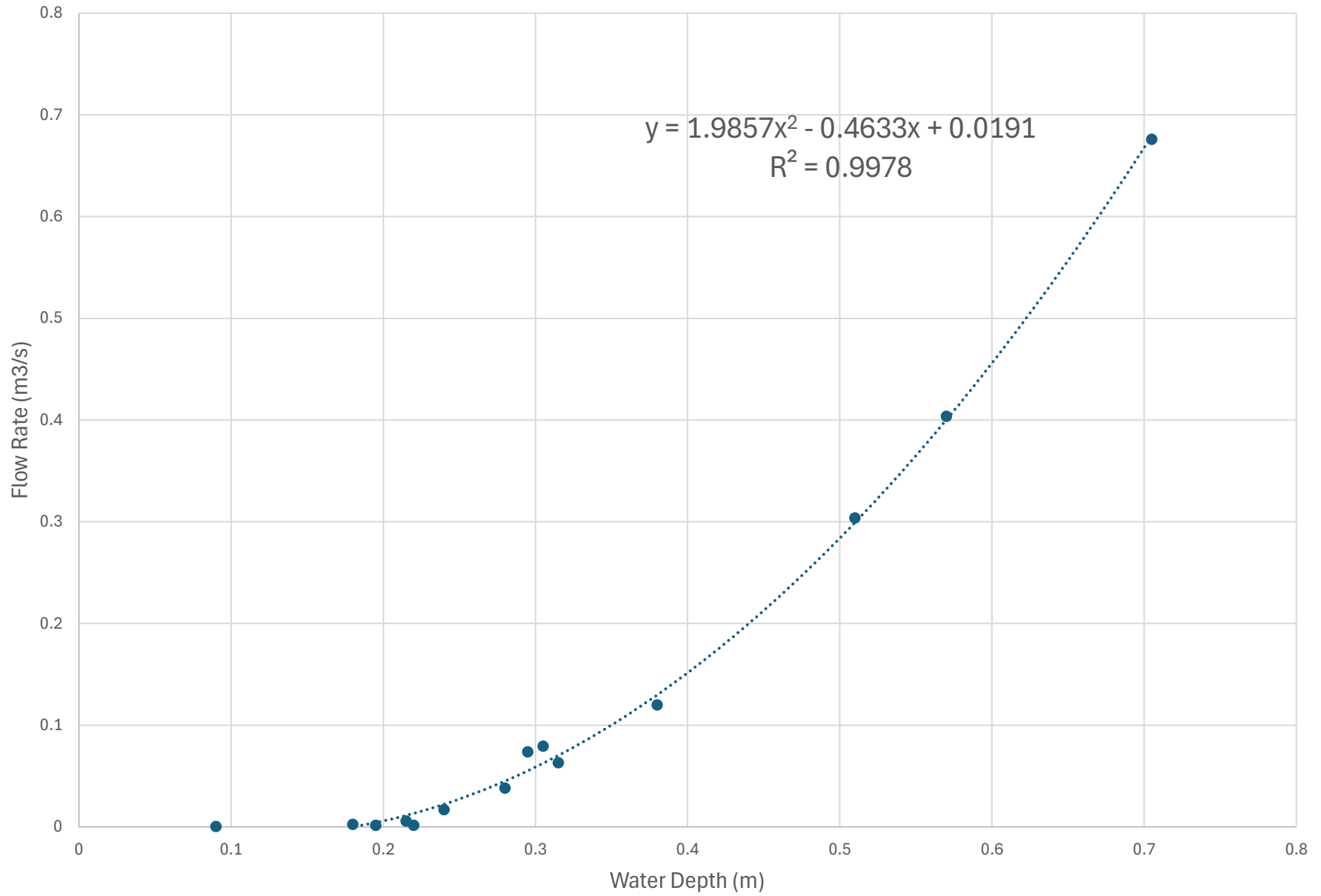
Observation Well (MP3) Water Levels 2024-25



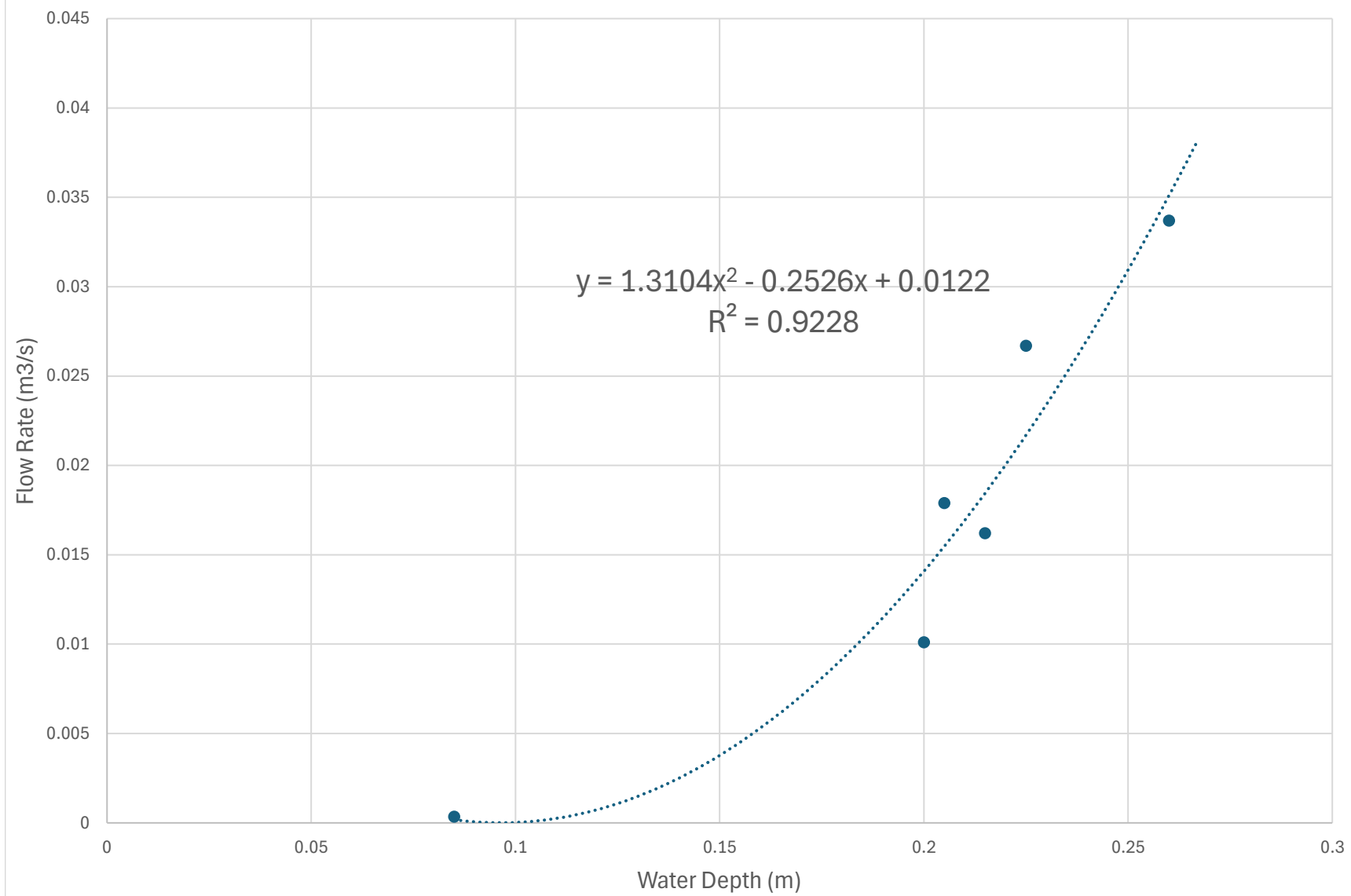
SW1 Ratings Curve



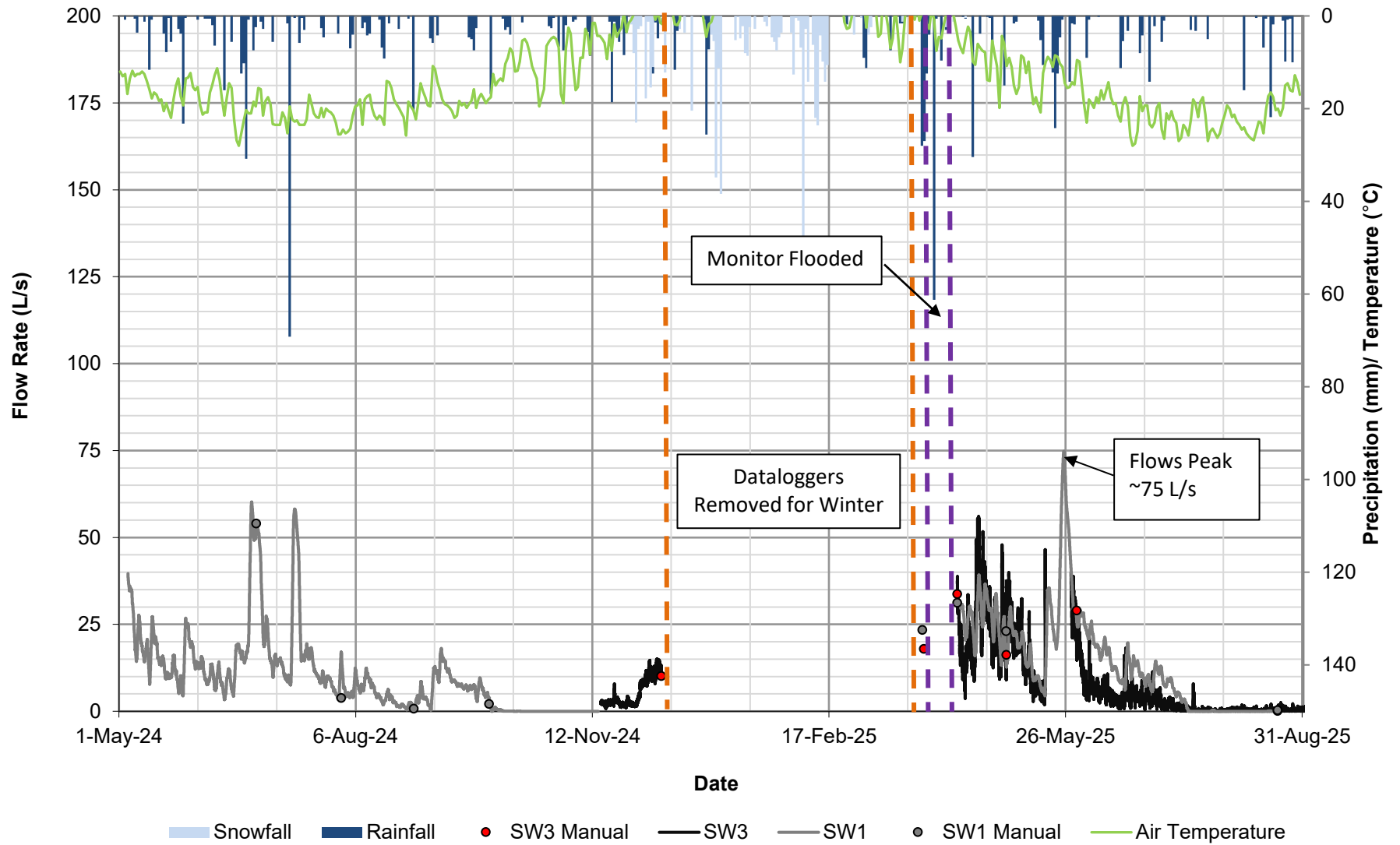
SW2 Ratings Curve



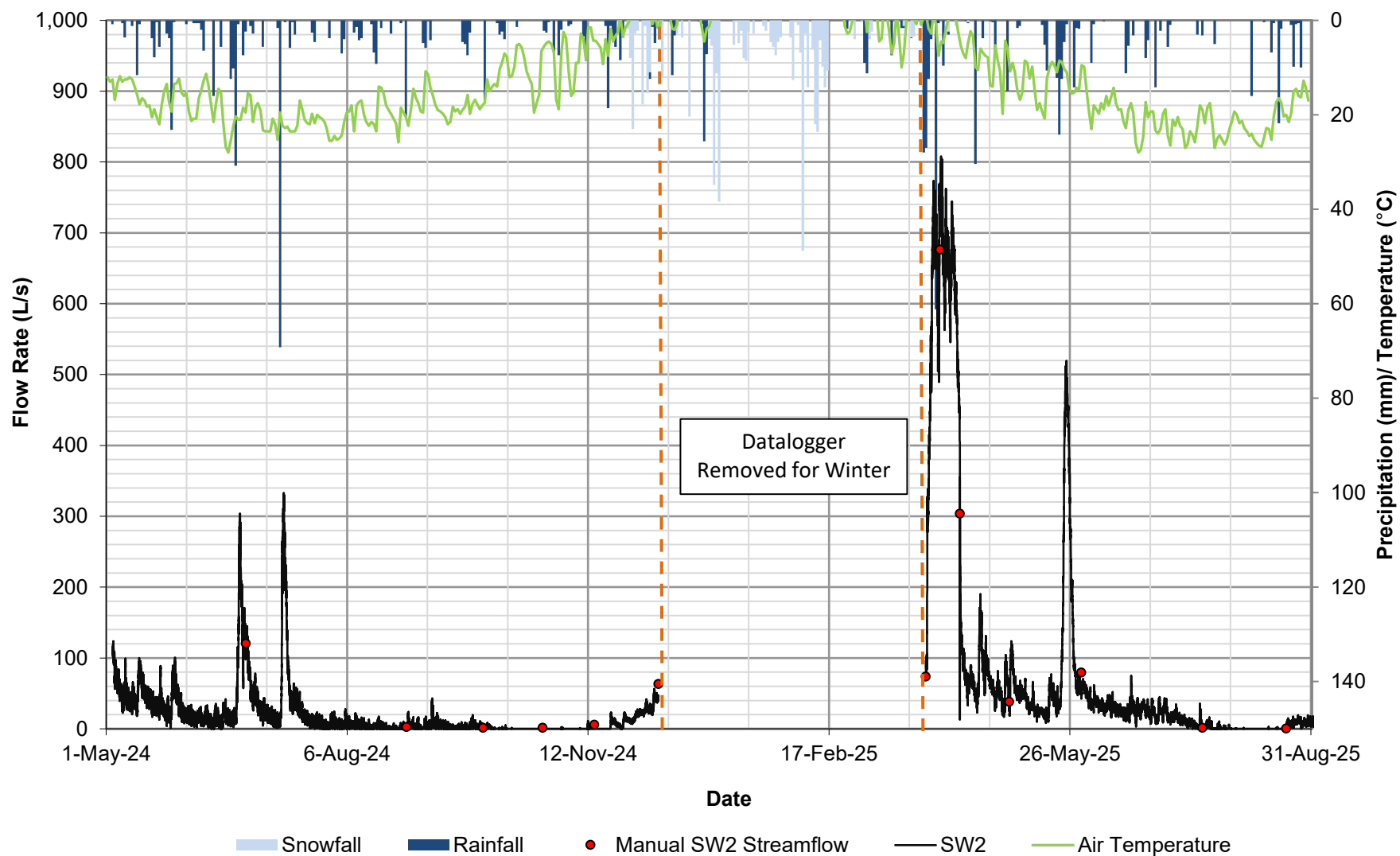
SW3 Ratings Curve



STREAMFLOW MONITORING STATION SW1/SW3 2024-2025 STREAMFLOW

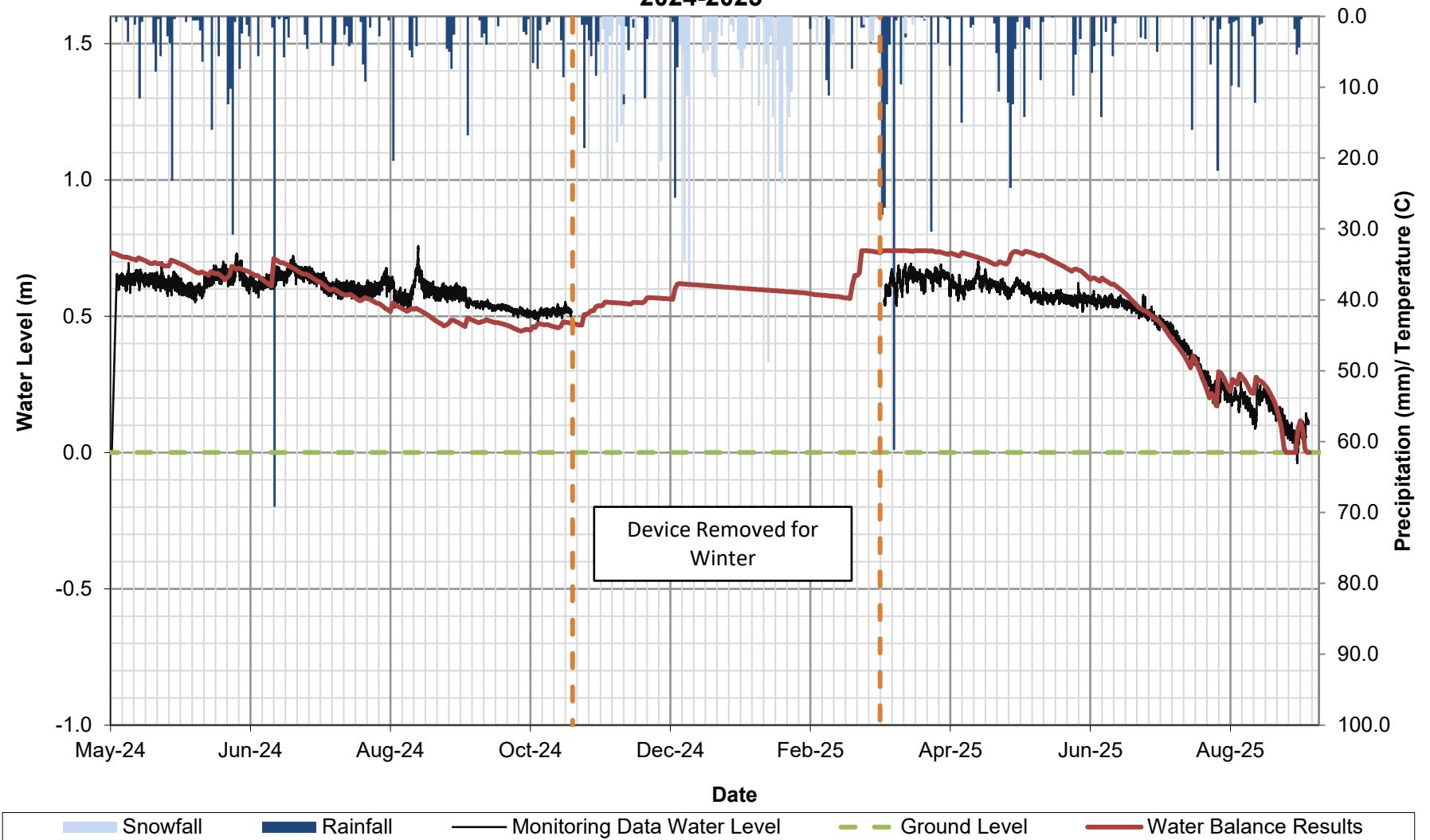


STREAMFLOW MONITORING STATION SW2 2024-2025 STREAMFLOW

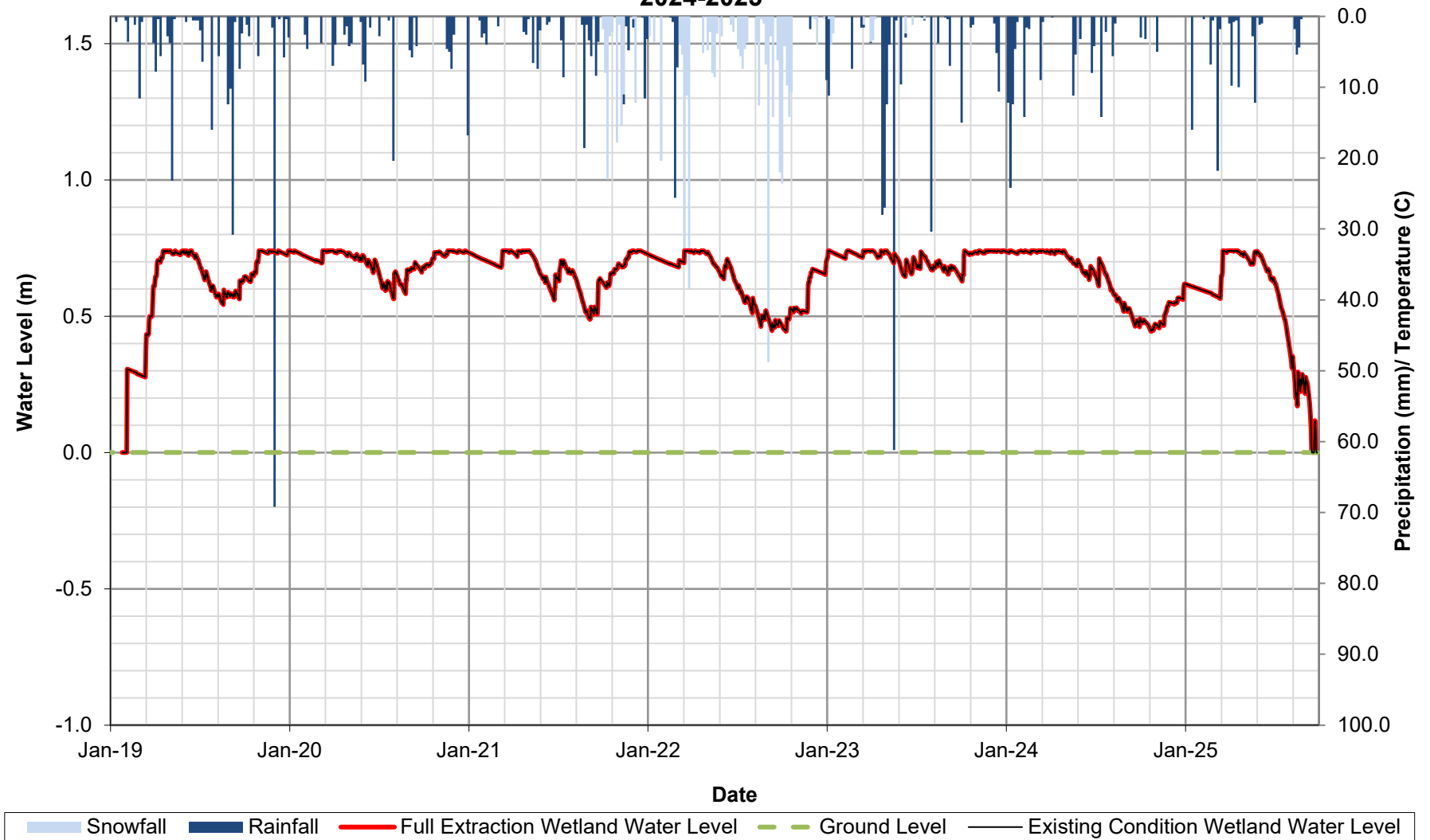


Appendix H: Water Balance

BRAND X MATERIALS AND SUPPLY INC. RAMARA QUARRY
WETLAND HYDROPERIOD SUMMARY - MONITORING STATION MP2
2024-2025



BRAND X MATERIALS AND SUPPLY INC. RAMARA QUARRY
WETLAND HYDROPERIOD SUMMARY - WETLAND WU-4
2024-2025



Project Details

Ramara Quarry	424371
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Prepared By

JG	10/24/2025
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$$T_{out} = T_s + (T_{in} - T_s) * e^{-NTU}$$

$$NTU = (h * a_s * A * L) / (m * c_p)$$

$$h = (Nu * k) / d_s$$

$$Nu = 2 + \left(\frac{1.1 * (p * U_s * d_s)}{u} \right)^{0.6} * \left(\frac{u * c_p}{k} \right)^{1/3}$$

Where:

T_{in} =	19.7	Initial Water Temperature (°C)
T_{out} =	18.9	Final Water Temperature (°C)
T_s =	10.0	Temperature of Stone (°C)
d_s =	0.15	Stone Diameter (m)
k =	0.6	Thermal Conductivity of Water (W/(m.K))
h =	1094.76	Convective Heat Transfer Coefficient
e =	0.4	Porosity of Infiltration Feature
A =	24.6	Cross-Sectional Area of Infiltration Feature (m ²)
a_s =	9.8	Specific Area (m ²)
L =	190	Length of Infiltration Feature (m)
m =	75.0	Mass Flow Rate of Water (kg/s)
C_p =	4180	Heat Capacity of Water (J/kg.C)
Nu =	273.7	Nusselt Number
NTU =	0.1	Number Transfer Units

Appendix I: Integrated Surface Water- Groundwater Model Development and Calibration Report



Ramara Quarry

Groundwater Modelling Assessment

Submitted to:

Brand X Materials and Supply Inc.

15 Sarjeant Drive

Barrie, ON

L4N 4V9

Attention: Michael MacMillan

Submitted by:

Equilibrium Mining Inc.

April 7, 2026

Reference: 001-Rev1

Project Number: SCL-2025001



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APPENDICES

APPENDIX A

Conceptual Hydrogeological Model

APPENDIX B

Model Setup and Parameterization

APPENDIX C

Model Calibration

APPENDIX D

Forecast Simulations

LIMITATIONS AND USE OF REPORT

This report has been prepared for Brand X Materials and Supply Inc. and Tatham Engineering Limited (Tatham) by Equilibrium Mining Inc. (Equilibrium). The factual information and interpretations presented herein are specific to the scope of work outlined in this report. Under no circumstances may this information be used for any other purpose than those specified in this scope of work unless explicitly stated in the text of this report or formally authorized by Equilibrium. This report must be read in its entirety as some sections could be misinterpreted when taken individually or out of context. The final version of this report and its contents supersede any other preliminary version of this information by Equilibrium.

With respect to the groundwater modelling services performed in support of this scope of work, these were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the quantity and quality of available data and the time limits and financial constraints applicable to the services. Unless otherwise specified, the data and results from previous or simultaneous work provided by other sources than Equilibrium are considered as having been obtained according to recognized and accepted professional rules and practices; and therefore, deemed valid. The model presented herein provides a scientific tool to help evaluate the potential impacts on the groundwater flow and surface water systems at the proposed Ramara Quarry site in support of a Level 1 and Level 2 Hydrogeological Assessment. However, despite the professional care taken during the development, calibration, and application of the model, its accuracy is bound to the normal uncertainty associated with groundwater modelling and no warranty, expressed or implied, is made.

1.0 INTRODUCTION

1.1 Background

Brand X Materials and Supply Inc. is applying for an *Aggregate Resources Act* (ARA) Class A Quarry Below Water license to permit an aggregate extraction operation for the proposed Ramara Quarry (referred to hereafter as the 'Site' or the 'Proposed Quarry'). Equilibrium Mining Inc. (Equilibrium) has been retained by Brand X Materials and Supply Inc. to provide groundwater modelling services in support of the Level 1 and Level 2 Hydrogeological Assessment Report for the Proposed Quarry which is being prepared by Tatham Engineering Limited (Tatham).

The Proposed Quarry is located approximately 14 kilometres north of Lake Simcoe in the Township of Ramara, Ontario (Figure 1). The Site is approximately 72 hectares in size and is comprised of undeveloped woodland in the north part of the Site and wetland in the south part of the Site. The area surrounding the Site is primarily undeveloped wetland and wooded areas, existing aggregate extraction operations, and a few rural residential properties. Existing approved quarry operations surrounding the Site include ARA License Number 3601 to the west (referred to hereafter as 'Cut Above'), ARA License Number 608542 to the east (referred to hereafter as 'James Dick'), and ARA License Number 104616 to the southwest (referred to hereafter as 'Bot'). The Bot and Cut Above properties are currently approved to extract below the water table so they have been included as part of the modelling assessment. The James Dick quarry is only approved for above water extraction and therefore is not included in the modelling simulations. Figure 1 below presents the location of the proposed Ramara quarry and the neighbouring quarries.

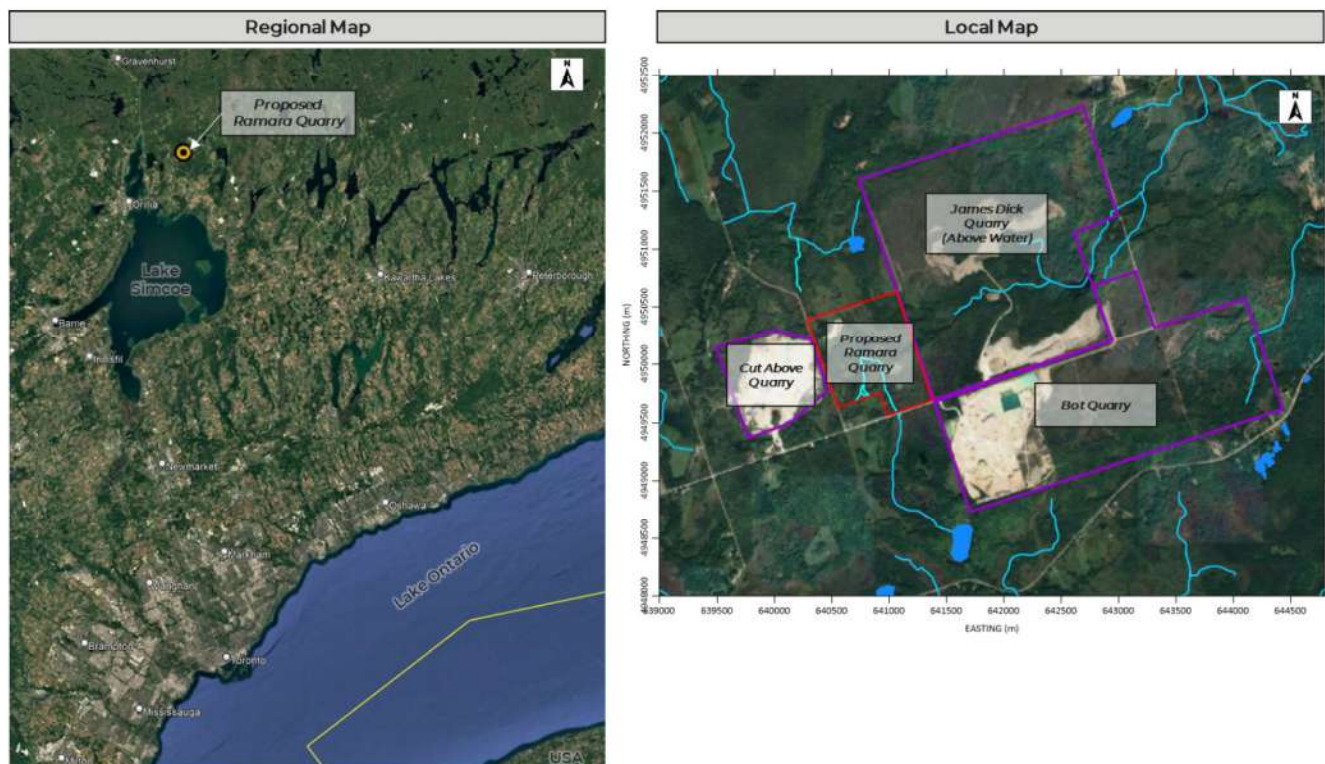


Figure 1: Site Location

1.2 Objective

The objective of the groundwater modelling assessment is to evaluate potential changes in hydrogeological conditions associated with the development of the Proposed Quarry. This includes estimates of the extent of groundwater drawdown during quarry operation and rehabilitation, and groundwater inflow estimates to the Proposed Quarry during operations.

1.3 Scope of Work

In order to meet the above objective, the following tasks were completed:

- Review of on-site data and regional publicly available data to support development of a Conceptual Hydrogeological Model (CHM). Site data includes groundwater elevations, stream flow rates, and the results of hydraulic conductivity testing collected during the 2024/2025 hydrogeological field program (Tatham, 2025). Additional local data available for nearby quarry sites was used to supplement the on-site data (Waterloo Geoscience Consultants, 1999; Harden, 2016). Regional data including geological mapping, water well information, climate data and topography were sourced from publicly available sources provided by the Ontario Geological Survey (OGS), the Geological Survey of Canada (GSC), the Ontario Ministry of the Environment Conservation and Parks (MECP), the Ontario Ministry of Natural Resources and Forestry (MNRF) and Environment and Climate Change Canada (ECCC).
- Development of a regional scale 3D groundwater flow model using HydroGeoSphere (HGS) that is suitable for the hydrogeological setting and the goals of the model simulations (i.e., to estimate the hydrogeological impacts of the proposed quarry development).
- Calibration of the regional scale 3D groundwater flow model to observed historical conditions at the site, including groundwater elevations and estimates of surface water flow in the area.
- Following construction and calibration of the groundwater flow model, complete forecast simulations to estimate the effect of the proposed quarry activities on hydrogeological conditions in the project area. This includes estimates of inflow rates to the Proposed Quarry and groundwater elevations (and extent of drawdown) surrounding the Proposed Quarry. The forecast simulations consider planned quarry activities at the Site as well as cumulative effects from neighbouring below water quarry operations (Cut Above and Bot Quarries).

The report is organized as follows: Section 2.0 describes the CHM for the Site; Section 3.0 describes the construction and calibration of the groundwater flow model, and Section 4.0 describes the model setup and results of the forecast simulations for the proposed quarry development.

2.0 CONCEPTUAL HYDROGEOLOGICAL MODEL

The CHM for the Site as it relates to the construction and calibration of the groundwater flow model is discussed in this section. The CHM is largely derived from the work completed by Tatham (2025); full details of the CHM can be found by reviewing their report.

- **Topography and Drainage:** The topography and drainage of the Region is presented in Appendix A.1. The Proposed Quarry and the neighbouring quarries are located at a regional topographic high. Drainage is to the north and northwest towards Head River and Black River which eventually discharges to Lake St. John. Locally, the topography on Site is gently sloping and ranges between 242 and 257 metres above sea level (masl). The highest elevation is at the northeast corner of the Site, and the low point is at the centre of the Site. Drainage is generally towards this local depression feature which exists in the centre of the Site. Surface water runoff, including a south to north watercourse, collects in this central area before disappearing from the surface water system (infiltrating to the groundwater flow system). The surface water loss ("sink") in the central area of the Site is inferred to reappear as surface water to the north of the Site at the Head River Tributary. The flows at a location upstream of the surface water "sink" (SW1) and a location at the downstream Head River Tributary (SW2) were established to measure surface water flows during the field program. It is noted that the SW1 location would only capture a portion of the total flow reaching the "sink" area as not all the runoff would flow past this location. Flow rates measured at the SW1 location between May 2024 and August 2025 varied between approximately 0 and 75 L/s (0 to 6,480 m³/d) with the largest flows during the spring freshet. Flow rates measured at the SW2 location varied between 0 and 700 L/s (0 and 60,480 m³/d) with the largest flows measured during the spring freshet and following significant rainfall events (Tatham 2025).
- **Surficial Geology:** Appendix A.2 presents the surficial geology of the study area based on mapping published by the OGS (2010). Local to the Site, the surficial geology is primarily mapped as Paleozoic bedrock at surface surrounded by areas of primarily sand or diamicton. Based on the field program, the south part of the site has more fine-grained organic soil which inhibits surface water infiltration and results in the presence of wetlands (Tatham, 2025). To the north of the site the Precambrian bedrock is mapped at surface. A map of the overburden thickness was generated using on-site data, depth to bedrock data from the MECP water well database and the OGS surficial geology mapping and is presented in Appendix A.3. The overburden is generally thin (< 1 m thickness) at the north of the study area and near the Site. Larger areas of thicker overburden deposits (>10 m thickness) are primarily located to the south of the Site.
- **Bedrock Geology:** The bedrock geology of the study area based on OGS Paleozoic bedrock geology mapping (Armstrong and Dodge, 2007) is presented in Appendix A.4. The bedrock sequence present in the study area has three Paleozoic bedrock formations including, in descending order, the Bobcaygeon Formation (limestone/shale), the Gull River Formation (limestone/dolostone), and the Shadow Lake Formation (sandstone/shale) which overlie the Precambrian basement rock. Interpreted elevations of the Paleozoic and Precambrian bedrock formations along with interpreted thicknesses of the Paleozoic bedrock formations were based on site data and publicly available sources such as a Leapfrog geological model of southern Ontario (Carter et al., 2019) and are presented in Appendix A.5 to A.11. The dip of the Paleozoic bedrock formations is interpreted to be to the southwest within the study area. The Bobcaygeon Formation is not present on Site but exists within the study area primarily to the south of the Site and at topographic highs located east and northeast of the Site. Based on published mapping and the field investigation completed by Tatham, the uppermost bedrock formation present on Site is the Gull River Formation. The interpreted thickness of the

Gull River Formation on Site is between approximately 10 and 16 metres. The Shadow Lake Formation, which subcrops to the north of the Site, underlies the Gull River Formation and is approximately 9 to 11 metres thick on Site. Underlying the Paleozoic bedrock is the Precambrian basement bedrock which subcrops to the north of the Site.

- **Groundwater Flow:** Observed groundwater level contours are provided in Appendix A.12. Within the study area, groundwater elevation and flow is interpreted to mirror topography with higher groundwater elevations at topographic highs such as where the Proposed Quarry and neighbouring quarries are located. Groundwater flow is radial out from these higher elevations towards the topographic low areas of the surrounding lakes and watercourses. Locally in the Site area, groundwater flow is to the north towards Head River and Black River. Based on the field investigation by Tatham, there is a downward vertical gradient present on site with shallow groundwater levels generally approximately 2 to 5 metres higher than the deeper Gull River groundwater levels.
- **Hydraulic Conductivity:** A summary of the hydraulic conductivity data collected on Site during the Tatham field investigation and supplementary data extracted using reports from the neighbouring quarries (Waterloo Geoscience Consultants, 1999; Harden, 2016) is presented in Appendix A.13. Site data collected during the field investigation was focused primarily on the Gull River Formation and included single well response tests, packer tests, and a constant rate pumping test. A more detailed summary of these tests can be found in the Tatham report (2025). There was not a significant trend in hydraulic conductivity with depth identified within Gull River Formation on Site. The hydraulic conductivity of the Gull River Formation ranged between 5.6×10^{-7} to 1.5×10^{-5} m/s with a geomean of 3.6×10^{-6} m/s. This was comparable to the data reported for the Cut Above property where the geomean of hydraulic conductivity in the Gull River Formation was 2×10^{-6} m/s (Harden, 2016). For the Shadow Lake Formation, there was one test that was within this formation on Site which had a measured hydraulic conductivity of 5.7×10^{-6} m/s. There were no tests completed within the Bobcaygeon Formation (not present on Site) or the Precambrian bedrock, so the nearby Bot property reporting (Waterloo Geoscience Consultants, 1999) was used as a supplementary source for these. At the Bot site, the hydraulic conductivity of the Bobcaygeon Formation had a range in hydraulic conductivity between 1.8×10^{-10} to 1.4×10^{-7} m/s and a geomean of 3.5×10^{-9} m/s which is generally lower than the range measured in the Gull River Formation for the current investigation. There was one test at the Bot property completed in the Precambrian bedrock where the hydraulic conductivity was measured as 5×10^{-9} m/s.
- **Hydrostratigraphic Units:** The hydrostratigraphic units identified in the study area are the Overburden, Bobcaygeon Formation bedrock, Weathered Gull River Formation bedrock, Gull River Formation bedrock, Shadow Lake Formation bedrock, and Precambrian bedrock. The overburden is generally thin and discontinuous across the study area. The Bobcaygeon Formation is interpreted to be a low transmissivity aquitard where present. The Gull River Formation is interpreted to be an aquifer based on the hydraulic conductivity testing completed on Site. A weathered unit at the top of the Gull River with increased transmissivity compared to the underlying Gull River Formation is inferred to be present based on field observations provided by Tatham. This weathered unit is assumed to only exist where the Gull River Formation is the upper bedrock formation present and exposed to weathering (i.e., no weathered Gull River present beneath the Bobcaygeon Formation). The underlying Shadow Lake Formation is interpreted to be an aquifer and the Precambrian basement bedrock is interpreted to be an aquitard.

3.0 GROUNDWATER MODEL CONSTRUCTION AND CALIBRATION

3.1 Modelling Approach

The objective of the groundwater modelling assessment is to provide estimates of the potential impact of the proposed Ramara Quarry on local and regional groundwater conditions. This includes potential changes in groundwater elevations which may impact nearby water uses or surface water features compared to existing conditions. This entailed the construction of a 3D numerical model of the quarry and surrounding regional groundwater flow system.

The 3D model was constructed based on the CHM presented in Section 2.0, with additional detail documented in Tatham (2025), and is calibrated to observed groundwater elevations and surface water flows under steady state conditions. The calibrated numerical flow model is then used as a basis for forecast simulations of the proposed quarry development.

3.2 Code Description

HydroGeoSphere (HGS) was used as the numerical simulation tool for this assessment (Aquanty, 2025). HGS uses a globally-implicit approach to simultaneously solve the 2D diffusion-wave equation (surface flow domain) and the 3D form of Richards' equation (i.e., variably saturated flow) in the subsurface domain. The HGS platform uses a Newton iteration to handle nonlinearities in the governing flow equations, a robust and efficient iterative sparse matrix solver, which has been parallelized to utilize high performance computing facilities for addressing large-scale problems. HGS revision 2732 (build date October 4, 2024) was used to complete the simulations presented in this report.

3.3 Model Domain and Discretization

The model domain and model mesh are shown in Appendix B.1. The model domain is approximately 160 km² in size with the boundary following Dalrymple Lake in the east to Head River and Black River in the North then to Lake St. John and Mud Lake in the west. The southern model boundary does not follow a surface water feature but was selected to be sufficiently far from the Site to not significantly influence groundwater conditions at the Proposed Quarry.

The 3D model is discretized into a triangular prismatic mesh with horizontal node spacing of approximately 10 m in the Site area, transitioning to 100 m within 1 km of the property boundary, and 600 m in the regional model area. To represent the hydrostratigraphy within the HGS model, a total of 14 numerical layers were used (described further in Section 3.4). Additional layers were adopted in the model to allow for increased resolution of vertical hydraulic heads within the model domain. A total of 81,422 elements are specified per model layer, for a total of 1,139,908 elements across the full 14 layers of the model domain.

3.4 Hydrostratigraphy and Model Parameterization

The generalized hydrostratigraphy for the site is described in the CHM presented in Section 2.0, with additional detail documented in Tatham (2025). The hydrostratigraphic units included in the groundwater model, from the ground surface down, are summarized as follows:

- Overburden (Layers 1-3)
 - In areas where the bedrock surface is close to topography the underlying bedrock formations (Bobcaygeon, Gull River, Shadow Lake, and Precambrian bedrock) may be present within Layers 1 to 3.

- **Bobcaygeon (where present) Layer 4**
 - Bobcaygeon is present primarily in the south of the model domain and at topographic highs to the east and northeast of the Site.
- **Weathered Gull River (Layers 4 and 5)**
 - The weathered Gull River unit is present across model domain where the Gull River exists except in areas that are overlain by the Bobcaygeon formation (Gull River not exposed to weathering) and within the extraction areas of the active quarries where it is inferred to have been removed by extraction activities.
 - An additional zone within this hydrostratigraphic unit was defined in Layer 4 which has consistent properties with the weathered Gull River unit except it includes a lower vertical hydraulic conductivity. This zone was defined based on the field data and observations provided by Tatham of water ponding around Site and south of the Site in wetland areas. Conceptually, it is inferred that water is ponded in this area due to the organic soils present causing a lower vertical conductivity in this weathered Gull River unit and resulting in water levels being perched in the wetland.
- **Gull River (Layers 6 to 12)**
 - Exists across the model domain except to the north of the Site where it is eroded away and the underlying Shadow Lake and Precambrian bedrock subcrop.
- **Shadow Lake (Layer 13)**
 - Exists across the model domain except to the north of the Site where it is eroded away and the underlying Precambrian bedrock subcrops.
- **Precambrian (Layer 14)**
 - Exists across the model domain.

The hydraulic conductivities assigned to each hydrostratigraphic unit were assigned within the range of available measured data and adjusted during the model calibration process (Section 3.6). The distribution of hydrostratigraphic units within these layers, and the hydraulic conductivity values applied to each unit are shown in Appendix B.2 and B.3. Appendix B.3 includes a cross-section through the model domain illustrating the hydrostratigraphic units incorporated.

3.5 Model Boundary Conditions

Boundary conditions are applied to both the 2D surface water domain and the 3D groundwater domain to represent interactions within the hydrological and hydrogeological domains. The locations of the boundary conditions applied in the model are presented in Appendix B.4 and B.5.

A summary of the boundary conditions applied to the 2D surface water domain is provided below.

- **Recharge:** Recharge in the model is applied as an average annual net surplus of 586 mm/year based on 2019 to 2025 climate data from the Orillia Brain Climate Station (ID 6115811). The surplus is applied to the 2D surface water domain (which is coincident with the upper layer of the 3D groundwater domain) and depending on the hydrological and hydrogeological conditions, a portion of this surplus will infiltrate into the groundwater domain, and the excess will runoff based on topography.

- **Critical Depth:** A critical depth boundary condition is assigned to the perimeter of the model. A critical depth boundary allows water to flow freely from (exit) the surface flow domain if surface water ponding occurs.
- **Drain (Quarries):** A drain was applied at the topographic low within the extraction area of the Cut Above (245.4 masl) and Bot (248.2 masl) quarries. The surface topography applied in the model is assumed to represent the current extraction conditions at the neighbouring quarries and therefore the drain was only applied within the surface domain to represent drainage to the sump.
- **Drain (SW1*):** A drain boundary condition was added to the top surface of the model within the 'sink' area of the Site (discussed in Section 2.0) at an elevation of 242.3 masl. This location of this drain is specified as SW1* as it is located just downstream of Tatham surface water monitoring location SW1. This drain outflow is then specified as an inflow to the first node of the discrete linear feature defined within the groundwater flow domain which connects the 'sink' area to the downstream Head River tributary (SW2*). The details of this discrete linear feature are discussed below with the groundwater domain boundary conditions.

A summary of the boundary conditions applied to the 3D groundwater domain is provided below.

- **Constant Head Boundary:** The southwest perimeter boundary of the model within the Shadow Lake (top and bottom of Layer 13) is assigned as constant head nodes to accommodate regional groundwater flow to the southwest.
- **No Flow Boundary:** The remaining perimeter model boundary and the base of the model (180 masl within the Precambrian bedrock) is assigned as a no flow boundary.
- **Discrete Linear Feature and Flux Nodal Boundary:** a discrete linear feature is defined as a connected set of nodes to route the infiltration at the SW1* "sink" location and groundwater to the Head River tributary north of the Site. The connected set of nodes is defined using a "well domain" in HGS which allows it to function similarly to that of a groundwater pumping well by applying a specified flux nodal boundary condition to the final node of the linear sequence. This linear feature begins in the Gull River (Layer 6) below SW1* (the drain outflow from SW1* is applied as an inflow here) then decreases in elevation to the base of the Gull River (Layer 12) at the north Site boundary before continuing northwest within Layer 12 and finally connecting up to the top surface of the model at the inferred outlet location to the Head River tributary. The outlet location of the Head River tributary is located just upstream of the Tatham monitoring location SW2 and defined as SW2*. The flux nodal boundary condition at SW2* is specified at an elevation of 238.1 masl which allows groundwater along the connected nodes to be drained to this elevation and routed through to the outlet at SW2*. The resulting groundwater outflow from this flux nodal boundary condition (which includes the SW1* drain outflow) is then re-introduced as an inflow to the surface water domain at the SW2* location. A zone of increased hydraulic conductivity consistent with the properties of the weathered Gull River unit was assigned within approximately 100 metres of this linear well feature to represent the concept that increased fracturing may be present in this area.

3.6 Model Calibration

The calibration of the model involved the refinement of material properties of the hydrostratigraphic units, while reasonably representing the conceptual hydrogeological model (described in Section 2.0). Adjustments were made to hydraulic parameters until the simulated and observed conditions compared reasonably well in the study area. It is noted that there was no publicly available pumping data reported for either of the neighbouring quarries (Cut Above and Bot), so simulated quarry inflows were not included in the calibration process.

The following targets were used to evaluate the model calibration:

- Average groundwater elevations at 6 on-site groundwater monitoring wells (Tatham, 2025; referred to as the MW-series wells in Appendix A.1).
- Average groundwater elevations at 3 on-site mini-piezometers (Tatham, 2025; referred to as the MP-series wells in Appendix A.1).
- Average surface water elevations at 2 on-site surface water monitoring locations (Tatham, 2025; SW1 and SW2 as shown in Appendix A.1).
- Surface water flow rates at 2 surface water monitoring locations (Tatham, 2025; SW1 and SW2 as shown in Appendix A.1).
- Average groundwater elevation data reported for 16 monitoring well locations at the Cut Above Quarry site (Harden, 2016).
- Average groundwater elevation data reported for 28 monitoring well locations at the Bot Quarry site (Waterloo Geoscience Consultants, 1999).
- Groundwater elevations at 462 water wells extracted from the MECP water well database.

The results of the calibration process are presented in Appendix C.1 (in the context of the overall regional model) and Appendix C.2 (in the context of the Proposed Quarry Site). A review of the results in Appendix C.1 and C.2 allows the following observations:

- Groundwater flow directions simulated by the model are *similar* to those inferred based on the observed water levels (see comparison of observed and simulated groundwater elevation contours in a regional context in Appendix C.1 and local to the Site in Appendix C.2).
- The residual maps show there is not a significant spatial bias in the difference between observed and simulated groundwater levels.
- Simulated groundwater and surface water elevations compare well with the observed values (for the on-site data in particular) as indicated by the mean absolute error of 0.56 m, 1.67 m and 2.51 m for the site data, neighbouring quarry data, and regional data, respectively (see Appendix C.1).
- The mean error for the groundwater elevations in the model is 0.26 m, 0.45 m and 1.39 m for the site data, neighbouring quarry data and regional data, respectively. This indicates there is not a significant bias to overpredict or underpredict the hydraulic heads in the model.
- The simulated surface water flows at monitoring locations SW1 and SW2 are within the range of measured data (see table in Appendix C.2).
- The normalized root mean squared error (NRMSE) for the groundwater elevations in the model is 9.3%, 9.5%, and 8.7% for the site data, neighbouring quarry data, and regional data, respectively.

3.6.1 Existing Conditions Water Balance

The total simulated inflow and outflow was compared for the steady-state existing conditions model to check for model stability and mass balance error. The mass balance error was low (<0.01%), with the individual components of the water balance summarized in Table 1.

Table 1: Steady-State Model Calibration – Mass Balance Summary

Component/Boundary	Net Inflow/Outflow ^(a) [m ³ /day]
Recharge (Net Surplus Applied)	261,859
Critical Depth Boundary	-259,594
Regional Constant Head – South Boundary; Shadow Lake	-980
Cut Above Quarry	-267
Bot Quarry	-1,018
SW1* Drain	-6,573
Flux Nodal Linear Discrete Feature (Not Including SW1* Drain Inflow)	-621
SW2* Outlet	7,194
Total	≈ 0

(a) Negative numbers represent a net outflow from the model domain and positive numbers represent a net inflow to the model domain.

4.0 FORECAST SIMULATIONS

4.1 Approach

Based on discussion with Tatham, the following future conditions scenarios have been considered for the forecast simulations:

- **Baseline:** Full extraction of the existing approved neighbouring quarries (Cut Above and Bot) with no extraction at the Proposed Quarry.
- **Full Extraction:** Full extraction of the existing approved neighbouring quarries (Cut Above and Bot) with full extraction at the Proposed Quarry.
- **Baseline Rehabilitation:** The Cut Above and Bot Quarries are rehabilitated as lakes based on the approved site plans. The Proposed Quarry is at full extraction conditions.
- **Rehabilitation:** The Proposed Quarry and the neighbouring quarries are fully rehabilitated. Based on the approved site plans for the neighbouring quarries, both Cut Above and Bot are rehabilitated as lakes. The Proposed Quarry is rehabilitated by backfilling the excavation back to existing topography.

4.2 Forecast Simulations Model Setup

To complete the forecast simulations, adjustments were made to the model to represent the extraction and rehabilitation of the Proposed Quarry, the Cut Above Quarry, and the Bot Quarry. The model adjustments are summarized below and presented in Appendix D.1.

Operations

- Drain boundary conditions are used to represent the dewatered quarry extraction areas. The drain boundary simulates the removal of water at a rate that maintains the quarry water level at a specified elevation. Within each quarry extraction area, the drain boundary is assigned to a single node in Layer 12 at the lowest elevation of the base of the Gull River (Layer 12). It is noted that the drain boundaries are assigned at the node location that coincides with the low point of the Gull River formation to facilitate dewatering and may not be representative of the operating quarry sump locations. The location and elevation of the quarry drain boundaries are presented in Appendix D.1.
- The overburden and bedrock material removed during extraction is simulated as a high hydraulic conductivity zone (1 m/s) to represent the "air space" of the quarry. This allows for the entire extraction area to be dewatered by the single specified drain boundary condition.
- The surface water domain is made inactive over the footprint of the operating quarries. The inactive surface water domain results in the surplus not being applied over the quarry footprint and also prevents overland flow from directly flowing into the excavation.
- The SW1* drain boundary condition and the linear discrete feature and flux nodal boundary condition that is specified in the Gull River formation is removed from within the quarry footprint (i.e., the linear discrete feature starts at the north extraction area boundary instead of below SW1*) during quarry extraction.
- During extraction of the Proposed Quarry there is anticipated to be a need to control overland flow particularly to the south of the Phase 2 and Phase 3 extraction areas. In order to prevent ponded water in this area and to be able to track this overland flow volume separately from the groundwater inflow component, drain boundary conditions within the surface water domain were assigned at topography south of the Phase 2 and Phase 3 extraction areas.

Rehabilitation

- During rehabilitation, the quarries represented as lakes (Cut above and Bot) remain with a high hydraulic conductivity material filling the “air space” of the extracted bedrock. The drain boundary condition used for dewatering during extraction is removed and the surface water domain is made active to allow surplus to be applied to the surface and the quarry to fill with water.
- During rehabilitation the Proposed Quarry is planned to be backfilled to original topography. Based on discussions with Tatham, the backfill material is assumed to have a hydraulic conductivity of 5×10^{-5} m/s everywhere except near surface (Layers 1 to 4) across the southern portion of the extraction area where a lower hydraulic conductivity material (1×10^{-6} m/s) will be used.
- Under rehab conditions when the quarry is backfilled the SW1* drain boundary is re-established similar to the existing conditions model. The linear discrete feature and flux nodal boundary condition is not re-established within the backfilled quarry footprint (i.e., the linear discrete feature starts at the north extraction area boundary instead of below SW1*).

4.3 Results

4.3.1 Simulated Drawdown

The results of the groundwater flow model simulations for each of the four forecast scenarios are presented in Appendix D.2 to D.7. The results are presented as shallow groundwater drawdown (model layer 4) and at the base of the Gull River (model layer 12).

Drawdown for the two operations scenarios (baseline and full extraction) is calculated by comparing the simulated head under existing conditions (calibrated model) to the simulated head in each operations forecast scenario (Appendix D.2 and D.3). The incremental drawdown is presented in Appendix D.4 which represents the incremental drawdown which would be contributed by the development of the Proposed Quarry on top of the drawdown caused by the two neighbouring quarries. The results in Appendix D.2 to D.4 show less drawdown from the Proposed Quarry in the shallow groundwater system compared to at the base of the Gull River. The extent of the incremental drawdown is more limited due to the drawdown simulated by the development of the already approved quarries.

Drawdown for the two rehabilitation scenarios (baseline rehabilitation and rehabilitation) is calculated by comparing the simulated head under existing conditions (calibrated model) to the simulated head in each rehabilitation forecast scenario (Appendix D.5 and D.6). The incremental drawdown is presented in Appendix D.7 which represents the incremental drawdown which would be contributed by the rehabilitation of the Proposed Quarry compared to when the Proposed Quarry is fully extracted and the neighbouring quarries are rehabilitated. The results in Appendix D.5 to D.7 show less drawdown from the Proposed Quarry extraction area in the shallow groundwater system compared to at the base of the Gull River. With the three quarries fully rehabilitated (Appendix D.6) there is generally a decrease in water levels from existing conditions in the shallow system, but it does not extend far from the rehabilitated quarries. At the base of the Gull River the water levels generally increase around the Proposed Quarry and the Cut Above Quarry whereas there is a small decrease compared to existing conditions around the Bot Quarry.

4.3.2 Proposed Quarry Groundwater Inflows

In addition to the drawdown results, groundwater inflow rates to the Proposed Quarry were provided to Tatham to be used in their water balance analysis. The model was run for both Phase 1 of the development and for the full extraction scenario. To provide a seasonal range in groundwater inflows, the model was run transiently using an average monthly surplus rather than the annual average which was applied in the steady state model. The monthly surplus applied in the model and the monthly groundwater inflows simulated for the Proposed Quarry are presented in Appendix D.8.

5.0 CLOSURE

We trust that this report meets the current requirements. Please contact the undersigned should you have any questions or require further information regarding the information contained within.

Equilibrium Mining Inc.



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APPENDIX A

Conceptual Hydrogeological Model

A.1: Topography and Drainage

A.2: Surficial Geology

A.3: Overburden Thickness

A.4: Bedrock Geology

A.5: Top of Bedrock

A.6: Bobcaygeon Formation Thickness

A.7: Top of Gull River

A.8: Gull River Thickness

A.9: Top of Shadow Lake

A.10: Shadow Lake Thickness

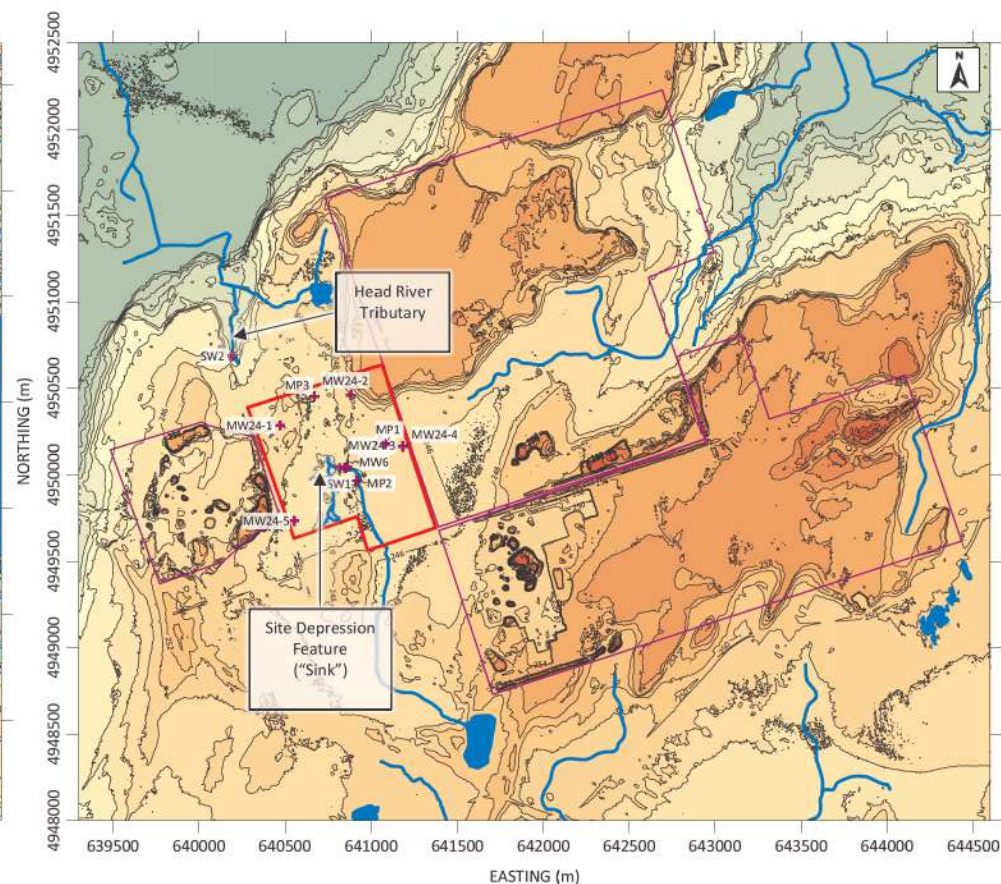
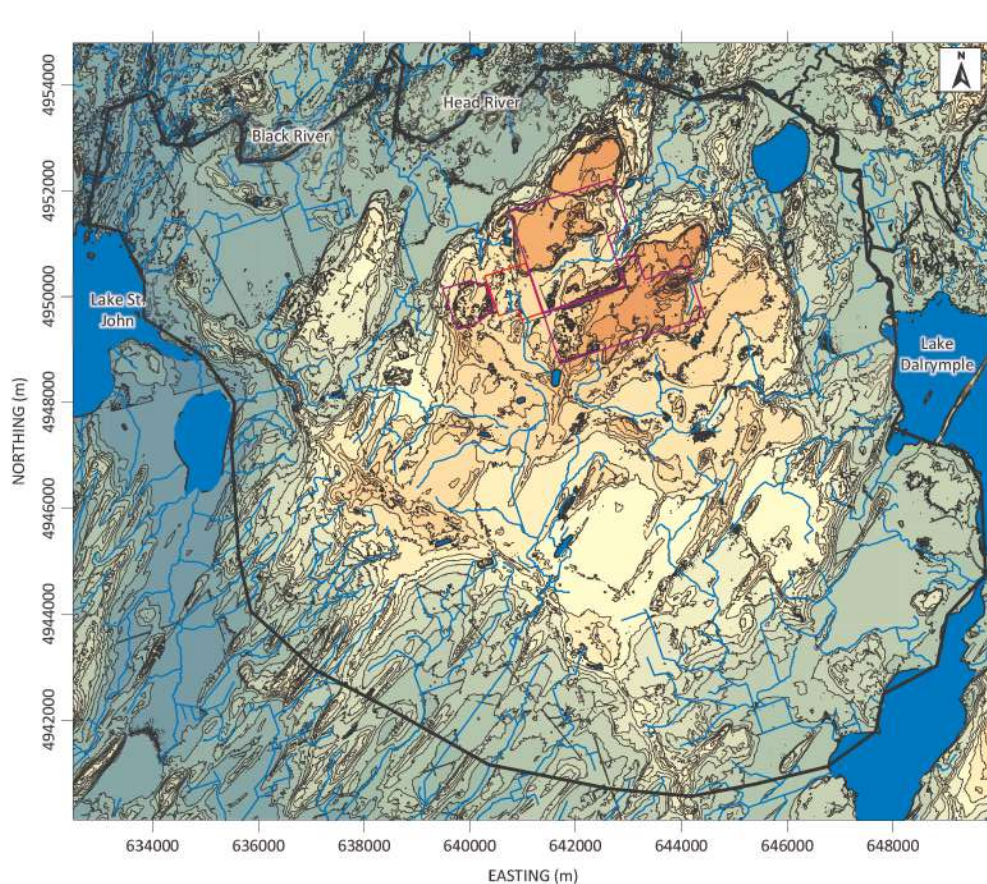
A.11: Top of Precambrian

A.12: Groundwater Elevation Contours

A.13: Hydraulic Conductivity



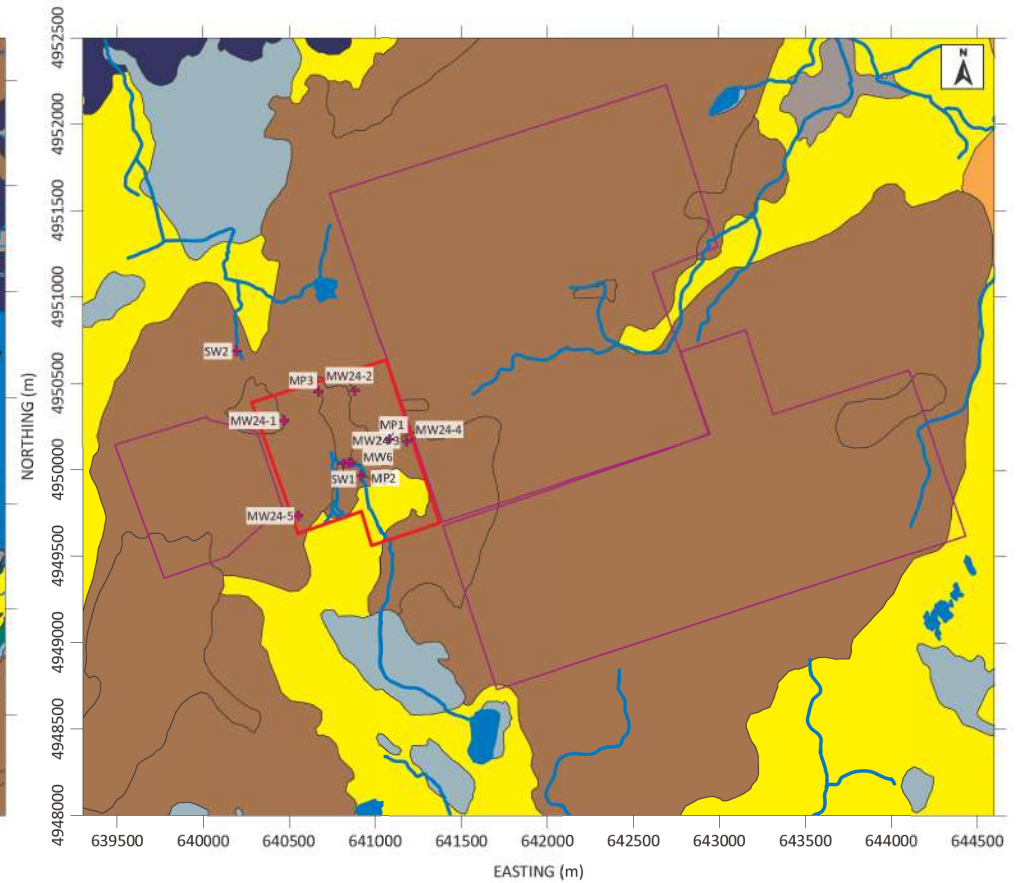
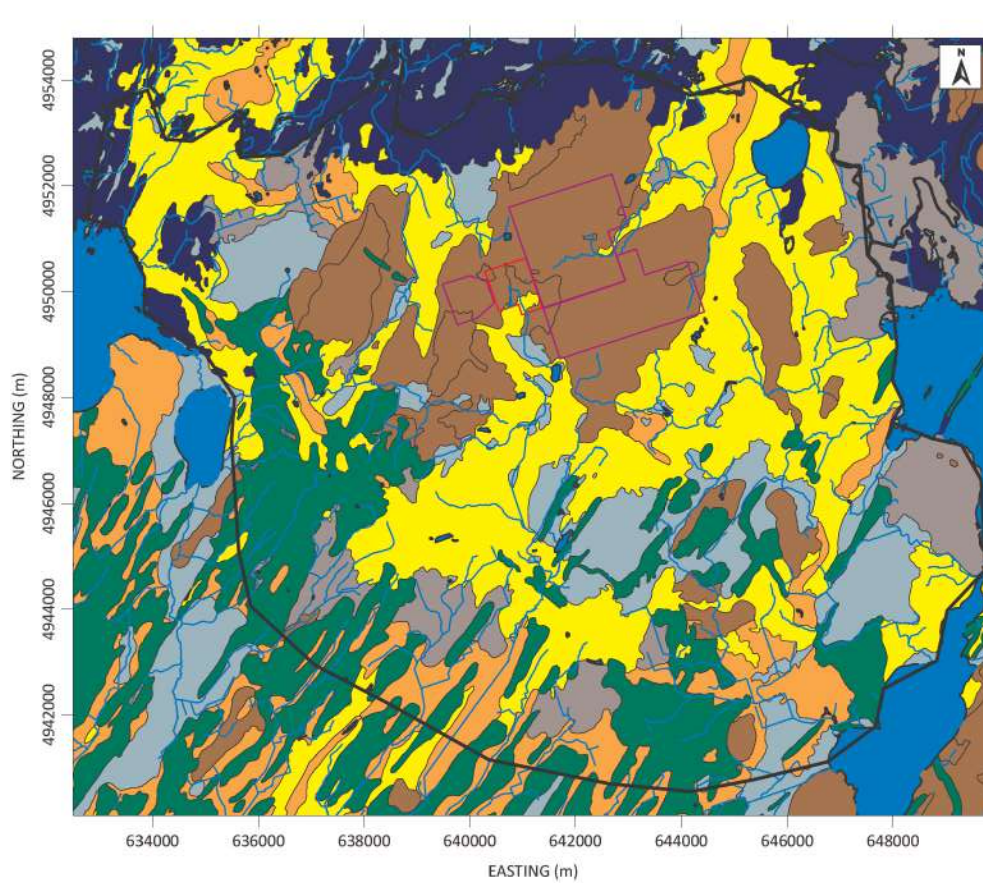
A.1: Topography and Drainage



Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Contains information licensed under the Open Government License – Ontario
3. Topography uses MNR DTN (2022) regionally and Site Topography provided by Tatham locally.

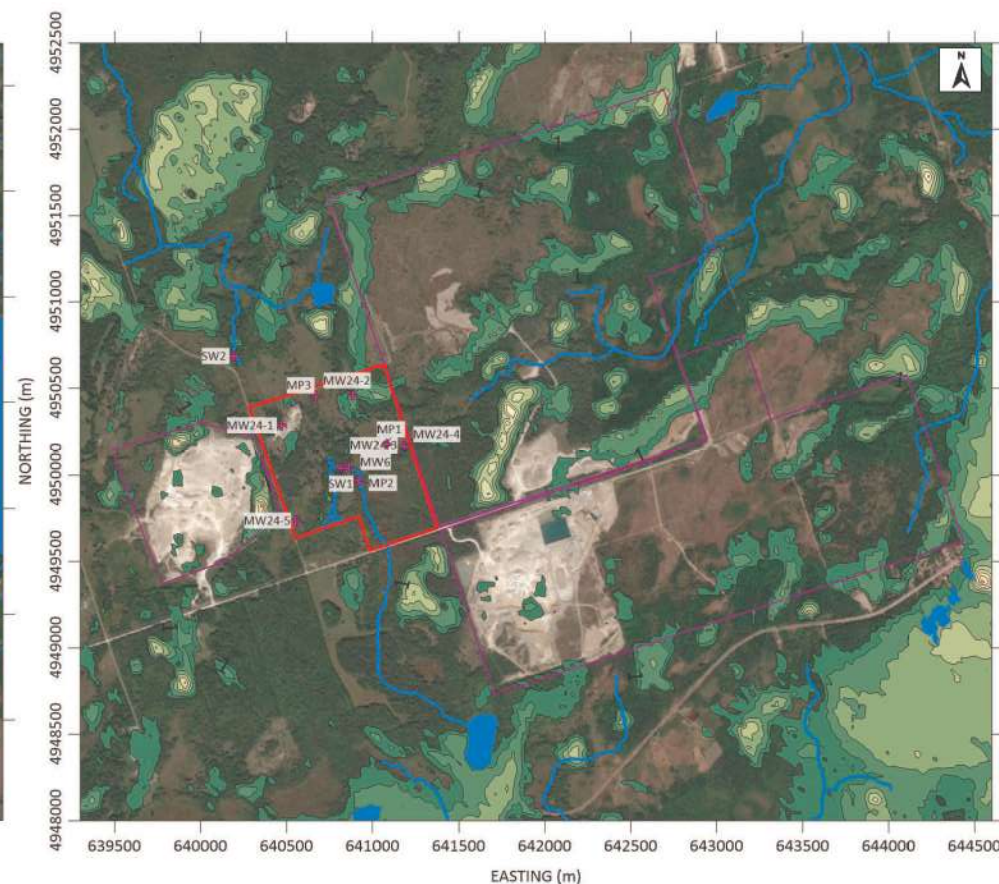
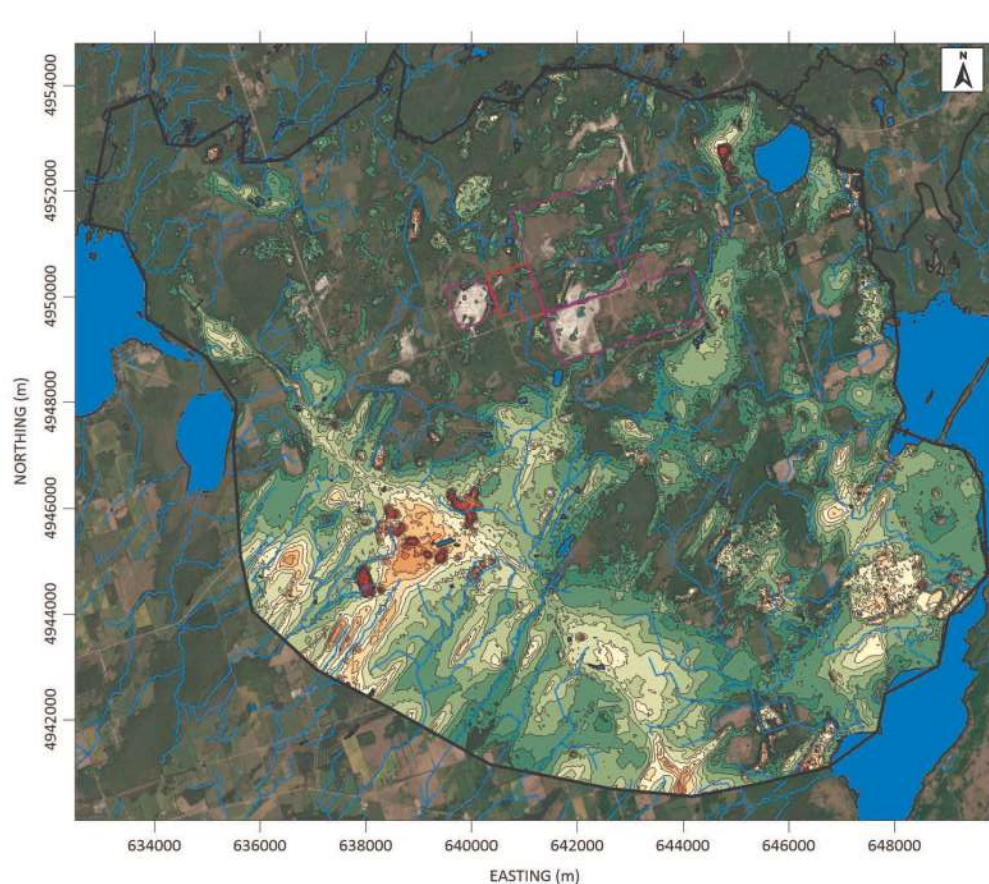
A.2: Surficial Geology



Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
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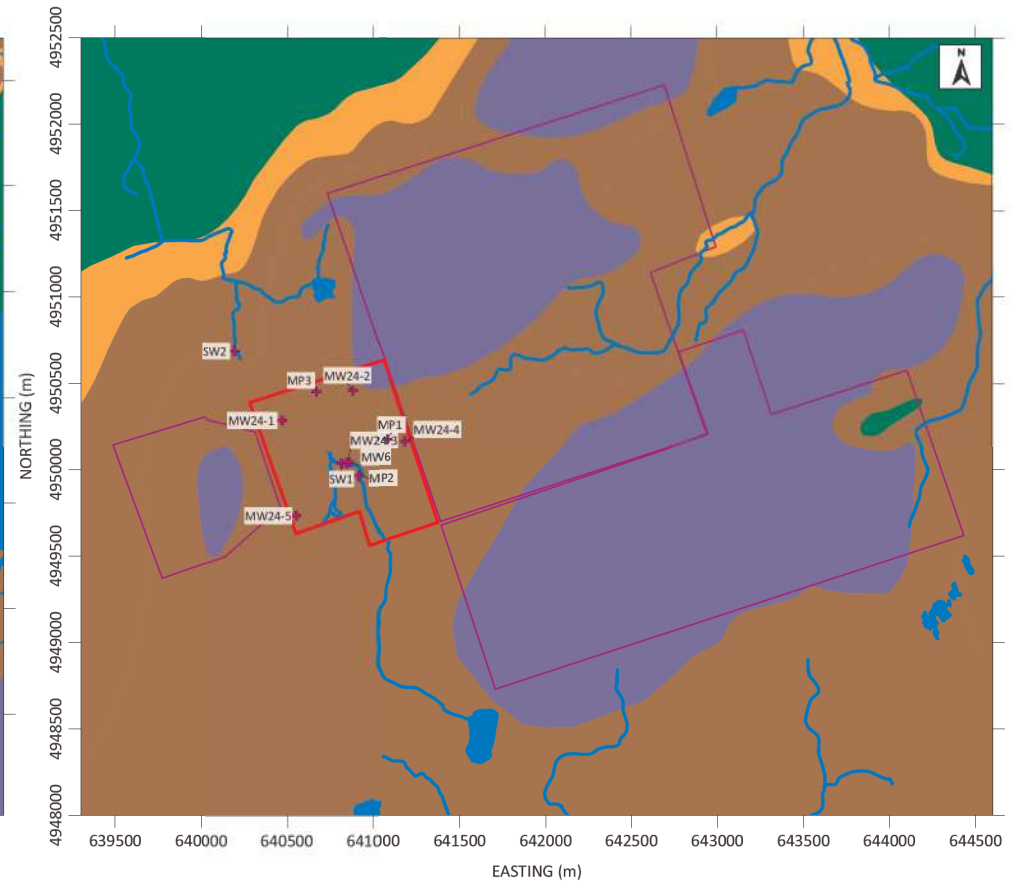
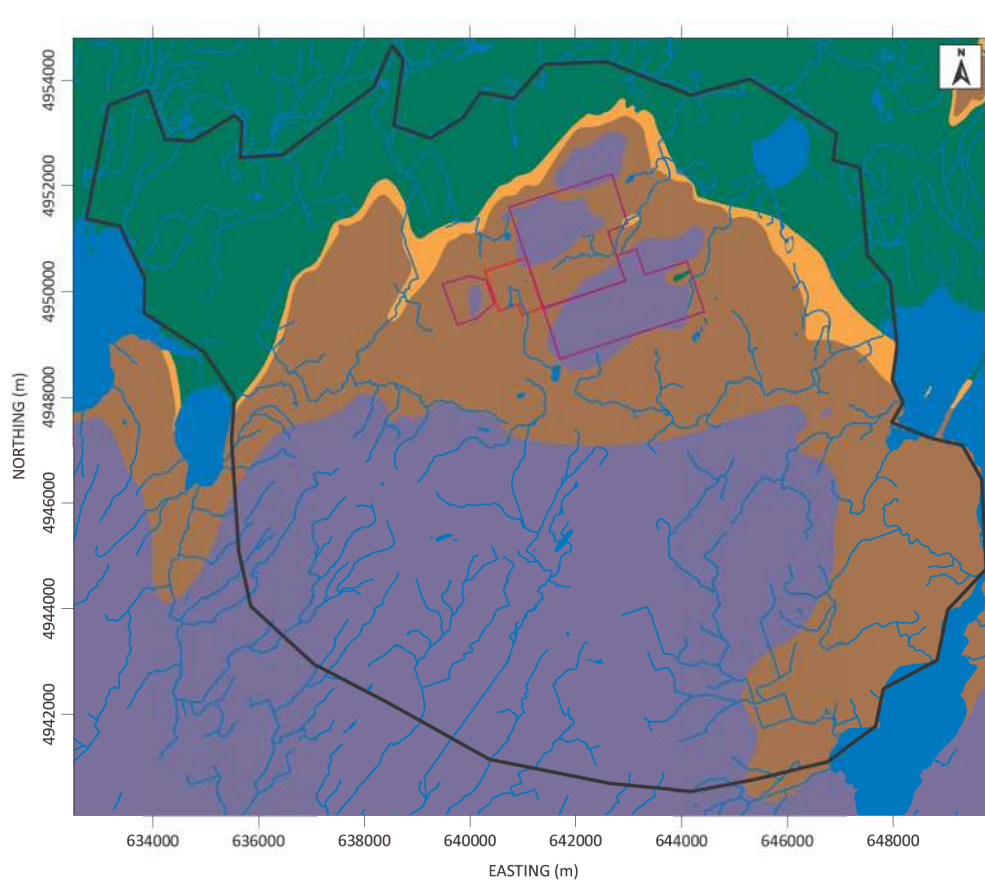
A.3: Overburden Thickness



Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Contains information licensed under the Open Government License - Ontario
3. Thickness generated using information from Site data, MECP Well Database, and OGS Mapping

A.4: Bedrock Geology



Legend

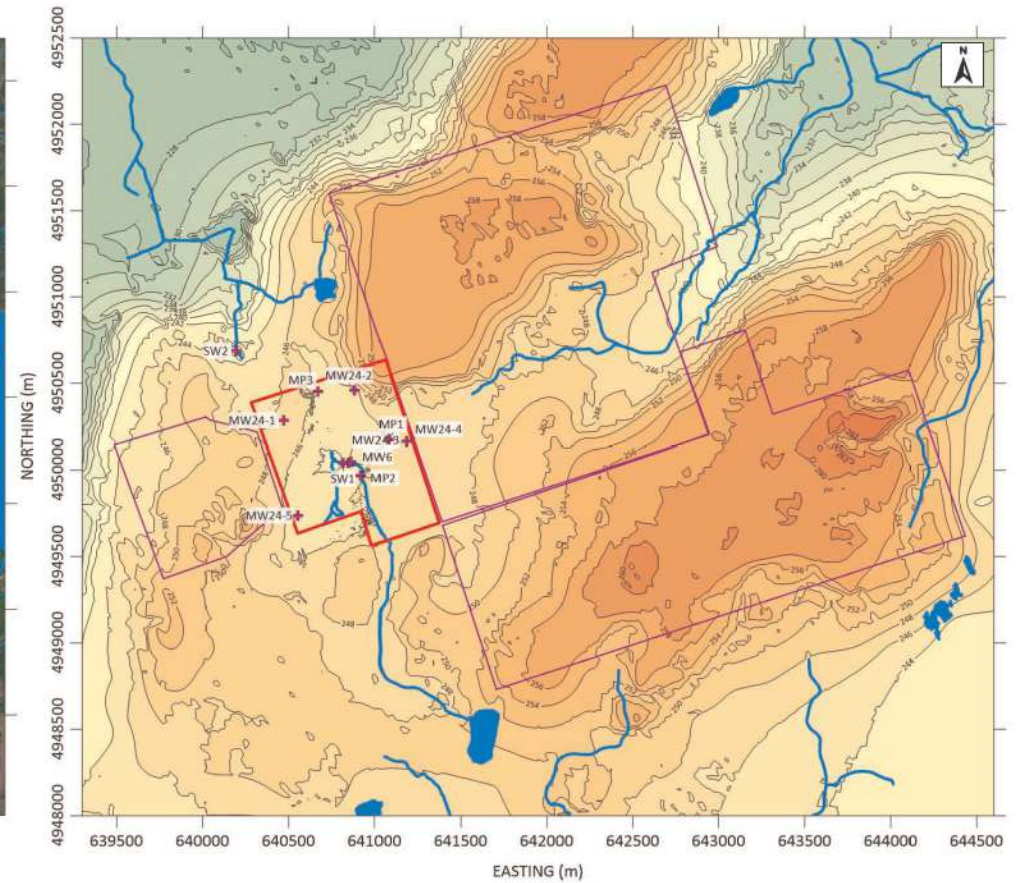
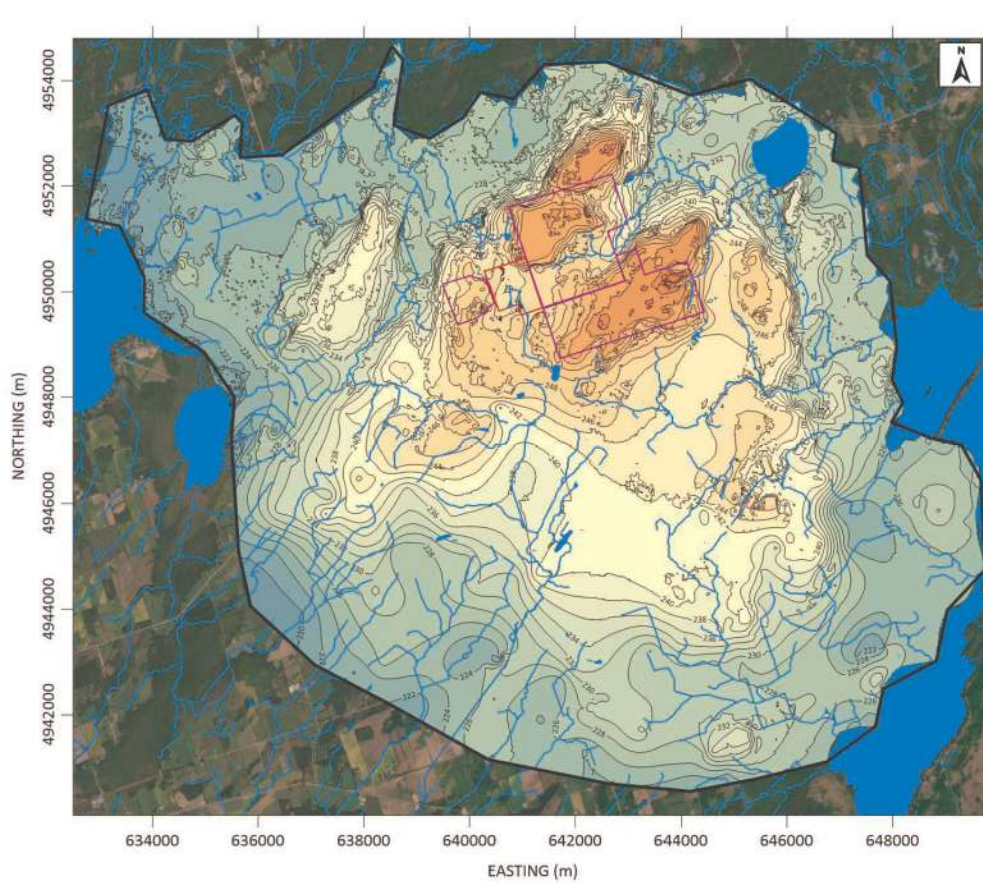
- Monitoring Location
- Model Domain
- Proposed Quarry Property Boundary
- Neighbouring Quarry Property Boundary

- Bobcaygeon
- Gull River
- Precambrian
- Shadow Lake

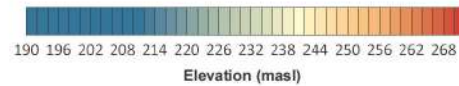
Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
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A.5: Top of Bedrock



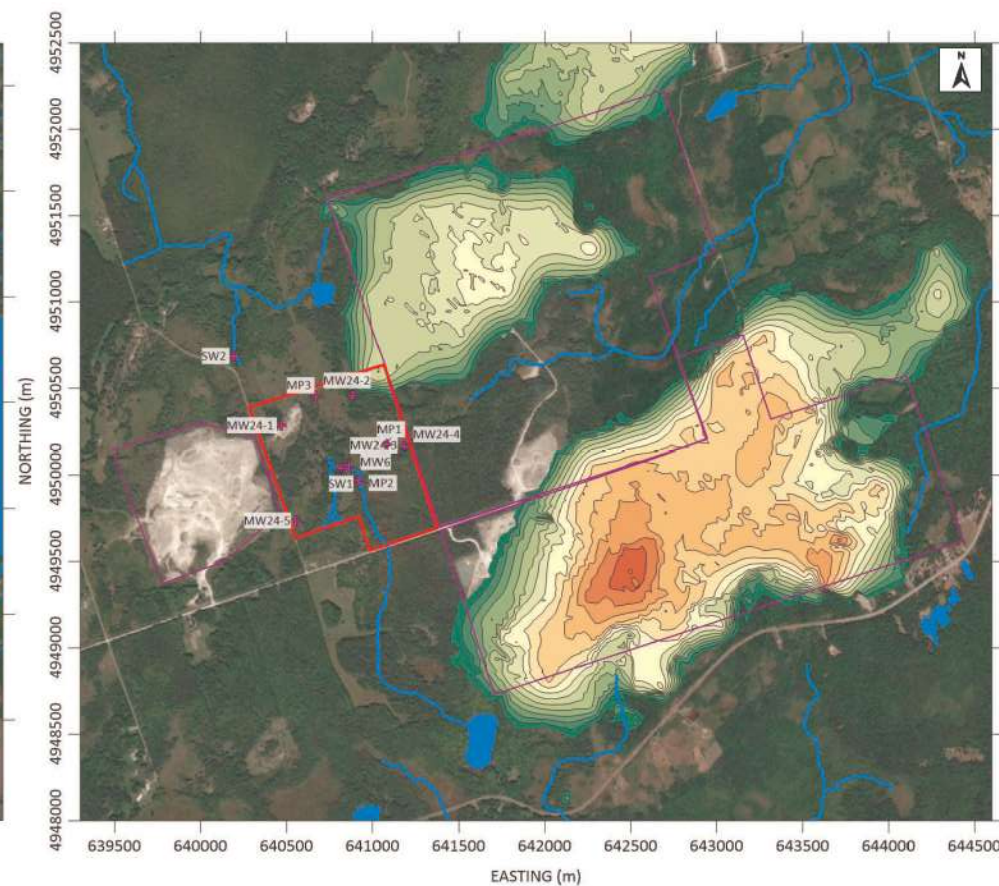
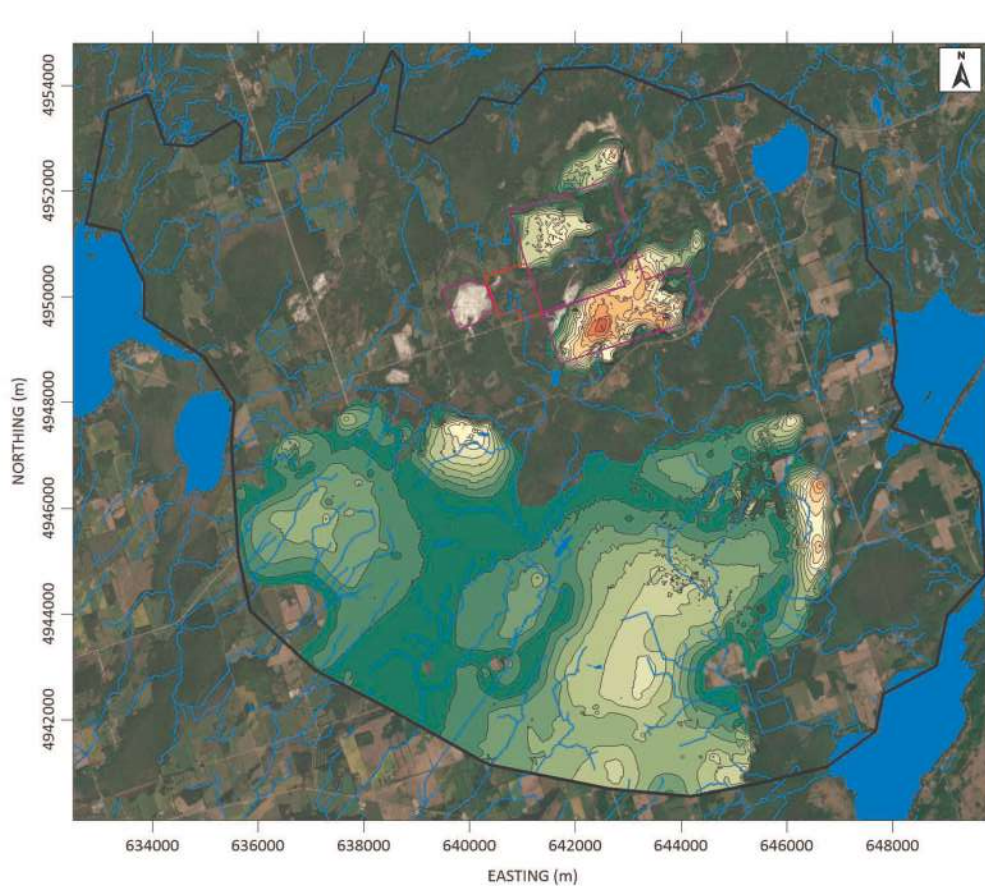
- Legend**
-  Monitoring Location
 -  Model Domain
 -  Proposed Quarry Property Boundary
 -  Neighbouring Quarry Property Boundary



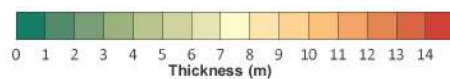
Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Contains information licensed under the Open Government License - Ontario
3. Elevation generated using information from Site data, MECP Well Database, and OGS Mapping

A.6: Bobcaygeon Formation Thickness



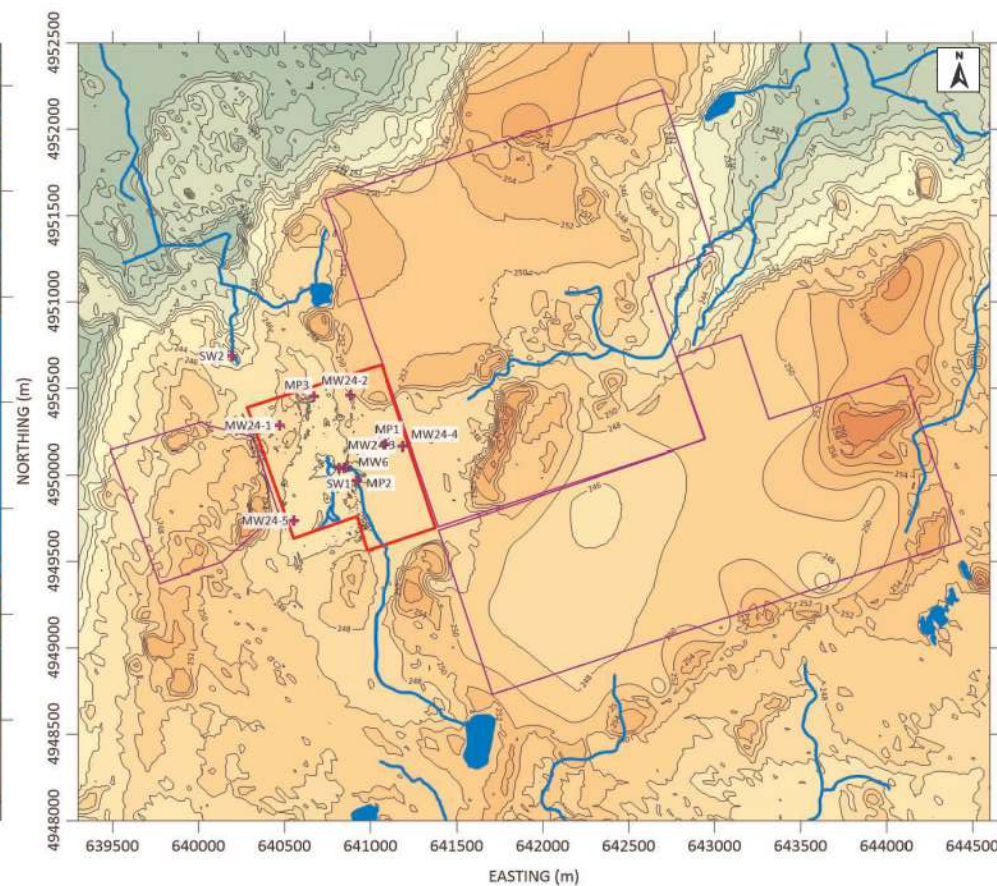
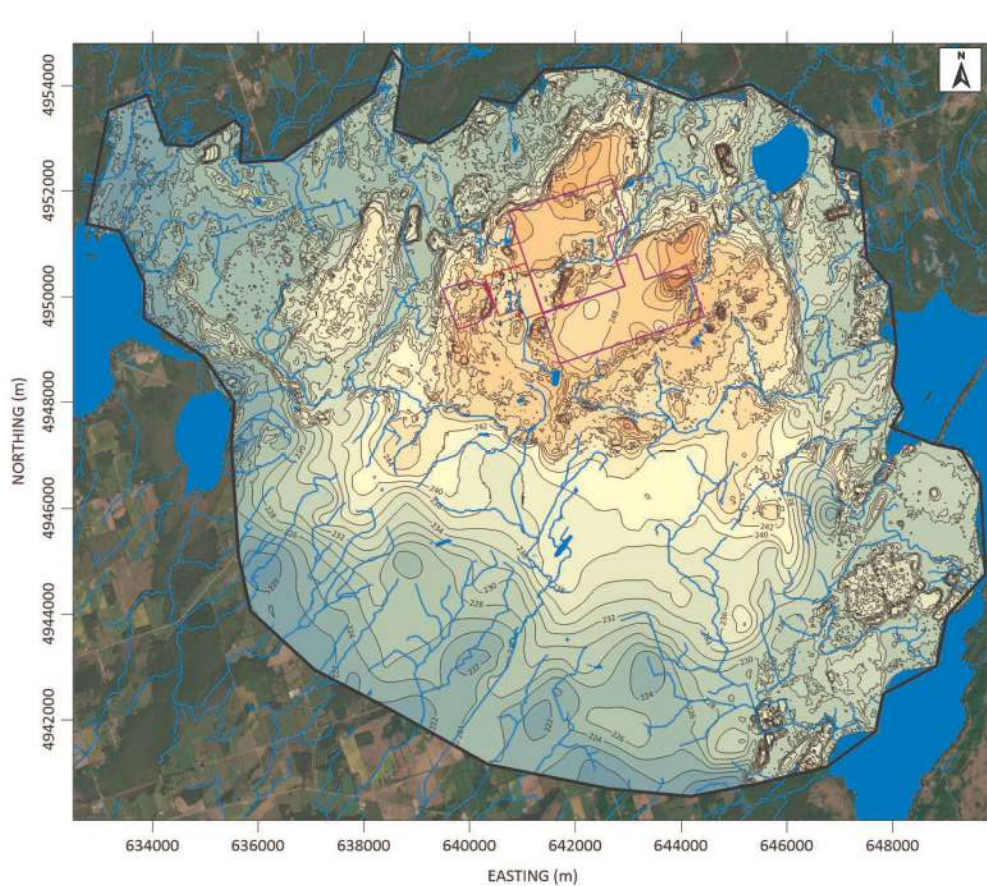
- Legend**
- Monitoring Location
 - Model Domain
 - Proposed Quarry Property Boundary
 - Neighbouring Quarry Property Boundary



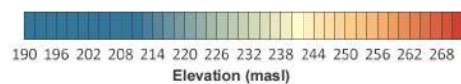
Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Contains information licensed under the Open Government License - Ontario
3. Thickness generated using information from Site data, MECP Well Database, and OGS Mapping

A.7: Top of Gull River



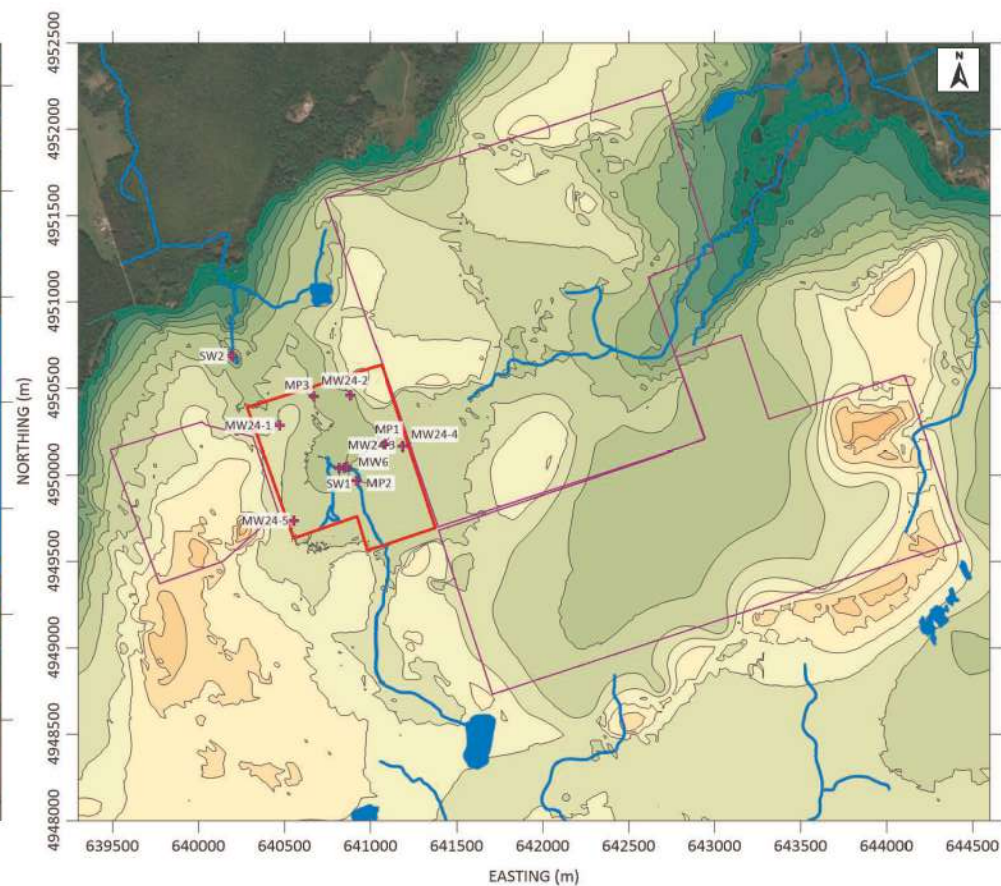
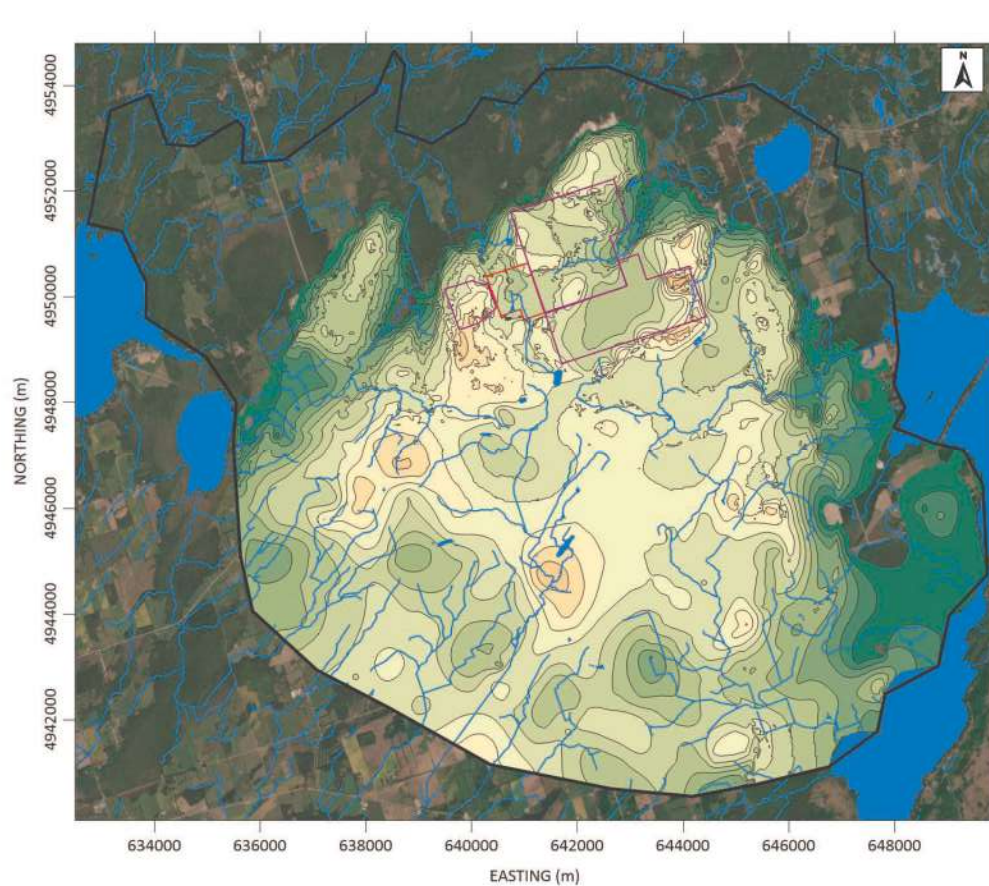
- Legend**
-  Monitoring Location
 -  Model Domain
 -  Proposed Quarry Property Boundary
 -  Neighbouring Quarry Property Boundary



Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
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3. Elevation generated using information from Site data, MECP Well Database, and OGS Mapping

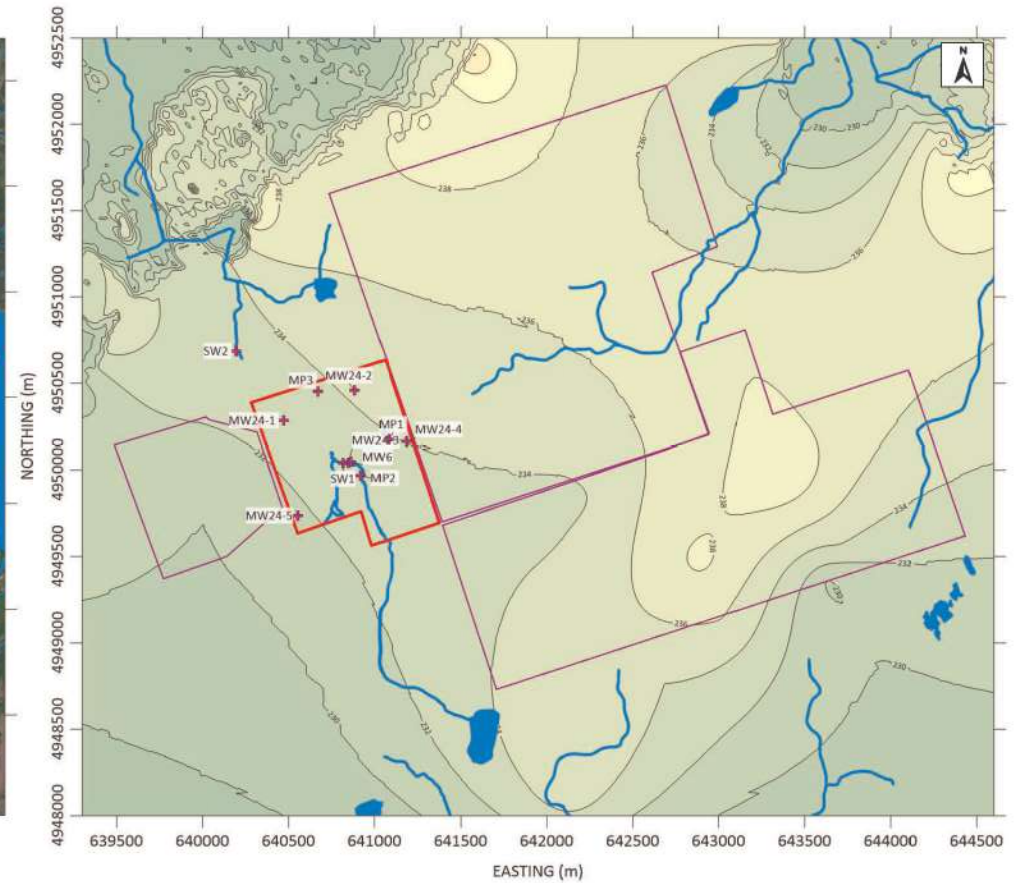
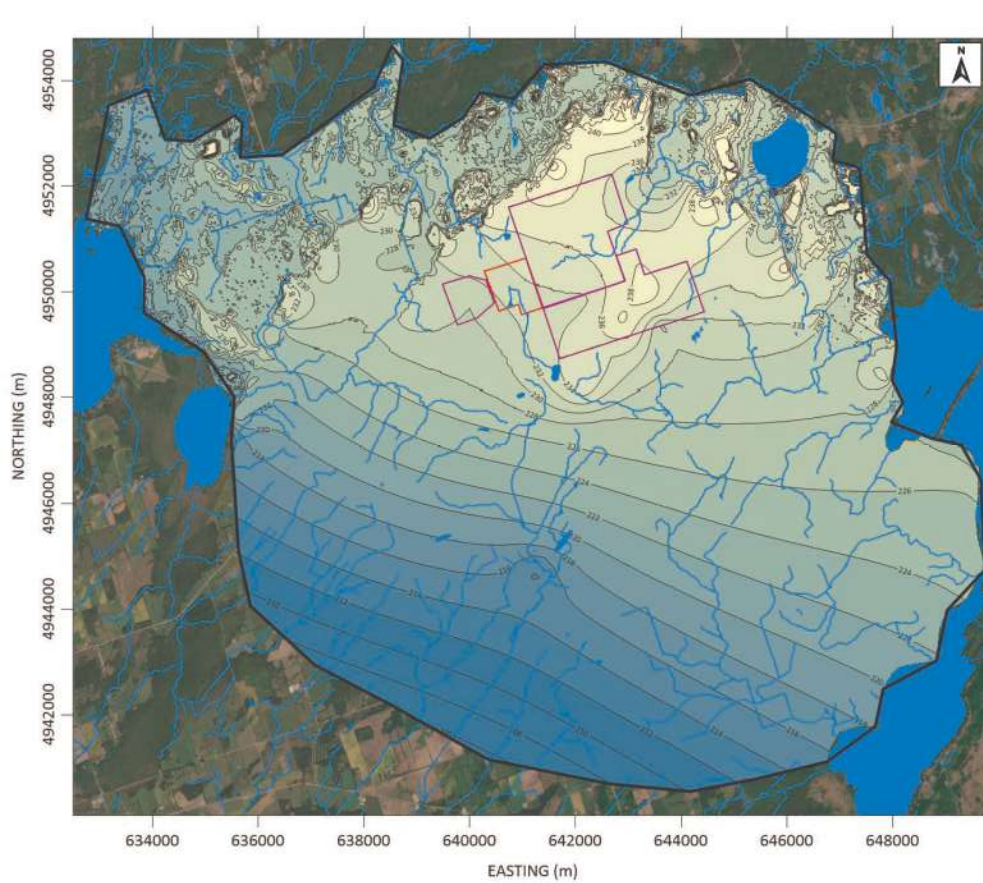
A.8: Gull River Thickness



Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
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3. Thickness generated using information from Site data, MECP Well Database, and OGS Mapping

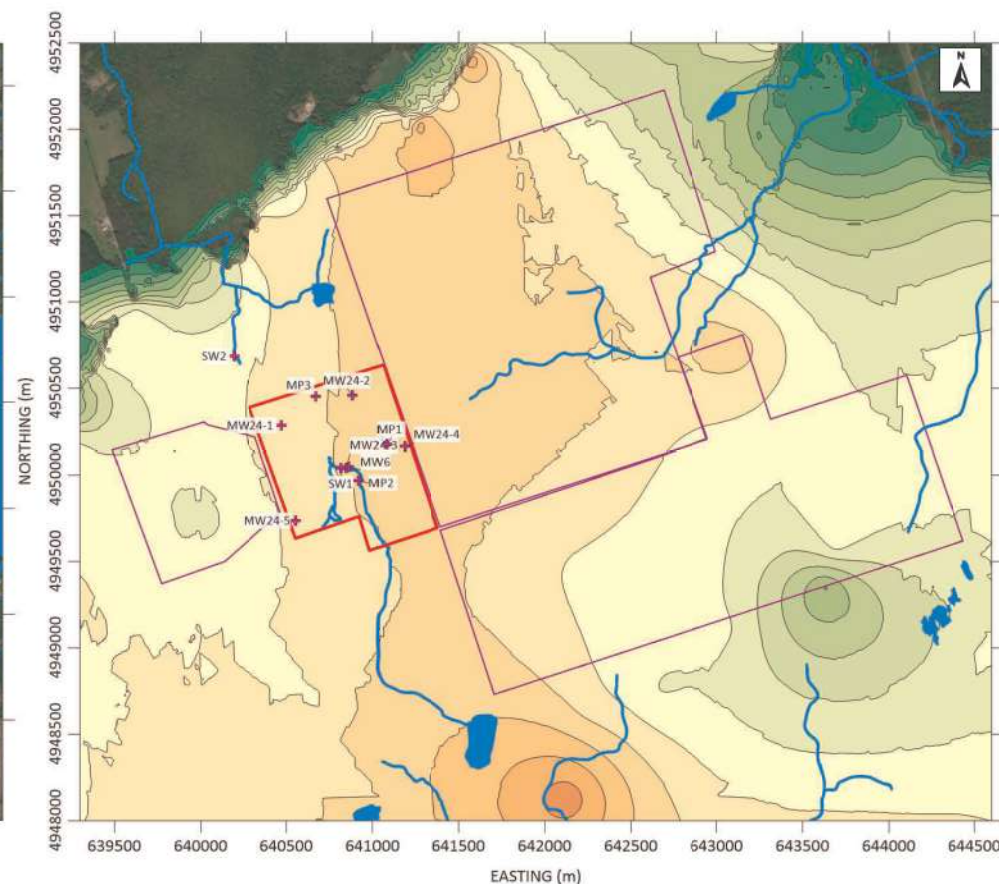
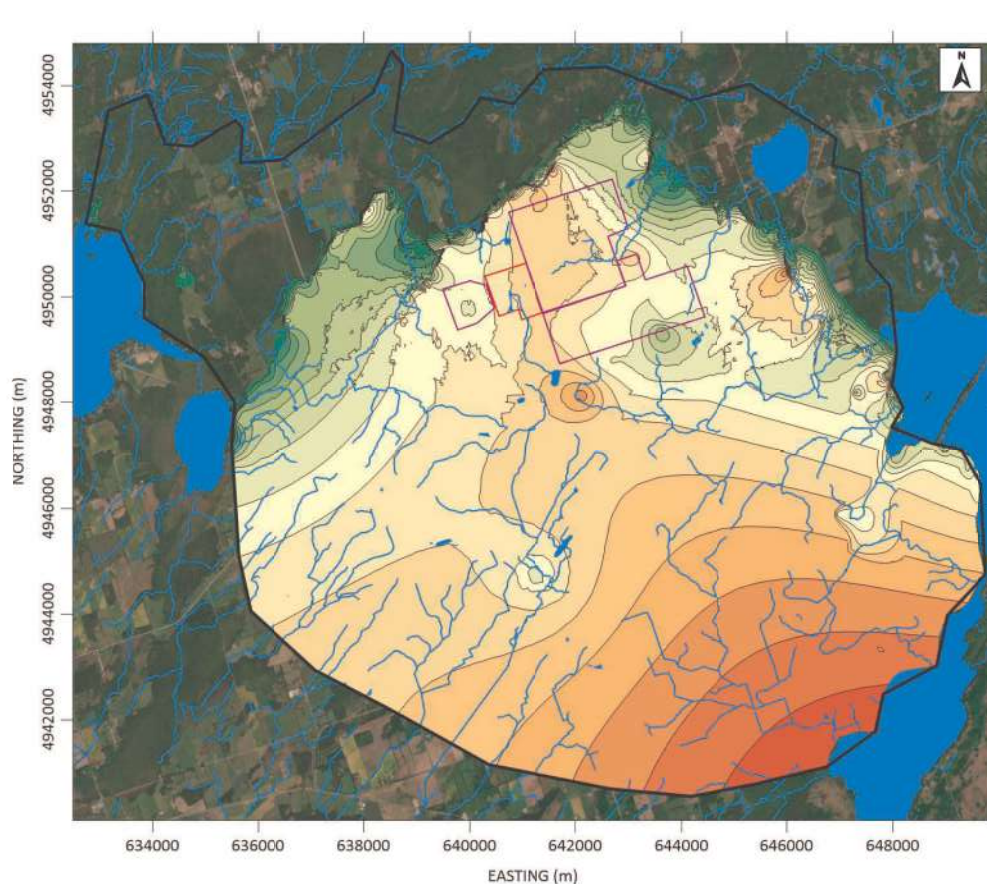
A.9: Top of Shadow Lake



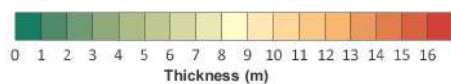
Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
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3. Elevation generated using information from Site data, MECP Well Database, and OGS Mapping

A.10: Shadow Lake Thickness



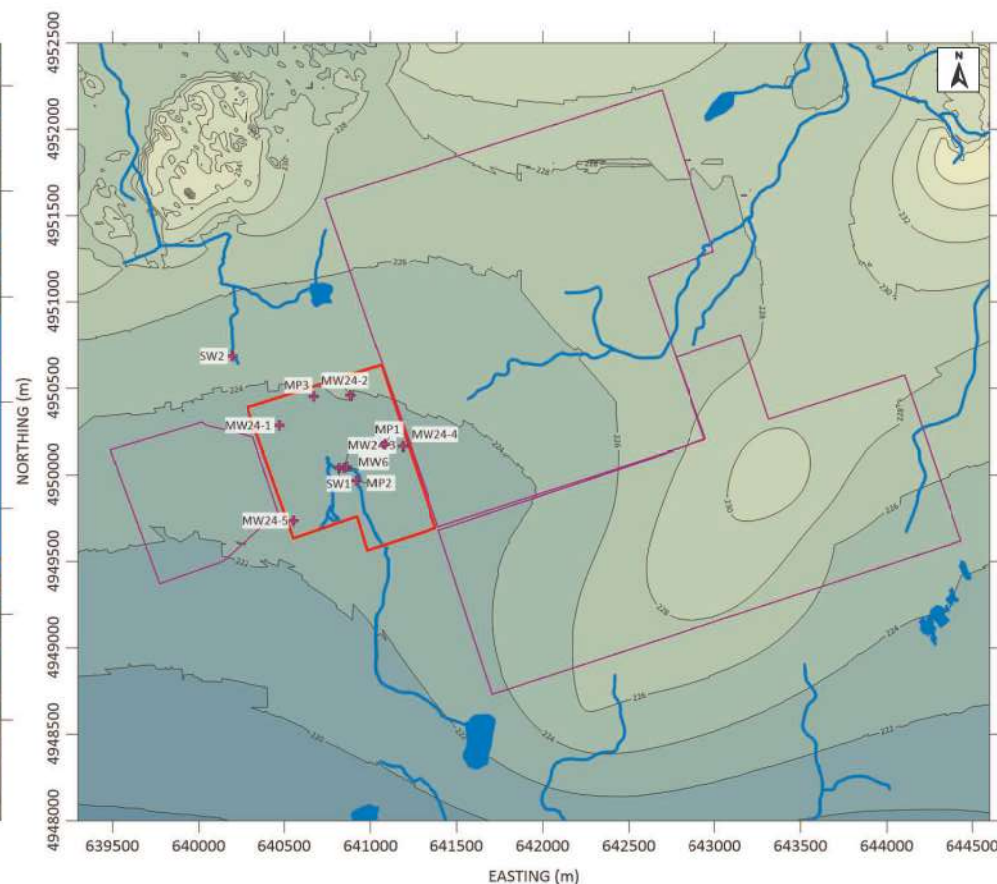
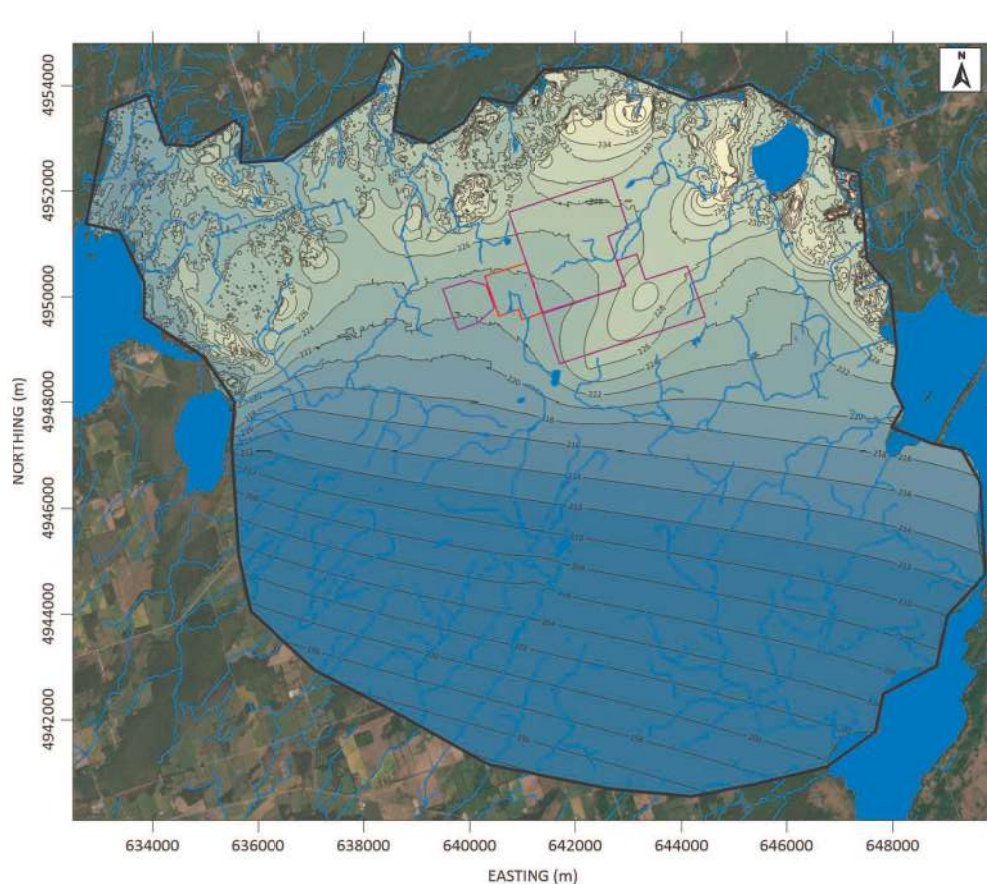
- Legend**
- Monitoring Location
 - Model Domain
 - Proposed Quarry Property Boundary
 - Neighbouring Quarry Property Boundary



Notes:

- Coordinate system: NAD 1983 UTM Zone 17N
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- Thickness generated using information from Site data, MECP Well Database, and OGS Mapping

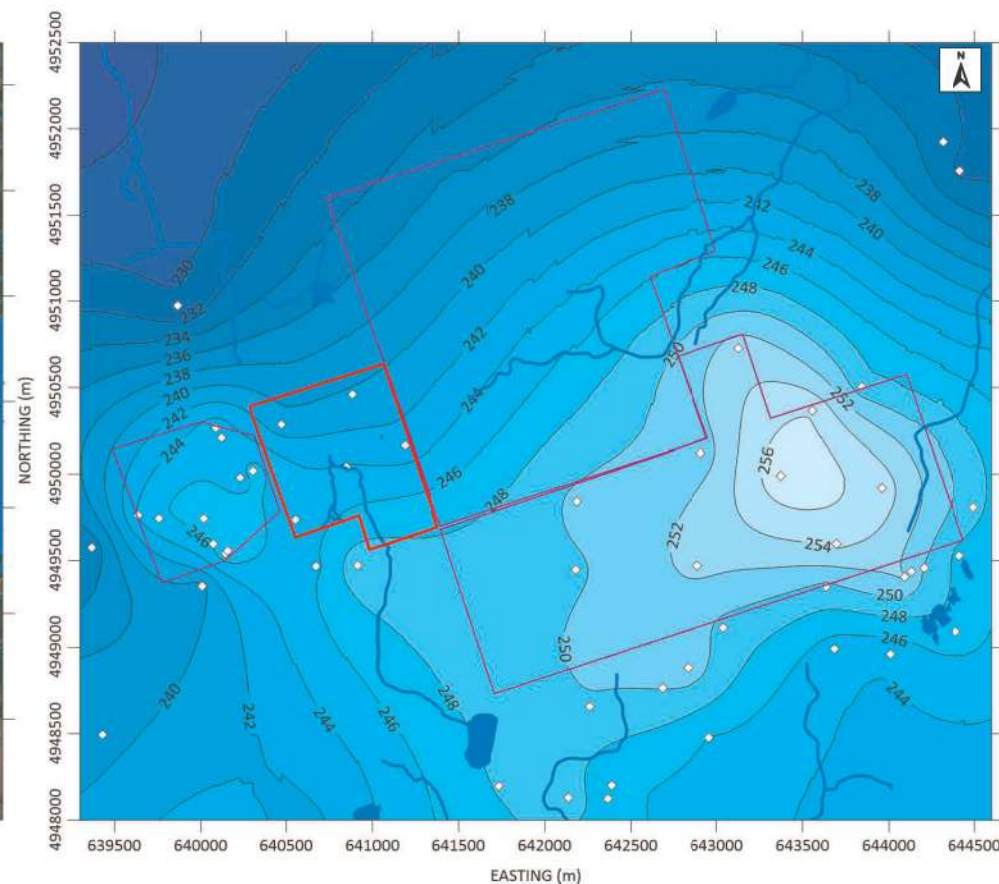
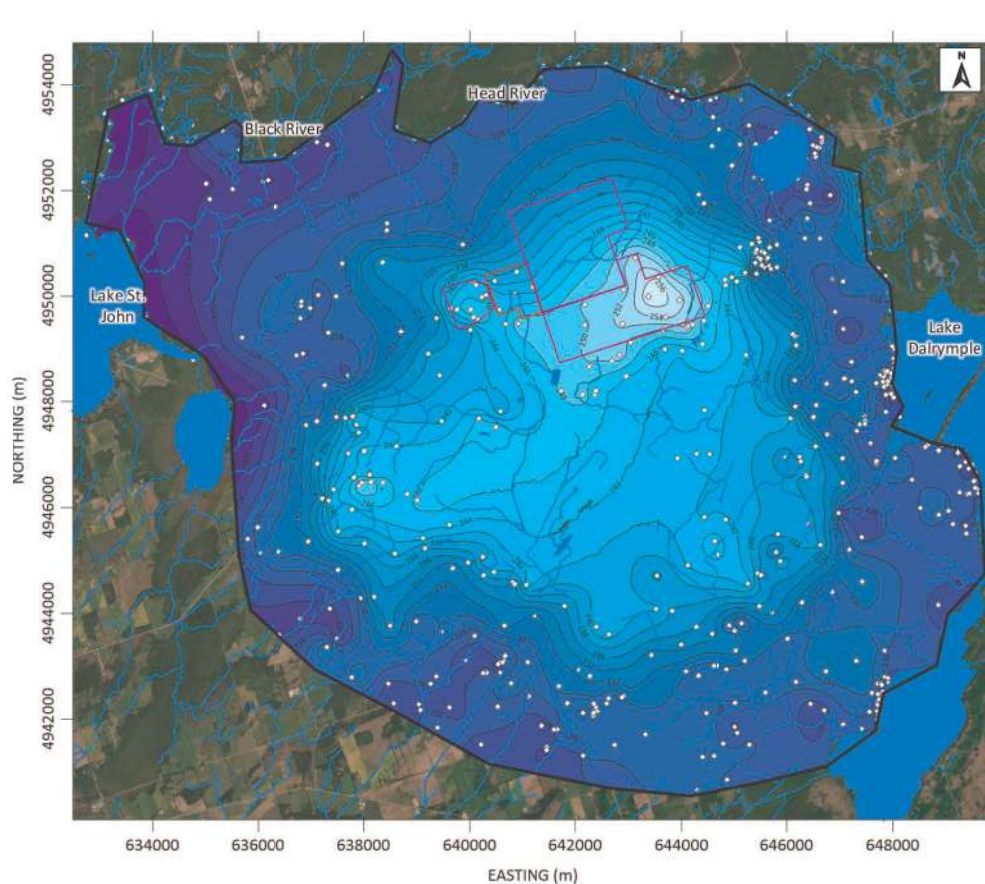
A.11: Top of Precambrian



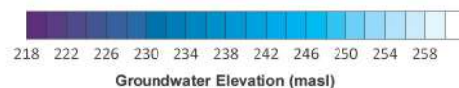
Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
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3. Elevation generated using information from Site data, MECP Well Database, and OGS Mapping

A.12: Groundwater Elevation Contours



- Legend**
- ◊ Water Level Observation Point
 - Model Domain
 - Proposed Quarry Property Boundary
 - Neighbouring Quarry Property Boundary

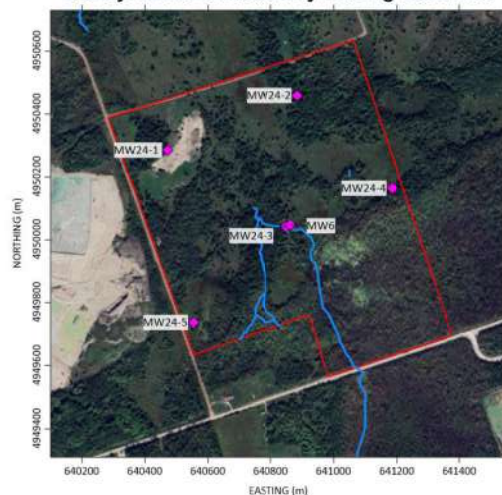


Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Contains information licensed under the Open Government License - Ontario
3. Groundwater levels based on Site water levels provided by Tatham, water levels from neighbouring quarry investigations (Cut Above and Bot) and water level observations extracted from the MECP well database (2025)

A.13: Hydraulic Conductivity

Site Hydraulic Conductivity Testing Locations



Unit	Measured Hydraulic Conductivity			Notes
	Min (m/s)	Max (m/s)	Mean (m/s)	
Bobcaygeon	1.8×10^{-10}	1.4×10^{-7}	3.5×10^{-9}	Bot Report ³
Gull River	5.6×10^{-7}	1.5×10^{-5}	3.6×10^{-6}	Cut Above ³ Geomean: 2×10^{-6} m/s
Shadow Lake	-	-	5.7×10^{-6}	One test from Site
Precambrian	-	-	5×10^{-9}	Bot Report ³

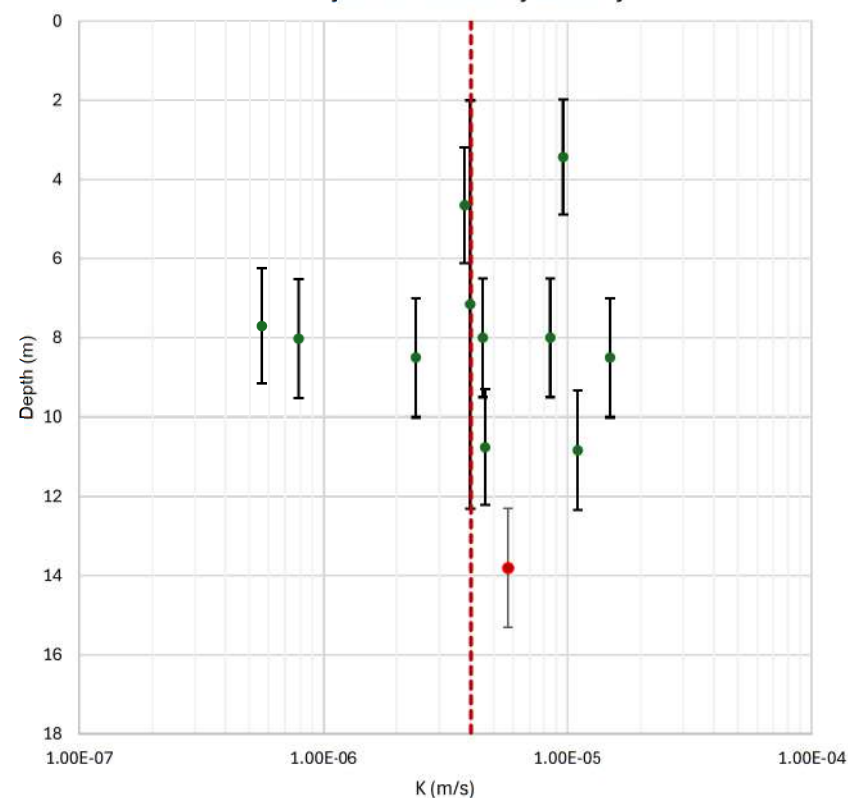
Legend

- Site Hydraulic Conductivity Observation
- Proposed Quarry Property Boundary

Notes:

- Coordinate system: NAD 1983 UTM Zone 17N
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- Waterloo Geoscience Consultants, 1999
- Harden, 2016

Site Hydraulic Conductivity Summary



--- Site Geomean (Shadow Lake and Gull River) ● Gull River ● Shadow Lake

APPENDIX B

Model Setup and Parameterization

B.1: Model Domain and Discretization

B.2: Model Parameterization

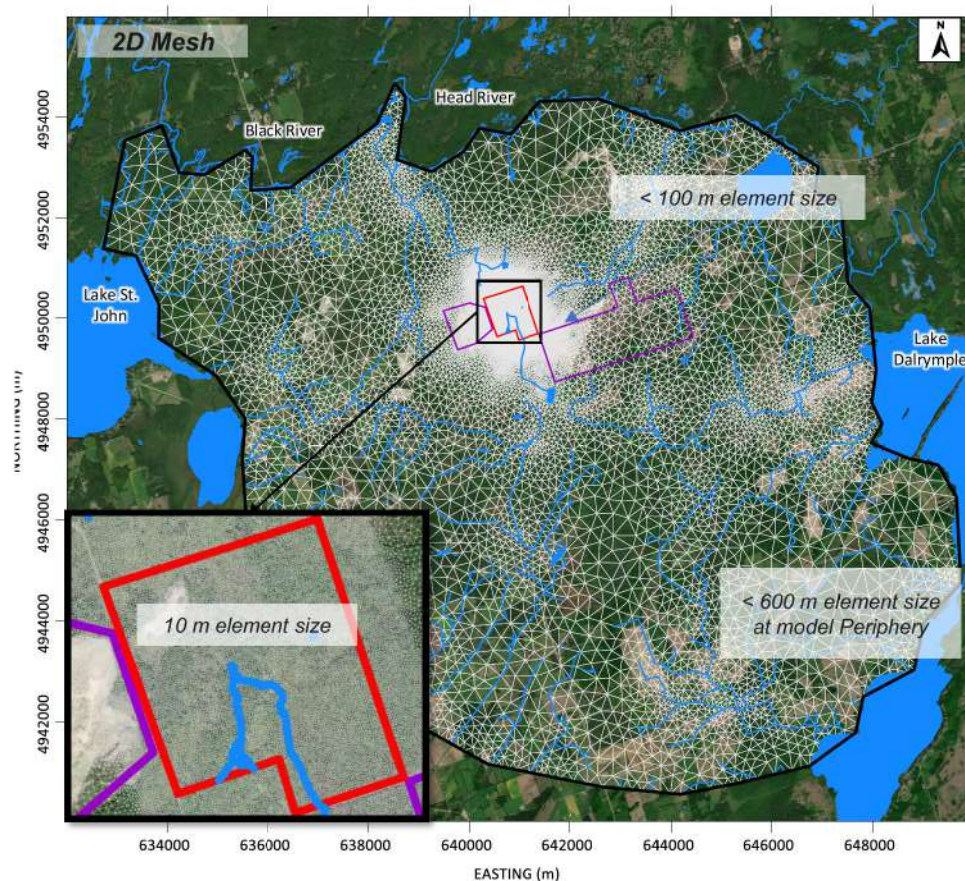
B.3: Model Cross-Section

B.4: Regional Boundary Conditions

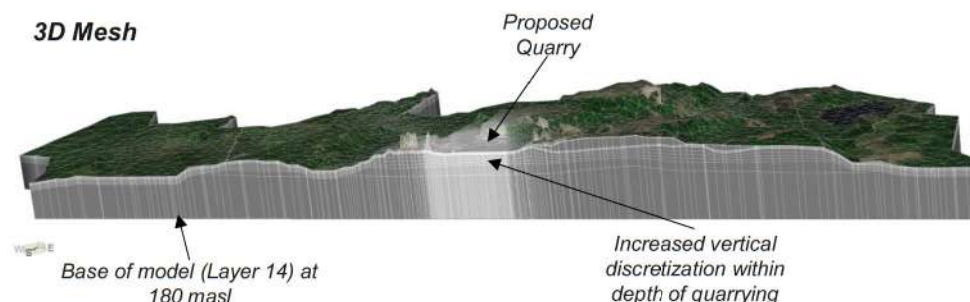
B.5: Local Boundary Conditions



B.1: Model Domain and Discretization



3D Mesh



Mesh Summary:

- 81,422 elements specified for each model layer
- 10 m element size within ~150 m of Proposed Quarry property boundary
- Typically, 100 m or less within 1 km of Proposed Quarry property boundary
- Increasing to ~600m maximum element size towards model periphery
- 14 layers and 1,139,908 elements defined across 3D model domain
- Additional vertical discretization added within depth of quarrying (from ground surface down to the base of the Gull River Formation; refer to Appendix B.3)

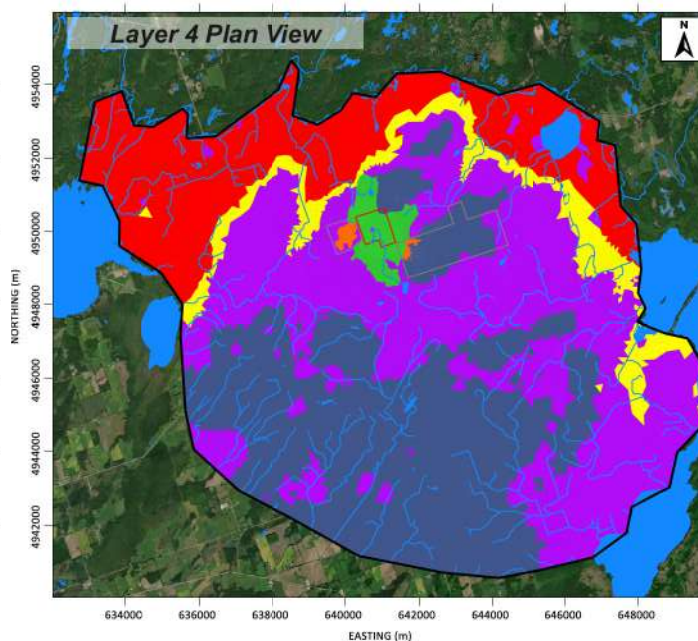
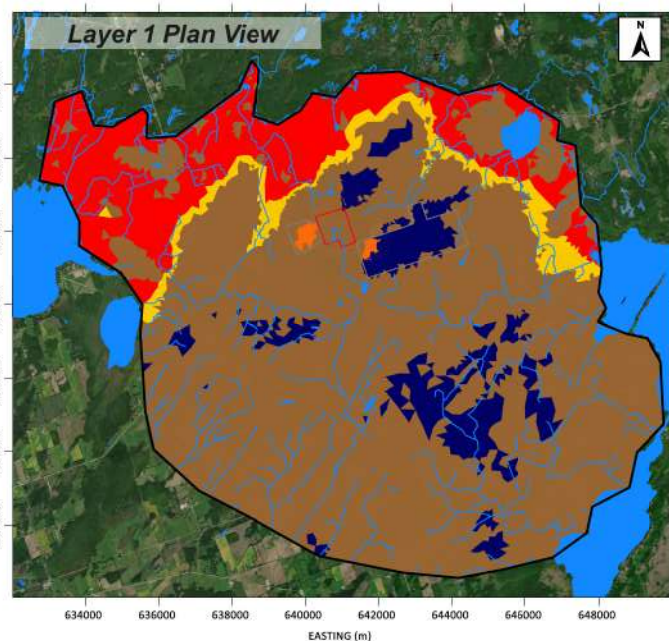
Legend

- Model Domain
- Proposed Quarry Property Boundary
- Neighbouring Quarry Property Boundary

Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
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B.2: Model Parameterization



Legend

- Model Domain
- Proposed Quarry Property Boundary
- Neighbouring Quarry Property Boundary

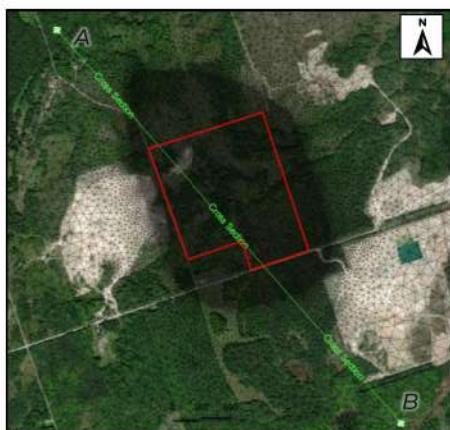
Notes:

- Coordinate system: NAD 1983 UTM Zone 17N
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Unit	Modelled Hydraulic Conductivity	
	K_H (m/s)	$K_H:K_V$
Overburden	1×10^{-5}	1:1
Bobcaygeon	1×10^{-9}	10:1
Weathered Gull River	1×10^{-5}	1:1
Low K_V Weathered Gull River	1×10^{-5}	100,000:1
Gull River	1×10^{-6}	1000:1
Shadow Lake	6×10^{-6}	1:1
Precambrian	1×10^{-9}	10:1

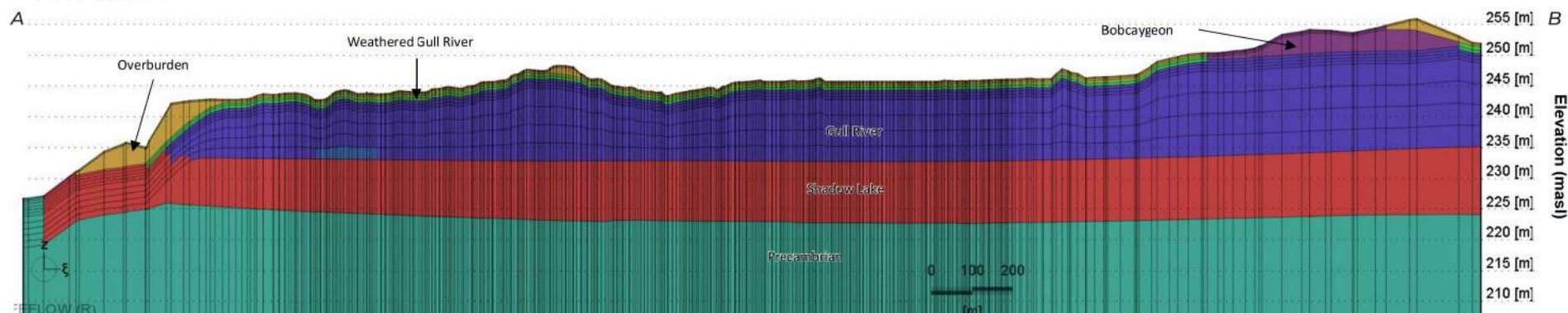
B.3: Model Cross-Section

Plan View

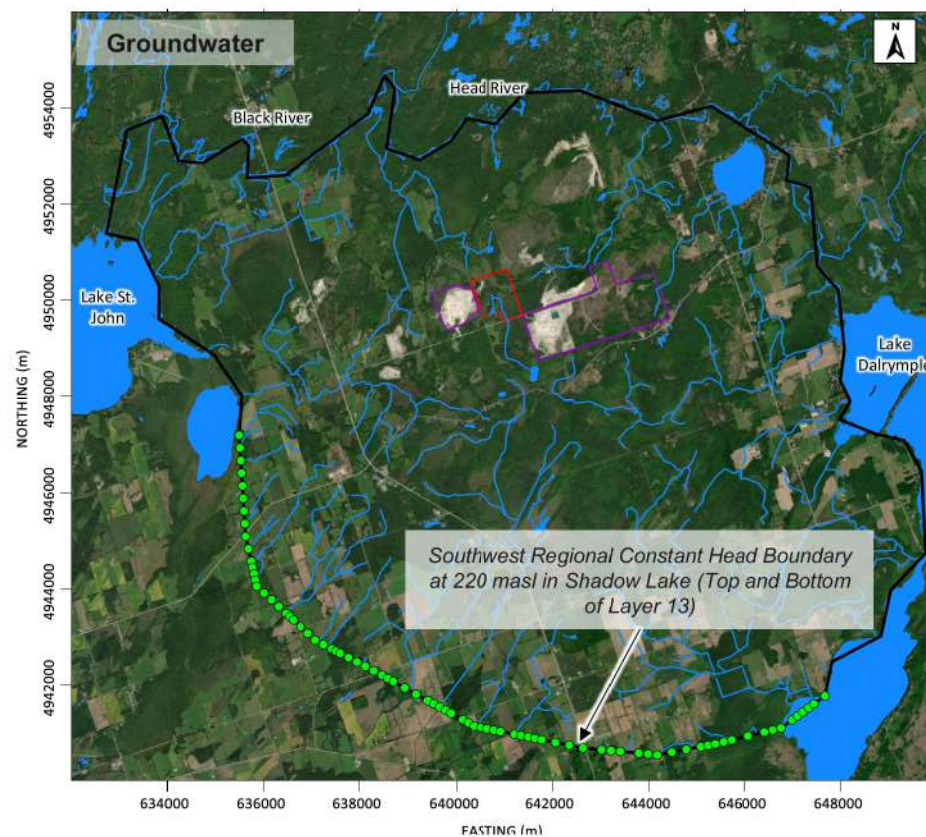
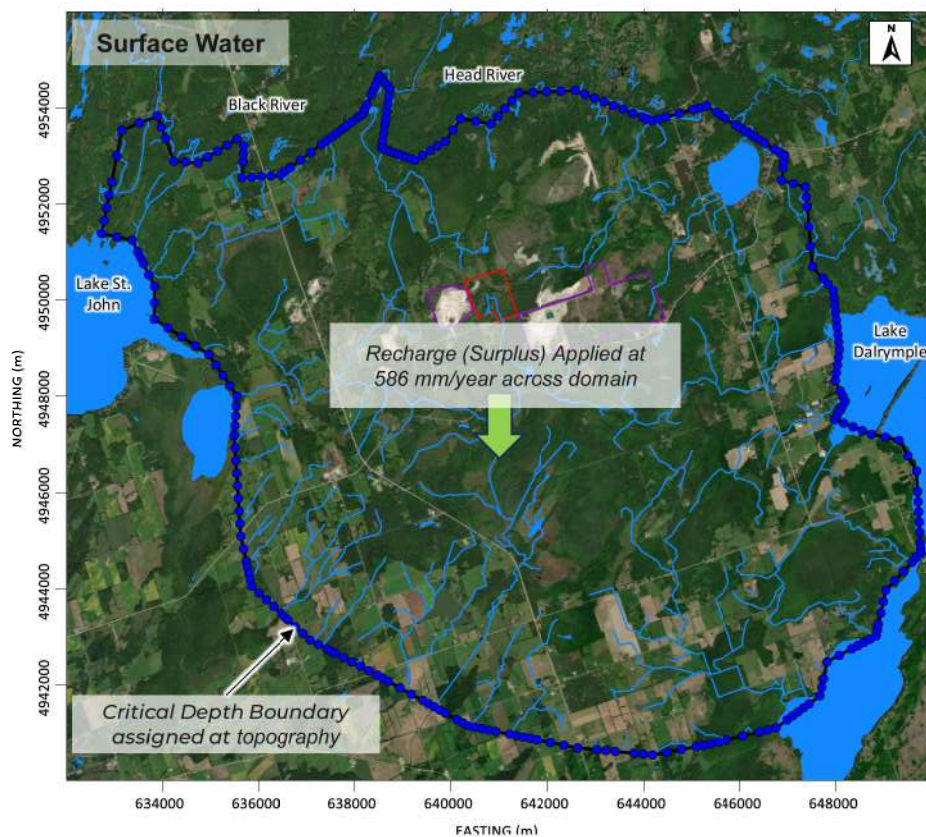


Model Layers	Primary Hydrostratigraphic Unit	Layering Description
1 to 3	Overburden	- Top based on topography - Minimum total thickness is 0.6 m - Layer 1 = 0.1 m constant thickness - Layer 2 = 0.2 m constant thickness - Layer 3 = variable based on overburden thickness, with minimum at 0.3 m
4	Bobcaygeon Formation	- Top surface based on top of bedrock - Minimum total thickness is 0.4 m
4 to 5	Weathered Gull River	- Top 2 layers of Gull River - Only where Gull River is upper bedrock (i.e., not beneath Bobcaygeon) - Total thickness of 0.9 m - Layer 4 = 0.4 m constant thickness (includes low K_v Weathered Gull River) - Layer 5 = 0.5 m constant thickness
6 to 12	Gull River Formation	- Minimum total thickness is 5.5 m - Layers 6 to 8 = 0.5 m constant thickness - Layer 9 to 12 = variable thickness based on Gull River thickness with 1 m minimum thickness in each layer
13	Shadow Lake Formation	Variable thickness based on Shadow Lake thickness with a minimum of 1 m
14	Precambrian	- Base of model at 180 masl - Minimum thickness of 14 m

Cross-Section

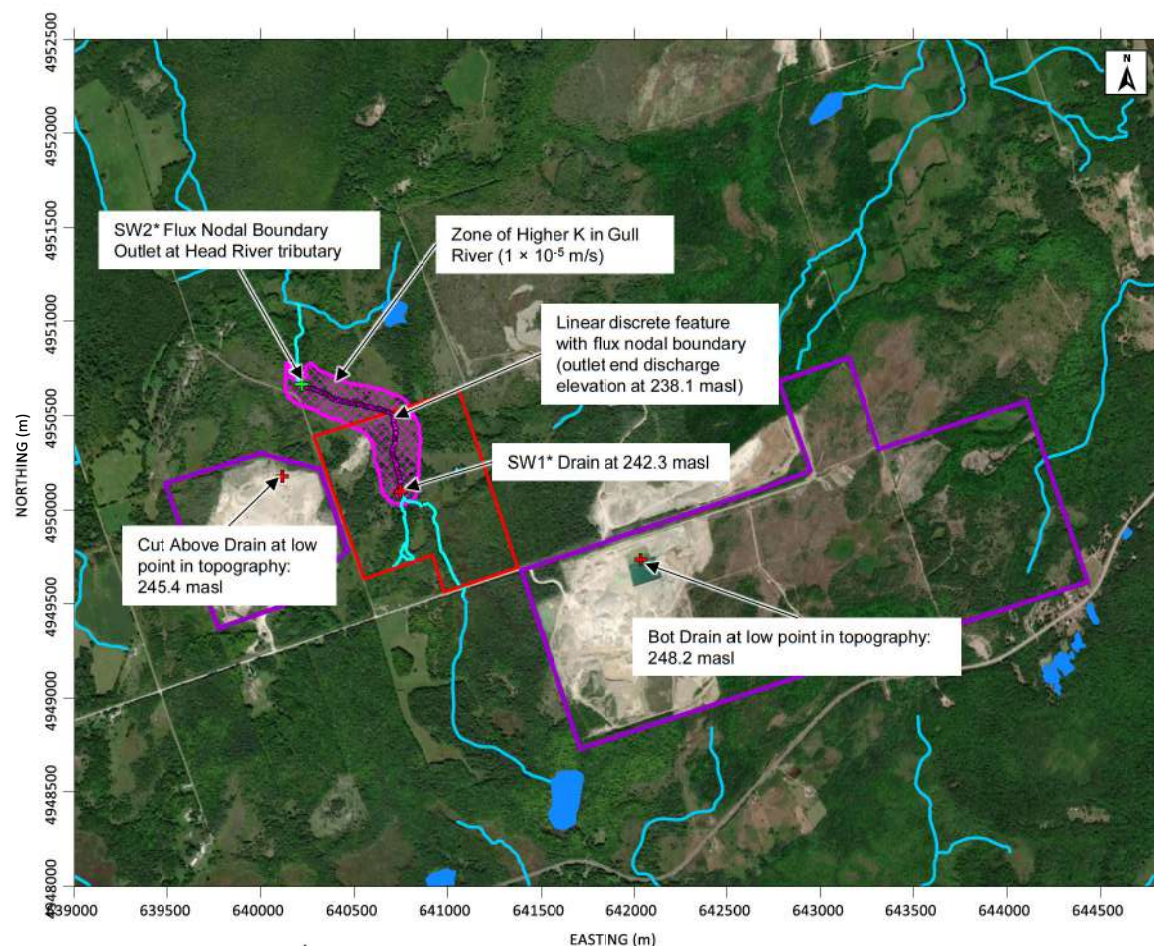


B.4: Regional Boundary Conditions



- Legend**
- Model Domain
 - Proposed Quarry Property Boundary
 - Neighbouring Quarry Property Boundary
- Notes:**
1. Coordinate system: NAD 1983 UTM Zone 17N
 2. Contains information licensed under the Open Government License – Ontario

B.5: Local Boundary Conditions



Legend

- Model Domain
- Proposed Quarry Property Boundary
- Neighbouring Quarry Property Boundary

Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Contains information licensed under the Open Government License – Ontario

Local Boundary Conditions Notes:

- SW1* drain outflow added back to model as an inflow to the south end of the linear discrete feature in the Gull River below SW1*.
- Linear discrete feature begins in the Gull River (Layer 6) below SW1* then decreases in elevation to the base of the Gull River (Layer 12) at the north Site boundary before continuing northwest within layer 12 and connecting to the top surface of the model at the inferred outlet location to the Head River tributary.
- Increased hydraulic conductivity specified within approximately 100 m of the linear discrete feature consistent with Weathered Gull River hydrostratigraphic unit.
- Water will discharge to the connected linear nodes based on the specified flux nodal boundary elevation specified at the north outlet of the feature.
- The outflow of the flux nodal boundary (including the inflow added from the SW1* drain) is re-introduced to the model as an inflow to the SW2* location in the Head River tributary.

APPENDIX C

Model Calibration

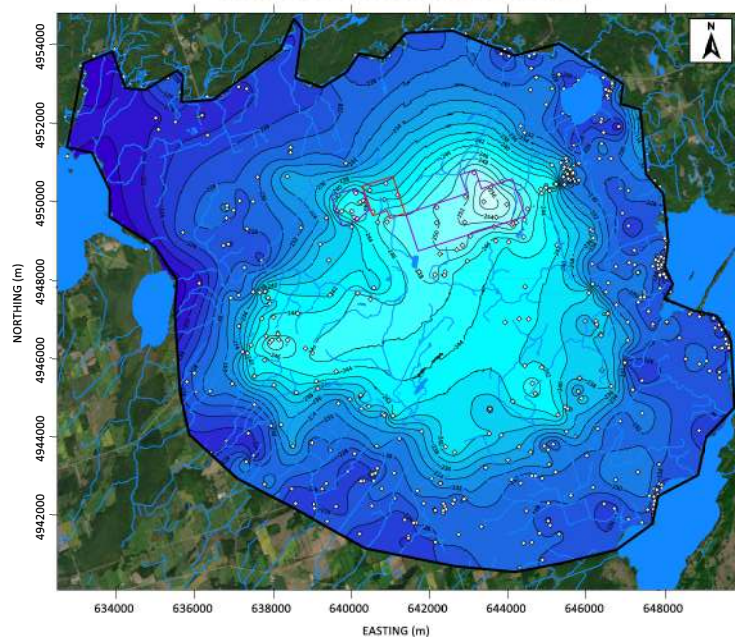
C.1: Model Calibration – Regional

C.2: Model Calibration – Site

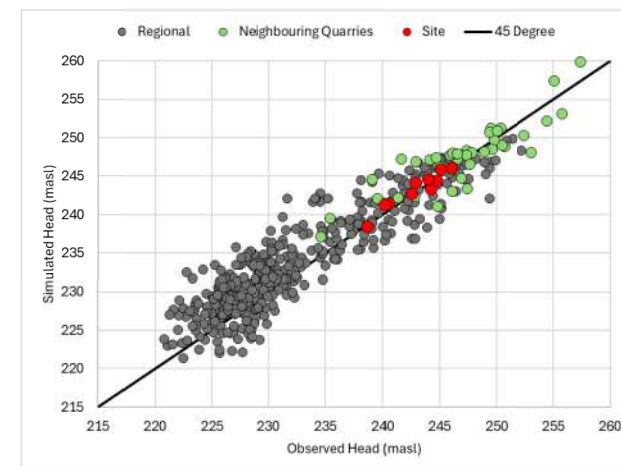
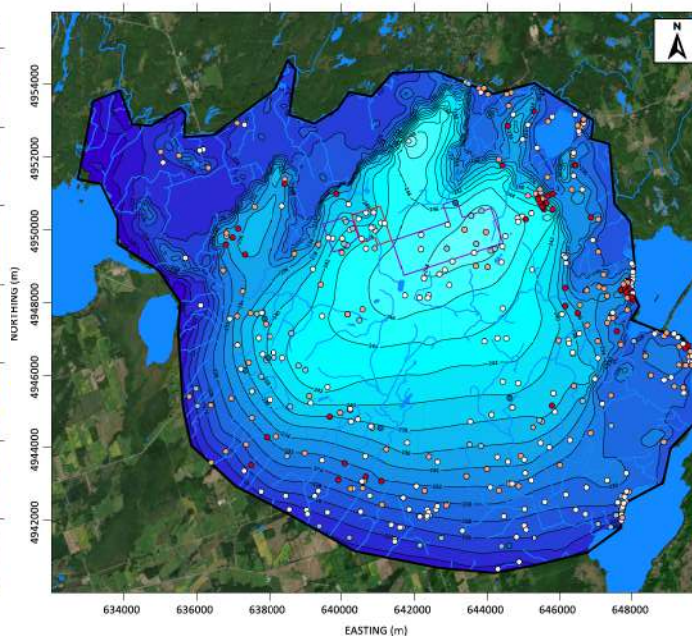


C.1: Model Calibration – Regional

Observed Groundwater Elevation



Simulated Gull River Head and Residuals



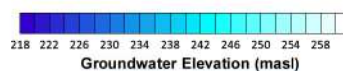
Calibration statistics	Regional	Local	Site
Number of observations	517	55	11
Mean Error (m)	1.39	0.45	0.26
Mean Absolute Error (m)	2.51	1.67	0.56
Root Mean Squared Error	3.17	2.17	0.69
Normalized RMS (%)	8.66	9.51	9.29

Legend

- Water Level Observation Point
- Model Domain
- Proposed Quarry Property Boundary
- Neighbouring Quarry Property Boundary

Residual (Simulated - Observed, m)

- < -5
- 5 to -2
- 2 to 2
- 2 to 5
- > 5

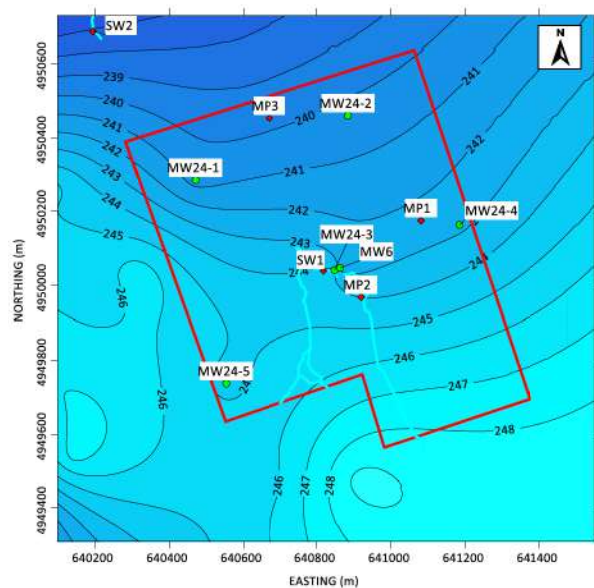


Notes:

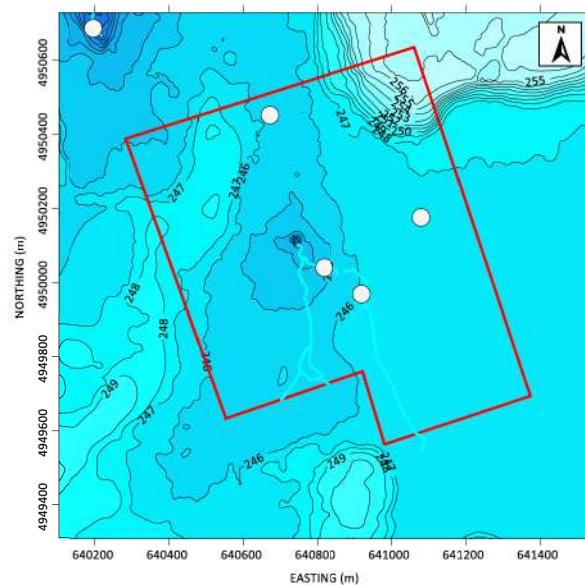
- Coordinate system: NAD 1983 UTM Zone 17N
- Contains information licensed under the Open Government License - Ontario
- Observed Groundwater levels based on Site water levels provided by Tatham, water levels from neighbouring quarry investigations (Cut Above and Bot) and water level observations extracted from the MECP well database (2025)
- Simulated Head extracted from model layer 12

C.2: Model Calibration – Site

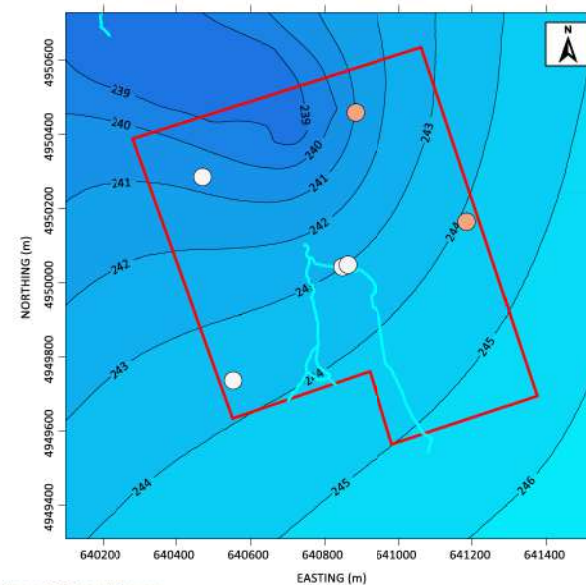
Observed Gull River Groundwater Elevation



Simulated Shallow Groundwater Head and Residuals



Simulated Gull River Head and Residuals



Surface Water Flows

Surface Water Monitoring Location	Average Observed (m ³ /day)	Max Observed (m ³ /day)	Simulated (m ³ /day)
SW1	1,080	6,480	1,034
SW2	5,610	60,480	7,460

Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Contains information licensed under the Open Government License - Ontario
3. Observed Groundwater levels based on Site water levels provided by Tatham in the Gull River (i.e., MP1, MP2, MP3, SW1, and SW2 not included)
4. Simulated shallow head extracted from model layer 4 and residuals presented are for Layer 4 and shallower
5. Simulated Gull River Head extracted from model layer 12 and residuals presented are for Layer 10 and deeper

APPENDIX D

Forecast Simulations

D.1: Forecast Model Setup

D.2: Groundwater Drawdown at Baseline

D.3: Groundwater Drawdown at Full Extraction

D.4: Incremental Groundwater Drawdown at Full Extraction

D.5: Groundwater Drawdown at Baseline Rehabilitation

D.6: Groundwater Drawdown at Full Rehabilitation

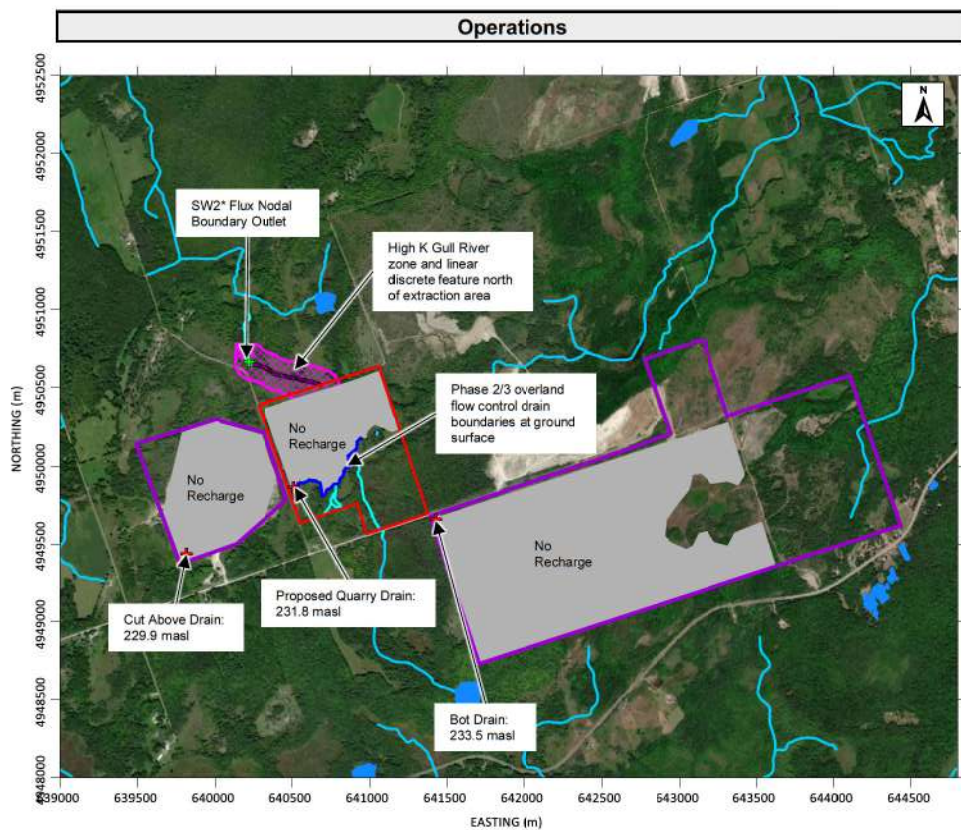
D.7: Incremental Groundwater Drawdown at Full Rehabilitation

D.8: Groundwater Inflow to Proposed Quarry



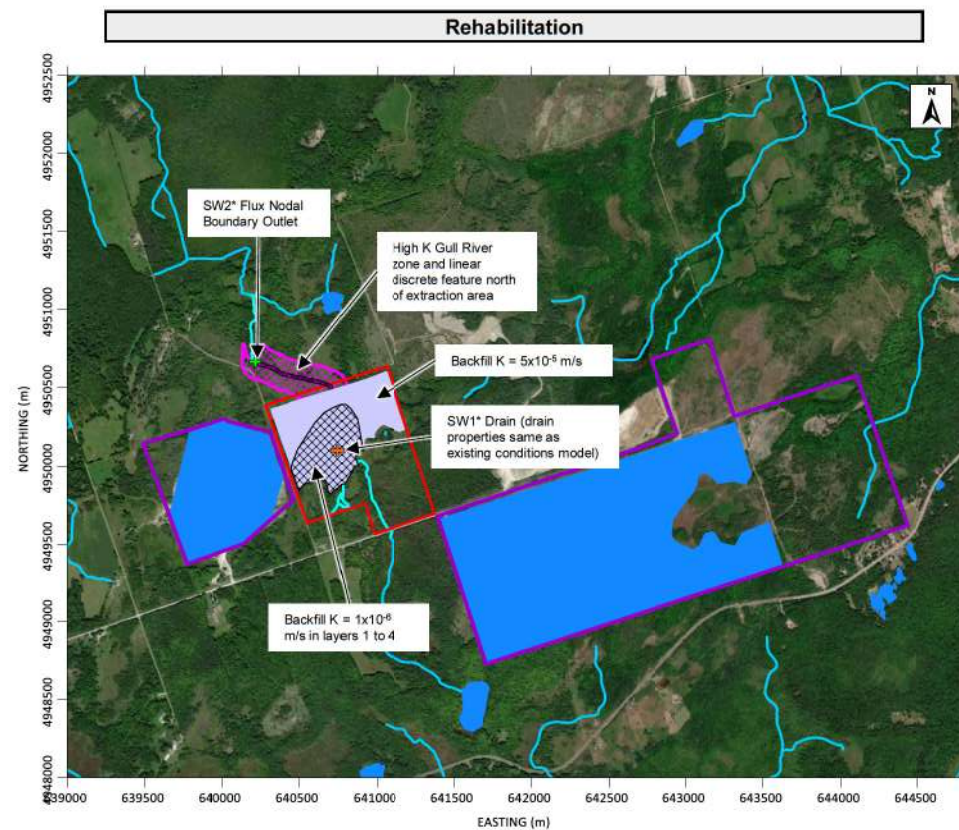
D.1: Forecast Model Setup

Changes From Existing Conditions (Calibrated) Model Setup



Legend

-  Quarry Drain Boundary
-  Rehabilitated Quarry Lake
-  Extracted Bedrock Replaced with High K Material (1 m/s)
-  Proposed Quarry Property Boundary
-  Neighbouring Quarry Boundary
-  Rehabilitated Backfilled Quarry

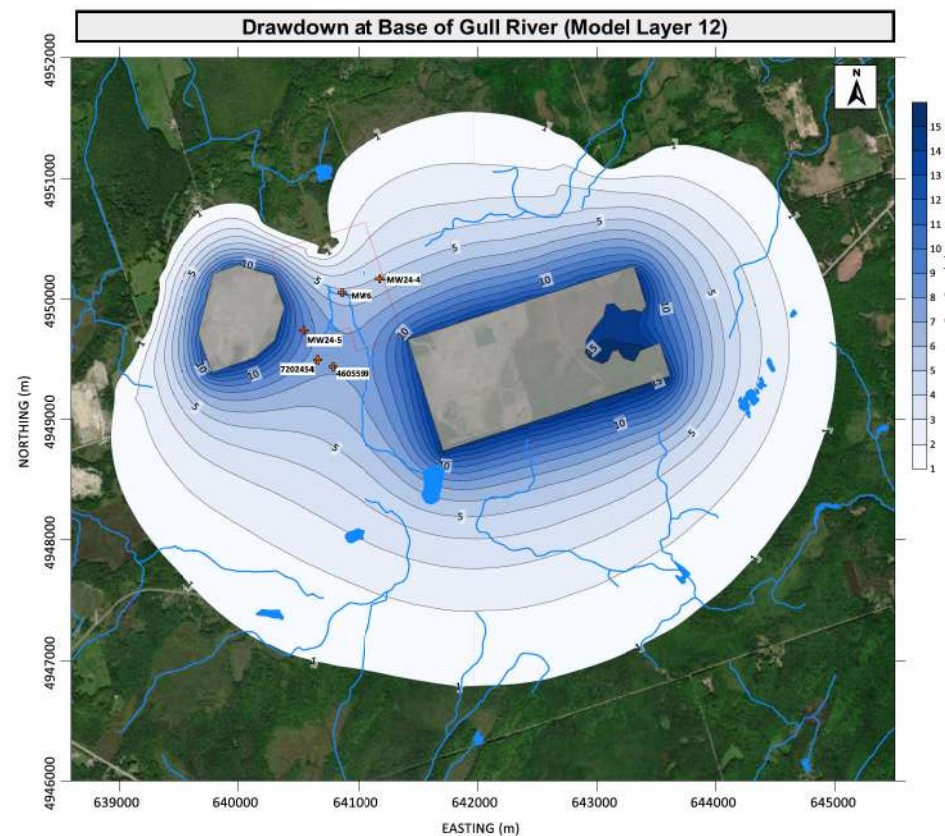
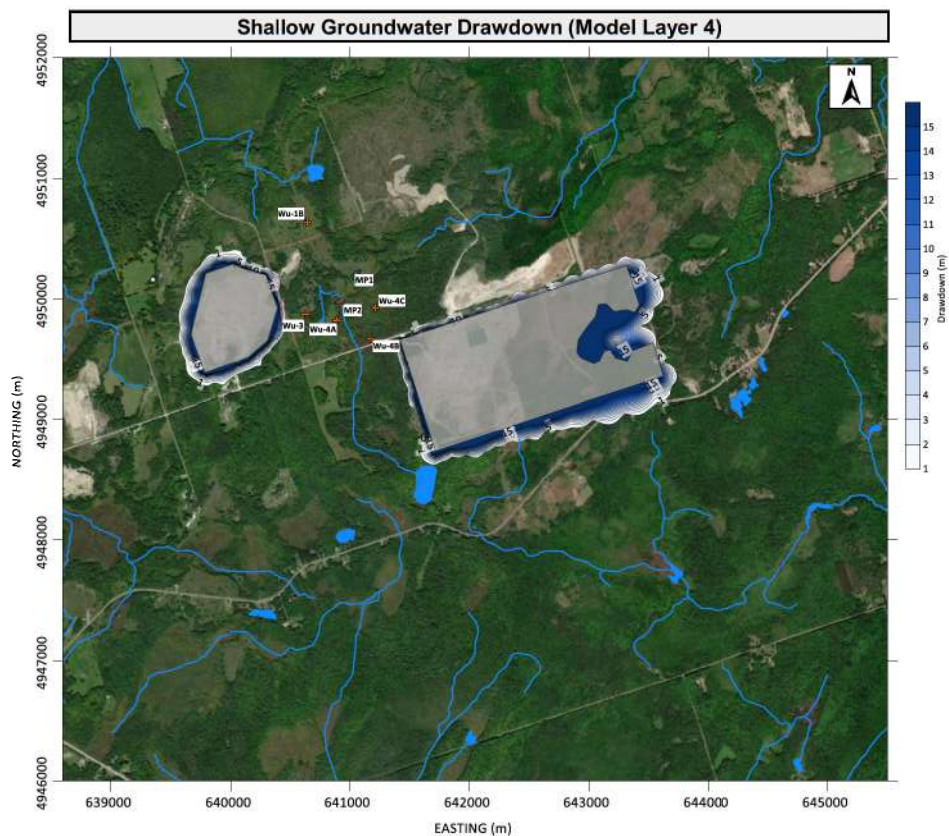


Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Contains information licensed under the Open Government License - Ontario

D.2: Groundwater Drawdown at Baseline

No Extraction at the Proposed Quarry and the Neighbouring Quarries Fully Extracted - Drawdown Relative to Existing Conditions



Legend

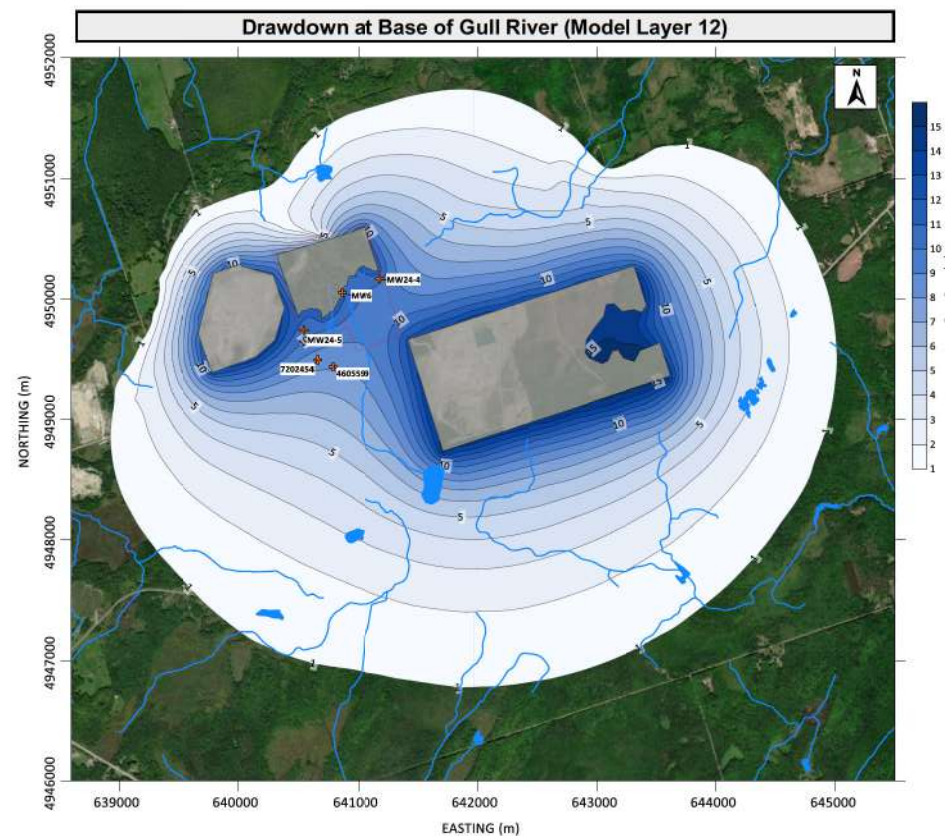
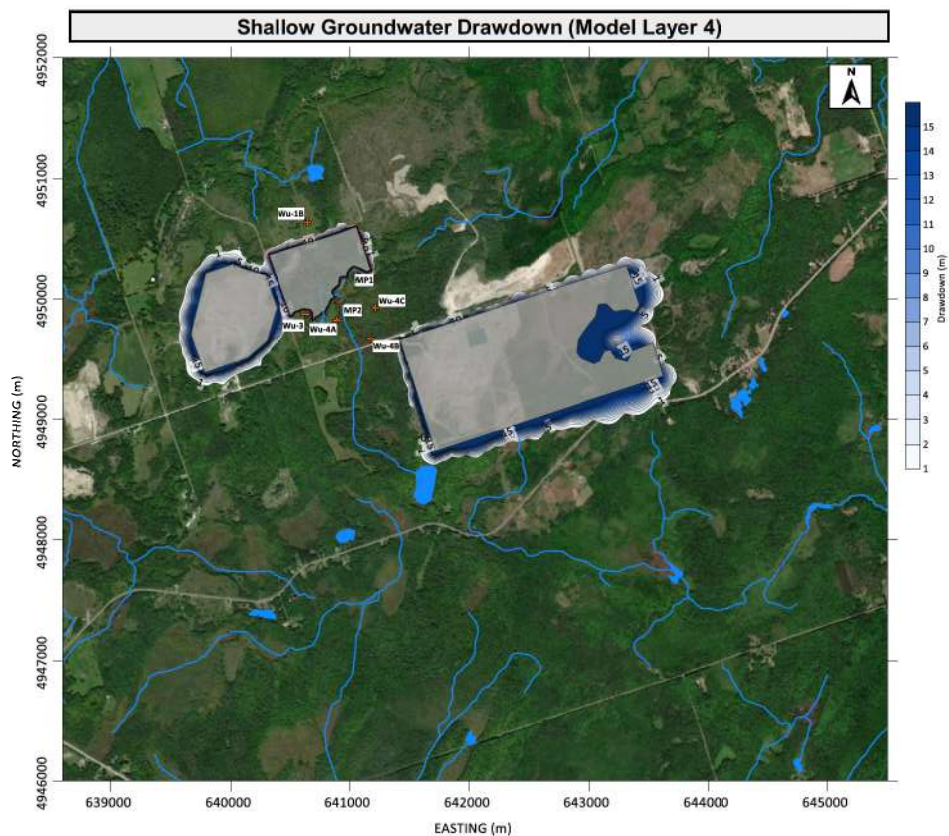
-  Evaluation Location
-  Extracted Bedrock
-  Proposed Quarry Property Boundary

Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Evaluation locations presented were provided by Tatham Engineering
3. Contains information licensed under the Open Government License - Ontario
4. Shallow groundwater level drawdown represents drawdown to the water table (first zone of saturation)

D.3: Groundwater Drawdown at Full Extraction

Full Extraction at the Proposed Quarry and the Neighbouring Quarries - Drawdown Relative to Existing Conditions



Legend

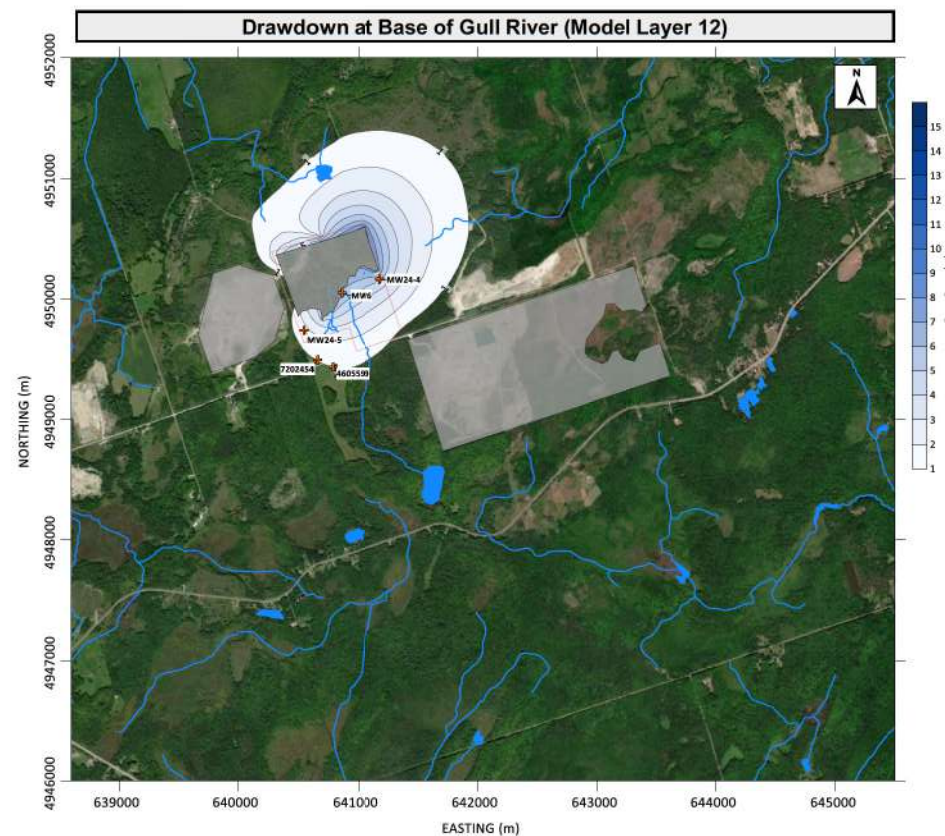
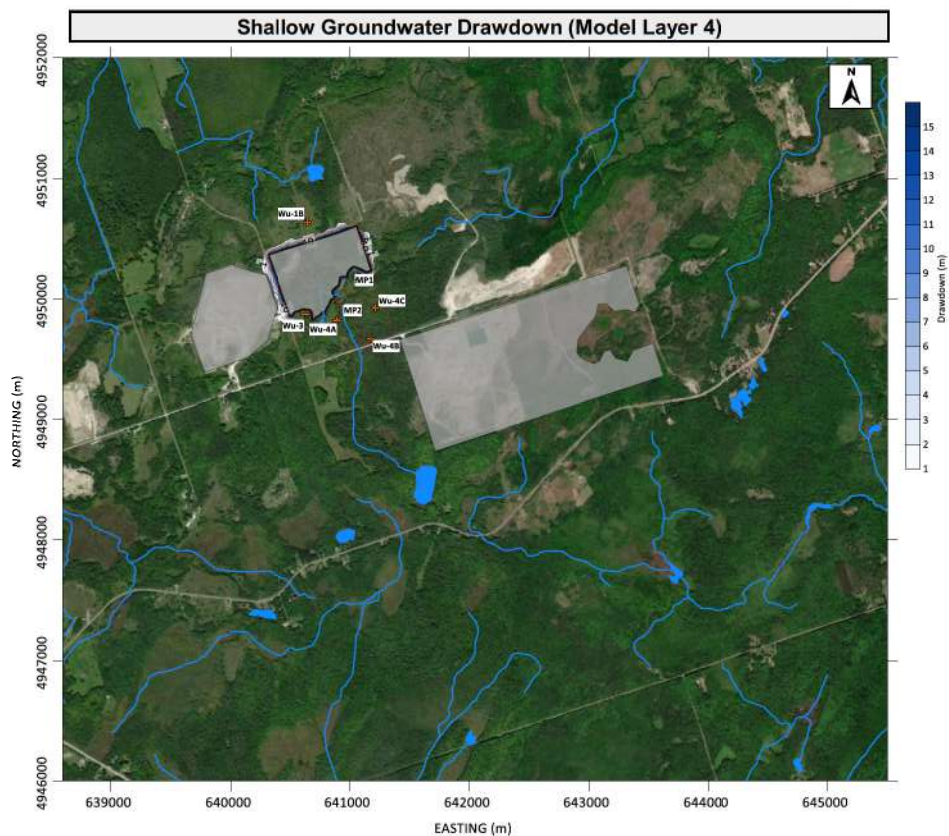
-  Evaluation Location
-  Extracted Bedrock
-  Proposed Quarry Property Boundary

Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Evaluation locations presented were provided by Tatham Engineering
3. Contains information licensed under the Open Government License – Ontario
4. Shallow groundwater level drawdown represents drawdown to the water table (first zone of saturation)

D.4: Incremental Groundwater Drawdown at Full Extraction

Full Extraction at the Proposed Quarry and the Neighbouring Quarries - Drawdown Relative to Baseline Conditions



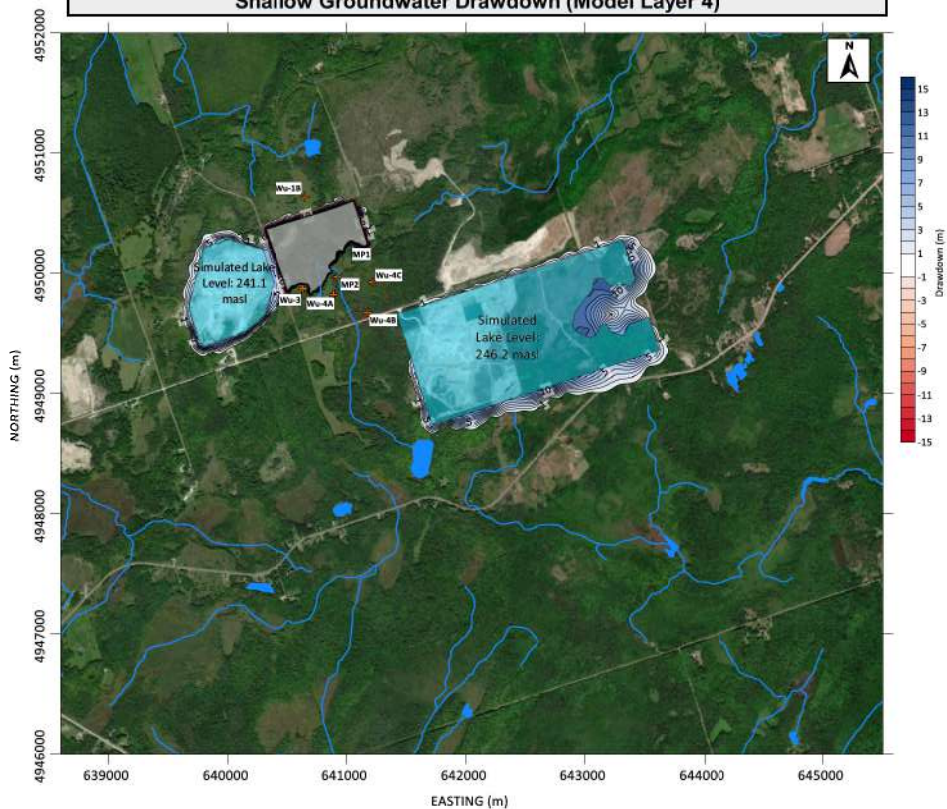
Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Evaluation locations presented were provided by Tatham Engineering
3. Contains information licensed under the Open Government License – Ontario
4. Shallow groundwater level drawdown represents drawdown to the water table (first zone of saturation)

D.5: Groundwater Drawdown at Baseline Rehabilitation

Full Extraction at the Proposed Quarry and the Neighbouring Quarries Rehabilitated - Drawdown Relative to Existing Conditions

Shallow Groundwater Drawdown (Model Layer 4)

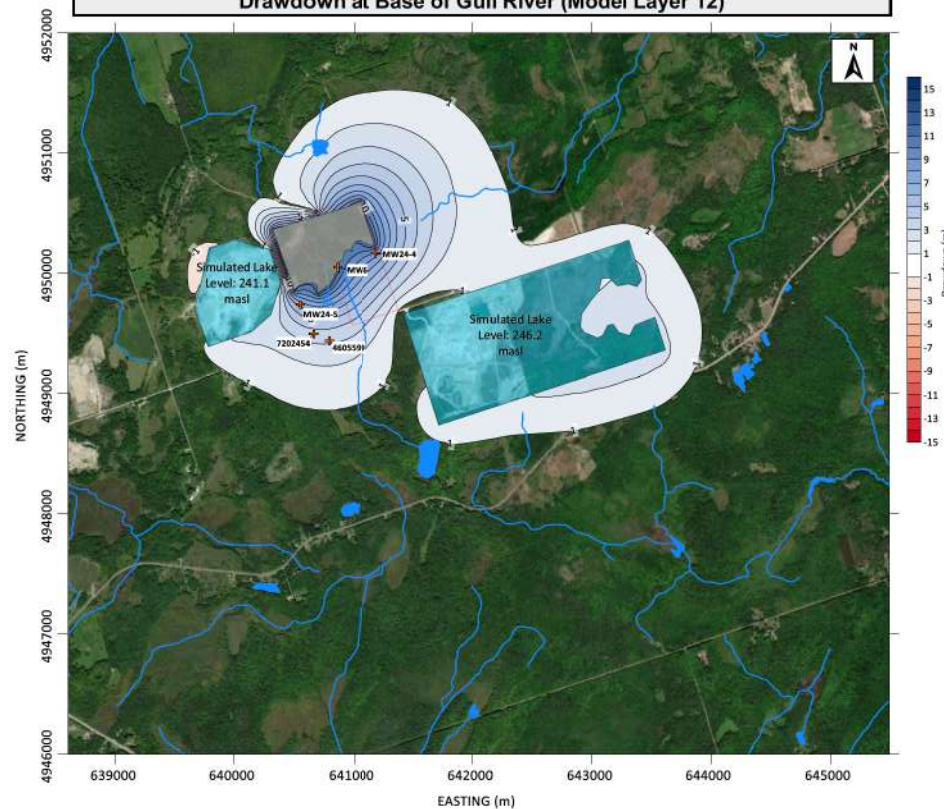


- Legend**
-  Evaluation Location
 -  Extracted Bedrock
 -  Rehabilitated Quarry Lake
 -  Proposed Quarry Property Boundary

Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Evaluation locations presented were provided by Tatham Engineering
3. Contains information licensed under the Open Government License – Ontario
4. Shallow groundwater level drawdown represents drawdown to the water table (first zone of saturation)

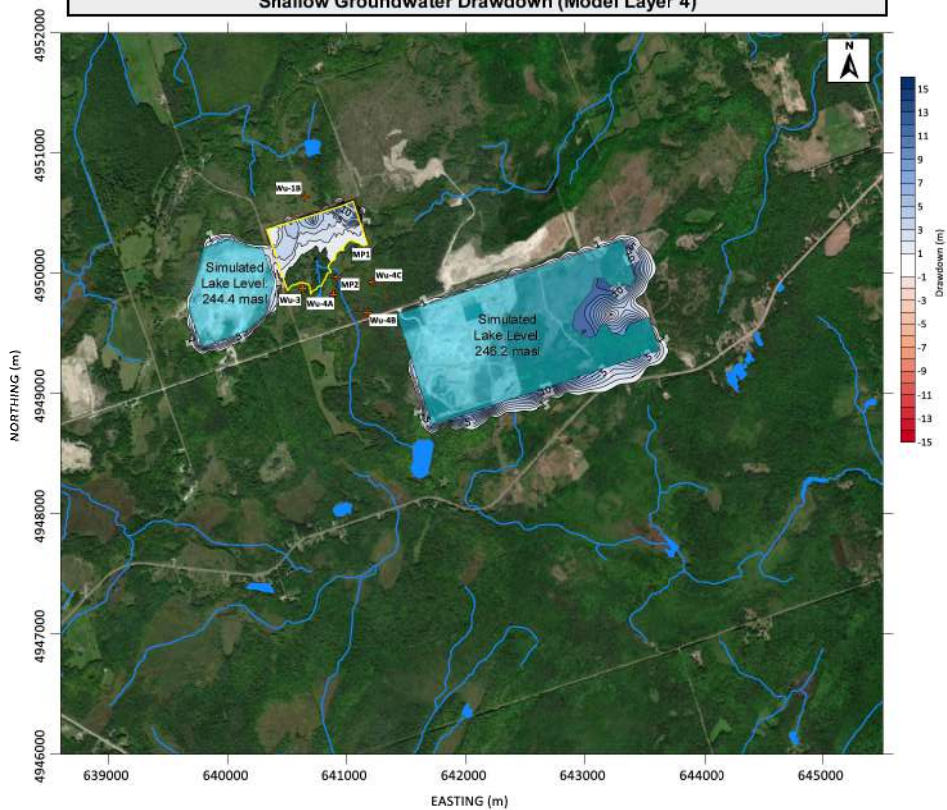
Drawdown at Base of Gull River (Model Layer 12)



D.6: Groundwater Drawdown at Full Rehabilitation

Rehabilitation at the Proposed Quarry and the Neighbouring Quarries Rehabilitated - Drawdown Relative to Existing Conditions

Shallow Groundwater Drawdown (Model Layer 4)

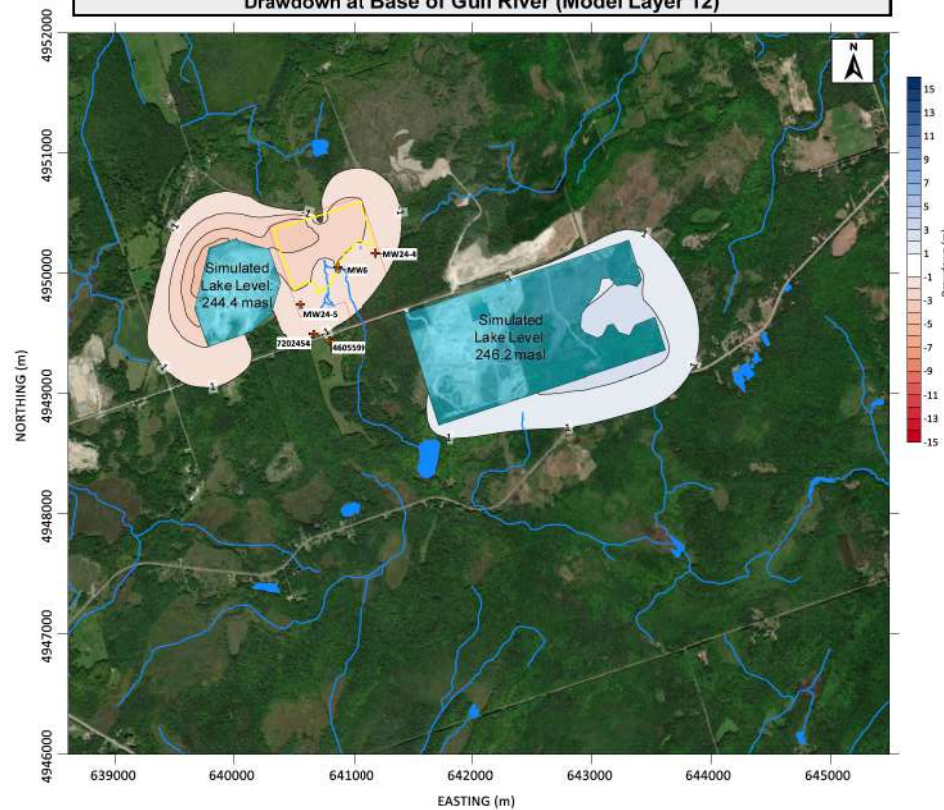


- Legend**
-  Evaluation Location
 -  Backfilled Rehabilitated Quarry
 -  Rehabilitated Quarry Lake
 -  Proposed Quarry Property Boundary

Notes:

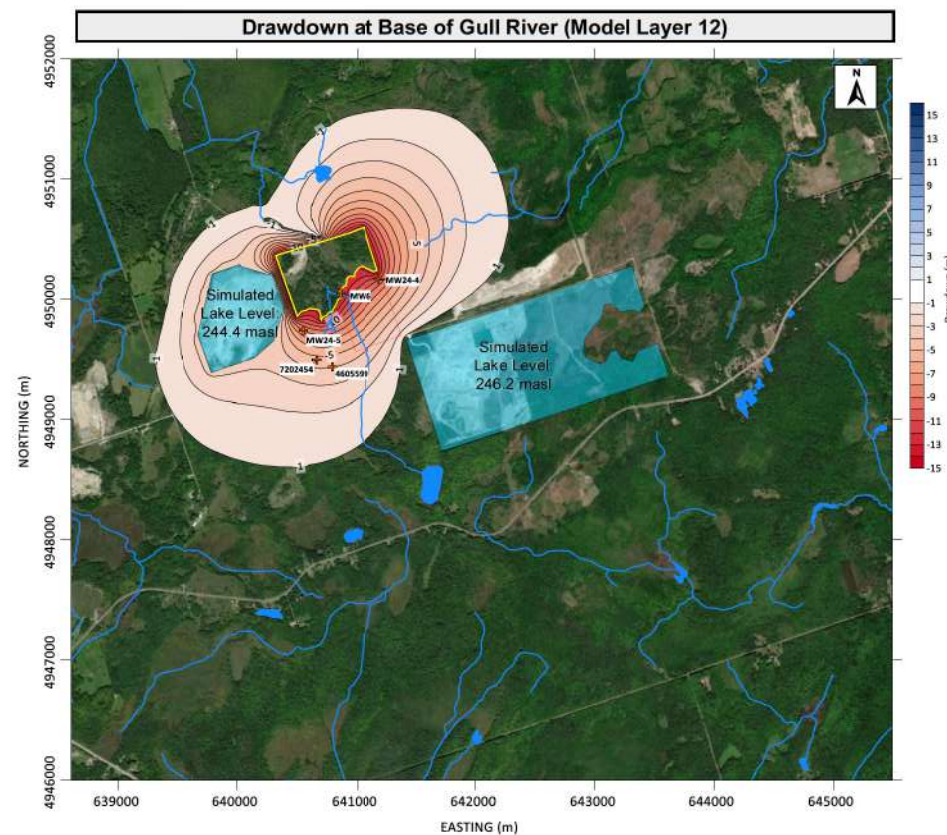
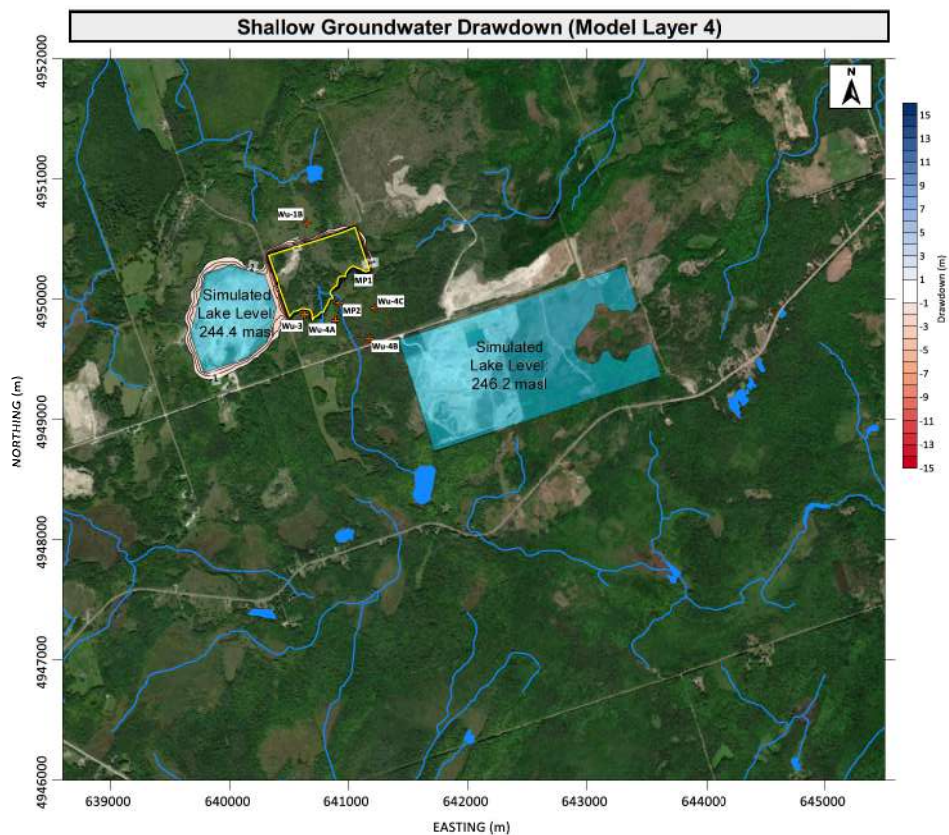
1. Coordinate system: NAD 1983 UTM Zone 17N
2. Evaluation locations presented were provided by Tatham Engineering
3. Contains information licensed under the Open Government License – Ontario
4. Shallow groundwater level drawdown represents drawdown to the water table (first zone of saturation)

Drawdown at Base of Gull River (Model Layer 12)



D.7: Incremental Groundwater Drawdown at Full Rehabilitation

Rehabilitation at the Proposed Quarry and the Neighbouring Quarries Rehabilitated - Drawdown Relative to Baseline Rehabilitation Conditions



Legend

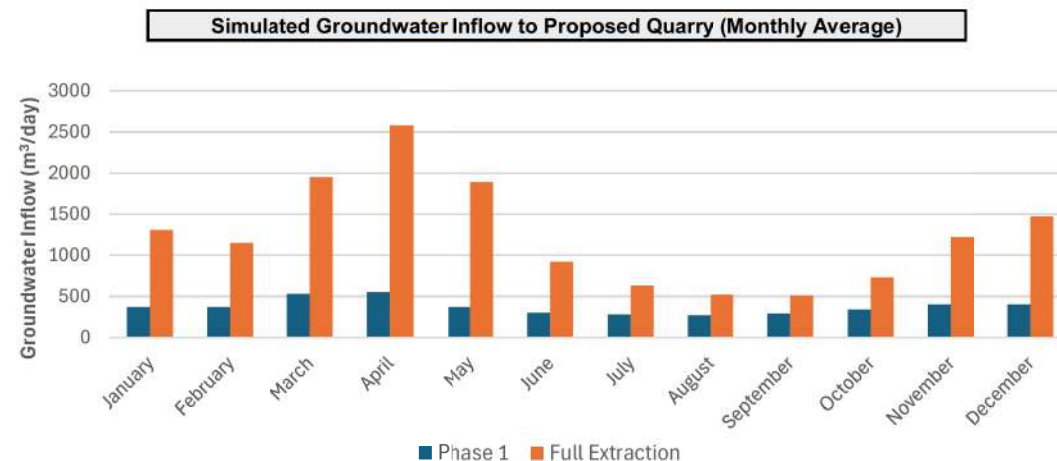
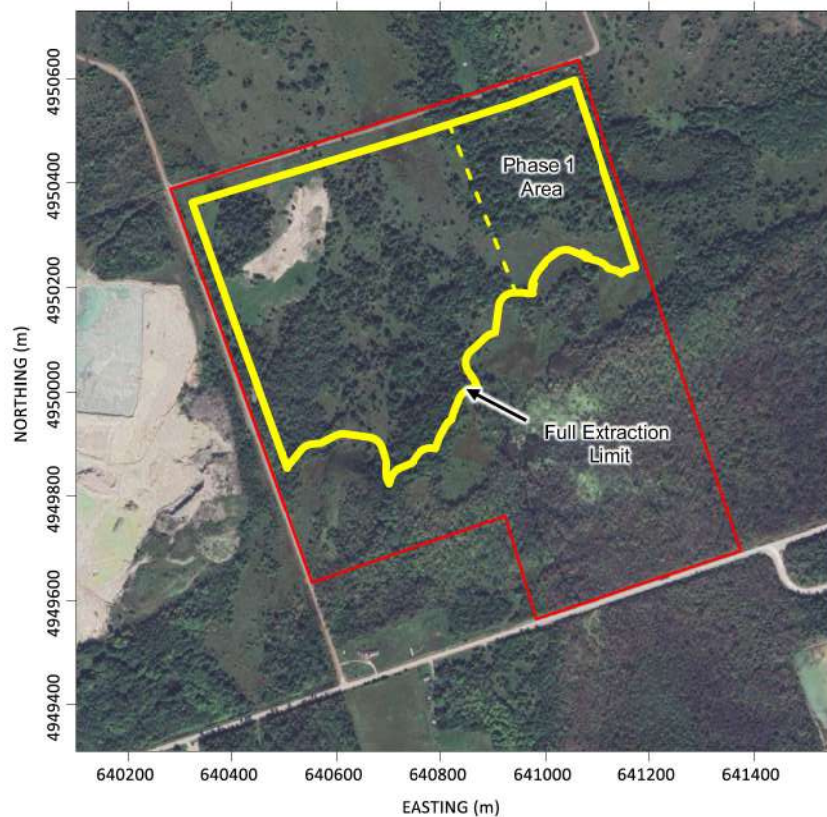
-  Evaluation Location
-  Backfilled Rehabilitated Quarry
-  Rehabilitated Quarry Lake
-  Proposed Quarry Property Boundary

Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Evaluation locations presented were provided by Tatham Engineering
3. Contains information licensed under the Open Government License – Ontario
4. Shallow groundwater level drawdown represents drawdown to the water table (first zone of saturation)

D.8: Groundwater Inflow to Proposed Quarry

Transient Simulation to Provide Seasonal Groundwater Inflow



Month	Surplus (mm/d)	Phase 1 Groundwater Inflow (m³/d)	Full Extraction Groundwater Inflow (m³/d)
January	0.82	370	1310
February	1.05	370	1150
March	6.10	530	1950
April	4.89	550	2580
May	0.00	370	1890
June	0.00	300	920
July	0.00	280	630
August	0.00	270	520
September	0.53	290	510
October	2.10	340	730
November	2.42	400	1220
December	2.03	400	1470

Legend

-  Quarry Extraction
-  Proposed Quarry Property Boundary

Notes:

1. Coordinate system: NAD 1983 UTM Zone 17N
2. Evaluation locations presented were provided by Tatham Engineering
3. Contains information licensed under the Open Government License – Ontario
4. Monthly Surplus based on 2019 to 2025 climate data from the Orillia Brain Climate Station (ID 6115811)

