REPORT

Duntroon Quarry

2023 Annual Summary and Performance Report

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March 31, 2024

Distribution List

1 electronic copy to WAI

1 copy to file

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1.0 INTRODUCTION

1.1 Background

The Duntroon Quarry (Site) operated by Walker Aggregates Inc., (WAI) is located on County Road 91, west of the village of Duntroon in the Township of Clearview, County of Simcoe, as shown on **Figure 1**. The Duntroon Main Quarry (ARA Licence no. 3514) is located south of County Road 91, while the Extension Quarry (ARA Licence no. 607841) is located north of County Road 91. The Site is located adjacent to the east of Osprey Quarry (ARA Licence no. 608061) operated by St. Mary's Cement (formerly referred to as the MAQ Aggregates Inc. (MAQ) Highland Quarry). The locations of these quarry properties and additional lands owned by WAI are shown on **Figure 2**.

The Main Quarry has been in operation on the south side of County Road 91 since the early 1960s. However, extraction from the Site currently occurs within the Extension Quarry licence granted in 2014, and extraction within Phase 1 was initiated in June 2016. A summary of the Licence area and Limit of Extraction is provided in **Table 1.1**.

Table 1.1: Quarry Licence Area and Limit of Extraction

	Main Quarry (ARA Licence 3514)	Extension Quarry (ARA Licence 607841)
Licence Area	57.5 hectares (142.1 acres)	65.9 hectares (162.8 acres)
Limit of Extraction	47.1 hectares (116.4 acres)	58.5 hectares (144.6 acres)

1.2 Monitoring Requirements

The monitoring requirements for the Site are governed by three documents.

1) The Adaptive Management Plan (AMP) is a requirement of the Extension Quarry ARA Licence and was finalized on December 6, 2013. The AMP outlines the monitoring required during each operational phase until final rehabilitation of the site.

2) The quarry is licensed to extract aggregate below the water table, down to a final floor elevation of 500 metres above sea level (masl) for the Main Quarry and 490 masl for Phase 4 of the Extension Quarry. To maintain dry working conditions, the quarry is dewatered under Permit to Take Water (PTTW) number 7725-AACS54, issued September 16, 2016. The PTTW specifies a maximum offsite discharge rate of 250 L/s, as measured at the sump discharge line. A copy of the PTTW is provided in **Appendix A-1**.

3) Discharge from the Site is permitted under Environmental Compliance Approval for Industrial Sewage Works (ECA (Sewage)) number 1521-A4VJ4X, issued October 17, 2016. The discharge is directed to Rob Roy Swamp 6 located west of the Main Quarry and flows to twin culverts located on Grey Road 31 (designated as station "SW1") and eventually to the Beaver River South Tributary further west of the Site. A copy of the ECA (Sewage) is provided in **Appendix A-1**.

   Outstanding ECA Clarification:

   WAI and WSP have been in communication with the Ministry of Environment, Conservation and Parks (MECP) regarding suspected inaccuracies in the ECA document text, as issued in October 2016. Some clarification remains outstanding as of this report.

- Condition 3(2) indicates a maximum discharge rate from the Works of 250 L/s which is consistent with the Permit to Take Water for the site (PTTW No. 7725-AACS54). The first line of the first paragraph on page 1 of the ECA (Sewage) refers to 130 L/s and this should be consistent with the 250 L/s quantity.
- Wording for the proposed Works is unclear and does not match the WAI application. WAI indicated in their application that they are planning to discharge from Sump 3 using a submersible pump from the Extension Quarry to the Main Quarry. The water will be either discharged via a gravity pipeline to Sump 2 or pumped directly to the Storage Reservoir, during extreme wet weather events or periods of rapid snow melt.
- ECA (Sewage) sampling occurs from a sampling point in the discharge line and not from the channel itself to accommodate safety protocols. Visual observations on the effluent in the channel remain part of the sampling program. WAI received an oral confirmation from the MOECC (now MECP) that this approach would meet the requirements, but the ECA (Sewage) document was not updated with the proposed revisions.

1.3 Objectives and Scope

The objectives of this report are to summarize the monitoring activities during the period between January 1, 2023 and December 31, 2023 to satisfy the requirements of:

- The AMP;
- PTTW No. 7725-AACS54; and
- ECA (Sewage) No. 1521-A4VJ4X.

WSP was retained to complete the 2023 report. In 2023, field monitoring tasks were completed by WSP and WAI staff.

1.4 Current Site Operations

Currently, extraction is ongoing within the Extension Quarry Phase 1 and moving to Phase 2A as of 2021. Extraction during Phase 1 was not expected to result in any negative impacts to off-site water resources or ecological features. AMP monitoring program data obtained during the Phase 1 extraction has been used as input to establish baseline ranges for ecological features that will be compared to later phases as the quarry footprint expands.

The Main Duntroon Quarry has been mined such that bedrock resource is no longer extracted from within that Licence. Rehabilitation slopes have been constructed along the east and south quarry faces, while internal berms have been constructed in the western portion of the quarry to form the Storage Reservoir pond and wash plant ponds, which help mitigate potential dewatering impacts to the Rob Roy Swamp 6 (RR6) wetland to the west.

ARA Site Plan Notes 14 and 15 on the Operation Plan (Sheet 2A of 4) indicate that the processing plant shall be moved from the Main Quarry to the Extension Quarry once the quarry floor reaches a sufficient area (i.e., 18 hectares (ha)), and the tunnel connecting the two quarries shall subsequently be sealed. The AMP document specifies that once the tunnel has been sealed, lake filling in the Main Quarry will commence. The estimated timeframe for this to occur was towards the completion of extraction within Phase 2A. As of October 2023, the quarry floor area remains below the 18 ha threshold.

Aggregate processing of the Extension Quarry resources is primarily completed on the floor of the Main Quarry, with limited processing now also occurring in the Extension Quarry. This will continue until there is sufficient room in the extracted footprint of the Extension Quarry for processing equipment and stockpiles. The movement of aggregate resources between the Main Quarry and the Extension Quarry is facilitated by the tunnel under County Road 91.

The current water management system as depicted on **Figure 2A** consists of two sumps in the Main Quarry, Sump 1 and Sump 2, both of which are equipped with submersible pumps. Sump 2 was moved to its current location in 2016 to allow for the addition of the Storage Reservoir. Water that collects in the Extension Quarry flows via gravity from Transient Sump 3 to the Main Quarry, where the water is managed with the existing discharge works.

In the Main Quarry, water from Sump 2 is either pumped to the Storage Reservoir within the western portion of the Site or directly to Sump 1. Water outflow from the Storage Reservoir is controlled using a weir to direct water as needed to Sump 1 via a gravity sewer line. Any leakage from the Storage Reservoir is directed across the quarry floor to Sump 1. The water elevation in Sump 1 is controlled with a float-activated switch. Water from Sump 1 is discharged either directly off site or can be redirected to the Storage Reservoir via a 300 mm solid pipe. The 300 mm pipe outlets on WAI property, in the wetland, north of SW1; however, leaks and breaks in the pipe were observed in 2023. It is noted that replacement of the solid pipe was initiated in late 2023 and was completed in February 2024. The Storage Reservoir is used to retain water if it is needed for operations, or if there are concerns with water quality.

Pump DN1 in Sump 1 is operated by means of a float switch that can be raised or lowered to maintain the desired water level at the sump. The partitioning of water pumped by DN1 (i.e., between the reservoir and wetland) is facilitated through the manual operation of a control valve by the quarry operator. The flow meter that measures the quarry discharge is located on the pipe directed to the wetland, downstream of the valve. It is noted that the flow meter was replaced in 2023. During the spring snowmelt period or during particularly wet periods at other times of the year, additional pumps may be required to manage excess water on the quarry floor and direct them to Sump 1.

Pump DN2 is located in Sump 2 within the channel that directs water collected from the quarry floor to Sump 1. Water pumped by DN2 is directed into the Storage Reservoir. Historically, DN2 has operated periodically, as required in the winter / spring months to manage increased water flow across the quarry floor (i.e., in response to snowmelt or significant precipitation events) and / or to prevent freezing conditions within the water collection channel. It is noted that pump DN2 was used intermittently during the current monitoring period.

Pump DN3A is located in a shallow water collection channel on the quarry floor along the toe of the containment berm of the Storage Reservoir. Pump DN3A is used on an as-needed basis to remove excess water from the quarry floor. Water pumped via DN3A is directed over the containment berm and re-circulated into the Storage Reservoir. It is noted that pump DN3A was used intermittently during the current monitoring period.

Aggregate washing is completed using portable wash plants located on the quarry floor. Water used for aggregate processing is pumped from the Sump 1 (via pump WP1), located on the quarry floor. Similarly, Sump 1 and / or the three (3) Sedimentation Ponds along the southwest quarry wall are used for settling of the wash water fines. When operational, the aggregate washing process functions as a closed-loop system with all water contained and recycled within the quarry excavation.

1.4.1 St. Mary’s Cement Osprey Quarry

It is noted that the former M.A.Q. Aggregates Highland Quarry is now referred to as the Osprey Quarry, owned and operated by St. Mary’s Cement. As of the end of 2020, extraction at the Osprey Quarry was interpreted to be ongoing within its Phase 1 extraction area. The approximate extent of the working face is illustrated on **Figure 2**. The 2020 Groundwater and Surface Water Compliance Monitoring Report (Tatham Engineering, March 2021) indicates that the floor elevation within the extraction area remains at 514 masl. Groundwater level data through 2020 in the excavation corresponds to the Osprey Quarry second bench floor elevation of 502 masl.

2.0 SITE SETTING

The Amabel Formation dolostone is the principal groundwater supply aquifer for residential, agricultural and commercial activities above and to the west of the Niagara Escarpment. This aquifer, known as the Amabel Aquifer, is part of the Guelph and Lockport-Amabel Aquifer System, as described by the MECP in its series on Major Aquifers in Ontario (1978). Considerable re-interpretations of these hydrostratigraphic units have been conducted by the Ontario Geologic Survey since 1978, however as a conceptual model for hydrogeology of the Site, these descriptions remain quite useful.

In the vicinity of the Site, the northern and eastern limits of the Amabel aquifer coincide with the face of the Niagara Escarpment. Groundwater movement in the aquifer occurs along open sections of bedding planes and fracture planes and causes preferential chemical dissolution of the dolostone along some discontinuities (i.e., karstification). The MECP notes that, in general, the dolostone appears to be most transmissive in the upper 6 m of the rock, which is reflective of the greater number of fractures in that zone, and the accompanying karstification that can occur.

Underlying the Amabel Formation dolostone is the more thinly bedded Fossil Hill Formation dolostone. At the Site, the Fossil Hill Formation is considered to act as a lower-activity basal section of the Amabel aquifer system.

The configuration of the groundwater contours within the Amabel Formation bedrock has historically reflected the topography of the ground surface. The tableland of dolostone bedrock is bounded by the steep slopes of the Escarpment, the eastern valley wall of the Beaver River valley, and the Mad River valley wall to the south. Based on the historical groundwater contour mapping, there was a local groundwater high in the eastern section of the Extension Quarry, and another local groundwater high in the western section of the Extension Quarry, resulting in a groundwater divide through the area under baseline conditions. To the west, groundwater flow is interpreted to be westwards, towards the Beaver River valley. Adjacent to the Escarpment, groundwater flow is eastwards towards the Niagara Escarpment.

The Amabel and Fossil Hill Formations are underlain by shale of the Cabot Head Formation. The shale is considered to be an aquitard which restricts the vertical movement of groundwater. As a result, groundwater flow in the Amabel Formation is generally sub-horizontal towards the Escarpment or towards the Beaver River valley in response to the prevailing hydraulic gradient. At the Escarpment face, groundwater discharges from the lower sections of the aquifer at or near the contact with the underlying shale. The discharge may occur both as diffuse seepage areas and as individual spring locations. These groundwater springs form the headwaters of small tributary streams that feed into the main reaches of Batteaux Creek, Pretty River and Mad River, as illustrated on **Figure 1**.

Beneath the Cabot Head shale is the argillaceous dolostone of the Manitoulin Formation and the thinner sandstone of the Whirlpool Formation. Both the Manitoulin and the Whirlpool Formations are considered to be confined aquifers, though water yields typically are low. The Cabot Head shale aquitard overlies these two formations and restricts the amount of vertical groundwater recharge into these confined aquifers. In the vicinity of the Escarpment, groundwater movement in the Manitoulin and Whirlpool Formations is towards the Escarpment where it is inferred to discharge. Historical field investigations at the Escarpment have identified groundwater springs discharging from the face to the east and northeast of Duntroon Quarry.

Beneath the Whirlpool sandstone are thick Ordovician shale sequences of the Queenston Formation and the Georgian Bay Formation. Both of these shale formations are considered to be regional aquitards that generally restrict the vertical and horizontal movement of groundwater.

The bedrock sequence at the Niagara Escarpment near the Site is as follows:

Table 2.1: Summary of Bedrock Stratigraphy

Formation	Description	Approximate Thickness (m)
Amabel	Grey medium to coarse grained fossiliferous dolostone (reefal and flank facies)	15 to 40+
Fossil Hill	Grey thin bedded fossiliferous dolostone	5 to 10
Cabot Head	Red to greenish grey shale with limestone interbeds	10
Manitoulin	Grey medium grained argillaceous dolostone	15
Whirlpool	Grey fine grained quartz sandstone	2
Queenston	Red shale with siltstone and carbonate layers	84
Georgian Bay	Grey shale with limestone interbeds	120

For this report, the active groundwater system in the vicinity of the Site consists of the Amabel aquifer. With the exception of local discharges from the Manitoulin Formation at the Escarpment face, the groundwater systems in the bedrock beneath the Cabot Head shale are not part of the routine monitoring completed at the Site.

3.0 MONITORING PROGRAM

The following sections describe the annual monitoring program undertaken at the Site in 2023 to satisfy the conditions of the AMP, PTTW and ECA (Sewage).

3.1 Groundwater Levels and Temperature

Manual water level measurements are obtained at the wells and drivepoints outlined in **Table A-1**, **Appendix A-2**. The monitoring locations are shown on the Site Plan, **Figure 2**. Available borehole logs are provided in **Appendix A-3**. In late 2022, all wells and drivepoints in the monitoring program were equipped with automated dataloggers for continuous water level monitoring. As part of the current program, monitoring well loggers are downloaded twice per year in May and October, while the drivepoint loggers are downloaded during each monthly / bi-weekly monitoring event between March and August and during the October monthly event. In addition to water levels, the drivepoint loggers also continuously monitor temperature. It is noted that some loggers experienced malfunctioning communications in mid- to late-2023 as a result of a manufacturer defect. These loggers were repaired under warranty and reinstalled in October 2023.

3.1.1 Monitoring Wells

Groundwater levels are obtained at five (5) monitoring wells situated on the Main Quarry licence, designated MW6, PW99-1, BH98-8, BH98-9 and BH98-12. Manual water level data are provided in **Table B-1** while hydrographs are provided in **Figures B-1 to B-5**.

In the spring of 2003, a groundwater monitoring well network was established for the Extension Quarry and was later expanded with additional locations in 2015 as a condition of licence. The network currently consists of twenty-four (24) monitoring wells as noted on **Table A-1**. Manual water level data are provided in **Table B-2** while hydrographs are provided in **Figures B-6 to B-30**. It is noted that loggers have also been installed to monitor water levels at staff gauges SG1 and SG2 at BH03-7 near Rob Roy Swamp 2 north of the Extension Quarry, and at drivepoint NW10DP at well nest NW10 northwest of the Extension Quarry. Staff gauge water levels are shown in **Figure B-73**.

As extraction within the Extension Quarry has progressed, a number of monitoring wells have been removed from the program as they are situated within the limit of extraction. Monitoring ceased at NW2 in 2018, BH02-3, BH02-4 and NW4 in 2019, BH02-1 in 2020, NW3 in 2022 and NW5 in 2023. It is noted that BH02-2 (Phase 2A), NW6 and NW7 (Phase 2B) and NW8, BH03-9, TW04-2 and TW04-3 (Phase 3A) are also situated within the limit of extraction and will be removed from the program as the quarry development progresses.

Groundwater levels are also monitored by loggers at seven (7) off-site monitoring wells situated at the undeveloped former Osprey Quarry property west of the Main Quarry. Manual water level data are provided in **Table B-6** while hydrographs are provided in **Figures B-55 to B-62**. It is noted that OW1-6 was destroyed in 2009 and OW3-1 was destroyed in 2016 and both wells are no longer monitored.

3.1.2 Injection Wells

In 2015, five (5) injection wells were installed east / northeast of the Extension Quarry on WAI-owned lands as a condition of licence as part of the AMP potential contingency measures. Use of these contingency injection wells has not been required to date. Manual water level data are provided in **Table B-3** while hydrographs are shown in **Figures B-31 to B-34**.

3.1.3 Domestic Wells

In 2003, monthly groundwater level monitoring was initiated at a number of domestic wells located at private residences surrounding the Main and Extension Quarries. Additional domestic wells were added to the monitoring program in 2008. Currently, ten (10) domestic wells are included in the monthly water level monitoring as shown in **Table A-1**. Manual water level data are provided in **Table B-4** while hydrographs are provided in **Figures B-35 to B-49**. It is noted that RW16 and RW18 are situated on property owned by WAI. Former domestic wells RW18 and RW19 were also located on WAI-owned lands but were removed from the monitoring program in 2022 and 2020 respectively, as they were located within the Phase 2A limit of extraction.

Annual groundwater sampling is completed at domestic wells RW1 and RW2 as per the AMP Long-Term Trend Groundwater and Surface Water Monitoring (LTTWM).

In February 2009, RW16 (owned by WAI) was upgraded to remove a historical well pit and the present configuration of this well is in accordance with O.Reg. 903.

It is noted that monitoring of RW9 was discontinued in 2009 as it is located within the St. Mary's Osprey Quarry licence, while monitoring of RW4 and RW6 were discontinued in 2019 and 2022 respectively, at the owner's request.

Since 1996, manual groundwater level measurements have also been obtained at three (3) domestic wells situated on the Carmarthen Lakes Farms (CLF) property south of the Main Quarry. Manual water level data are provided in **Table B-5** while hydrographs are provided in **Figures B-50 to B-54**. Historically, water level monitoring was also completed at domestic wells CLF1 and CLF2 but the well casings have failed and these wells can no longer be monitored.

3.1.4 Wetland Drivepoints

Water level elevation and temperature measurements are obtained at ten (10) drivepoints installed at the wetland features surrounding the Site. Surface water depth surrounding the drivepoint is also recorded for comparison. Bi-weekly monitoring at selected drivepoints is also completed during May, June and July. Drivepoints DP1 to DP4 were installed in 1999 in the vicinity of the Main Quarry, while the remaining drivepoints were installed later as part of the Extension Quarry licencing. Manual water level data are provided in **Table B-7**, temperature data are provided in **Table B-8** and hydrographs are provided in **Figures B-63 to B-74**. It is noted that DP10 and DP11 in Rob Roy Swamp 3 northwest of the Site are monitored as part of the St. Mary's Osprey Quarry monitoring program.

During Phase 1 Extension Quarry operations, it was intended to install a drivepoint monitor within a more distant reference wetland beyond the area of the potential quarry influence in either the Nottawasaga Lookout Provincial Park or the Pretty River Provincial Park. This would have served as an additional monitoring point for assessment and comparison of potential impacts to wetland water levels in areas within the potential quarry influence if required. A satisfactory reference wetland was not located during the Phase 1 monitoring period.

3.2 Surface Water Flows and Quality

Surface water monitoring is completed to monitor features outside of the limit of extraction that are potentially sensitive to fluctuations in groundwater levels, such as wetlands and fish habitat. Monitoring includes:

- Springs that discharge at the Niagara Escarpment east of the Site. These springs help to sustain surface water flow and fish habitat below the brow of the Niagara Escarpment in tributary streams of the Pretty River and Batteaux Creek;
- Surface water flows that support fish habitat in the Beaver River west of the Site; and
- Surface water levels and flows that support wetland features and functions.

Monthly manual flow measurements and field parameters (pH, conductivity, temperature and dissolved oxygen) are obtained during the trigger period at the surface water stations shown on the AMP Tables 3.4 and 4.2. Bi-weekly monitoring during June, July and August is also undertaken at selected Escarpment Spring stations as noted on AMP Table 3.4. The monitoring locations are shown on the Site Plan, **Figure 2**. In late 2022, all surface water stations were equipped with automated dataloggers for continuous water level and temperature monitoring and are downloaded during each monthly / bi-weekly monitoring event. Preliminary stage-discharge relationships were developed using manual water level measurement data at the stilling wells installed at each station and the manual flow measurements. The preliminary rating curve parameters are provided on the station logs in **Appendix A-4**. Logger water level data converted to estimated flow rates are shown on the hydrographs in **Appendix C**. In addition, quarterly sampling is completed at the quarry dewatering sumps and annual surface water sampling is completed at selected stations as shown on the AMP Tables 3.4 and 4.2. Laboratory analysis is completed by BureauVeritas, a CALA-accredited laboratory.

3.2.1 Surface Water Stations

Surface water flow and field parameter measurements are currently obtained at thirty-six (36) stations as shown on **Table A-2**, **Appendix A-2**. Surface water station instrumentation details are provided in **Appendix A-4**. Stations SW1, SW2, SW0-2, and QFSW2 were historically monitored as part of the Main Quarry monitoring program. Former stations SWB-1 and QFSW1 were removed from the program when the Main Quarry sumps were re-configured. Additional stations were added to the monitoring program as part of the Extension Quarry licencing. Stations SW3A, SW5, SW6, SW12, SW12A, SW17B, SW21D, SW22B, SW23, SW24, SW24B, SW24C, SW25, SW25A, SW26, SW26A, SW27, SW27A and SW27B were monitored as part of the hydrogeological studies for the Extension Quarry; however, long-term monitoring is not required as a condition of licence and these stations are no longer included in the program. In addition, stations SW3B (Rob Roy Swamp 3 Karst) and SW3C (Rob Roy Swamp 3 Out) northwest of the Site are monitored as part of the St. Mary's Osprey Quarry monitoring program. Also, monitoring of station SW7 (former Millar Pond outlet) was discontinued in 2022 once the former Millar Pond was decommissioned. Staff gauges have been installed at stations: SW1, SW2, SW0-2, SW3, SW6A, SW9, SW10, SW11E, SW14, SW15, SW16, SW17, SW18, SW19, SW24A, PR Control and BC Control.

Manual flow measurement data are provided in **Tables C-1 and C-2**, **Appendix C**. Field parameter data are provided in **Table C-3**. Concentration versus time graphs for flow and temperature are provided in **Figures C-1 to C-49**.

Quarterly water quality sampling is completed for the discharge at the Main Quarry Sumps 1 and 2 and at station QFSW2 while annual water quality sampling is conducted at selected stations. The laboratory analysis includes general chemistry (alkalinity, hardness, colour and ammonia), total suspended solids, major ions, nutrients, metals, total petroleum hydrocarbons and BTEX compounds. The surface water quality data are shown in **Table C-4**. Microbial analyses are completed at selected stations as shown in **Table C-5**.

During the winter months, a number of surface water monitoring stations typically have limited access due to snow cover and/or ice accumulation.

It was intended that the PR and BC control stations would function as real-time logger to web stations. However, the locations of these stations are remote and when measured by WSP the cellular network signal strength was found to be insufficient for remote cell telemetry. As an alternative, updated graphs showing precipitation data and surface water flow and temperature data are generated on a monthly basis and uploaded to a publicly available website.

3.2.2 Escarpment Springs

During the months of June, July and August, bi-weekly monitoring is completed at the Escarpment Springs stations SW10, SW11, SW11A-E, SW21C, SW24A and SW77. Monthly monitoring is conducted at other times of the year. Monitoring includes field temperature measurement and an assessment of flow conditions through either the use of an electromagnetic flow meter or in some cases by visual assessment.

3.3 Climate Data

Historically, climate data from the Thornbury Slama climate station were used to assess annual water budget components as part of the monitoring programs at the Main Quarry. Operation of the Thornbury Slama climate station was cancelled in May 2005. The Shanty Bay climate station, located on Lake Simcoe approximately 60 km east of the Site, has historically provided a reasonable correlation with the climate data from the Thornbury Slama climate station.

In 2008, WAI established an automatic weather station (WAI station) in the vicinity of the Site to provide the following local climate data:

- Wind speed and direction;
- Average hourly air temperature (°C); and
- Total hourly precipitation (mm).

The station has operated successfully since 2015. Some data gaps due to equipment failure have occurred sporadically and operations have been adjusted as required to limit data loss.

The combination of climate data from the Shanty Bay climate station and WAI station have been used to assess deviation from historic climate norms and evaluate the potential impact on the surrounding local hydrology and ecology. The 30-year climate normal (1971 – 2000) for Thornbury Slama climate station is provided in **Table D-1**, **Appendix D**. Annual water budgets based on the Thornthwaite-Mather method using the available Shanty Bay and WAI climate station data since 2003 are provided in **Tables D-2 to D-22**. Graphs of the estimated monthly net surplus and average temperature are provided in **Figures D-1 and D-2**.

The long-term regional flow data for the Mad River and the Pretty River Environment Canada hydrometric stations are presented in **Figures D-3 and D-4**. The data for these figures were obtained from the Environment Canada real-time hydrometric data web-site (https://wateroffice.en.gc.ca). Baseline (pre-Phase 2A) data for the Mad River station (02ED015) are available from 1988 through 2020 and for the Pretty River station (02ED031) from 2006 through 2020. The average daily surface water flow data for both stations in 2023 was obtained from the available real-time data set. These data provide an indication of the surface water runoff, a component of the available water surplus, for the current monitoring period compared to the baseline monitoring period.

3.4 Quarry Discharge Volume and Quality

The Main Quarry Sump 1 dewatering pump and associated current totalizers is designated DN1. Off-site quarry discharge is monitored using a flow meter installed on the discharge line since January 2017. It is noted that the flow meter was upgraded in early 2023. The flow meter and the totalizers are downloaded monthly, when accessible. Quarry sump locations and the flow meter location are shown on **Figure 2A**.

The water pumped from DN1 at Sump 1 is directed to a control valve that regulates the flow of the water to either the storage reservoir or off-site via a 300 mm discharge pipe that outlets into the wetland west of the site, upstream of the culverts at SW1. The flow meter is installed on the discharge pipe leading to the wetland. Replacement of the discharge pipe was initiated late 2023 and was completed in February 2024. Daily flow volumes are provided in **Table E-1**, **Appendix E** and graphed in **Figure E-1**.

As noted previously, additional water pumped at DN2 and DN3a are for internal water management purposes only and are not regulated under the current PTTW / ECA (Sewage).

Monthly samples are obtained from the Sump 1 discharge line to meet the requirements of the ECA (Sewage) and ensure the discharge quality is maintained within the specified Effluent Limits in Table 3.1 of the ECA (Sewage). The analysis includes the parameter list provided in Table 3.2 of the ECA (Sewage). A summary of the monthly discharge sampling results and Effluent Limit compliance is provided in **Table E-2**.

4.0 RESULTS AND DISCUSSION

4.1 Climate Data

The climate data from the Shanty Bay station are used to calculate the water budget for the Site using the Thornthwaite-Mather method to estimate the available monthly net water surplus available for runoff or infiltration to the groundwater system. The results are shown graphically on **Figure D-1**, **Appendix D**.

Baseline (2003 – 2020) monthly net water surplus estimates for the Shanty Bay climate station are summarized in box and whisker plots in **Figure D-1**. In the plot, the “whiskers” represent the maximum and minimum historic monthly values, the upper and lower edges of the “box” represent the 75^{th} and 25^{th} percentile of the historic data range and the solid line through the box represents the median value. Individual data points occasionally may plot outside of the “whiskers”. These data points are interpreted to be outliers, as they are outside of 1.5 times the interquartile range (i.e., 1.5 times the range of the “box”).

The Thornbury Slama 30-year monthly climate normal is also shown for comparison. The baseline data for the Shanty Bay stations are similar to that of the climate normal.

The monthly net water surplus values calculated using the 2023 Site data from WAI station and the Shanty Bay station are also shown on the plot. The 2023 monthly net water surplus calculated for both stations is similar, although the WAI station shows a lower monthly net water surplus in January, February, March and December and a higher net water surplus in April, June, July and November. Overall, the data indicate that during 2023, the monthly water surplus was below the median of the baseline data during the winter, while the late spring, early summer and late autumn had a monthly water surplus above the baseline median.

Baseline average monthly temperature data for the Shanty Bay climate station are summarized in box and whisker plots in **Figure D-2**, with the 30-year normal shown for comparison. Once again, the baseline data for Shanty Bay station is similar to that of the climate normal.

The average monthly temperatures from the 2023 Site data from WAI station and the Shanty Bay station are also shown on the plot. The WAI station temperatures are typically 1°C to 2°C cooler than the Shanty Bay station. The WAI station data suggest that temperatures were similar to the median of the baseline data at the Site in 2023. It is noted that the January and December average temperatures were about 2°C to 4°C warmer than the baseline data.

Baseline average daily discharge data for the Mad River hydrometric station south of the Site and the Pretty River hydrometric station north of the Site are summarized in box and whisker plots in **Figures D-3 and D-4**. The 2023 average daily discharge data are also shown for comparison and indicate that the observed flows were generally similar to the median of the baseline data for both watercourses. However, a number of discharge events were observed to exceed the 75^{th} percentile in January, February, April, July and December, while drier periods (i.e., discharge below the 25^{th} percentile) were observed in early March and November.

4.2 Groundwater Levels

4.2.1 Seasonal Variation

Typically, groundwater levels achieve seasonal high elevations in the spring following the snow melt and then progressively decline throughout the summer months due to higher evapotranspiration (ET) rates. In the fall, the balance between precipitation rates and lower evapotranspiration rates can result in a rise in groundwater levels.

In the winter months, when precipitation is bound up in the snowpack and the shallow ground surface is frozen, groundwater levels tend to decline until the spring snow melt, when the cycle repeats.

The magnitude of seasonal variation is generally the greatest at the topographically high groundwater recharge areas, with less seasonal variation occurring in the topographically lower lying areas and adjacent to surface water courses and / or lakes that serve as groundwater discharge areas.

4.2.2 Long-Term Trends

As noted in **Section 4.1**, the monthly net water surplus in the winter of 2023 was below the median of the baseline data, indicating drier than normal conditions during that period. Conversely, the monthly net water surplus in the late spring, early summer and late autumn was above the median of the baseline data, indicating wetter than normal conditions during those periods. Generally, water levels in 2023 were within historical ranges. Localized drawdown due to quarry extraction activities is observed at some locations in the vicinity of Phase 2A, as expected based on the numerical model predictions.

A summary of long-term water level trends at each location is presented below.

Main Quarry Monitoring Wells

The groundwater hydrographs for the Main Quarry monitoring wells indicate that the groundwater levels along the north boundary of the Main Quarry in proximity to the tunnel, showed signs of local influence from this excavation. The remaining wells show variations consistent with historical data. The operation of the Storage Reservoir and the secondary reservoir on the quarry floor appears to be mitigating drawdown at PW99-1 and 98-8 to the west and southwest of the Main Quarry.

Table 4.1: Long-Term Water Level Trends at Main Quarry Monitoring Wells

Monitoring Well	Figure	Discussion
MW6	**B-1**	Approximately 15 m of historical drawdown through 2003 and generally stable groundwater level variations since that time. Potentially influenced by tunnel construction (began October 2015).
98-8	**B-2**	Groundwater levels gradually increased between 2001 and 2015 with the operation of the Storage Reservoir and have generally remained stable since that time.
98-9	**B-3**	Approximately 11 m of historical impact from aggregate extraction through 2003. Stable groundwater variations since 2003 with water levels showing seasonal fluctuations comparable to previous monitoring years. Seasonal high elevations have generally decreased since 2020, although a rebound of about 4 m was observed in 2023.
98-12	**B-4**	Approximately 14 m of historical impact from aggregate extraction through 2007. Stable groundwater levels with muted seasonal variation observed since 2008.
PW99-1	**B-5**	Similar to 98-8, operation of the Storage Reservoir caused increase in water levels between 2001 and 2015, with generally stable groundwater levels since that time.

Extension Quarry Monitoring Wells

The Extension Quarry monitoring wells that are showing influence from quarry dewatering and extraction tend to be close to (i) the active extraction areas located at the north property boundary of the Main Quarry and (ii) the south portion of Phase 1 of the Extension Quarry, near the tunnel construction. Aggregate extraction in Phase 1 of the Extension Quarry began at the end of June 2016.

Table 4.2: Long-Term Water Level Trends at Extension Quarry Monitoring Wells

Monitoring Well	Figure	Discussion
BH02-1	**B-6**	Historically this monitor has shown drawdown impacts prior to Extension Quarry extraction. Approximately 2 m of additional decline in groundwater level since 2015. Seasonal variation in water levels slightly above 10 m. *(removed from monitoring program in 2020)*
BH02-2	**B-7**	Groundwater level shows a drawdown of about 10 m since 2016 as the quarry face moves northeast towards the monitoring location.
BH02-3	**B-8**	Fluctuating water levels with no apparent trend. *(removed from monitoring program in 2019)*
BH02-4	**B-9**	Seasonal fluctuation of about 7 m. About 8 m drawdown between 2015 and 2019. *(removed from monitoring program in 2019)*
BH02-5 (nest)	**B-10(a,b,c)**	Groundwater levels within previously recorded seasonal variation of about 2 m in the overburden, shallow Amabel bedrock and deeper Amabel / Fossil Hill bedrock.
BH02-6	**B-11**	Decline in water level of about 8 m in 2015 due to tunnel construction. Water levels have remained stable since that time.
BH03-7 (nest)	**B-12(a,b,c)**	Groundwater levels within previously recorded seasonal variation of about 2 m in the overburden, shallow Amabel bedrock and deeper Amabel / Fossil Hill bedrock.
BH03-8	**B-13**	Groundwater levels within previously recorded seasonal variation of about 3 m.
BH03-9	**B-14**	Water levels began showing larger seasonal variations in 2016. New minimum groundwater elevation reported in October 2019 due to dry conditions, however water levels have recovered to historical ranges since 2020. Changes in groundwater levels in the southwest corner of the Extension property at BH03-9 have historically been buffered by the presence of a spring located in this area. After the new minimum water elevation was set in October 2019, groundwater levels rebounded by the end of the year to within seasonal averages. The spring also provides flow to SW2.
TW4-01 TW4-02 TW4-03	**B-15 B-16 B-17**	Wells are in close proximity to each other and show redundant information. Similar to BH03-9, water levels began showing larger seasonal variations in 2016 with historic lows observed in October 2019 due to dry conditions but have recovered to historical ranges since 2021.
BH08-1 BH08-2 BH08-3	**B-18 B-19 B-20**	Wells are in close proximity to each other and show redundant information. Historic lows observed in late fall 2022, inferred to be the result of lower than normal precipitation. However, these wells are noted to be in the predicted radius of influence of the Extension Quarry. Water levels in 2023 appear to have marginally rebounded. Monitoring of emerging trends will be continued.
NW1	**B-21**	Groundwater levels declined after July 2016, now stable at about 502 masl, the approximate elevation of the Extension Quarry floor.
NW2	**B-22**	Monitoring ceased in June 2018 due to extraction progression.
NW3	**B-23**	Groundwater levels have been consistent and display seasonal variation of about 5 m. *(removed from monitoring program in 2022)*

Monitoring Well	Figure	Discussion
NW4	**B-24**	Groundwater levels have shown an overall decline since 2016. *(removed from monitoring program in 2019)*
NW5	**B-25**	Groundwater levels show drawdown of about 8 m since 2016. *(removed from monitoring program in late 2023)*
NW6	**B-26**	Groundwater levels show drawdown of about 5 m since 2016.
NW7	**B-27**	The groundwater levels have been variable. The cause of this is undetermined but may be related to monitor construction / location. Overall drawdown of about 2 m since 2016.
NW8	**B-28**	Groundwater levels have been consistent and display seasonal variation of about 2 m.
NW9	**B-29**	Groundwater levels have been consistent and display seasonal variation of about 2 m. Similar to BH03-9 and TW04-1 to TW04-3, minimum water levels were observed in 2019 but the water levels appear to have recovered to the historical range since that time.
NW10 (nest)	**B-30**	Overburden groundwater levels remain stable with about 1 m seasonal variation. Shallow and deep bedrock monitoring well groundwater levels have been consistent and display seasonal variation of about 2 m.

Extension Quarry Injection Wells

Table 4.3: Long-Term Water Level Trends at Extension Quarry Injection Wells

Injection Well	Figure	Discussion
IW1 / IW1a	**B-31**	Groundwater levels displaying seasonal variations. Approximately 10 m difference between peak and low water levels.
IW2	**B-32**	Groundwater levels displaying seasonal variation of about 4 m. Historic low observed in late fall 2022, inferred to be the result of lower than normal precipitation. However, these wells are noted to be in the predicted radius of influence of the Extension Quarry. Water levels in 2023 appear to have rebounded. Monitoring of emerging trends will be continued.
IW3	**B-33**	Groundwater levels displaying seasonal variations. About 9 m difference between peak and low groundwater levels.
IW4	**B-34**	Groundwater levels show fluctuations related to seasonal climate variations of about 4 m.

Domestic Wells

Residential water supplies in the area can be grouped into those located above the Niagara Escarpment, and those located below the brow of the Escarpment. Above the Escarpment, potable water supplies are typically obtained by means of drilled wells that are developed in the Amabel Aquifer. Below the brow of the Niagara Escarpment, drilled water supplies can be more difficult to develop due to the nature of the Queenston and the Georgian Bay Formations.

Review of the hydrographs for the domestic wells indicates that groundwater levels have generally remained within the historical range with no apparent influence from ongoing quarry extraction.

Table 4.4: Long-Term Water Level Trends at Domestic Wells

Domestic Well	Figure	Discussion
RW1	**B-35**	Groundwater levels have fluctuated within a 6 m seasonal variation. In the late fall of 2022, a new low water level, marginally below the historic range, was observed. Water levels in 2023 appear to have rebounded. Monitoring of emerging trends will be continued.
RW2	**B-36**	Access not initially granted by new homeowners in 2018 but access restored in 2019. The 2019 to 2022 water levels were observed to vary over a wider range compared to pre-2018 data. The 2023 logger data range is similar to the historical logger data range from 2009 to 2017.
RW3	**B-37**	Groundwater levels within previously recorded seasonal variation of about 4 m.
RW4	**B-38**	Seasonal variation of about 3 m. *(removed from monitoring program in 2019 at well owner's request)*
RW5	**B-39**	Groundwater levels have fluctuated within previously recorded seasonal variation of about 2 m. Groundwater level spikes were observed in 2020 and 2021but are likely anomalous. A historic low water level was observed in late 2022 but appears to be anomalous. Going forward, the logger data will be used to assess trends at this well. It is noted that RW5 is below the escarpment and baseline water levels (~460 masl) are substantially below the quarry sump elevation (~500 masl) and as such, quarry impacts at this well are not anticipated.
RW6	**B-40**	Groundwater levels within seasonal variation of about 2 m. *(removed from monitoring program in 2022 at well owner's request)*
RW7	**B-41**	Groundwater levels within previously recorded seasonal variation of about 2 m. New minimum groundwater levels reported in August and September 2020, but levels returned to historic range since that time.
RW8	**B-42**	RW8 is located on a local topographical high north of the Main and Extension quarries and outside of their influence. Groundwater levels within previously recorded seasonal variation of about 3 m.
RW9	**B-43**	*(removed from monitoring program in 2014, within Osprey Quarry licence boundary)*
RW12	**B-44**	Seasonal variation of about 2 m.
RW13	**B-45**	Seasonal variation of about 2 m.
RW16 (owned by WAI)	**B-46**	Groundwater levels within seasonal variation of about 5 m, with the exception of the late fall 2022 where a historical low was observed. Seasonal low water levels in 2023 appear to have rebounded by about 1 m. Monitoring of emerging trends will be continued.
RW17	**B-47**	Groundwater levels within previously recorded seasonal variation of about 2 m.
RW18 (owned by WAI)	**B-48**	Historical seasonal variation of about 2 m. Decrease in water level of about 2 m in 2021. *(removed from monitoring program in 2022 as it is within Phase 2A)*
RW19 (owned by WAI)	**B-49**	Decrease in water level of about 4 m between 2015 and 2020. *(removed from monitoring program in 2020 as it is within Phase 2A)*

Carmarthen Lake Farms has several domestic wells that are used for livestock watering and for the various residences that are present on the property.

CLF2 is located close to the southern property boundary of the Main Quarry and is approximately 700 m from the southern limit of the extraction face. The water levels at CLF2 have historically shown influences from aggregate extraction. However, since the Storage Reservoir has been used consistently, the groundwater levels at CLF2 have remained relatively stable, showing seasonal fluctuations but no apparent influences from aggregate extraction. Monitoring of CLF2 ceased in 2020 as the well casing has reportedly failed. As noted previously, the well casing at CLF1 also failed and monitoring was discontinued in 2013. Adequate water level monitoring data is provided by the remaining wells CLF3, CLF4 and CLF5.

Table 4.5: Long-Term Water Level Trends at Carmarthen Lake Farm Domestic Wells

Domestic Well	Figure	Discussion
CLF3	**B-52**	Groundwater levels within previously recorded seasonal variation of about 2 m.
CLF4	**B-53**	Groundwater levels within previously recorded seasonal variation of about 2 m.
CLF5	**B-54**	Groundwater levels within previously recorded seasonal variation of about 1.5 m.

Off-Site Monitoring Wells

Table 4.6 summarizes the long-term trends at the groundwater monitoring wells on the undeveloped former Osprey Quarry property.

Table 4.6: Long-Term Water Level Trends at Off-Site Monitoring Wells

Monitoring Well	Figure	Discussion
101-B	**B-55**	Groundwater levels within previously recorded seasonal variation of about 2 m.
102-C	**B-56**	Groundwater levels within previously recorded seasonal variation of about 1 m.
103-D	**B-57**	Groundwater levels within previously recorded seasonal variations. Seasonal variation has decreased from 2 m in 2003 to about 1 m since 2013.
104-A	**B-58**	Groundwater levels within previously recorded seasonal variation of about 4 m.
OW1-4	**B-59**	Groundwater levels have increased since 2005, seasonal variation of about 1 m.
OW5-2	**B-61**	Groundwater levels within previously recorded seasonal variation of about 2 m.
OW6-3	**B-62**	Groundwater levels within previously recorded seasonal variation of about 1 m.

Wetland Drivepoints

The wetland drivepoints included in the groundwater monitoring program represent the shallow groundwater table near various sensitive features in close proximity to the Site. During the winter and summer months, drivepoint water levels can become unmeasurable when the surrounding water freezes or dries up. These events are noted in **Table B-7** where they were observed during the monitoring event. Trends and observations for drivepoint monitoring stations are summarized in **Table 4.7**.

Table 4.7: Long-Term Water Level Trends at Wetland Drivepoints

Drivepoint	Figure	Discussion
DP1	**B-63**	Groundwater levels have increased by about 1 m since 2015 at this drivepoint situated in Rob Roy Swamp 6. In late 2023, replacement of the discharge pipe (running through Rob Roy Swamp 6) with a new solid pipe was initiated, with completion in February 2024. Operation of the new solid discharge pipe is expected to lower surface water levels in Rob Roy Swamp 6. Monitoring of emerging trends will be continued.
DP2	**B-64**	Water levels display a slight increasing trend since 2010-2011. Historical high water levels were observed on several occasions in 2022 but these are believed to be related to a field data transcription issue which has been corrected. The logger water level data confirms a historic high water level in March 2023. Monitoring of emerging trends will be continued.
DP3	**B-65**	Water levels have fluctuated within the historical seasonal variation of about 1.5 m.
DP4	**B-66**	Seasonal variation generally consistent prior to 2011. Since 2011, water levels during drier periods have remained above the historical range and since 2018, water levels have increased by about 0.5 m. These results suggests that the Rob Roy 6 wetland has remained saturated for longer periods of time in comparison to baseline observations. In previous reports, an incorrect measuring point elevation was inadvertently used to correct water level data to geodetic elevation since 2018. The historical geodetic elevation data has been corrected as presented in **Figure B-66**.
DP5	**B-67**	Seasonal variation within historical range of about 1.5 m.
DP6	**B-68**	Seasonal variation within historical range of about 1.5 m.
DP7	**B-69**	Seasonal variation within range of about 1 m. Elevated water levels observed in September 2021 and early 2022 are believed to be related to a field data transcription issue which has been corrected. The 2023 manual and logger water level data are consistent with pre-2021 ranges.
DP8	**B-70**	Muted seasonal variation within a narrow range of less than 0.5 m. Elevated water level in mid-2022 may be related to field data transcription issue which has been corrected. It appears that water levels at this drivepoint in Rob Roy Swamp 6 have increased by about 0.3 m since 2016. Operation of the new discharge pipe, which corrects historic leaks in the pipe, is expected to lower surface water levels in Rob Roy Swamp 6 over time. Monitoring of emerging trends will be continued.
DP9	**B-71**	Seasonal variation within a range of about 1 m. Elevated water levels observed in September 2021 and mid 2022 are believed to be related to a field data transcription issue which has been corrected. The 2023 manual and logger water level data are consistent with pre-2021 ranges.
Bridson DP	**B-72**	Seasonal variation within historical range of about 1.5 m.

The temperature of the surface water ponded at the drivepoints is recorded when possible. Surface water at these locations is often frozen in the winter months and can dry up in the summer / fall. Temperature values are presented in **Table B-8**, **Appendix B**.

4.2.3 Groundwater Configuration

The monitoring wells and domestic wells included in the monitoring program are generally constructed as open holes that extend into and sometimes through the Amabel Formation into the Fossil Hill Formation. The open hole monitors and water wells provide a generalized measure of potentiometric head through the entire rock column.

Groundwater elevations were contoured for May 2023 (spring conditions) and October 2023 (fall conditions), to illustrate the local groundwater configuration and general flow directions within the Amabel aquifer, presented as **Figures 3 and 4**. The groundwater configuration and flow pattern remain similar throughout the year.

Within the Main Quarry extraction area, Sump 1 extends below the quarry floor to approximate elevation 498 masl, such that sump water levels can be maintained at or below the quarry floor elevation of approximately 500 masl. The transient Sump 3 water levels in the Extension Quarry are maintained at about 502 masl, which promotes gravity flow to the Main Quarry sumps.

The interpreted groundwater configuration exhibits an elliptical pattern that is centred upon the areas of higher surface elevation formed by local bedrock highs near NW8 west of the Phase 1 extraction area. A groundwater divide is present in the Extension Quarry. The groundwater flow direction in the eastern portion is towards the Escarpment and generally to the Batteaux Creek sub-catchment. In the western portion, groundwater flow is to the north, generally towards the Pretty River sub-catchment, and to the west, contributing to the Beaver River sub-catchment. A southerly component of groundwater flow towards the Main Quarry property is also present from the bedrock high at NW8 to the vicinity of BH02-6. Groundwater levels at BH02-6 show influence from the construction of the tunnel in 2015 and from the subsequent aggregate extraction activities in the Extension Quarry. However, drawdown at this location is inferred to be mitigated by operation of the Storage Reservoir.

South of the Main Quarry, groundwater flow is interpreted to be radially away from areas of higher elevation towards the Carmarthen Lake Farms wetland (DP3). Further south, Edward Lake is interpreted to be a local groundwater discharge area as well as a collection area for local surface water run-off. The surface elevation is approximately 507 masl and the lake is reported to be approximately 4 m deep. There is an overflow outlet culvert at the southwest corner of the lake.

At the St. Mary's Osprey Quarry west of the Site, water level data are available through 2020. The average April and November elevations are shown on **Figures 3 and 4**. The quarry extraction appears to be influencing water levels at Osprey Quarry monitoring well nests OW1 and OW3 in close proximity to the estimated extraction limit.

4.2.4 Inferred Zone of Influence

Historically, during extraction of the Main Quarry, there has been a progressive drawdown influence of 12 m to 20 m on the local water table. As the size of the extraction area increased, the zone of influence of the quarry on the local groundwater system increased as well. The magnitude and lateral extent of the drawdown zone of influence is somewhat variable around the Site due to the inferred variable hydraulic conductivity of the bedrock.

In order to estimate the magnitude and lateral extent of the zone of influence and the distance drawdown effects of the Extension Quarry on the local groundwater system, long-term trends in groundwater level data obtained from the monitoring network wells have been evaluated.

Figure 5 provides a summary of the drawdown observed at individual monitoring well and domestic well locations. Only wells where drawdown is observed are labelled on the figure. Similar to the Main Quarry, there has also been a progressive drawdown influence from dewatering of the Extension Quarry. To date, drawdown is inferred to have occurred at NW1 and BH02-6 generally south of Phase 1, NW6 and NW7 west / northwest of Phase 1 and BH02-2 north of Phase 1 / Phase 2A. It is noted that the majority of the observed drawdown to date has occurred within the Extension Quarry limit of extraction. In 2022, historical low water elevations were observed east of the Extension Quarry Phase 2A at RW16, BH08-1, BH08-2, BH08-3 and IW2. These low water levels coincided and are attributed to lower than normal precipitation during the late fall of 2022. Seasonal low water levels in 2023 appear to have rebounded by about 1 m. These wells are within the predicted zone of influence and therefore a quarry influence is not unexpected. Monitoring of emerging trends will be continued in 2024. It is noted that excavation in Phase 2A closest to these wells is complete and as such, future drawdown within these wells from an expanding quarry footprint is not anticipated.

In 2021, the 5-year Comprehensive AMP Report was completed for the Site, which included an update / re-calibration of the numerical groundwater models, and revised predictions for the drawdown influence for Phase 2A and 2B. The predicted limit of drawdown during Phase 2A extraction is shown on **Figure 5**. As expected, quarry dewatering impacts have been limited to the monitoring wells within the predicted limit.

Domestic well CLF2, located approximately 700 m southwest of the Main Quarry, has historically shown drawdown effects from excavation of the Main Quarry. Since 2010 however, it appears that the operation of the Storage Reservoir is providing a hydraulic buffer; stabilizing the influence of quarry dewatering on local groundwater levels in the area to the west and southwest of the Main Quarry.

4.3 Surface Water

4.3.1 Stream Flow and Temperature

A summary of the stream flow monitoring results is presented in **Table 4.8**.

Table 4.8: Stream Flow and Temperature Long-Term Trend Observations

Station	Figure	Discussion
Beaver River Tributary System		
SW1	**C-1**	Surface water flows and temperature fluctuating within seasonal ranges. Historic high flow observed in April 2020 but flows have returned to historic range since that time.
SW2	**C-2**	Surface water flows and temperature fluctuating within seasonal ranges.
SW0-2	**C-3**	Surface water flows and temperature fluctuating within seasonal ranges. Historic high flow observed in March 2023.
QFSW2	**C-4**	Surface water flows and temperature fluctuating seasonally. Decreasing trend in flows between 2012 and 2021 but stable since that time. Historic low flow observed in February 2023.
SW3	**C-5**	Surface water flows and temperature fluctuating within seasonal ranges.
SW4	**C-7**	Surface water flows and temperature fluctuating within seasonal ranges.
SW6A	**C-10**	Surface water flows and temperature fluctuating within seasonal ranges. High flow measured in April 2023 similar to previous highs observed in April 2005 and February 2018.
Batteaux Creek Tributary System		
SW8	**C-12**	Minimal flow typically observed at this station.
SW9	**C-13**	Surface water flows and temperature fluctuating within seasonal ranges.
SW13	**C-23**	Surface water flows and temperature fluctuating within seasonal ranges.
SW14	**C-24**	Surface water flows and temperature fluctuating within seasonal ranges.

Station	Figure	Discussion
SW15	**C-25**	Surface water flows and temperature fluctuating within seasonal ranges. It is noted that in 2021, the culvert at this station was replaced as part of Concession 10 road re-construction. The new culvert invert appears to be at a higher elevation than the previous culvert from which the flow trigger values were developed.
SW19	**C-31**	Surface water flows and temperature fluctuating within seasonal ranges.
SW21	**C-33**	Minimal flow typically observed at this station.
SW21A	**C-34**	Surface water flows and temperature fluctuating within seasonal ranges.
SW21B	**C-35**	Surface water flows and temperature fluctuating within seasonal ranges. Historic high flow observed in March 2021 likely anomalous.
SW22	**C-38**	Surface water flows and temperature fluctuating within seasonal ranges.
SW22A	**C-39**	Surface water flows and temperature fluctuating within seasonal ranges. Historic high flow in June 2020 likely anomalous.
SW22C	**C-40**	Surface water flows and temperature fluctuating within seasonal ranges.
BC Control	**C-49**	Surface water flows and temperature fluctuating within seasonal ranges.
Pretty River Tributary System		
SW16	**C-26**	Surface water flows and temperature fluctuating within seasonal ranges. Historic high temperature observed in June 2023 is not consistent with logger data and appears to be anomalous.
SW17	**C-27**	Surface water flows and temperature fluctuating within seasonal ranges. Temperature maximum observed in late August 2021 likely associated with high ambient air temperatures / very low flow conditions in the watercourse.
SW17A	**C-28**	Surface water flows and temperature fluctuating within seasonal ranges. Historic high temperature observed in August 2020 appears to be anomalous.
SW18	**C-30**	Surface water flows and temperature fluctuating within seasonal ranges. Accessibility limited in 2021 due to Concession 10 re-construction.
SW20	**C-32**	Surface water flows and temperature fluctuating within seasonal ranges.
PR Control	**C-48**	Surface water flows and temperature fluctuating within seasonal ranges.

4.3.2 Escarpment Springs

A summary of the stream flow monitoring results is presented in **Table 4.9**.

Table 4.9: Escarpment Spring Flow and Temperature Long-Term Trend Observations

Station	Figure	Discussion
SW10	**C-14**	Surface water flows and temperature fluctuating within seasonal ranges.
SW11	**C-15**	Surface water flows and temperature fluctuating within seasonal ranges.
SW11A	**C-16**	Surface water flows and temperature fluctuating within seasonal ranges.
SW11B	**C-17**	Surface water flows and temperature fluctuating within seasonal ranges.

Station	Figure	Discussion
SW11C	**C-18**	Surface water flows and temperature fluctuating within seasonal ranges.
SW11D	**C-19**	Surface water flows and temperature fluctuating within seasonal ranges.
SW11E	**C-20**	Surface water flows and temperature fluctuating within seasonal ranges.
SW21C	**C-36**	Surface water flows and temperature fluctuating within seasonal ranges. Elevated temperatures observed in August 2021 and June 2023 likely associated with high ambient air temperatures / very low flow conditions in the watercourse.
SW24A	**C-42**	Surface water flows and temperature fluctuating within seasonal ranges. Landowner significantly altered this tributary in 2021.
SW77	**C-45**	Surface water flows and temperature fluctuating within seasonal ranges. Higher than normal seasonal flows observed between late 2020 to early 2022.

4.3.3 Surface Water Quality

The annual water quality sampling event was completed for selected surface water monitoring stations on May 15-15, 2023. Field chemistry parameters (temperature, pH, conductivity and dissolved oxygen) were recorded at the time of sampling and observations on the flow volume and appearance of the surface water station were noted. The 2023 laboratory results are included in **Table C-4**.

Duplicate samples were obtained at stations SW17 and BC Control. The results of the 2023 surface water duplicate analysis are provided on **Table C-6**. The relative percent difference (RPD) was calculated for the duplicate results and was within 20% for all of the parameters at SW17 and BC Control. Therefore, the 2023 surface water quality results are considered to be representative of conditions in the field at the time of sampling.

Surface water quality analytical results are compared to the Provincial Water Quality Objectives (PWQO) (MECP, July 1994 and updates). The water quality samples obtained in 2023 generally met the PWQO with the exception of the following:

- Total phosphorus concentrations at SW0-2, and SW16.
- Aluminum concentrations at SW11E, SW16, SW17, SW18 and BC Control.
- Cobalt, copper and iron concentrations at SW16.
- The zinc concentration at SW15.

The 2023 PWQO exceedances in the surface water samples are generally consistent with historic results.

4.4 Quarry Discharge

Water accumulating on the quarry floor originates from the following three (3) identified sources:

- **Direct precipitation and surface runoff.** Based on the existing surface topography around the perimeter of the Site, it has been estimated that approximately 80%, or 46 ha, of the licensed property area contributes surface water runoff into the quarry, with the remainder flowing west into Rob Roy Swamp 6, east to the Batteaux Creek system and south to the Carmarthen Lake Farms wetland (closed karst basin). The amount of surface water runoff that accumulates on the quarry floor varies seasonally, being highest in the spring and late fall, with lesser amounts through the winter and summer seasons.

- **A portion of the excess water that is pumped off site and discharged to Rob Roy Swamp 6 is recirculated back into the quarry through the west and southwest extraction faces.** Depending on the water level in the Storage Reservoir, the volume of discharge water that recirculates back into the quarry from the wetland is currently inferred to be lower as compared to pre-reservoir conditions.
- **Groundwater discharge to the quarry excavation area from the surrounding bedrock.** Historical inspection of the quarry walls found that the majority of accumulating water was entering the quarry through the exposed rock faces on the west / southwest face of the Main Quarry. This component of total accumulation has been somewhat mitigated with the construction of the Storage Reservoir. There is also a component of groundwater seepage along the remaining walls of the quarry and towards Sump 1 through the rock beneath the quarry floor. The construction of the tunnel in the north wall of the Main Quarry in late 2015 has facilitated dewatering of the Extension Quarry. Historical studies indicate that between 10 L/s to 20 L/s of groundwater discharge flows into the quarry excavation, fluctuating seasonally with the highest inflows occurring during the spring and late fall.

The volume and timing of dewatering and associated off-site discharge pumping correlates to the seasonal influx of precipitation and runoff. As noted previously, process water from Sump 1 is used for aggregate washing activities on the quarry floor in a closed-loop type system.

The main discharge pump within Sump 1 (i.e., pump DN1) is operated by a float switch that can be raised or lowered depending on the desired water level in the sump. The discharge of pump DN1 is controlled with a manual valve which regulates the volume of discharge that is released to the Storage Reservoir or to Rob Roy Swamp 6. During the winter season (usually mid-December to early April); the pump normally operates on a daily basis to prevent the dewatering system from freezing.

4.4.1 Daily Discharge Volumes

During the current reporting period, DN1 was the only pump used to facilitate off-Site quarry dewatering / water management operations. Pumps DN2 and DN3a were used intermittently in 2023 to control water on the quarry floor.

As of January 2017, in compliance with the amended PTTW, the quarry discharge volume has been measured using a flow meter installed on the discharge line, where a quarry discharge limit of 250 L/s is applied. The flow meter records for the total volumeof quarry discharge in 1,000 L increments. Average daily flow rates were calculated based on the recorded flow volumes at the flow meter. The daily quarry discharge rates and volumes for 2023 are provided in **Table E-1**, **Appendix E**. The average daily rate of discharge is provided in L/s on **Figure E-1**. The daily discharge rates were within the maximum permitted discharge rate during 2023.

4.4.2 Discharge Quality

Monthly discharge water quality samples were obtained in 2023 to satisfy the conditions of the ECA (Sewage), presented in **Table E-3**, **Appendix E**. A summary of ECA (Sewage) Effluent Limit compliance is provided on **Table E-2**. Further discussion is provided in **Section 6.0**.

Quarterly discharge water quality samples were also obtained from the Sump 1 and Sump 2 discharge lines and station QFSW2 in the Main Quarry on February 23, May 17, August 30 and October 31, 2023. The laboratory results for the quarterly water quality sampling are included in **Table C-4**, **Appendix C**.

Duplicate samples were obtained at station QFSW2 during the February and October quarterly events, and at station Sump 2 during the May and August quarterly events. The RPD was calculated for the duplicate results taken during each monitoring event. The results of the 2023 surface water duplicate analysis are provided on **Table C-6**. The RPD was within 20% for the May, August and October events. During the February event, concentrations of hardness, most major ions, nitrate, and some metals exceeded the acceptable RPD. It is suspected that the elevated TSS in the original sample compared to the duplicate sample is the cause of the RPD exceedances. Both the original and duplicate results for these parameters were within the historic range of concentrations at their respective sampling locations. Therefore, the 2023 quarterly discharge quality results are considered to be representative of conditions in the field at the time of sampling.

As shown in **Table C-4**, the 2023 quarterly discharge water quality samples generally met the PWQO. The exceptions were the concentrations of iron at Sump 1 in July and total phosphorus, aluminum, cobalt, copper, iron, lead and zinc at QFSW2 in August.

As shown in **Table C-5**, bacteriological results for the 2023 quarterly discharge samples indicate that total coliforms and E.coli were generally detected in both dewatering sumps throughout the year. The presence of bacteriological parameters in the sumps is not unexpected, since they exist as natural surface water ponds in the quarry floor, subject to surface water runoff and use as temporary waypoints for waterfowl.

The quarterly discharge quality results have hardness concentrations ranging from 270 - 420 mg/L, which is not unexpected since a portion of the water collected in the sumps is from groundwater influx to the quarry.

4.5 Quarry Impact Assessment

The Site has been in operation since the 1960s. The Main Quarry has been extracted to its licenced final floor elevation of 500 masl. The sinking cut to facilitate the tunnel construction was made in October 2015. Aggregate extraction activities at the Extension Quarry began in June 2016 and have proceeded into the Phase 1 and a portion of the Phase 2A limit of extraction.

The Site is licenced to extract aggregate below the water table which results in the accumulation of water on the working floor of the quarry. The extraction of the rock and the associated dewatering system influences surface water runoff and groundwater conditions on-site, as well as local groundwater patterns around the quarry property. Groundwater elevations in the bedrock aquifer have been drawn down around the perimeter of the extraction area. The magnitude of the drawdown decreases with increasing distance away from the quarry and is variable around the quarry.

The historical and recent groundwater level data obtained from on-site monitoring wells and local domestic wells have been evaluated in order to estimate the magnitude and lateral extent of the zone of influence. As reported, groundwater levels at some of the wells near the Extension Quarry display evidence of drawdown related to the quarry dewatering. However, to date, drawdown has primarily been observed within the licenced area.

The Rob Roy Swamp 6 west of the Main Quarry is a Provincially Significant Wetland (PSW) complex. This PSW feature was evaluated by Stantec Inc. as part of the Extension Quarry licensing. Stantec's report, entitled: *Duntroon License Expansion – Level 2 Natural Environment Technical Report* (dated October 7, 2005), states, in part, the following with respect to baseline conditions in Rob Roy Swamp 6:

> *"The ground surface elevation in the wetland is approximately 512 to 513 m asl, which is 12-13 m above the floor of the existing quarry. The water table in the surficial soils varies seasonally from*

being at or above ground surface in the spring and late fall, to in excess of 1 m below ground in the summer. Prior to extraction, the groundwater level in the wetland would have fluctuated on a seasonal basis. Changes to the species composition of the wetland may have occurred over time as a result of the existing operation; however, the unit continues to exhibit the characteristics of a resilient and functional wetland, with hydric soils and swamp and scattered marsh communities."

Stantec (2005) also assessed conditions in the Carmarthen Lake Farms wetland feature located south of the Main Quarry and concluded that similar conditions exist within that wetland. Based on the monitoring to date, water levels in the RR6 wetland have marginally increased compared to pre-expansion levels. Water levels in the RR6 wetland may be influenced by any restrictions of the twin culverts under Grey Road 31 (Osprey Clearview Townline) where the wetland outlets to the downstream portions of Beaver River. As noted previously, replacement of the discharge pipe (running through RR6 wetland) was initiated in late 2023 and was completed in February 2024. Operation of the new discharge pipe could be expected to lower surface water levels in RR6 wetland over time as leaks in the pipes have now been eliminated.

5.0 PTTW COMPLIANCE SUMMARY

The compliance monitoring program and reporting requirements are outlined in Condition 3 and Condition 4 of PTTW No. 7725-AACS54. Refer to **Appendix A-1** for a copy of the PTTW. PTTW compliance is summarized in the following sections.

5.1 Condition 4.1 – Daily Discharge Monitoring

As noted previously, average daily flow rates were calculated based on discharge volumes monitored by the flow meter on the discharge pipe from Sump 1. Daily flow volumes are summarized in **Table E-1**, **Appendix E**. The daily discharge rates were within the maximum permitted discharge rate during 2023.

5.2 Condition 5.2 – Well Interference

In September 2023, WAI received a well interference complaint from the resident at address 1152 Concession 10 North Nottawasaga. This resident has a cistern which utilizes the SW21C escarpment spring flow as the supply and noted that spring flows appeared to be low. Notification to the MECP was provided on September 25, 2023. A well interference investigation was completed, and it was determined that the issues with the resident's cistern are not related to the quarry operations. Therefore, no further mitigation measures were implemented.

The well interference investigation and mitigation program is a WAI document from the company's Environmental Operating Procedures (Title: 4.8 – Water Well Interference Complaint Response Procedures).

The groundwater monitoring locations to be monitored monthly include:

- 98-8
- 98-9
- 98-12
- MW6
- PW99-1
- CLF2 *
- BH02-1 *
- BH02-2
- BH02-3 *
- BH02-4 *
- BH02-5
- BH02-6
- BH03-7-I
- BH03-7-II
- BH03-8
- BH03-9
- BH08-1
- BH08-2
- BH08-3
- RW1
- RW2
- RW16 (owned by WAI)
- RW18 (owned by WAI) *
- RW19 (owned by WAI) *

* Monitoring of CLF2 was discontinued as the casing failed in 2020. Adequate water level monitoring data are obtained at the remaining wells CLF3, CLF4 and CLF5. Historic monitoring wells BH02-1, BH02-3, BH02-4 and domestic wells RW18 and RW19 have been removed from the monitoring program as they are situated within the limit of extraction.

The groundwater monitoring was completed successfully in 2023 as shown in **Tables B-1, B-2 and B-4** and the hydrographs in **Appendix B**. As noted previously, all monitoring well locations were equipped with automated loggers in late 2022 and were downloaded in May and October 2023.

5.3 Condition 5.3 – Surface Water and Drivepoint Monitoring

From Table 3.4 in the AMP, the following monitoring program is required:

Table 5.1: PTTW Surface Water Monitoring Program

Monitoring Station	Monitoring Type	Monitoring Frequency
SW1, SW2 and SW0-2	Datalogger	Hourly water temperature and water level
	Streamflow measurement	Quarterly[2]
	Temperature, pH, Dissolved Oxygen and Conductivity	Monthly
	Laboratory analysis[3]	Annually
SW4[1]	Streamflow measurement	Quarterly
	Temperature, pH, Dissolved Oxygen and Conductivity	Monthly
DP2 and DP4	Groundwater level, ponded depth and water temperature	Bi-weekly May, June & July

NOTES:

[1] SW4 is not included in Table 3.4 of the AMP. Monitoring type and frequency was interpreted to be similar to the other surface water stations identified in Table 3.4 by the MECP, without the requirement for laboratory analysis.

[2] WAI obtains streamflow measurements on a monthly basis when the field chemistry is being obtained since the field technician is already at each location.

[3] Laboratory analysis includes the following parameters: General chemistry (alkalinity, hardness, colour, and ammonia), total suspended solids, major ions, metals, nutrients, total petroleum hydrocarbons and BTEX compounds.

Surface Water Monitoring

Flows at stations SW1, SW2, SW0-2 and SW4 were measured monthly in 2023 to meet the requirements of the PTTW monitoring program as shown in **Tables C-1 and C-2**. Monthly field measurements are provided in **Table C-3** and annual water quality analysis results are provided in **Table C-4**. It is noted that field chemistry and flows could not be measured during the winter months at some locations due to frozen conditions.

The flow upstream of Rob Roy Swamp 6 is measured at station SW2, where the water enters the northwest corner of the wetland through a culvert beneath Simcoe County Road 91. Surface water at this location includes the natural flow from a bedrock spring located near BH03-9, as well as surface runoff from the field and bush area to the east and from a short section of roadside ditch. The SW2 hydrograph (**Figure C-2**) illustrates that surface flows exhibit wide seasonal variations. Since monitoring began at this location in 1996, observed flow rates at SW2 have generally consisted of highs in the spring of between approximately 35 L/s to greater than 100 L/s, and summer and autumn low flows that typically range from less than 1 L/s up to about 5 L/s.

The observed flows at SW2 reflect prevailing climatic conditions, including periods of rain and the spring thaw, moderated by base flow provided by the groundwater spring, as summarized below:

- Annual High Flows (typically up to 40 L/s or greater)
- Spring Freshet Flows 5-18 L/s
- Summer Months Base Flow <1 to 4 L/s
- Fall Flow 0.7 to 1.5 L/s

Following the spring freshet, spring flows at SW2 generally range between about 5 L/s and 18 L/s. During the summer months (July, August & September), measured flow rates at SW2 typically represent base flow conditions associated with the rate of discharge from the nearby groundwater spring. During the baseline monitoring period, average summer base flow rates measured at SW2 have been found to range from less than 1 L/s up to about 4 L/s. During the fall months (October, November & December), flows have average rates ranging between 0.7 L/s and 1.5 L/s during drier-than-normal years. In comparison, average fall flows of between 3.5 L/s and 18.5 L/s have been observed in wetter years, where the amount of precipitation received is either at or above normal values. The average summer flow at SW2 in 2023 was 5.2 L/s and the average fall flow was 3.7 L/s.

The measured flow at SW1 is a combination of flow entering the wetland from SW2, the incident precipitation or runoff into the wetland, and the quarry discharge. The measured flow at SW1 is presented on **Figure C-1**.

It was previously estimated that approximately half of the water that was discharged into the wetland from the quarry infiltrated into the ground and recycled back into the quarry extraction area. To address this issue, the Storage Reservoir was constructed along the western wall of the Main Quarry. The Storage Reservoir serves the dual purpose of providing temporary storage of excess water as well as providing a hydraulic barrier against the western limit of the Main Quarry, to reduce the amount of water that recycles back into the quarry from the wetland.

During periods of discharge from the quarry into the adjacent wetland at SW1, the contribution to flow from SW2 at the culverts is obscured. In contrast, during periods of no quarry discharge, the flow from SW2 typically infiltrates into the ground prior to reaching SW1, with the subsurface water either flowing back into the quarry or west beneath Grey County Road 31.

The water that leaves the wetland at SW1 provides flow to the headwaters of the south tributary of the Beaver River that eventually flows through the undeveloped former Osprey Quarry property. The flow is measured on the former Osprey Quarry property at SW0-2. Measured flows at SW0-2 are presented on **Figure C-3**. Downstream of this station, water flows through additional wetland areas where it merges with other surface water courses that originate to the north and continues onward through the rest of the Rob Roy PSW complex.

Surface water station SW4 is located in the Beaver River sub-catchment upstream of the outlet of SW1 and SW0-2. Surface water station SW4 has been monitored since 2005 and typically flows only during the spring freshet or other high flow conditions (winter snow melt or rainstorms resulting in a high volume of runoff). The measured flows at SW4 are presented on **Figure C-7**.

Drivepoint Monitoring

Water levels and temperatures at drivepoints DP2 and DP4 were continuously monitored with loggers in 2023 to meet the requirements of the PTTW monitoring program, with bi-weekly and monthly manual measurements during the trigger period as shown in **Tables B-7 and B-8**. The automated data loggers were downloaded during each trigger monitoring event with the final download occurring in October.

Drivepoint DP2 is located in the Rob Roy Swamp 6 wetland where the quarry discharges. DP2 has been monitored monthly since the fall of 1999, when accessible, as shown in **Figure B-64**. Water levels at DP2 have shown a slight increasing trend between 2011 and 2019 and have been relatively stable since that time. As noted previously, elevated water levels observed in 2022 are believed to be anomalous as a result of a field transcription issue which has been corrected. The logger water level data confirms a historic high water level in March 2023.

DP4 is located west of station SW1, immediately downstream of the twin culverts that pass under Grey County Road 31. The quarry discharge also provides a buffer to water levels at DP4. Water levels at DP4 have been monitored monthly since the fall of 1999, when accessible, as shown in **Figure B-66**. Since 2011, water levels during drier periods have remained above the historical range and since 2018, water levels have generally increased by about 0.5 m. These results suggests that the Rob Roy 6 wetland has remained saturated for longer periods of time in comparison to baseline observations.

The temperature of the surface water ponded at the drivepoints is recorded when possible. Surface water at these locations is often frozen in the winter months and can dry up in the summer / fall. Temperature values for 2023 are presented in **Table B-8**. Seasonal variation in surface water temperature was observed, ranging from frozen conditions to high temperatures of 23.0ºC in July at DP2 and 22.4ºC in July at DP4.

6.0 ECA COMPLIANCE SUMMARY

The Effluent Limits, monitoring program and reporting requirements are outlined in Conditions 3, 4, 5, 6 and 7 of ECA (Sewage) No. 1521-A4VJ4X. Refer to **Appendix A-1** for a copy of the ECA. ECA compliance is summarized in the following sections.

6.1 Condition 3(2) – Maximum Discharge Rate

A flow meter combined with a back-up pump run time logger located at the quarry discharge, provide a daily offsite discharge rate. The average daily flow rate was calculated based on the measured discharge volumes recorded by the flow meter. The recorded rate was below the maximum permitted 250 L/s limit during the 2023 reporting period as shown in **Table E-1**.

6.2 Condition 4(1) – Effluent Limits

The discharge Effluent Limits are provided in Table 1 of the ECA, as reproduced below.

Table 6.1: ECA (Sewage) Effluent Limits

Effluent Parameter	Concentration Limit
pH	6.0 to 9.5 inclusive, at all times
Oil and Grease	15 mg/L
Total Suspended Solids (TSS)	25 mg/L

Table E-2 provides a summary of the monthly effluent water quality data for comparison to the Effluent Limits noted above. The 2023 monthly discharge quality generally complied with the ECA (Sewage) Effluent Limits. The exceptions were the April 24 field pH value and the July 26 TSS concentration. For the April pH Effluent Limit exceedance, a follow-up field pH measurement was completed on May 2 and the April pH exceedance was not confirmed. A follow-up confirmation sample was not obtained for the July TSS Effluent Limit exceedance; however, the TSS concentration in the August 30 sample was below the Effluent Limit; therefore, the TSS Effluent Limit exceedance was not confirmed, and the Works complied with the Effluent Limits in 2023.

6.3 Condition 5 – Effluent Visual Observations

Visual observations were made during each of the 2023 monthly monitoring events. Water discharging was clear, clean and free of floating or settleable solids during each monitoring event.

6.4 Condition 6 – Effluent Quality Monitoring

The discharge monthly effluent monitoring requirements are provided in Table 2 of the ECA, as reproduced below.

Table 6.2: ECA (Sewage) Effluent Monitoring

Sampling Location	The outlet channel discharge point to the wetland.[1]
Sampling Frequency	Once each month during periods of effluent discharge.
Sampling Type	Grab

Sampling Parameters	Total Suspended Solids, Oil and Grease, Nitrite Nitrogen, Nitrate Nitrogen, Total Ammonia Nitrogen, pH (field), Temperature (field), Total Phosphorus, Conductivity (field), Chloride, Sulphate, Sodium, Potassium, Boron, Cadmium, Total Chromium, Cobalt, Copper, Iron, Lead, Nickel, Silicon, Silver, Zinc, Alkalinity, Total Dissolved Solids, Phenols (4AAP), Hardness and Turbidity

NOTES:

[1] Correspondence with the MECP indicated that a grab sample could be obtained using a tap on the discharge line to ensure the health and safety of staff completing the effluent monitoring.

Discharge samples were obtained from the sampling port located downstream of the flow meter on the 300 mm discharge pipe. The monthly sampling results are presented in **Table E-2**. The concentrations of un-ionized ammonia were calculated as per ECA (Sewage) Condition(6)(5).

The PWQO for each parameter is also shown in **Table E-2** for comparison, as required by Condition 7(3)(a) of the ECA (Sewage). In summary, the 2023 monthly discharge water quality generally met the PWQO for the respective parameters. The exceptions were the field pH values in March and April, and the iron concentration in July.

The following observations were made based on the 2023 monthly discharge quality results:

- pH levels ranged between 5.9 and 8.8 (field measurements).
- Total oil and grease was reported at a detectable limit in three out of twelve grab samples. The highest concentration of total oil and grease reported during 2023 was 1.2 mg/L in October. The ECA (Sewage) Effluent Limit for total oil and grease is 15 mg/L.
- Total suspended solids (TSS) was typically reported as less than 10 mg/L in 2023, with the exception of April 24 (21 mg/L), July 26 (48 mg/L), August 30 (12 mg/L) and December 18 (12 mg/L). The ECA (Sewage) Effluent Limit for TSS is 25 mg/L. The August 30 sample complied with the ECA (Sewage) Effluent Limit for TSS.
- The additional parameters included in the monthly analysis show some minor variation in concentrations over the 2023 monitoring year, likely attributable to seasonal fluctuations in the ratio of groundwater to surface water in the discharge (i.e., more surface water and snow melt in the spring and a higher content of groundwater in the late summer). Metals concentrations are typically not detected above the laboratory reported detection limit (RDL).

The 2023 monthly effluent quality results indicate quarry discharge is not expected to adversely impact the receiving watercourse with respect to water quality.

6.5 Condition 7(3) – Other Reporting

Overall, the results of the ECA (Sewage) compliance monitoring demonstrate that the Works was operated successfully in 2023 and is adequate to meet the Effluent Limits.

Quality Assurance / Quality Control (QA / QC)

The following effluent QA / QC measures were undertaken during the 2023 reporting period.

- QA / QC procedures are in place for the sampling of effluent quality for laboratory analysis, including sampling protocols as outlined in the ECA (Sewage).

- Blind duplicate samples were obtained during the quarterly and annual sampling to verify the integrity of the samples and accuracy of laboratory results.
- Sample containers are consistently labelled with a sample ID indicating the location of the sample ("sump" or "quarry discharge") and a date, time, project name and project number.
- The location where the effluent is sampled is characteristic of the quality and the quantity of the effluent stream. In 2023 the effluent was sampled from the discharge pipe during a period of water discharge off-site (the pipe is otherwise empty).
- Field parameters and observations are recorded electronically during the sampling event. Factors such as air temperature, weather and the appearance of the effluent are noted.

Calibration and Maintenance

Equipment calibration records are maintained by WAI for each in-service water pump and for the discharge pipe flow meter. Maintenance of the Works equipment is performed as required. It is noted that the flow meter was upgraded in early 2023.

7.0 AMP COMPLIANCE SUMMARY

7.1 Monitoring Requirements

The AMP is a requirement of the Extension Quarry ARA Licence and was finalized on December 6, 2013 (Stantec and Hims GeoEnvironmental Inc.). The AMP provides an in-depth review of the monitoring planned during each operational phase until final rehabilitation of the site.

The monitoring components, as required by the AMP, consist of the following categories:

- **Performance Indicator Trigger Monitoring (PITM):** Comparison of annual surface water flow and temperature monitoring data and wetland water levels to historical values / performance triggers to ensure extraction activities are not having an adverse impact on these features.
- **Long-Term Groundwater and Surface Water Monitoring Program (LTTWM):** Review of groundwater and surface water monitoring results to confirm that the data match forecasted trends.
- **Long-Term Trend Ecological Monitoring (LTTEM):** Comparison of annual monitoring data for surrounding ecological features to historic observations to confirm that the extraction activities are not causing unacceptable impacts to plants or to wildlife.
- **Ecological Enhancement and Mitigation Monitoring (EEMM):** Confirmation that ecological enhancements and mitigation measures at the Site will result in an improved ecological condition upon rehabilitation.

7.2 Performance Indicator Trigger Monitoring (PITM)

The Performance Indicator Trigger Monitoring (PITM) program is the regulatory compliance component of the AMP with respect to water-related issues.

The purpose of the PITM program is to monitor the effects of quarry operations on water resources with respect to surface water flows and temperatures and wetland water levels, and to initiate any actions necessary to adapt quarry operations to maintain these parameters within their baseline ranges. Long-term changes in prevailing climatic conditions are also considered and two surface water flow and temperature control stations located in the Pretty River and Batteaux Creek watersheds have been established for this purpose. These two control stations are situated beyond any possible influence of quarry operations as shown on **Figure 1**.

The PITM is completed to monitor features outside of the limit of extraction that are potentially sensitive to fluctuations in groundwater levels, such as wetlands and fish habitat.

Appropriate actions may be taken to modify routine quarry operations and / or implement contingency mitigation measures to ensure that quarry operations do not negatively impact water resources which directly support these features of interest, namely:

- Springs that discharge at the Niagara Escarpment east of the Site. These springs help to sustain surface water flow and fish habitat below the brow of the Niagara Escarpment in tributary streams of the Pretty River and Batteaux Creek;
- Surface water flows that support fish habitat in the Beaver River west of the Site; and
- Surface water levels and flows and groundwater levels that support wetland features and functions.

In some instances, atypical climate conditions that are not associated with quarry operations might be observed in surface water flow and / or temperatures at some monitoring locations. The PITM is designed to assist in identifying the cause and impacts to surface water flow and temperature and wetland water levels.

For Phase 1 quarry operations, the potential for off-site water-related impacts to any of the wetlands and / or Escarpment springs was considered low. Therefore, Phase 1 monitoring was used as an extended “baseline” period to establish long-term ranges for the trigger parameters. Trigger values were updated as part of the 5-year AMP Comprehensive Review report (WSP and Stantec, September 2021).

7.2.1 Methods

Surface Water Flow and Temperature Monitoring

A description of the PITM surface water trigger stations is included in Table 3.3 of the 2013 AMP document and reproduced in **Table A-2**, **Appendix A-2**. Trigger monitoring locations are highlighted in yellow on **Figure 2**. The surface water catchment areas for the Pretty River, Batteaux Creek, Beaver River and Mad River systems are provided on **Figure 1**.

The PITM surface water monitoring stations are situated in three separate watersheds (bolded and italicized text indicates background / control stations):

- The Pretty River tributary system: SW16, SW17, SW17A, SW18, SW24A, SW77 and ***PR Control***;
- The Batteaux Creek tributary system: SW9, SW10, SW11, SW14, SW15, SW21C and ***BC Control***; and
- The Beaver River tributary system: SW1, SW2, SW0-2, SW3, SW6A and ***SW3B (‘RR3 Karst’)***.

As noted previously, in late 2022, all surface water stations were equipped with automated dataloggers for water level and temperature monitoring. Staff gauges have been installed at PITM stations: SW1, SW2, SW0-2, SW3, SW6A, SW9, SW10, SW14, SW15, SW16, SW17, SW18, SW24A, PR Control and BC Control. It was intended that the PR and BC control stations would function as real-time logger to web stations. However, the locations of these stations are remote and when measured by WSP the cellular network signal strength was found to be insufficient for remote telemetry. As an alternative, updated graphs showing precipitation data and surface water flow and temperature data are generated on a monthly basis and uploaded to a publicly available website.

During the months of July and August, bi-weekly monitoring is completed at the surface water Escarpment springs (SW10, SW11, SW11A-E, SW21C, SW24A and SW77). Monthly monitoring is conducted at other times of the year. Monitoring includes temperature measurement and an assessment of flow conditions through either the use of an electromagnetic flow meter, or in some cases by manual measurement or visual assessment. Additional field chemistry parameters (pH, dissolved oxygen and conductivity) are also recorded monthly at selected stations noted in Table 3.4 of the AMP. In addition, hourly logger intervals are required at stations SW1, SW2, SW0-2, SW3, SW6A, SW9, SW10, SW11E, SW14, SW15, SW16, SW17, SW17A, SW18, SW21C, PR Control and BC Control.

Monitoring has been conducted at the prescribed frequency at the monitoring stations in accordance with the AMP with only a few instances where measurements have not been available for events due to field conditions (i.e., frozen / buried with snow, inaccessible due to safety or other access concerns, etc.).

Wetland Drivepoint Water Level Monitoring

A description of the PITM wetland drivepoint trigger locations is provided in **Table A-1**, **Appendix A-2**. Trigger monitoring locations are highlighted in yellow on **Figure 2**.

The PITM drivepoints are located in the following wetlands:

- ANSI A wetland: DP6 (vernal pool)
- ANSI B wetland: Bridson DP and DP9
- Rob Roy Swamp 2 (RR2) wetland: DP5 (vernal pool) and DP7 (vernal pool)
- Rob Roy Swamp 6 (RR6) wetland: DP2, DP4 and DP8

During the months of May, June and July, drivepoint monitors in the wetlands are monitored bi-weekly and at monthly intervals between March and October. All drivepoints were equipped with dataloggers in late 2022 and were downloaded during each monthly / bi-weekly monitoring event, with the final download in October 2023. Monitoring includes manual measurements of groundwater level, ponded water depth and water temperature.

During Phase 1 quarry operations, it was intended to install an offsite drivepoint monitor within a reference wetland in either the Nottawasaga Lookout Provincial Park or the Pretty River Provincial Park as a reference monitoring point for assessment of potential impacts to wetland water levels. A satisfactory reference wetland was not located during the Phase 1 monitoring period.

7.2.2 Trigger Levels

Updated interim trigger values using available baseline data from 2003 to 2020 were included in the 5-Year Comprehensive Review report (WSP and Stantec, September 2021) and are provided in the tables below following the same methodology for red / yellow trigger designation as outlined in Table 3.2 of the AMP. It was intended that the triggers would apply once extraction in the Extension Quarry proceeded beyond Phase 1.

Surface water temperature and flow graphs and drivepoint water level target hydrographs, including the updated interim red / yellow triggers, are provided in **Figures F-1 to F-25**, **Appendix F**. Copies of trigger exceedance correspondence for 2023 are provided in **Appendix F-1**. The figures also summarize the baseline monitoring period data by month as “box and whisker” plots. In the plots, the “whiskers” represent the maximum and minimum historic monthly values, the upper and lower edges of the “box” represent the 75th and 25th percentile of the historic data range, the solid line through the box represents the median value and the line graph represents the average monthly values. It is noted that the “whiskers” do not include outlier data, which are outside of 1.5 times the interquartile range (i.e., 1.5 times the range of the “box”).

Surface Water Flow and Temperature Triggers

The red flow trigger value is set as the baseline monitoring period lowest monthly flow recorded at each station. The yellow flow trigger value is calculated either by increasing the red value by 15%, or by using the third-lowest monthly flow value over the baseline monitoring period, whichever is the higher value. Green flow trigger values (i.e., normal quarry operating conditions) are set above the yellow trigger value.

The red temperature trigger value is set as the baseline monitoring period highest monthly temperature recorded at each station. The yellow temperature trigger value is set at 10% below the red value. Green temperature trigger values are set below the yellow trigger value.

The surface water flow and temperature triggers generally apply from June to September, except at stations SW1, SW2 and SW0-2 where they apply for each month of the year.

The updated interim surface water flow and temperature triggers are summarized in the **Tables 7.1 to 7.4** below.

Table 7.1: Updated Interim Surface Water Flow Triggers – January to December Stations

Month	SW1		SW2		SW0-2	
	Red	Yellow	Red	Yellow	Red	Yellow
January	0.9	10.5	0.8	1.1	30.4	78.3
February	4.8	9.0	0.6	0.9	94.6	280.5
March	0.6	4.3	0.7	2.4	69.3	104.3
April	1.5	7.1	2.7	5.8	27.0	31.7
May	0	2.5	3.1	3.6	14.5	16.7
June	(nf)	(nf)	1.6	1.8	(nf)	3.9
July	(nf)	(nf)	0.2	0.5	(nf)	1.1
August	(nf)	(nf)	0.1	0.3	(nf)	(nf)
September	(nf)	(nf)	0.4	0.5	3.2	3.6
October	(nf)	(nf)	0.01	0.1	0.1	1.2
November	(nf)	(nf)	0.2	0.4	0	4.4
December	(nf)	(nf)	(nf)	0.1	(nf)	14.1

NOTES:

[1] All flow triggers in litres / second (L/s).

[2] (nf) indicates no flow observed during baseline monitoring period.

Table 7.2: Updated Interim Surface Water Flow Triggers – June to September Stations

Month	SW3		SW6A		SW9		SW10		SW11	
	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow
June	(nf)	(nf)	58.3	83.4	(nf)	(nf)	(nf)	0.1	(nf)	2.3
July	(nf)	(nf)	45.2	52.0	(nf)	(nf)	(nf)	(nf)	0.7	0.8
August	(nf)	(nf)	24.9	32.1	(nf)	(nf)	(nf)	(nf)	0.1	0.4
September	(nf)	(nf)	14.5	16.6	(nf)	(nf)	(nf)	(nf)	0.28	0.32

Month	SW14		SW15		SW16		SW17		SW17A	
	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow
June	1.2	1.7	(nf)	0.2	0.06	0.6	0.3	0.5	3.9	6.8
July	0.5	1.1	(nf)	(nf)	(nf)	0.2	0.2	0.3	1.7	2.9
August	0.4	1.1	(nf)	0.05	(nf)	(nf)	0.1	0.3	0.5	1.1
September	0.5	0.6	(nf)	(nf)	(nf)	(nf)	0.2	0.3	1.2	1.4

Month	SW18		SW21C		SW24A		SW77	
	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow
June	7.0	11.8	(nf)	1.2	(nf)	0.2	0.06	0.1
July	3.8	5.9	0.7	1.2	0.1	0.2	0.04	0.1
August	3.0	3.5	0.1	0.3	0.1	0.12	0	0.1
September	2.4	2.7	0.6	0.7	0.1	0.12	0.04	0.1

NOTES:

[1] All flow triggers in litres / second (L/s).

[2] (nf) indicates no flow observed during baseline monitoring period.

Table 7.3: Updated Interim Surface Water Temperature Triggers – January to December Stations

Month	SW1		SW2		SW0-2	
	Red	Yellow	Red	Yellow	Red	Yellow
January	8.4	7.5	7.5	6.7	4.7	4.3
February	3.7	3.4	6.5	5.9	0	0
March	10.5	9.5	7.7	6.9	10.6	9.5
April	11.5	10.3	8.6	7.7	12.2	11.0
May	20.8	18.7	13.7	12.3	23.2	20.9
June	26.0	23.4	13.5	12.2	25.4	22.9
July	24.1	21.7	17.4	15.7	29.2	26.3
August	20.6	18.5	17.3	15.6	21.6	19.4
September	19.0	17.1	14.2	12.8	23.1	20.8
October	14.0	12.6	12.4	11.1	17.1	15.4
November	10.9	9.8	10.9	9.8	11.1	10.0
December	7.6	6.8	9.2	8.3	5.1	4.6

NOTES:

[1] All temperature triggers in degrees Celcius (°C).

Table 7.4: Updated Interim Surface Water Temperature Triggers – June to September Stations

Month	SW3		SW6A		SW9		SW10		SW11	
	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow
June	18.8	16.9	25.2	22.7	16.4	14.8	18.3	16.4	12.1	10.9
July	19.8	17.9	23.4	21.1	19.2	17.3	21.3	19.2	16.0	14.4
August	(dry)	(dry)	22.0	19.8	(dry)	(dry)	22.0	19.8	16.6	15.0
September	(dry)	(dry)	20.5	18.4	(dry)	(dry)	20.0	18.0	14.9	13.4

Month	SW14		SW15		SW16		SW17		SW17A	
	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow
June	21.8	19.6	23.0	20.7	19.4	17.5	21.4	19.2	14.0	12.6
July	24.0	21.6	23.8	21.4	20.7	18.6	23.0	20.7	16.0	14.4
August	22.2	20.0	21.5	19.4	19.1	17.2	21.2	19.1	22.0	19.8
September	20.3	18.3	16.9	15.2	18.3	16.5	21.6	19.4	15.1	13.6

Month	SW18		SW21C		SW24A		SW77	
	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow
June	17.9	16.1	13.5	12.2	13.5	12.2	10.9	9.8
July	20.7	18.6	13.0	11.7	15.0	13.5	13.0	11.7
August	19.3	17.4	12.2	10.9	17.7	15.9	15.7	14.1
September	18.9	17.0	12.1	10.9	15.6	14.0	14.2	12.8

NOTES:

[1] All temperature triggers in degrees Celcius (°C).

[2] (dry) indicates no baseline monitoring period temperature data due to dry conditions.

Wetland Drivepoint Water Level Triggers

The wetland drivepoint water level triggers for wetland vegetation apply to both “too dry” and “too wet” conditions. For dry conditions, the red trigger value is greater than one (1) month where the water level is below the lowest baseline monitoring period water level by 10% while the yellow trigger value is set at up to 20% above the red trigger value. For wet conditions, the red trigger value is greater than one (1) month where the water level is above the highest baseline monitoring period water level by 10% while the yellow trigger value is set at up to 20% below the red trigger value.

The wetland drivepoint water level triggers for wetland vegetation apply from spring to fall (i.e., March to August), as summarized in **Table 7.5** below.

Table 7.5: Wetland Water Level Triggers for Wetland Vegetation

Month	DP2				DP4 *				DP5			
	Dry		Wet		Dry		Wet		Dry		Wet	
	Red	Yellow	Yellow	Red	Red	Yellow	Yellow	Red	Red	Yellow	Yellow	Red
March	510.79	511.03	511.96	512.20	510.95	511.15	511.93	512.13	509.72	509.82	510.22	510.32
April	511.72	511.83	512.27	512.38	511.30	511.41	511.83	511.93	509.75	509.84	510.20	510.29
May	511.08	511.30	512.20	512.42	511.28	511.39	511.83	511.94	509.51	509.64	510.13	510.26
June	510.64	510.94	512.14	512.44	511.04	511.18	511.77	511.91	509.54	509.66	510.12	510.23
July	510.64	510.94	512.18	512.48	510.66	510.86	511.70	511.90	508.91	509.14	510.05	510.27
August	510.63	510.93	512.12	512.42	510.58	510.80	511.64	511.86	508.50	508.79	509.96	510.25

Month	DP6				DP7				DP8			
	Dry		Wet		Dry		Wet		Dry		Wet	
	Red	Yellow	Yellow	Red	Red	Yellow	Yellow	Red	Red	Yellow	Yellow	Red
March	511.45	511.55	511.94	512.04	509.31	509.33	509.37	509.39	511.29	511.29	511.29	511.29
April	511.33	511.44	511.88	511.99	509.32	509.33	509.37	509.38	511.02	511.10	511.40	511.48
May	511.60	511.66	511.87	511.93	509.03	509.09	509.37	509.43	511.25	511.29	511.41	511.45
June	510.81	511.01	511.83	512.03	509.16	509.20	509.33	509.37	511.21	511.25	511.38	511.42
July	509.99	510.39	512.02	512.43	508.75	508.85	509.27	509.37	511.20	511.24	511.40	511.44
August	509.86	510.28	511.97	512.39	508.29	508.45	509.09	509.25	511.18	511.22	511.39	511.43

Month	DP9				BRIDSON DP			
	Dry		Wet		Dry		Wet	
	Red	Yellow	Yellow	Red	Red	Yellow	Yellow	Red
March	507.76	507.78	507.83	507.85	509.90	510.02	510.46	510.58
April	507.79	507.79	507.83	507.83	510.38	510.44	510.66	510.72
May	507.67	507.70	507.82	507.85	510.36	510.38	510.50	510.52
June	507.57	507.61	507.76	507.80	510.07	510.15	510.46	510.54
July	507.04	507.18	507.73	507.87	509.01	509.31	510.55	510.85
August	506.54	506.76	507.66	507.88	508.80	509.12	510.36	510.68

NOTES:

[1] All water level triggers in metres above sea level (masl).
* DP4 trigger values updated in May 2023 based on revised baseline data.

Between 2018 and 2022, an incorrect reference point elevation was used to correct DP4 water levels to geodetic elevation (which includes two years of the baseline range used to develop the water level trigger values). As such, the trigger levels for DP4 were revised in 2023 as shown in **Table 7.5** above.

Additional wetland drivepoint water level triggers also apply for amphibian habitat vernal pools at DP5, DP6 and DP7. The red trigger value is no standing water during the short breeding period (March to 2nd week of July) (i.e., the surveyed ground surface elevation). The yellow trigger value is the depth of pond below 80% of the baseline monitoring period pond depth during the extended breeding period (March to 2nd week of August). The wetland drivepoint water level triggers for amphibian habitat are summarized in **Table 7.6** below.

It is noted that where amphibian habitat wetland water level triggers are applicable, in each case, the trigger values are below the wetland vegetation triggers above. Therefore, the amphibian habitat wetland water level triggers are redundant.

Table 7.6: Wetland Water Level Triggers for Amphibian Habitat

Month	DP5		DP6		DP7	
	Red	Yellow	Red	Yellow	Red	Yellow
March	509.66	509.74	511.45	511.49	509.18	509.29
April	509.66	509.77	(dry)	(dry)	509.18	509.29
May	(dry)	(dry)	511.45	511.60	(dry)	(dry)
June	(dry)	(dry)	(dry)	(dry)	(dry)	(dry)
July	(dry)	(dry)	(dry)	(dry)	(dry)	(dry)
August	(n/a)	(dry)	(n/a)	(dry)	(n/a)	(dry)

NOTES:

[1] All water level triggers in metres above sea level (masl).

[2] (n/a) – red water level triggers are not applicable in August.

[3] (dry) – no red or yellow water level trigger as minimum monthly water level during the baseline monitoring period was below ground surface.

7.2.3 Trigger Exceedances

Trigger monitoring results and exceedances are tabulated in the following section, and shown graphically in **Figures F-1 to F-20** (surface water flow and temperature results) and **Figures F-21 to F-27** (wetland drivepoint water level results), **Appendix F**. Copies of trigger exceedance correspondence for 2023 are provided in **Appendix F-1**.

Surface Water Flow and Temperature Control Stations

As shown in **Figures F-18 and F-19**, respectively, the majority of the 2023 surface water flow and temperature results for the Pretty River and Batteaux Creek Control stations are consistent with the baseline monitoring period. The exceptions at the Pretty River Control station are the surface water temperatures in October and December which were above the 75th percentile of baseline conditions while flows in January to June were below the 25th percentile of the baseline range. At the Batteaux Creek Control station, the surface water temperatures in October and December were also above the 75th percentile of baseline conditions. The lower flows observed in winter at the Pretty River Control station are consistent with the climate data presented in **Section 4.1** and **Figure D-1**, where the monthly net surplus in winter 2023 was observed to be at the lower end of the baseline monitoring period range. The elevated temperatures at both control stations are also consistent with elevated monthly average temperatures at Shanty Bay climate station in October and December as presented on **Figure D-2**.

Because these control stations are outside of the influence of the quarry dewatering, any deviations from the baseline flow and temperature ranges at these stations are inferred to be the result of climate conditions in 2023. Similar trends at the PITM surface water stations may also be related to climate conditions and not necessarily a result of a quarry dewatering influence.

Surface Water Flow and Temperature Trigger Results

The 2023 surface water flow and temperature monthly / bi-weekly trigger monitoring results are summarized in **Tables 7.7 to 7.12** below.

Table 7.7: Surface Water Flow Trigger Monitoring Results – January to December Stations

Month	SW1	SW2	SW0-2
January	frozen	6.14	frozen
February	frozen	4.92	frozen
March	94.2	20.8	912.0
April	81.0	8.8	251.8
May	93.6	9.0	95.1
June		7.6	140.1
July		7.3	96.6
August		0.82	
September		3.3	22.5
October		1.0	150.3
November		6.8	frozen
December		2.4	73.9

NOTES:

[1] All flow values in litres / second (L/s).

[2] Grey shading indicates no applicable monthly trigger.

Table 7.8: Surface Water Flow Trigger Monitoring Results – June to September Stations

Month	SW6A	SW14	SW15	SW16	SW17	SW17A	SW18
June	466.4	2.4	dry	3.1	3.6	19.1	166.2
July	582.3	7.7		dry	4.2	35.4	137.2
August	287.1	4.4	dry		1.2	4.1	63.4
September	288.9	0.75			2.5	4.9	37.0

NOTES:

[1] All flow values in litres / second (L/s).

[2] Grey shading indicates no applicable monthly trigger.

Table 7.9: Surface Water Flow Trigger Monitoring Results – Escarpment Spring Stations

Month	SW10	SW11	SW21C	SW24A	SW77
June	0.27	9.4	3.4	1.7	0.47
July		3.2	3.6	2.2	0.18
		7.6	10.1	13.9	0.38
August		4.4	6.2	6.7	0.13
		1.4	1.8	0.77	0.01
September		0.46	6.3	1.1	0.08

NOTES:
[1] All flow values in litres / second (L/s).
[2] Grey shading indicates no applicable monthly trigger.

The following observations are provided regarding the surface water flow trigger monitoring results:

- As noted in the 5-Year Comprehensive Review report, SW21C was modified by the property owner in 2019. Therefore, data is no longer representative of baseline conditions and trigger exceedances at this station are not reliable. At downstream trigger station SW15, the culvert was replaced in 2021 as part of Concession 10 road re-construction. The new culvert invert appears to be at a higher elevation than the previous culvert and trigger exceedances at SW15 may therefore also not be reliable.
- Stations SW24A and SW24B are situated on private property and were modified by the property owner in summer 2021. The SW24A stream channel no longer exists and has been merged into SW24B; therefore, data is no longer representative of baseline conditions and trigger exceedances at this station are not reliable. It is recommended that trigger assessment be continued at downstream stations SW17.
- There were no red trigger exceedances for surface water flows in 2023.
- Yellow trigger exceedances for surface water flow were observed at SW15 (June and August), SW16 (July) and SW77 (August and September). Continued trigger monitoring at these stations will be completed in 2024 to confirm trends.
- The surface water flow trigger exceedances observed during 2023 are not attributed to the Extension Quarry due to (a) the sporadic, generally discontinuous nature of the trigger exceedances and (b) the interpreted drawdown cone from the Extension Quarry did not extend beyond the Licence boundary in 2023.

Table 7.10: Surface Water Temperature Trigger Monitoring Results – January to December Stations

Month	SW1	SW2	SW0-2
January	-0.1	4.5	0.0
February	0.0	3.6	frozen
March	0.5	6.2	0.1
April	12.5	10.7	10.1
May	17.2	11.5	15.2
June	20.7	10.2	18.7
July	19.0	9.8	17.7
August	17.8	12.9	15.6
September	13.6	11.3	13.1
October	6.0	9.2	6.2
November	0.0	5.9	0.3
December	1.5	7.4	1.5

NOTES:
[1] All temperatures in degrees Celcius (°C).

Table 7.11: Surface Water Temperature Trigger Monitoring Results – June to September Stations

Month	SW3	SW6A	SW9	SW14	SW15	SW16	SW17	SW17A	SW18
June	dry	18.4	dry	19.9	dry	23.3	20.2	13.3	17.0
July	dry	17.6	dry	17.7	18.7	dry	18.2	12.4	15.5
August		17.4		17.3	dry	dry	17.4	11.8	15.5
September		13.1		14.6	dry	dry	15.5	12.0	13.0

NOTES:

[1] All temperatures in degrees Celcius (°C).

[2] Grey shading indicates no applicable monthly trigger.

Table 7.12: Surface Water Temperature Trigger Monitoring Results – Escarpment Spring Stations

Month	SW10	SW11	SW21C	SW24A	SW77
June	14.1	12.3	13.4	11.2	10.3
July	14.8	10.7	11.6	9.6	10.2
	14.7	9.6	11.6	9.1	10.3
August	14.9	10.8	11.1	9.7	11.2
	13.8	12.6	10.8	11.1	10.8
September	15.7	12.1	10.6	9.9	11.1

NOTES:

[1] All temperatures in degrees Celcius (°C).

The following observations are provided regarding the surface water flow trigger monitoring results:

- As noted in the 5-Year Comprehensive Review report, SW21C was modified by the property owner in 2019. Therefore, data is no longer representative of baseline conditions and trigger exceedances at this station are not reliable. At downstream trigger station SW15, the culvert was replaced in 2021 as part of Concession 10 road re-construction. The new culvert invert appears to be at a higher elevation than the previous culvert and trigger exceedances at SW15 may also not be reliable.
- Stations SW24A and SW24B are situated on private property and were modified by the property owner in summer 2021. SW24A stream channel no longer exists and has been merged into SW24B; therefore, data is no longer representative of baseline conditions and trigger exceedances at this station are not reliable. It is recommended that trigger assessment be continued at downstream stations SW17.
- Red trigger exceedances for surface water temperature were observed at SW1 (April), SW2 (April), SW11 (June) and SW16 (June). Conditions returned to the “green zone” for the subsequent month suggesting that no trend exists.
- Yellow trigger exceedances for surface water temperature were observed at SW14 (June), SW17 (June), SW17A (June), SW18 (June), SW21C (June and August) and SW77 (June). Conditions returned to the “green zone” for the subsequent month suggesting that no trend exists.

- Surface water temperature triggers were exceeded at a number of stations in June; since conditions returned to the green zone after this event, the June temperature trigger exceedances are inferred to be related to conditions at the time of sampling and not related to the quarry.
- The remaining surface water temperature trigger exceedances observed during 2023 are not attributed to the Extension Quarry due to (a) the sporadic, generally discontinuous nature of the trigger exceedances and (b) the interpreted drawdown cone from the Extension Quarry did not extend beyond the Licence boundary in 2023.

Wetland Drivepoint Water Level Trigger Results

The 2023 wetland drivepoint water level monthly / bi-weekly trigger monitoring results are summarized in **Table 7.13** below.

Table 7.13: Wetland Water Level Trigger Monitoring Results

Month	RR6			RR2		ANSI A	ANSI B	
	DP2	DP4	DP8	DP5	DP7	DP6	DP9	Bridson DP
March	frozen	511.43	**511.58**	509.74	509.37	frozen	507.71	510.40
April	**512.34**	511.26	**511.47**	510.02	509.36	511.83	507.78	510.39
May	**512.31**	**511.88**	**511.44**	510.01	509.35	511.81	507.75	510.33
	512.29	**511.86**	511.35	509.99	509.33	511.74	507.68	510.22
June	**512.30**	**511.86**	511.36	509.89	509.28	511.65	507.71	510.32
	512.31	**511.97**	**511.44**	509.85	509.18	511.43	507.67	510.20
July	**512.28**	**511.85**	**511.42**	509.88	509.22	511.50	507.67	510.22
	512.34	**511.90**	**511.48**	509.99	**509.33**	511.78	**507.75**	510.23
August	**512.26**	**511.88**	511.34	509.88	**509.22**	511.24	507.55	510.10

NOTES:
[1] All water levels in metres above sea level (masl).
[2] Underlined and bolded values indicate exceedance of "wet" trigger.

The following observations are provided regarding the surface water flow trigger monitoring results:

- Unlike the surface water flow and temperature triggers, a red trigger exceedance for wetland water levels is confirmed when the water levels exceed the red trigger for more than one month. Therefore, red trigger exceedances for wetland water levels were observed as follows:
  - **Rob Roy 6 (RR6) Wetland:** "wet" triggers were exceeded at DP8 (June and July), however conditions returned to the "green zone" in August.
  - **ANSI Wetland B:** "dry" triggers were exceeded at DP9 (March and April), however conditions returned to the "green zone" in May.
- Yellow trigger exceedances for wetland water levels were observed as follows:

- **Rob Roy 6 (RR6) Wetland:** "wet" triggers were exceeded at DP2 (April to August), DP4 (May, June and July) and DP8 (April, May and July).
- **Rob Roy 2 (RR2) Wetland:** "dry" triggers were exceeded at DP5 (March) and DP7 (June), however conditions returned to the "green zone" in the subsequent month. Conversely, "wet" triggers were exceeded at DP7 (July and August).
- **ANSI Wetland B:** "dry" triggers were exceeded at DP9 (May) and Bridson DP (April), while "wet" triggers were exceeded at DP9 (July). Conditions returned to the "green zone" at DP9 in June and August.

- Replacement of the discharge pipe (running through RR6 wetland) was initiated in late 2023 and was completed in February 2024. Operation of the new solid discharge pipe is expected to lower surface water levels in RR6 wetland and help reduce "wet" trigger exceedances.
- The remaining wetland water level trigger exceedances observed during 2023 are not attributed to the Extension Quarry due to (a) the sporadic, generally discontinuous nature of the trigger exceedances and (b) the interpreted drawdown cone from the Extension Quarry did not extend beyond the Licence boundary in 2023.

7.3 Long-Term Trend Groundwater and Surface Water Monitoring (LTTWM)

The Long-Term Trend groundwater and surface water monitoring program (LTTWM) is used to track seasonal and year-over-year natural variations in the groundwater and surface water systems, as well as the progressive response of those systems as the Main Quarry was depleted and extraction at the Extension Quarry continues, followed by final rehabilitation to lakes. The LTTWM program data is used to identify short-term and long-term trends. The LTTWM includes selected PITM stations plus additional surface water and groundwater stations as described below.

7.3.1 Methods

Groundwater Monitoring

LTTWM groundwater monitoring locations are listed in Table 4.1 of the AMP, and reproduced in **Table A-1**, **Appendix A-2**. The LTTWM includes groundwater monitoring wells in the following locations:

- Main Quarry monitoring wells: 98-8, 98-9, 98-12 and PW99-1;
- Extension Quarry injection wells: IW1, IW2, IW3 and IW4;
- Extension Quarry monitoring wells: BH02-1 *, BH02-2, BH02-3 *, BH02-4 *, BH02-5 nest, BH02-6, BH03-7 nest, BH03-8, BH08-1, BH08-2, BH08-3, NW1-9 *, NW10 nest, BH03-9, TW04-1, TW04-2 and TW04-3; and
- WAI off-site monitoring wells: 101-B, 102-C, 103-D, 104-A, OW1-4, OW5-2 and OW6-3.

* As noted in **Section 3.1.1**, monitoring at wells BH02-1, BH02-3, BH02-4, NW2, NW3, NW4 and NW5 has been discontinued as these locations are now within the active quarry extraction area.

In late 2022, all of the groundwater monitoring locations were equipped with automated data loggers for continuous water level measurement. In 2023, manual measurements and logger downloads were completed in

May and October (when accessibility was not an issue). Loggers generally record water levels twice daily; however, an hourly recording frequency is required at selected locations.

Monitoring wells TW04-1, TW04-2 and TW04-3 in close proximity to BH03-9 and BH08-1, BH08-2 and BH08-3 in close proximity to RW16 were installed to complete historic pumping tests. These wells provide redundant information and are unnecessary for monitoring of long-term water level trends at the Site. It is therefore recommended that these six wells be removed from the monitoring program. This recommendation was included in the AMP 5-Year Comprehensive Review Report (WSP, September 2021) but requires regulatory approval to amend the AMP.

There are several private domestic water wells located around the Site (Jagger Hims, 2007). The locations of the private domestic wells are identified on **Figure 2** as ‘RW’ (residential or domestic wells). Selected domestic wells are monitored as part of the LTTWM:

- East of Site: RW1, RW2, RW5, RW6 *, RW7, RW8, RW16, and RW18 *.
- North of Site: RW3, RW4 * and RW17.
- Carmarthen Lake Farms property domestic wells: CLF2 *, CLF3, CLF4 and CLF5.

* As noted in **Section 3.1.3**, monitoring at wells RW4, RW6, RW18 and CLF2 has been discontinued.

As noted above, all of the domestic wells were equipped with automated data loggers for continuous water level measurement in late 2022, and in 2023, manual measurements and logger downloads were completed in May and October. Loggers generally record water levels twice daily; however, an hourly recording frequency is required at RW16.

Domestic wells RW1 and RW2 are also sampled annually for general chemistry, major and minor ions, nutrients, total petroleum and hydrocarbons, BTEX, total suspended solids and bacteriological parameters.

It is noted that RW12 and RW13 are currently voluntarily monitored by WAI but are not part of the LTTWM.

The LTTWM includes the drivepoints listed in the PITM plus these additional locations in the following wetlands:

- RR2 wetland: Staff Gauge 1 and Staff Gauge 2 (BH03-7 SG1 / SG2)
- RR3 wetland: DP11
- RR6 wetland: DP1
- CLF wetland: DP3

It is noted that DP11 in RR3 is monitored as part of the St. Mary’s Osprey Quarry monitoring program. The groundwater depth, ponded water depth (where available) and surface water temperature at the remaining locations are monitored continuously with loggers, with manual measurements and logger downloads completed in May and October.

<u>Surface Water Monitoring</u>

The LTTWM includes the stations listed in the PITM plus these additional locations in the following watersheds:

- The Pretty River tributary system: SW20

- The Batteaux Creek tributary system: SW7, SW8, SW10, SW11 series, SW13, SW19, SW21 series and SW22 series
- The Beaver River tributary system: SW3C ('RR3 Out')
- Main quarry floor: QFSW2 and dewatering sump

A description of each surface water monitoring station is provided in **Table A-2**, **Appendix A-2**. These stations were equipped with automated data loggers in late 2022 for continuous water level and temperature monitoring. In 2023, monthly manual flow measurements were completed at the LTTWM surface water stations between May and October to develop preliminary stage-discharge relationships to estimate flow rates from the continuous logger water level data. The preliminary stage-discharge parameters are provided in the station logs (**Appendix A-4**) and the flow rates (calculated from logger water level data) are provided on the hydrographs in **Appendix C**. It is noted that a stage-discharge relationship could not be reliably developed due to a lack of data. It is intended that monthly manual flow measurements will be completed between May and October 2024 to provide additional data to develop / verify the stage-discharge relationships.

Station SW7 (former Millar Pond outlet) has been removed from the monitoring program as the former Millar Pond has been decommissioned. Also, SW3C (RR3 outlet) is located within the St. Mary's Osprey Quarry licence and monitoring is completed by others.

7.3.2 Monitoring Results

A detailed analysis of long-term groundwater and surface water trends is provided in **Sections 4.2.2 and 4.3.1**. Overall, the 2023 water levels are generally within historical ranges. Sporadic measurements outside of the historic ranges have been observed, but subsequent measurements have generally returned to baseline ranges soon thereafter. In some cases, measurements outside of their historic ranges may be attributed to the deviation of climatic conditions in comparison to the baseline monitoring period. Continued monitoring of potential emerging trends will be completed.

Localized drawdown due to quarry extraction activities is observed at some locations in the vicinity of Phase 2A, as expected. As noted in **Section 4.2.4**, to date, drawdown is inferred to have occurred at NW1 and BH02-6 generally south of Phase 1, NW6 and NW7 west / northwest of Phase 1 and BH02-2 north of Phase 1 / Phase 2A. It is noted that the majority of the observed drawdown to date has occurred within the Extension Quarry limit of extraction. In 2022, historical low water elevations were observed east of the Extension Quarry Phase 2A at RW16, BH08-1, BH08-2, BH08-3 and IW2. It is currently unclear if these low water levels are due to lower than normal precipitation during the late fall, or if a quarry influence is beginning to take effect. Water levels at these locations appeared to rebound in 2023. These wells are within the predicted zone of influence and therefore a quarry influence is not unexpected. Monitoring of emerging trends will be continued.

The annual groundwater quality sampling at RW1 and RW2 was completed on May 31, 2023. The 2023 and historical results are provided in **Tables B-9 and B-10**, **Appendix B**. The groundwater chemical results for RW1 and RW2 are compared to the Ontario Drinking Water Quality Standards, Objectives and Guidelines (ODWQS) (MECP, June 2003 and updates). The groundwater quality at these locations generally meets the ODWQS, with the exception of the following:

- As shown on **Table B-10**, the total coliform counts exceeded the ODWQS health-related guideline at RW1 in 2020 and 2023 and at RW2 during each annual sampling event since 2016. E. coli counts have also exceeded the ODWQS health-related guideline at RW2 since 2020. In June 2021 and May 2023, re-sampling was completed at both an outside tap (upstream of the treatment system) and an inside tap (downstream of the treatment system). It was determined that the inside tap meets the ODWQS objectives for total coliforms and E. coli, while the outside tap does not. In 2023 the well casing at RW2 was inspected and was found to be in good condition with no obvious surface seal issues. However, there is a large chicken coop in close proximity to the well which is inferred to be the cause of the persistent bacteriological exceedances at RW2.

- Sodium has an aesthetic objective of 200 mg/L and a suggested maximum concentration of 20 mg/L under the ODWQS. As shown in **Table B-9**, sodium concentrations have generally exceeded the ODWQS suggested maximum concentration of 20 mg/L at RW1 and RW2 during each annual sampling event since 2016; however, concentrations do not exceed the aesthetic objective. The elevated sodium concentrations are inferred to be the result of natural conditions in the aquifer, and not related to the quarry.
- Hardness concentrations have generally exceeded the ODWQS operational guideline for treatment systems at RW1 and RW2 during each annual sampling event since 2016. The elevated hardness concentrations are inferred to be the result of natural conditions in the aquifer, and not related to the quarry.

The ODWQS guidelines for sodium and hardness are related to aesthetic objectives / treatment system operational guidelines and are not health related.

7.4 Long-Term Trend Ecological Monitoring (LTTEM)

Ecological monitoring is a component of the AMP. The LTTEM program was developed to supplement the information from the LTTWM program with information about the health and functioning of the natural heritage features in the vicinity of the Extension Quarry.

The wetland component of the LTTEM focuses on amphibian vernal breeding pools and ensuring hydroperiods are suitable for continued hydrophytic plant growth in the surrounding wetland zones. Wetland water level monitoring is conducted as part of the PITM and the LTTWM programs and is interpreted from a natural heritage perspective. Ecological monitoring to complement the water level monitoring includes two components: amphibian monitoring and wetland vegetation monitoring.

The ecological monitoring components were completed by Stantec Consulting Ltd. (Stantec).

7.4.1 Amphibian Monitoring Program

Wildlife monitoring in wetlands is focused on amphibians (Anura: frogs and toads and Urodela: salamanders). Amphibians are excellent indicators of wetland health and water regime trends that could be affecting wetland function. Wildlife monitoring was completed in 2023. The 2023 monitoring program, including methodology and results, is summarized in the *Amphibian Monitoring Program, 2023 Annual Monitoring Report* prepared by Stantec (**Appendix G**).

The 2023 Amphibian Monitoring Program at the Extension Quarry was completed successfully, fulfilling the requirement of the AMP. Data of amphibian habitat, egg mass occurrence and breeding calls at each survey station were collected, providing monitoring data for amphibian community and abundance at the Site. Habitat at each survey station was suitable for amphibians and, when comparing 2023 data to previous years' surveys, amphibian communities were similar in diversity and equal to or greater in abundance at each survey station.

7.4.2 Wetland Vegetation Monitoring

Vegetation monitoring was initiated in 2019 and continued through to 2023 at wetlands within the Rob Roy Swamp PSW Complex (RR2 and RR6) and ANSI wetlands A & B. The summary report, *Wetland Vegetation Monitoring: 2023 Annual Monitoring Report* prepared by Stantec (**Appendix G**), describes the methods and results from 2023 surveys and will be updated annually as part of the AMP reporting. This report represents the fifth year of terrestrial monitoring.

Generally, the wetlands remain consistent in their floristic character compared to the initial surveys in 2019 and remain as heathy wetland communities. As noted in previous years, RR6 appears to be experiencing inundation over a long period, particularly along Transect 6 (situated near drivepoint DP1). Most trees in this part of the wetland died prior to 2019 leaving the canopy open. The localized water level was lower in RR6 along Transect 5 (situated near drivepoint DP2) in 2023, similar to 2019 conditions. It is possible that the wetland in the vicinity of Transect 5 may also succeed to a more open canopy wetland environment in future years. As noted in previous reports, the RR6 wetland has historically been subject to variable water regimes as result of beaver activity at the County Road culverts and historic and current dewatering set up.

Future years of monitoring will provide greater opportunities to observe any changes in vegetation composition and wetland conditions along the transects.

7.4.3 Hart's Tongue Fern Monitoring

The AMP requires annual monitoring of an extensive American Hart's Tongue fern (Asplenium scolopendrium var. americanum) (AHTF) colony within the Extension Quarry starting two (2) years prior to quarry operations commencing in Phase 2B (per the registered Site Plans). The monitoring program is to be implemented annually for three (3) years from the commencement date, at which point the required effort will be re-evaluated. As operations were anticipated to begin in Phase 2B in 2023, baseline assessments of AHTF conditions were completed in 2022 and 2023.

The objectives of the AHTF monitoring program are:

- To determine whether the forest buffer is functioning as anticipated to protect the population and/or assess if dust from quarry activity causes a change in habitat conditions in the AHTF colony;
- To identify the cause-and-effect mechanism and implement appropriate mitigation measure(s) if the plants decline as a result of quarry activity; and
- To document natural changes in habitat conditions unrelated to quarry activity which may be causing a change in the AHTF colony.

<u>Summary of AHTF Baseline Monitoring</u>

Baseline AHTF data was obtained prior to the expansion of the quarry in Phase 2B. The information gathered in 2022 and 2023 is the foundation for ongoing monitoring of the health of the AHTF colony in future years and will allow the detection of any changes in habitat conditions as the quarry progresses.

Surveys completed in 2023 are documented in the summary report *American Hart's Tongue Fern: 2023 Annual Monitoring Report* prepared by Stantec (**Appendix G**). In 2023, several field visits were made to the AHTF colony to install and monitor dustfall collection jars and data loggers prior to the AHTF assessment on August 2, 2023.

Field surveyors made an on-site decision to forego the second year of baseline assessment at Plot 2 due to indications of disturbance. Plot 2 will be assessed in 2024 to reduce potential impacts to the colony.

Of note, garlic mustard is an invasive species that was recorded on the north side of the colony. Reductions in the canopy cover above the AHTF colony could increase light penetration to the ground vegetation layer, potentially creating suitable conditions for garlic mustard proliferation and expansion. In 2023, the garlic mustard in Plot 1 increased from 15% to 50% coverage. This drastic change may be due, in part, to difference in survey period (October 2022 versus July 2023). However, this may present a threat to the AHTF colony if unchecked. Continual monitoring of invasive species on Site will inform if management is required to maintain the integrity of the habitat for AHTF. If quarry activities (such as tree clearing) are determined to be causing an increase in exotic species abundance, then mitigation measures will be implemented to control the spread of non-native species in the colony.

Another noteworthy observation includes the difference in AHTF count with fronds over 2 cm in Plot 1 from 2022 to 2023. It appears that the numbers of individuals have dropped, which may again be related to different survey periods as noted above, as the overall plot coverage for AHTF has reduced from 28% to 20% in 2023 (as shown on Table 3 of the *American Hart's Tongue Fern: 2023 Monitoring Report*). Some other possibilities for this reduction include:

- Potential that AHTF fronds were more developed when they were surveyed later in the season; or
- The rosettes grew so large that they became larger clumps of AHTF over many individuals.

Monitoring of these differences will continue over the course of this program.

Overall, the AHTF colony has a high canopy closure rate, and both plots have observations of recurring sexual regeneration.

7.5 Ecological Enhancement and Mitigation Monitoring (EEMM)

The EEMM program includes mitigation and enhancement measures not directly related to the day-to-day operation of the quarry. The EEMM program is designed to make sure the ecological mitigation measures are properly implemented (e.g., appropriate number and species of trees are planted, amphibian habitat is self-sustaining) and that the resulting features are managed and adapted with changing conditions and trends (e.g., replanting for dead trees, controlling pest damage, control / allowing public access, etc.).

The EEMM program includes the Woodland Program, the Millar Pond relocation, the Bridson Pond enhancement and Butternut tree health re-assessments incorporated into the Woodland Program.

Woodland program monitoring, Millar Pond monitoring and Butternut tree health assessments were conducted in 2023.

7.5.1 Woodland Program

The Woodland Program was initiated in 2015, with tree planting and other enhancement measures undertaken over three years from 2015 to 2017. Reforestation efforts were divided between areas of active reforestation and areas of natural regeneration, which were delineated in the field based on Site conditions. Active reforestation lands included sodded fields, fallow fields, and worked fields which were treated with techniques including the planting and maintenance of varying sizes and species of trees. Natural regeneration lands consisted of areas of shallow soils, primary succession woodlots and naturalizing disturbed areas. Grading to create variable microtopography was utilized in both natural regeneration areas and at the margins of active regeneration sites where the physical dimensions or Site conditions were not feasible for active regeneration planting techniques. Approximate reforestation areas are shown on **Figure 2**.

The monitoring and maintenance of materials planted in 2016 and 2017 were monitored until 2018 and 2019, respectively. The monitoring activities are now focused on canopy closure.

The 2023 woodland program monitoring results are documented in the summary report *Reforestation Monitoring Program: 2023 Monitoring Report* prepared by Stantec (**Appendix H**). Based on the results of the 2023 monitoring program, the active planting plots and passive regeneration plots have met the 2020-2024 targets established in the Township Agreement, as shown on the report card (Table 2 of the *Reforestation Monitoring Program: 2023 Monitoring Report*). The degree to which the active planting plots meet the reforestation targets is a reasonable indication of woodland succession within the reforested areas. The current results show improvement in key metrics from 2020, including canopy height and closure, basal area, and native tree species diversity, including shade tolerant hardwood species. These results indicate a clear trend toward diverse, self-sustaining forest communities that are adapted to the microenvironments and climates found on this landscape.

Based on the 2023 reforestation surveys, the following observations and recommendations are provided:

- All plots in Zone E and F experience active cattle grazing which negatively affects tree survival rate. Measures should be implemented to eliminate the cattle from the area (i.e., electrical fences) to protect the remaining saplings and reduce the soil compaction to encourage a natural succession of the existing tree communities.
- Some plots show lower survival rate (B-267, C-123, C-142, C-174, C-231, C-213, C-216, C-161, C-176, F-36, F-5, F-16, F-31 and F-37); however, natural regeneration is evident. Natural regeneration is adapted to the existing microclimate conditions and should be allowed to continue. Should concerns be observed in future monitoring, additional enhancement planting may be considered.
- Removing all ties from the sapling stems is required to prevent girdling, which can result in the death of the area above the gridle overtime.
- It is recommended that the centre plot stakes and plot corners be surveyed using sub-metre GPS units to maintain plot location and consistent data comparisons for future reporting.

Reassessment of the forest regeneration will be completed again in 2028.

7.5.2 Millar Pond Relocation

In the fall of 2019, the new Millar Pond was excavated as per the EEMM Program. The new Millar Pond was intended to provide compensation for the original Millar Pond which provided amphibian breeding habitat in the local landscape that was approved for removal. The first year of monitoring of amphibian activity in the newly created pond was initiated in 2021 and reassessment was completed in 2023, incorporated into the LTTEM *Amphibian Monitoring Program: 2023 Annual Monitoring Report* (**Appendix G**).

It was found that the new pond supports three anurans recorded during the 2021 monitoring. The anurans found in the early successional feature included breeding spring peepers (Pseudacris crucifer), gray treefrogs (Hyla versocolor) and American Toad (Anaxyrus americanus). The first year results were indicative of an active pond environment that is anticipated to increase in diversity as the created pond becomes established on the landscape. As noted previously, the amphibian monitoring completed in 2023 indicates that the diversity and abundance of amphibian communities were similar to results from previous years.

7.5.3 Butternut Tree Management

In 2009, a total of twenty-seven (27) Butternut trees located within the approved Extension Quarry extraction area were assessed as retainable. Butternut tree health re-assessments were conducted on August 31, 2023, prior to the clearing of woodlands within the Phase 2B licensed extraction area. Of the previously identified retainable butternut trees, eleven (11) were located and re-assessed in 2023, of which five (5) were determined to be Category 1 and six (6) were Category 2. The remaining butternut trees were not located in 2023 and are presumed to have fallen and decomposed such that their locations could not be identified.

The results of the 2023 Butternut tree health re-assessment will be submitted to the MECP under separate cover for a 30-day assessment period. After this period, Butternut trees deemed for removal are to be registered under the Ontario Regulation (O. Reg.) 830/21 Part 5. As Butternut trees are listed as Endangered under the Endangered Species Act (ESA, 2007), individuals and their habitat are protected. Further mitigation and monitoring measures are to be applied or a one-time fee paid to the MECP Conservation Fund.

7.6 Mitigation Measures

Proposed mitigation measures that may be implemented (if required) are outlined in Section 2.3 of the AMP. It is noted that all mitigation measures are subject to approvals under the Ontario Water Resources Act (i.e., PTTW) and the Environmental Protection Act (i.e., ECA (Sewage)).

Routine Water Management Measures

Site Plan hydrogeology note 7 (Sheet 2B of 4) includes details on the proposed mitigation measures, one of which is the discharge of excess water from the Site to the northeast, north and northwest of Phase 2A and 2B to maintain baseline seasonal water level elevations within the ANSI A and B wetlands and RR2 wetland. A schematic cross section of the proposed surface discharge system is shown in Figure F.2 of the AMP document and the approximate locations are shown on the Operation Plan (Sheet 2A of 4).

A secondary objective to the dewatering discharge trenches is to replace the lost “catchment area” for each of these features due to the increased extraction footprint of the quarry. Appendix F of the AMP document includes initial estimates for the annual volume of discharge required to be directed to each of these features to replace the loss in catchment area, as summarized in **Table 7.14**.

Table 7.14: Estimated Annual Discharge to Recharge Trenches

<table>
<tr><th rowspan="2">Feature</th><th colspan="2">Estimated Discharge (m^3/day) (Igpm)</th></tr>
<tr><th>Phase 2A</th><th>Phase 2B</th></tr>
<tr><td>ANSI Wetland A</td><td rowspan="2">121
(~20 Igpm)
(44,240 m^3/year)</td><td>26
(~4 Igpm)
(9,480 m^3/year)</td></tr>
<tr><td>ANSI Wetland B</td><td>132
(~20 Igpm)
(48,190 m^3/year)</td></tr>
</table>

Feature	Estimated Discharge (m^3/day) (Igpm)	
	Phase 2A	Phase 2B
Rob Roy Swamp 2 Wetland	40 (~6 Igpm) (14,615 m^3/year)	84 (~13 Igpm) (30,810 m^3/year)

The discharge to each watershed / wetland may be adjusted, as necessary, based on the results of the on-going PITM to maintain the baseline target hydrographs. Discharge to the wetlands is managed by adjusting pumping rates and / or by means of flow restrictor valves in discharge lines, as required.

As noted in Appendix F of the AMP, the remainder of the quarry discharge would be directed to the RR6 wetland. Discharge to the RR6 wetland would occur as necessary to maintain the baseline flow volumes at the surface water trigger stations for this wetland (i.e., station SW1), as well as the baseline water elevations at the RR6 wetland drivepoint monitors.

As per Site Plan hydrogeology note 7 (E), the design for the trenches outside of the approved extraction area must be approved by the Ministry of Natural Resources and Forestry (MNRF) prior to construction. The design of the recharge trenches was submitted to the Ministry in September 2023. An ECA (Sewage) amendment (i.e., approval from MECP) will be necessary to allow discharge to the wetland mitigation system.

<u>Contingency Mitigation Measures</u>

In the event that the routine water management activities described above do not fully achieve the objectives of the AMP, contingency measures will be implemented. Proposed contingency measures are outlined in Section 2.4 of the AMP.

The contingency measures include, among other things, a network of injection wells situated on WAI-owned lands surrounding the Extension Quarry. The primary objective of the injection wells is to maintain baseline surface water flows at the escarpment seeps. As noted in the 5-Year Comprehensive Review report (WSP and Stantec, September 2021), the predicted impacts to the escarpment seeps under full Phase 2A and 2B extraction is expected to range between a 2% to 6% reduction compared to the baseline. Therefore, the use of injection wells during Phase 2A and 2B extraction is not predicted to be necessary, as the predicted reductions will likely not be distinguishable from natural variation.

Nonetheless, injection wells IW1, IW1a, IW2, IW3 and IW4 were installed in 2014, the locations are shown on **Figure 2**. Injection testing was completed at these wells later in 2014, with achievable injection rates of between 130 m^3/day and 400 m^3/day (20 Igpm to 60 Igpm). Predictive modeling completed as part of the 5-Year Comprehensive Review report (WSP and Stantec, September 2021) found that injection rates as low as 20 m^3/day (3 Igpm) were successful in matching the baseline flow rates. Therefore, the existing injection well network appears to be capable of mitigating the predicted impacts, if deemed necessary.

In summary, based on the monitoring data collected to date, use of the injection wells is not required at this time. The Phase 2A and 2B predictive modeling suggests that the activation of the injection wells will likely not be required during Phase 2 of the extraction. The need to activate the injection well system will be reassessed based on the on-going PITM results. It is noted that the ECA (Sewage) will need to be amended to allow discharge to the injection wells as a contingency measure, if necessary.

7.7 Operations Improvement Workshop

As part of its commitment to working with the community, WAI held an annual Operations Improvement Workshop for neighbours and other interested stakeholders on July 14, 2023. The 2022 Annual Summary and Performance Report was an agenda item at the Workshop.

7.8 Recommendations

The 5-Year Comprehensive Review report included a number of recommended changes to the AMP monitoring program, reproduced below.

Proposed Monitoring Network Changes

- Preliminary stage-discharge relationships for surface water stations have been developed using 2023 manual flow measurement and water level data to convert logger water level data to flow rates. Additional manual flow measurement and water level data obtained in 2024 will be used refine the stage-discharge relationships.
- Escarpment seep trigger station SW21C is situated on private property. It is understood that this feature was modified by the property owner in 2019. Therefore, data is no longer representative of baseline conditions and trigger exceedances at this station are not reliable. At downstream trigger station SW15, the culvert was replaced in 2021 as part of Concession 10 road re-construction. The new culvert invert appears to be at a higher elevation than the previous culvert and trigger exceedances at SW15 may also not be reliable. These factors should be considered when assessing trigger exceedances in future reports. Similarly, escarpment seep trigger station SW24A is situated on private property. It is understood that this feature was modified by the property owner in 2021 and the stream channels for SW24A and SW24B have been merged; therefore, data is no longer representative of baseline conditions and trigger exceedances at this station are not reliable. It is recommended that trigger assessment be continued at downstream stations SW17.
- A suitable, representative reference wetland within the Nottawasaga Lookout or Pretty River Provincial Parks has not been identified. Now that enough data are available to develop wetland target hydrographs, the use of a reference wetland to assess potential quarry impacts appears redundant. It is therefore recommended to discontinue the search for a reference wetland.

Proposed PITM Changes

An alternative long-term trigger mechanism and trigger values are proposed, as noted in Section 6.5 of the 5-Year Comprehensive Review report.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The information contained within this report meets the requirements of PTTW Condition 4.5, ECA (Sewage) Condition (7)(3) and the AMP. Based on the information presented in this report, the following conclusions and recommendations are provided.

- Dewatering effects are within predicted limits.
- Dewatering operations at the Site affect local groundwater elevations near the extraction area. The maximum drawdown occurs at the quarry rock face and decreases with distance from the quarry.
- Dewatering influences are generally confined to within the quarry licence area and are consistent with the maximum predicted limit of drawdown for Phase 2A from the recent 5-Year Comprehensive Review report. To date, local surface water features and domestic wells have not been affected by dewatering operations in the Extension Quarry.
- The quarry has been operated in compliance with the PTTW in 2023.
  - One water well interference complaint was received by WAI in September 2023; however, it was determined not to be related to the quarry and further mitigation measures were not required.
  - As per PTTW Condition 4.4 (i & ii), Rob Roy Swamp 6 and Beaver River Tributary continue to receive discharge within the historical range of flows and therefore, there is no requirement to adjust the discharge rates from the sump. In late 2023, replacement of the discharge pipe (running through Rob Roy Swamp 6) with a new pipe was initiated. This work was completed in February 2024. Operation of the new discharge pipe is expected to lower surface water levels in Rob Roy Swamp 6 over time by reducing leakage from the pipe network.
  - As per PTTW Condition 4.4 (iii), no changes to the PTTW are recommended at this time.
  - As per PTTW Condition 4.4 (iv), the 2023 monitoring results demonstrate that no undesirable effects on the environment from the quarry operations have occurred during this monitoring period.
  - It is recommended that the groundwater and surface water monitoring program outlined in Condition 4.3 of the PTTW should be continued in 2024 with no changes.
- The quarry has been operated in compliance with the ECA (Sewage) in 2023.
  - It is recommended that the outstanding ECA clarifications as mentioned in Section 1.2 be discussed with the MECP and incorporated into an amended ECA to allow discharge to the wetland mitigation system and contingency injection wells, if necessary.
  - It is recommended that the monitoring program outlined in the ECA (Sewage) should be continued in 2024 with no changes.
- The quarry has been operated in compliance with the AMP in 2023.
  - A number of PITM trigger exceedances were observed in 2023. However, the exceedances are not attributed to the Extension Quarry due to (a) the sporadic, generally discontinuous nature of the trigger exceedances and (b) the interpreted drawdown cone from the Extension Quarry did not extend beyond the Licence boundary in 2023.

  - As noted above, replacement of the discharge pipe (running through RR6 wetland) is expected to lower surface water levels in RR6 wetland over time and help reduce “wet” trigger exceedances.Where trigger exceedances were observed, conditions generally returned to the “green zone” for the subsequent event suggesting no trend exists.
  - The LTTWM was successfully completed as prescribed in the AMP. Overall, the 2023 water levels are generally within historical ranges. Sporadic measurements outside of the historic ranges have been observed, but subsequent measurements have generally returned to baseline ranges soon thereafter. In some cases, measurements outside of their historic ranges may be attributed to the deviation of climatic conditions in comparison to the baseline monitoring period.
  - The LTTEM amphibian and wetland vegetation monitoring indicates that the wetlands generally remain consistent in their floristic character and remain as healthy wetland communities. Rob Roy Swamp 6 remains as a diverse wetland feature but will continue to succeed to a more open canopy wetland environment.
  - The LTTEM American Hart’s Tongue fern (AHTF) baseline monitoring indicates that the colony has a high canopy closure rate with recurring sexual regeneration.
  - The EEMM woodland program monitoring results suggest that the reforestation areas are contributing to local forest function and are on a trajectory to becoming self-sustaining components of the woodland landscape through establishment of a healthy woodlot with enhanced species diversity, a shade-tolerant understorey and wildlife habitat. Reassessment will be completed in 2028.
  - The EEMM amphibian monitoring of the new Millar Pond was initiated in 2021 and reassessment was completed in 2023 as part of the LTTEM amphibian monitoring program. The first-year results indicated an active pond environment that is anticipated to increase in diversity as the created pond becomes established on the landscape. The 2023 results were consistent with previous observations.
  - The EEMM butternut tree health re-assessments were completed in 2023. Of the twenty-seven (27) retainable trees identified within the licenced extraction area in 2009, only eleven (11) could be located in 2023, with the remainder presumed fallen and decayed. The results of the 2023 butternut tree health re-assessment will be submitted to the MECP under separate cover.
  - A surface water discharge system is required as part of the routine water management measures in the AMP. The discharge system will require an ECA to operate and the design was provided to MNRF in September 2023. WAI is awaiting comments from MNRF to proceed with a formal ECA application with MECP.
  - Contingency mitigation measures (including the injection wells) were not required in 2023. The use of the injection wells during Phase 2A and 2B extraction is not predicted to be necessary, as per the 5-Year Comprehensive Review.
  - Recommended changes the AMP monitoring program are provided in **Section 7.8**. It is noted that regulatory approval is required to implement the proposed PITM changes.
- A copy of the 2023 Annual Summary and Performance Report should be submitted to the District Manager by March 31, 2024, per Condition 7 (3) of the ECA.

Signature Page

WSP Canada Inc.

ORIGINAL IS SIGNED

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https://wsponlinecan.sharepoint.com/sites/ca-ca00201996213/shared documents/06. deliverables/duntroon quarry - 2023 summary and performance report_f.docx

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