WALKER AGGREGATES INC.

DUNTROON QUARRY

2021 ANNUAL SUMMARY AND PERFORMANCE REPORT

APRIL 30, 2022

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WALKER AGGREGATES INC.

PROJECT NO.: 111-53312-05
DATE: APRIL 30, 2022

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April 30, 2022

WALKER AGGREGATES INC.
P.O. Box 100
Thorold, ON
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Attention: **Ms. Carrie Barnes**

Dear Ms. Barnes:

Subject: **Duntroon Quarry – 2021 Annual Summary and Performance Report**

We are pleased to provide a copy of the 2021 Annual Summary and Performance Report for Duntroon Quarry. The report contains a compilation of the groundwater and surface water data collected at Duntroon Quarry from January 1 to December 31, 2021. An assessment of the results, as required in Amended Permit-to-Take-Water (PTTW) No. 7725-AACS54, Environmental Compliance Approval for Industrial Sewage Works (ECA (Sewage)) No. 1521-A4VJ4X, and the Adaptive Management Plan (AMP) is also included.

It is noted that the data and reporting for the AMP Long-Term Trend Ecological Monitoring (LTTEM) and the Ecological Enhancement and Mitigation Monitoring (EEMM) was completed by Stantec Inc. and is appended to this report.

In summary, the daily water taking from the Site was conducted in compliance with the PTTW. Additionally, operation of the industrial sewage works was conducted in compliance with the ECA (Sewage). Some AMP trigger exceedances were observed in 2021 but are attributed to drier than normal conditions observed during winter and spring and not interpreted to be the result of quarry dewatering.

We thank you for the opportunity to be of service. If you have any questions or require clarification, please call.

Yours truly,

ORIGINAL IS SIGNED

Kevin Fitzpatrick, P.Eng.
Senior Project Engineer

WSP ref.: 111-53312-05

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The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by WSP and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 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 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 there has ceased with the Extension Quarry licence granted in 2014, and extraction within Phase 1 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 the Extension Quarry. To maintain dry working conditions, the quarry is dewatered under Permit to Take Water (PTTW) number 7725-AASC54, 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, 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). Some preamble text in the ECA (Sewage) refers to 130 L/s and this should be corrected.
- 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 sewer line 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 due to safety concerns. 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, 2021 and December 31, 2021 to satisfy the requirements of:

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

WSP was retained to complete the 2021 report. Since June 2018, field monitoring tasks are completed by WAI staff. Water resources monitoring is on-going.

1.4 MONITORING PROGRAM CONTACT NAMES

Carrie Barnes, B.Sc., P.Geo. – EPD Business Partner, Walker Industries

Jacqueline Forbes – EPD Coordinator, Walker Industries

Craig Leger, M.Sc., C.E.T. – Environmental Consultant, WSP Canada Inc.

Leigh Davis, M.A.Sc., P.Eng. – Project Engineer, WSP Canada Inc.

1.5 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 ecological features that will be compared to later phases as the quarry expands.

The Main Duntroon Quarry has been mined such that no bedrock resource is extracted. 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 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, 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 2021, extraction has only just reached the Phase 2A boundary and tunnel sealing activities therefore remain years into the future

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. As of 2021, 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 sewage 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. 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 pipe. The 300 mm pipe outlets on WAI property, in the wetland, north of SW1. 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. 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.

1.5.1 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 is 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 that site`s second bench floor elevation of 502 masl.

2 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 is a local groundwater high in the eastern section of the Extension Quarry, and another groundwater high in the western section of the Extension Quarry, resulting in a groundwater divide through the area. 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 both the Main Quarry and Expansion 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 MONITORING PROGRAM

The following sections describe the annual monitoring program undertaken at the Site in 2021 to satisfy the conditions of the AMP, PTTW and ECA (Sewage).

3.1 GROUNDWATER LEVELS AND TEMPERATURE

Monthly 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**. A number of wells are also equipped with automated dataloggers and downloaded periodically throughout the year. In addition, manual monthly temperature measurements are obtained at the specified drivepoints.

3.1.1 Monitoring Wells

Monthly 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 thirty (30) 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 monthly water levels are also obtained 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-74**.

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 and BH02-1 in 2020. It is noted that BH02-2 and NW3 (Phase 2A), NW5 (Phase 2B) an NW7 and NW8 (Phase 3A) are also situated within the limit of extraction and will be removed from the program as the quarry development progresses.

Monthly groundwater levels are also obtained 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. Since installation, monthly groundwater levels have been obtained, as shown on **Table B-3** and the hydrographs 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, twelve (12) domestic wells are included in the monthly water level monitoring. 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 well RW19 was also located on WAI-owned lands but was removed from the monitoring program in 2020 as it is located within the limit of extraction. RW18 is situated within the Phase 2A extraction area and will be removed as the quarry face advances.

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 which represented a health and safety issue for monitoring access, and concern for potential groundwater contamination. 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 was discontinued in 2019 at the owner's request.

Since 1996, monthly groundwater level measurements have also 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. It is noted that groundwater level measurements are difficult to obtain at the CLF wells due to the presence of equipment and cables within the well casing.

3.1.4 Drivepoints

Monthly manual water level elevation and temperature measurements are also obtained at eleven (11) drivepoints installed in the wetland features surrounding the Site. Surface water depth surrounding the drivepoint is also recorded monthly for comparison. 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 DP11 in Rob Roy Swamp 3 northwest of the Site is 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 reference wetland in either the Nottawasaga Lookout Provincial Park or the Pretty River Provincial Park as an additional monitoring point for assessment of potential impacts to wetland water levels. A satisfactory reference wetland could not be 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 at the surface water stations outlined in **Table A-2**, **Appendix A-2**. Bi-weekly monitoring during June, July and August is also undertaken at selected Escarpment Spring stations as noted below. The monitoring locations are shown on the Site Plan, **Figure 2**. A number of stations are also equipped with automated dataloggers for water level and temperature monitoring and are downloaded periodically throughout the year. In addition, quarterly and annual surface water sampling is completed at selected stations. Laboratory analysis is completed by Caduceon Laboratories (January 2021) and BereauVeritas (remainder of 2021, both of which are CALA-accredited laboratories.

3.2.1 Surface Water Stations

Monthly flow and field measurements are currently obtained at forty-nine (49) stations. 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 SW22B, SW23, 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. Dataloggers and staff gauges have been installed at stations: SW1, SW2, SW0-2, SW3, SW6A, SW9, SW15, SW16, SW18 and SW3B. Staff gauges have been installed at stations: SW14, SW17, SW17A PR Control and BC Control.

Manual flow measurement data are provided in **Tables C-1 and C-2**, **Appendix C**. **Table C-3** provides a yearly summary high, low and seasonal flow averages at each station. Monthly field parameter data are provided in **Table C-4**. 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 quarterly and annual surface water quality data are 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 communication with these devices has been intermittent since their establishment due to the rolling terrain and forest cover.

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 temperature 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. For the 2021 report, climate data from Collingwood climate station, located on Georgian Bay approximately 13 km north of the Site, has been included in the analysis for comparison as it is situated much closer to the Site.

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. Data gaps due to equipment failure have occurred over the past 5 years and operations have been adjusted as required to limit data loss.

The combination of climate data from the Shanty Bay and Collingwood climate stations 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 Thorthwaite-Mather method using the available Shanty Bay, Collingwood and WAI climate station data since 2003 are provided in **Tables D-2 to D-20**. 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 2021 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. 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. 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 Effluent Limit compliance is provided in **Table E-2**, while the full results of the monthly discharge sampling are provided in **Table E-3**.

4 RESULTS AND DISCUSSION

4.1 CLIMATE DATA

The climate data from the Shanty Bay and Collingwood stations 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 and Collingwood climate stations 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 75th and 25th 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 both Shanty Bay and Collingwood stations are similar to that of the climate normal; however, the monthly net surplus for the Collingwood station tends to be somewhat lower.

The net water surplus calculated using the 2021 Site data from WAI station and the Shanty Bay and Collingwood stations are also shown on the plot. The 2021 monthly net water surplus calculated for the three stations is similar. Overall, the data indicate that during 2021, the monthly water surplus was below the median of the baseline data during the winter and spring, while the remainder of the year was similar to the baseline median.

Baseline average monthly temperature data for the Shanty Bay and Collingwood climate stations 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 both Shanty Bay and Collingwood stations are similar to that of the climate normal; however, the monthly average temperature at the Collingwood station is typically 1°C to 2°C warmer.

The average monthly temperatures from the 2021 Site data from WAI station and the Shanty Bay and Collingwood stations are also shown on the plot. The temperature data from the Shanty Bay and Collingwood stations is similar, while the WAI station temperatures are typically 1°C to 2°C cooler, particularly during the fall. The WAI station data suggest that temperatures were similar to the median of the baseline data at the Site in 2021.

The WAI station data appears to track more similarly to the Collingwood climate station data, and it is recommended that this station be used in future reports.

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 2021 average daily discharge data are also shown for comparison and indicate that the observed flows were generally between the median and 75th percentile of the baseline data for both watercourses. This indicates that local runoff at the Site is expected to be marginally above baseline median conditions.

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 lands 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 and spring of 2021 was below the median of the baseline data, indicating drier than normal conditions during that period. Generally, water levels in 2021 recovered to within previously recorded ranges by the end of the year. Overall, the 2021 water levels are generally within historical ranges. Localized drawdown due to quarry extraction activities is observed at some locations in the vicinity of Phase 2A, as expected.

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

<u>Main Quarry Monitoring Wells</u>

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 for each monitor. 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. Water levels in 2020 were variable and inconsistent with previous water levels or seasonal variations but have returned to historic ranges in 2021. Further monitoring of the long-term trends will be completed.
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. Water levels in late 2020 and early 2021 were variable and inconsistent with previous observations but returned to historic ranges later in 2021. Further monitoring of the long-term trends will be completed.
98-12	**B-4**	Approximately 14 m of historical impact from aggregate extraction through 2007. Stable groundwater levels with 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 the (i) active extraction areas located at the north property boundary of the Main quarry and the (ii) 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.

Lower than normal precipitation during the 2018 and 2019 summer months resulted in multiple wells setting new minimum water levels but within predictions of hydrogeologic models completed as part of Site licencing.

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 Expansion 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 general decline 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)*

Monitoring Well	Figure	Discussion
BH02-4	**B-9**	Seasonal fluctuation of about 7 m. General decline between 2015 and 2019. *(removed from monitoring program in 2019)*
BH02-5	**B-10**	Groundwater levels within previously recorded seasonal variation of about 2 m.
BH02-6	**B-11**	Decline in water level of about 8 m in 2015 due to tunnel construction. Water levels have generally remained stable since that time.
BH03-7 nest	**B-12**	Groundwater levels within previously recorded seasonal variation of about 2 m.
BH03-8	**B-13**	Groundwater levels show seasonal variation of about 2 m. A new maximum groundwater level was reported in February 2020 but water levels have returned to historic ranges since that time. Further monitoring of the long-term trends will be completed.
BH03-9	**B-14**	Water levels began showing seasonal variations in 2016. New minimum groundwater elevation reported in October 2019 due to dry conditions. A new maximum groundwater level was reported in June 2020 but water levels have returned to historic ranges since that time. Further monitoring of the long-term trends will be completed.
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 seasonal variations in 2016 with a historic low observed in October 2019 due to dry conditions.
BH08-1 **BH08-2** **BH08-3**	**B-18** **B-19** **B-20**	Wells are in close proximity to each other and show redundant information. Groundwater levels within previously recorded seasonal variation of about 5 m.
NW1	**B-21**	Groundwater levels declining after July 2016, now stable at about 502 masl, the inferred 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 generally consistent and display seasonal variation of about 5 m. Several historic low water levels measured in late 2020 but water levels have returned to historic ranges in 2021. Further monitoring of the long-term trends will be completed.
NW4	**B-24**	Groundwater levels have shown an overall decline since 2016. *(removed from monitoring program in 2019)*
NW5	**B-25**	Groundwater levels have shown an overall decline since 2016.
NW6	**B-26**	Groundwater levels have shown an overall decline since 2016.
NW7	**B-27**	The groundwater levels have been generally variable. The cause of this is undetermined but may be related to monitor construction / location.
NW8	**B-28**	Groundwater levels have been generally consistent and display seasonal variation of about 2 m.
NW9	**B-29**	Groundwater levels have been generally consistent and display seasonal variation of about 2 m.

Monitoring Well	Figure	Discussion
NW10 nest	B-30	NW10 drivepoint groundwater levels remain relatively stable with about 1 m seasonal variation. NW10 shallow and deep monitoring well groundwater levels have been generally consistent and display seasonal variation of about 2 m.

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 rebound by the end of the year to fall within seasonal averages. The spring also provides flow to SW2.

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. Anomalous manual groundwater elevations recorded in 2019, as indicated by the logger data.
IW3	B-33	Groundwater levels displaying seasonal variations. Less than 9 m difference between peak and low groundwater levels. Likely anomalous water level in July 2021.
IW4	B-34	Groundwater levels show fluctuations related to seasonal climate variations of about 4 m. Likely anomalous water level in July 2021.

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 were within previously recorded seasonal variations. New maximum groundwater levels reported in April and May 2020 but water levels returned to the historical range in 2021. Further monitoring of the long-term trends will be completed.

RW2	**B-36**	Access not initially granted by new homeowners in 2018. Water levels continue to vary over a wider range since 2018. Further monitoring of the long-term trends will be completed.
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 within previously recorded seasonal variations with the exception of new maximum groundwater levels reported in 2020 and 2021. Further monitoring of the long-term trends will be completed.
RW6	**B-40**	Groundwater levels generally within previously recorded seasonal variation of about 2 m. June 2021 water level appears to be anomalously low. Further monitoring of the long-term trends will be completed.
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 in 2021. Further monitoring of the long-term trends will be completed.
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. New minimum groundwater level reported in February 2020 but levels returned to historic range in 2021. Further monitoring of the long-term trends will be completed.
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 averages, about 5 m of seasonal variation.
RW17	**B-47**	Groundwater levels within previously recorded seasonal variation of about 2 m.
RW18 (owned by WAI)	**B-48**	Historic low water levels observed in 2021. This well is within the limit of extraction and drawdown as quarry face advances is expected. Will eventually need to be removed as part of Phase 2A extraction.
RW19 (owned by WAI)	**B-49**	Decrease in water level of about 4 m between 2015 and 2020. *(removed from monitoring program in 2020)*

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 is no longer possible as the well casing has reportedly failed. Repairs to CLF2 are not recommended at this time, as 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 generally within previously recorded seasonal variation of about 1 m. A historic low groundwater level was observed in February 2020 but 2021 levels have returned to historic range. Further monitoring of the long-term trends will be completed.
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 generally increased since 2005, seasonal variation of about 1 m. A historic low groundwater level was observed in January 2020 but water levels in 2021 have returned to the historic range. Further monitoring of the long-term trends will be completed.
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.

Drivepoints

The drivepoints included in the groundwater monitoring program represent the shallow groundwater table near various sensitive features in close proximity to the Site. Monitoring at the two drivepoints is required under the Surface Water Monitoring section of the PTTW. During the winter and summer months, drivepoints 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 Drivepoints

Drivepoint	Figure	Discussion
DP1	**B-63**	Groundwater levels have generally increased by about 1 m since 2015. Further monitoring of the long-term trends will be completed.
DP2	**B-64**	Water levels have been stable and showing a slight increasing trend since 2010-2011.
DP3	**B-65**	Water levels generally within previously recorded seasonal variations. Historic low observed in July 2021. Further monitoring of the long-term trends will be completed.
DP4	**B-66**	Seasonal variation generally within previously reported values. New minimum level observed in April 2020 but water levels in 2021 have returned to the historic range. Further monitoring of the long-term trends will be completed.
DP5	**B-67**	Seasonal variation within previously reported values.
DP6	**B-68**	Seasonal variation generally within previously reported values. New maximum level observed in September 2021. Further monitoring of the long-term trends will be completed.
DP7	**B-69**	Limited data set. Seasonal variation generally within previously reported values. New maximum level observed in September 2021. Further monitoring of the long-term trends will be completed.
DP8	**B-70**	Limited data set. Muted seasonal variation within previously reported values. Water level observed in April 2020 was a historic low but water levels in 2021 have returned to historic range. Further monitoring of the long-term trends will be completed.
DP9	**B-71**	Limited data set. Muted seasonal variation generally within previously reported values. New maximum levels observed in June and September 2021. Further monitoring of the long-term trends will be completed.
DP10	**B-72**	Limited data set. Seasonal variation leading to historic high and low water levels were observed in 2020 and 2021. Further monitoring of the long-term trends will be completed.
Bridson DP	**B-73**	Seasonal variation within previously reported values.

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 and 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 April 2021 (spring conditions) and October 2021 (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 recent construction of the tunnel 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 m asl and 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 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 Expansion 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, NW5, NW6 and NW7 west / northwest of Phase 1 and BH02-2, RW18 and NW3 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 2021, the 5-year Comprehensive AMP Report was completed for the Site, and 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 remained within the monitoring wells within the predicted limit.

Domestic well CLF2, located approximately 700 m southwest of the Main Quarry, has historically shown drawdown effects. 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 Site.

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 Observations

Station	Figure	Discussion
Beaver River Tributary System		
SW1	**C-1** **C-1a**	Surface water flows and temperature fluctuating within seasonal ranges. New maximum flow observed in April 2020 but flows in 2021 have returned to historic range.
SW2	**C-2** **C-2a**	Surface water flows and temperature fluctuating within seasonal ranges.
SW0-2	**C-3** **C-3a**	Surface water flows and temperature fluctuating within seasonal ranges.
QFSW2	**C-4**	Surface water flows fluctuating seasonally, general decreasing trend since 2012.
SW3	**C-5** **C-5a**	Surface water flows and temperature generally fluctuating within seasonal ranges. New temperature maximum observed in logger data from May 2021 likely associated with high ambient air temperatures / very low flow conditions in the watercourse.
SW3A	**C-6**	Surface water flows fluctuating seasonally. Spring 2021 flows below historical observations due to drier than normal climatic conditions.
SW4	**C-7**	Surface water flows fluctuating seasonally.
SW5	**C-8**	Surface water flows fluctuating seasonally. Spring 2021 flows below historical observations due to drier than normal climatic conditions.
SW6	**C-9**	Surface water flows fluctuating seasonally.
SW6A	**C-10** **C-10a**	Surface water flows and temperature fluctuating within seasonal ranges.
SW3B **('RR3 Karst')**	**C-47** **C-47a**	Minimal flow typically observed at this station. High logger temperature data observed during summer months likely the result of high ambient air temperature during dry periods. April 2020 stream flow was above the historic range, but conditions were generally dry during 2021.
SW3C **('RR3 Out')**	**C-46**	Minimal flow typically observed at this station. New maximum observed in March 2021.

Batteaux Creek Tributary System		
SW7	**C-11**	Minimal flow typically observed at this station. Spring 2021 flows below historical observations due to drier than normal climatic conditions.
SW8	**C-12**	Minimal flow typically observed at this station. Spring 2021 flows below historical observations due to drier than normal climatic conditions.
SW9	**C-13** **C-13a**	Surface water flows and temperature generally fluctuating within seasonal ranges. Spring 2021 flows below historical observations due to drier than normal climatic conditions. New temperature maximum observed in May 2021 logger data likely associated with high ambient air temperatures / very low flow conditions in the watercourse.
SW12	**C-21**	Surface water flows fluctuating seasonally.
SW12A	**C-22**	Surface water flows fluctuating seasonally. Spring 2021 flows below historical observations due to drier than normal climatic conditions.
SW13	**C-23**	Surface water flows fluctuating seasonally.
SW14	**C-24** **C-24a**	Surface water flows and temperature fluctuating within seasonal ranges.
SW15	**C-25** **C-25a**	Surface water flows and temperature fluctuating within seasonal ranges.
SW19	**C-31**	Surface water flows fluctuating seasonally.
SW21	**C-33**	Minimal flow typically observed at this station.
SW21A	**C-34**	Surface water flows fluctuating seasonally.
SW21B	**C-35**	Surface water flows fluctuating seasonally. Spring 2021 flows below historical observations due to drier than normal climatic conditions.
SW21D	**C-37**	Minimal flow typically observed at this station. Spring 2021 flows below historical observations due to drier than normal climatic conditions.
SW22	**C-38**	Surface water flows fluctuating seasonally.
SW22A	**C-39**	Surface water flows fluctuating seasonally.
SW22C	**C-40**	Surface water flows fluctuating seasonally. Spring 2021 flows below historical observations due to drier than normal climatic conditions.
BC Control	**C-49** **C-49a**	Surface water flows and temperature fluctuating within seasonal ranges.

PRETTY RIVER TRIBUTARY SYSTEM		
SW16	**C-26** **C-26a**	Surface water flows and temperature fluctuating within seasonal ranges.
SW17	**C-27** **C-27a**	Surface water flows and temperature generally fluctuating within seasonal ranges. New temperature maximum observed in late August 2021 likely associated with high ambient air temperatures / very low flow conditions in the watercourse.
SW17A	**C-28** **C-28a**	Surface water flows and temperature fluctuating within seasonal ranges.
SW17B	**C-29**	Surface water flows fluctuating seasonally.
SW18	**C-30** **C-30a**	Surface water flows and temperature fluctuating within seasonal ranges. Accessibility limited in 2021 due to Concession 10 construction.
SW20	**C-32**	Surface water flows fluctuating seasonally.
SW24	**C-41**	Surface water flows fluctuating seasonally.
SW24B	**C-43**	Surface water flows fluctuating seasonally. Spring 2021 flows below historical observations due to drier than normal climatic conditions. Landowner has significantly altered this tributary in 2021.
SW24C	**C-44**	Surface water flows fluctuating seasonally.
PR Control	**C-48** **C-48a**	Surface water flows and temperature fluctuating within seasonal ranges. Spring 2021 flows below historical observations due to drier than normal climatic conditions.

4.3.2 Escarpment Springs

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

Table 4.9 Escarpment Spring Flow and Temperature Observations

Station	Figure	Discussion
SW10	**C-14** **C-14a**	Surface water flows and temperature fluctuating within seasonal ranges.
SW11	**C-15** **C-15a**	Surface water flows and temperature fluctuating within seasonal ranges.
SW11A	**C-16**	Surface water flows fluctuating within seasonal ranges.
SW11B	**C-17**	Surface water flows fluctuating within seasonal ranges.
SW11C	**C-18**	Surface water flows fluctuating within seasonal ranges.
SW11D	**C-19**	Surface water flows fluctuating within seasonal ranges.
SW11E	**C-20**	Surface water flows fluctuating within seasonal ranges.

SW21C	**C-36** **C-36a**	Surface water flows and temperature generally fluctuating within seasonal ranges. New maximum temperature observed in August 2021 likely associated with high ambient air temperatures / very low flow conditions in the watercourse.
SW24A	**C-42** **C-42a**	Surface water flows and temperature fluctuating within seasonal ranges. Landowner has significantly altered this tributary in 2021.
SW77	**C-45** **C-45a**	Surface water flows and temperature generally fluctuating within seasonal ranges. Higher than normal flows observed in late 2020 continued into early 2021; however, flows since that time have returned to historic range.

4.3.3 Surface Water Quality

The annual water quality sampling event was completed for selected surface water monitoring stations on May 26-27, 2021. 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 2021 results are included in **Table C-5**.

A duplicate sample was obtained at station PR Control. The relative percent difference (RPD) was calculated for the duplicate results and was within 20% for all of the parameters. Therefore, the 2021 water quality results are considered acceptable in terms of quality assurance and controls.

Surface water quality analytical results are compared to the Provincial Water Quality Objectives (PWQO) (MECP, July 1994). The water quality samples obtained in 2021 generally met the PWQO with the exception of the following:

- ➔ Total phosphorus concentrations at SW1, SW0-2, SW10, SW11B, SW11D, SW11E, SW16, SW21C and SW77.
- ➔ Iron concentrations at SW1, SW3, SW3B, SW11B, SW11E, SW16 and SW21C.

The 2021 PWQO exceedances in the surface water samples are generally consistent with historic results, although more exceedances were observed in 2021 than in previous years. Low flow / stagnant conditions in the tributaries due to drier than normal climate conditions likely contributed to the overall poorer surface water quality observed in 2021.

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 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 quarry dewatering / water management operations. Pumps DN2 and DN3a were used intermittently in 2021 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 a real-time flow rate for the quarry discharge. An average daily flow rate was calculated based on the recorded flow rates at the flow meter. The daily quarry discharge rates and volumes for 2021 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 volume met the permitted volumes during 2021.

4.4.2 Discharge Quality

Monthly discharge water quality samples were obtained in 2021 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 27, August 11 and October 7, 2021. It is noted that Sump 2 was frozen during the February sampling event. The results of the quarterly water quality sampling are included in **Table C-5**, **Appendix C**.

Duplicate samples were obtained at station Sump 1 in February, May and October and at QFSW2 in May and August. The RPD was calculated for the duplicate results taken during each monitoring event. The RPD was generally within 20%. The exceptions were concentrations of total phosphorus at Sump 1 and QFSW2 and colour at Sump 1 in May. Both the original and duplicate results for these parameters were within the historic range of concentrations at their respective sampling locations. Therefore, the 2021 quarterly discharge quality results are considered acceptable in terms of quality assurance and controls.

As shown in **Table C-5**, the 2021 quarterly discharge water quality samples met the PWQO.

Bacteriological results for the 2021 quarterly discharge water quality analysis 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. There is no specific objective for bacteriological parameters under the PWQO.

The quarterly discharge quality results generally have hardness concentrations ranging from 310 - 400 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 existing 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 wetland are similar to pre-expansion levels.

5 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** 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 real-time flow rates monitored by the flow meter on the discharge line from Sump 1. Daily flow volumes are summarized in **Table E-1**, **Appendix E**. The daily discharge volume met the permitted volume in 2021.

5.2 CONDITION 5.2 – WELL INTERFERENCE

During 2021, WAI received no well interference complaints from the local water well users. As such, the well interference investigation and mitigation programs were not implemented in 2021. 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)

The monthly groundwater monitoring was completed successfully in 2021 as shown in **Tables B-1, B-2 and B-4**. During winter months, the monitoring locations were occasionally inaccessible due to frozen conditions / snowdrift. In addition, a water level could not be obtained from RW1 in June as the well owner was unavailable.

As noted previously, monitoring of CLF2 was discontinued as the casing failed in 2020. There is no recommendation to repair or replace this well as adequate water level monitoring data are obtained by the remaining wells CLF3, CLF4 and CLF5. Historic monitoring wells BH02-1, BH02-3, BH02-4 and RW19 have been removed from the monitoring program in the current PTTW as they are situated within the limit of extraction.

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 Monthly for remainder of the year

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 a datalogger and laboratory analysis.
2 WAI obtains streamflow measurements on a monthly basis when the field chemistry is being collected since the field technician is already at each location. Flow data provides context for the chemistry data.
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 2021 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-4** and annual water quality analysis results are provided in **Table C-5**. 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 2021 was 4.1 L/s and the average fall flow was 15 L/s. This is consistent with the 2021 climate data which shows drier than normal conditions in the spring but more normal conditions in the fall.

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. At SW1, the elevation of the invert of the twin outlet culverts at Grey County Road 31 is set above the surrounding grade in the wetland, such that ponded surface water must accumulate in the wetland before flow can occur through the culverts. The measured flow at SW1 is presented on **Figure C-1**.

Historically, when the quarry stopped discharging off-site, flow through the culverts would continue until the water level in the wetland dropped below the invert of the culverts. 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 Osprey 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 monitored bi-weekly and monthly in 2021 to meet the requirements of the PTTW monitoring program as shown in **Tables B-7 and B-8**.

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.

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**. Water levels were relatively consistent between 2011 and 2017, but in 2018 dropped to similar levels observed in the early 2000s.

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 2021 are presented in **Table B-8**. Seasonal variation in surface water temperature was observed, ranging from frozen conditions to high temperatures of 22.9ºC in June at DP2 and 23.6ºC in June at DP4.

6 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** 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 flow rate recorded by the flow meter. The recorded rate was below the maximum permitted 250 L/s limit during the 2021 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 2021 monthly discharge quality generally complied with the ECA (Sewage) Effluent Limits. The exception was the July 8 TSS concentration. As per ECA (Sewage) Condition 4(2), a follow-up confirmation sample was obtained on July 26. The TSS concentration in the follow-up sample was below the Effluent Limit; therefore, the TSS Effluent Limit exceedance was not confirmed, and the Works complied with the Effluent Limits in 2021.

6.3 CONDITION 5 – EFFLUENT VISUAL OBSERVATIONS

Visual observations were made during each of the 2021 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

NOTE: 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 near the end of the 300 mm discharge line. The monthly sampling results are presented in **Table E-3**. 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-3 for comparison, as required by Condition 7(3)(a) of the ECA (Sewage). In summary, the 2021 monthly discharge water quality generally met the PWQO for the respective parameters. The exceptions were the alkalinity concentrations in July, August, September and October; however, subsequent monthly samples met the PWQO for alkalinity. The 2021 alkalinity exceedances are similar to historic results. It is noted that the only background sample in 2021 was obtained in May and may not be representative of conditions in the watercourse during the months when the alkalinity PWQO was exceeded.

The following observations were made based on the 2021 monthly discharge quality results:

- pH levels ranged between 7.4 and 8.1 (field measurements).
- Total oil and grease was reported at a detectable limit in two out of thirteen grab samples. The highest concentration of total oil and grease reported during 2021 was 2.5 mg/L in January. 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 2021, with the exception of July 8 (52 mg/L), July 26 (19 mg/L) and September (13 mg/L). The ECA (Sewage) Effluent Limit for TSS is 25 mg/L. The July 8 sample which exceeded the TSS Effluent Limit was resampled on July 25 and was found to comply.
- The additional parameters included in the monthly analysis show some minor variation in concentrations over the 2021 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 2021 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 2021 and is adequate to meet the Effluent Limits.

Quality Assurance / Quality Control (QA / QC)

The following effluent QA / QC measures were undertaken during the 2021 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 proficiency 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 2021 the effluent was sampled from the discharge line during a period of water discharge off-site (the line is otherwise empty).
- ➔ Field parameters and observations are recorded in a dedicated field book 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 line flow meter. Maintenance of the Works equipment is performed as required.

7 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 is 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**. 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’)***.

Dataloggers and staff gauges have been installed at stations: SW1, SW2, SW0-2, SW3, SW6A, SW9, SW15, SW16, SW18 and SW3B. Staff gauges have been installed at stations: SW14, SW17, SW17A, PR Control and BC Control. It was planned 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 communication with these devices has been intermittent since installation. Real time monitoring would again be considered if the local communication infrastructure was to be improved.

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 and an assessment of flow conditions through either the use of an electromagnetic flow meter, and in some cases by manual measurement or visual assessment. Field chemistry parameters (temperature, pH, dissolved oxygen and conductivity) are also recorded monthly. In addition, more detailed hourly monitoring at selected PITM surface water stations equipped with data loggers was also conducted.

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**. 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 3 (RR3) wetland: DP10
- 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 for the remainder of the year. Drivepoints DP5 and DP6 are equipped with dataloggers. Monitoring includes 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-26**, **Appendix F**. 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").

<u>Surface Water Flow and Temperature Triggers</u>

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	511.15	511.25	511.66	511.76	509.75	509.84	510.20	510.29
May	511.08	511.30	512.20	512.42	511.14	511.25	511.65	511.75	509.51	509.64	510.13	510.26
June	510.64	510.94	512.14	512.44	511.01	511.13	511.65	511.77	509.54	509.66	510.12	510.23
July	510.64	510.94	512.18	512.48	510.67	510.85	511.54	511.72	508.91	509.14	510.05	510.27
August	510.63	510.93	512.12	512.42	510.60	510.78	511.51	511.69	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**				**DP10**				**BRIDSON DP**			
	Dry		**Wet**		**Dry**		**Wet**		**Dry**		**Wet**	
	Red	**Yellow**	**Yellow**	**Red**	**Red**	**Yellow**	**Yellow**	**Red**	**Red**	**Yellow**	**Yellow**	**Red**
March	507.76	507.78	507.83	507.85	507.34	507.36	507.40	507.42	509.90	510.02	510.46	510.58
April	507.79	507.79	507.83	507.83	506.70	506.82	507.33	507.45	510.38	510.44	510.66	510.72
May	507.67	507.70	507.82	507.85	506.47	506.79	508.04	508.36	510.36	510.38	510.50	510.52
June	507.57	507.61	507.76	507.80	507.25	507.33	507.62	507.70	510.07	510.15	510.46	510.54
July	507.04	507.18	507.73	507.87	506.39	506.57	507.28	507.46	509.01	509.31	510.55	510.85
August	506.54	506.76	507.66	507.88	506.87	507.00	507.53	507.67	508.80	509.12	510.36	510.68

NOTES:
1 All water level triggers in metres above sea level (masl).

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.

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.

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.

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-26**, **Appendix F**.

Surface Water Flow and Temperature Trigger Results

The 2021 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	0.5	frozen
February	frozen	frozen	frozen
March	0.15	10.5	99
April	156	9.8	119
May	23	4.6	12.1
June		4.5	5.9
July		3.1	73
August		2.7	
September		6.4	n/a
October		36	57
November		8.8	27
December		0.3	5.8

NOTES:
1 All flow values in litres / second (L/s).
2 Grey shading indicates no applicable monthly trigger.
3 n/a – results not available, please see notes below.

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

Month	SW3	SW6A	SW9	SW14	SW15	SW16	SW17	SW17A	SW18
June		19.7		11	dry	dry	7.8	7.2	40
July		29.7		3.4		0.6	3.6	3.8	n/a
August		62		n/a	n/a		1.1	3.8	n/a
September		304		n/a			5.7	5.8	n/a

NOTES:
1 All flow values in litres / second (L/s).
2 Grey shading indicates no applicable monthly trigger.
3 n/a – results not available, please see notes below.

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

Month	SW10	SW11	SW21C	SW24A	SW77
June	dry	2.1	2.7	1.9	1.6
July		0.4	0.9	0.2	0.2
		1.6	4.0	0.8	0.3
August		0.4	0.1	0.5	0.11
		0.3	0.6	<0.1	<0.1
September		5.6	4.9	1.8	0.3

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:

- ➔ Concession 10 road construction in 2021 meant stations SW14, SW15 and SW18 were generally inaccessible during the summer months.
- ➔ SW0-2 inaccessible during September monthly event, flow data not available.
- ➔ As noted in the 5-Year Comprehensive Review report, SW21C was modified by the property owner in 2019 and the gauge is no longer situated within the watercourse. Therefore, data is no longer representative of baseline conditions and trigger exceedances at this station are not 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 / SW17A.
- ➔ Red trigger exceedances for surface water flow were observed at SW1 (March), SW2 (January), SW0-2 (May), SW6A (June and July), SW11 (July), SW16 (June) and SW24A (August). In each case except SW6A in June, conditions returned to the "green zone" for the subsequent event suggesting that no trend exists.
- ➔ Yellow trigger exceedances for surface water flow were observed at SW0-2 (March and December), SW10 (June), SW11 (June and August), SW15 (June), SW21C (July and August) and SW77 (August). Conditions generally returned to the "green zone" for the subsequent event suggesting that no trend exists.
- ➔ As noted in **Section 4.1** and **Figures D-1 and D-2**, the monthly net surplus in winter and early spring 2021 was at the lower end of the baseline monitoring period range, while average monthly temperatures were consistently at the higher end of the baseline monitoring period range.
- ➔ The surface water flow trigger exceedances observed during 2021 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 2021. The trigger exceedances are therefore attributed to the above noted deviation of 2021 climatic conditions in comparison to the baseline monitoring period.

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

Month	SW1	SW2	SW0-2
January	frozen	0.06	frozen
February	frozen	frozen	frozen
March	7.0	7.0	5.0
April	8.3	7.4	7.7
May	18.7	8.4	17.6
June	dry	8.8	14.7
July	16.3	10.3	17.2
August	20.1	11.9	19.3
September	12.2	9.6	n/a
October	6.8	10.3	6.2
November	frozen	5.7	4.4
December	frozen	5.5	4.1

NOTES:
1 All temperatures in degrees Celcius (°C).
2 n/a – results not available, please see notes below.

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	16.3	dry	15.0	dry	15.3	19.2	11.6	13.7
July	dry	17.3	dry	17.7	17.6	16.1	20.2	13.2	n/a
August		19.6		n/a	n/a	19.0	23.0	16.2	n/a
September		12.1		n/a	n/a	12.7	12.5	10.0	n/a

NOTES:
1 All temperatures in degrees Celcius (°C).
2 Grey shading indicates no applicable monthly trigger.
3 n/a – results not available, please see notes below.

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

Month	SW10	SW11	SW21C	SW24A	SW77
June	dry	9.9	10.1	9.9	9.1
July	dry	10.3	11.0	11.4	10.2
	16.4	11.4	10.9	11.5	12.1
August	20.6	14.2	13.5	14.1	14.6
	21.0	14.8	13.2	13.9	15.7
September	11.8	8.9	9.5	10.0	10.8

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

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

- Concession 10 road construction in 2021 meant stations SW14, SW15 and SW18 were generally inaccessible during the summer months.
- SW0-2 inaccessible during September monthly event, temperature data not available.
- As noted in the 5-Year Comprehensive Review report, SW21C was modified by the property owner in 2019 and the gauge is no longer situated within the watercourse. Therefore, data is no longer representative of baseline conditions and trigger exceedances at this station are not 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 / SW17A.
- Red trigger exceedances for surface water temperature were observed at SW17 (August) and SW21C (August). In each case, conditions returned to the "green zone" for the subsequent event suggesting that no trend exists.
- Yellow trigger exceedances for surface water temperature were observed at SW1 (August), SW2 (March), SW10 (August), SW16 (August) and SW77 (July and August). Conditions generally returned to the "green zone" for the subsequent event suggesting that no trend exists.
- As noted in **Section 4.1** and **Figures D-1 and D-2**, the monthly net surplus in winter and early spring 2021 was at the lower end of the baseline monitoring period range, while average monthly temperatures were consistently at the higher end of the baseline monitoring period range.
- The surface water temperature trigger exceedances observed during 2021 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 2021. The trigger exceedances are therefore attributed to the above noted deviation of 2021 climatic conditions in comparison to the baseline monitoring period.

Wetland Drivepoint Water Level Trigger Results

The 2021 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	DP2	DP4	DP5	DP6	DP7	DP8	DP9	DP10	BRIDSON DP
March	frozen	511.01	frozen	frozen	frozen	frozen	frozen	506.76	510.42
April	512.21	511.22	509.81	511.43	508.81	511.33	**508.13**	506.57	510.40
May	**512.23**	511.17	509.78	511.70	509.25	511.24	**508.18**	506.43	510.40
	512.23	511.17	509.78	511.69	509.23	511.24	**508.18**	506.43	510.30
June	**512.25**	511.15	509.90	511.72	509.30	**511.52**	dry	506.32	dry
	512.25	511.20	509.71	511.29	509.12	511.19	dry	506.33	510.35
July	**512.27**	511.16	509.75	511.22	509.13	511.37	507.66	506.49	510.35
	511.99	511.14	509.60	511.28	508.41	511.39	507.56	506.23	510.04
August	512.00	511.08	509.29	dry	508.67	511.36	507.59	506.03	509.60

NOTES:
1 All water levels in metres above sea level (masl).
2 Underlined and bolded values indicate exceedance of "wet" trigger.
3 n/a – results not available, please see notes below.

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 at DP8 (May and June), DP9 (April to June) and DP10 (March to June and July to August). At DP8 and DP9, conditions returned to the "green zone" for the subsequent event suggesting no trend exists.
- It is noted that DP10 is situated on the adjacent licenced property. Given its location, distal to the Site, and the absence of groundwater drawdown, the red trigger results are therefore suspect. It is possible that the drivepoint could be compromised. Monitoring in 2022 should reconfirm top of pipe elevation and its integrity.
- Yellow trigger exceedances for wetland water levels were observed at DP2 (May to July), DP4 (March to May), DP5 (April), DP6 (April), DP10 (June and July) and Bridson DP (April). Conditions generally returned to the "green zone" for the subsequent event suggesting no trend exists.
- As noted in **Section 4.1** and **Figures D-1 and D-2**, the monthly net surplus in winter and early spring 2021 was at the lower end of the baseline monitoring period range, while average monthly temperatures were consistently at the higher end of the baseline monitoring period range.
- The wetland water level trigger exceedances observed during 2021 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 2021. The trigger exceedances are therefore attributed to the above noted deviation of 2021 climatic conditions in comparison to the baseline monitoring period.

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 old 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**. 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;
- WAI off-site monitoring wells: 101-B, 102-C, 103-D, 104-A, OW1-4, OW5-2 and OW6-3;

The LTTWM includes monthly manual groundwater level measurements and a network of data loggers that record hourly or twice daily water levels at selected groundwater monitoring wells.

As noted in **Section 3.1.1**, a number of monitoring wells have been removed from the LTTWM. 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.

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.

Data loggers have been installed at domestic wells RW1, RW2 and RW16 and record either hourly or twice daily groundwater levels. In addition to the electronic data, manual groundwater levels are obtained monthly. Domestic wells RW1 and RW2 are also sampled annually for general chemistry, major and minor ion constituents, nutrients, total petroleum and hydrocarbons, BTEX, total suspended solids and bacteriological parameters.

As noted in **Section 3.1.3**, a number of domestic wells have been removed from the LTTWM. RW12 and RW13 are currently routinely monitored but are not part of the LTTWM. Monitoring of these wells should be discontinued.

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 Osprey Quarry monitoring program. The groundwater depth, ponded water depth (where available) and surface water temperature are measured monthly at the drivepoints. The surface water depth is recorded monthly at the staff gauges.

Surface Water Monitoring

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, SW11E, SW13, SW19, SW21 series, SW22, SW22A and SW22C
- 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**. The surface water monitoring completed as part of the LTTWM includes monthly stream flow and temperature measurements at the surface water monitoring stations. Annual measurement of field chemistry parameters (temperature, pH, conductivity and dissolved oxygen) and water quality sampling also occurs at selected surface water stations.

Historical surface water stations that are not required under the LTTWM include: SWB-1, QFSW1, SW3A, SW4, SW5, SW6, SW12, SW12A, SW17B, SW21D, SW22B, SW23, SW24, SW24B, SW24C, SW25, SW26, SW26A, and SW27. These historical stations were monitored as part of the studies completed for the Site ARA Licence application but given the extensive monitoring program in place, they are considered unnecessary to monitor the quarry dewatering impacts.

7.3.2 Monitoring Results

A detailed analysis of long-term groundwater and surface water trends are provided in **Sections 4.2.2 and 4.3.1**. Overall, the 2021 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 are 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, NW5, NW6 and NW7 west / northwest of Phase 1 and BH02-2, RW18 and NW3 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.

The annual groundwater quality sampling at RW1 and RW2 was completed on May 27, 2021. The groundwater chemical results for RW1 and RW2 are compared to the Ontario Drinking Water Quality Standards, Objectives and Guidelines (ODWQS) (MECP, June 2006 and updates). The groundwater quality at these locations generally meets the ODWQS, with the exception of the following:

- The total coliform counts exceeded the ODWQS health-related guideline in the samples obtained from RW1 on one occasion and RW2 during each annual sampling event since 2016.

- The sodium concentration exceeded the ODWQS aesthetic guideline in the samples obtained from RW1 and RW2 during each annual sampling event since 2016. Sodium has an aesthetic objective of 200 mg/L and a suggested maximum concentration of 20 mg/L under the ODWQS. The water quality at RW2 is interpreted to be representative of local groundwater quality, which is naturally hard.
- The hardness exceeded the ODWQS operational guideline for treatment systems in the samples obtained from RW1 and RW2 during each annual sampling event since 2016. Hardness has an operating guideline range of 80-100 mg/L. The water quality at RW2 is interpreted to be representative of local groundwater quality, which is naturally hard.

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, including wetland 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 the health of the wetland area and water regime trends that could be affecting wetland function. Wildlife monitoring was initiated in 2018 and continued through 2020.

As noted in Figure 1.3 of the AMP, monitoring is required for a period of two (2) years after the start of Phase 1, and then once every 5 years and / or the start of a new phase. As such, wildlife monitoring was not completed in 2021.

7.4.2 Wetland Vegetation Monitoring

Vegetation monitoring was initiated in 2019 and continued through to 2021 at wetlands within the Rob Roy Swamp PSW Complex (RR2 and RR6) and ANSI wetlands A & B. The summary report, Wetland Vegetation Monitoring 2021 prepared by Stantec (**Appendix G**), describes the methods and results from 2021 surveys and will be updated annually as part of the AMP reporting. This report represents the third year of terrestrial monitoring.

Generally, the wetlands remain consistent in their floristic character and remain as heathy wetland communities. As noted in previous years, RR6 appears to be experiencing inundation over a long period which is changing the character of the wetland floristic diversity. However, the wetland remains as a diverse wetland feature, but will continue to succeed to a more open canopy wetland environment. This wetland has historically been subject to variable water regimes.

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

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 plantings incorporated into the Woodland Program.

The Woodland Program has been initiated. The Millar Pond was relocated in 2019. The remaining EEMM tasks required no action in 2021.

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.

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.

On average, the Active Planting Units and Passive Regeneration Units have met the 2020-2024 targets established in Township Agreement. The degree to which the Planting Units meet the reforestation targets is a reasonable indication of the ecological function of the reforested areas. The current results suggest that the reforestation areas are contributing to local forest function and 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 of the forest regeneration will be completed again in 2023.

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 that was approved for removal and was amphibian breeding habitat in the local landscape. The first year of monitoring of amphibian activity in the newly created pond was initiated in 2021. The results of that monitoring are present in **Appendix H**.

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). These initial first year results are indicative of an active pond environment that is anticipated to increase in diversity as the created pond becomes established on the landscape.

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 (m³/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 m³/year)</td><td>26
(~4 Igpm)
(9,480 m³/year)</td></tr>
<tr><td>ANSI Wetland B</td><td>132
(~20 Igpm)
(48,190 m³/year)</td></tr>
<tr><td>Rob Roy Swamp 2 Wetland</td><td>40
(~6 Igpm)
(14,615 m³/year)</td><td>84
(~13 Igpm)
(30,810 m³/year)</td></tr>
</table>

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 Northern Development, Mines, Natural Resources and Forestry (MNDMNRF) prior to construction. The design of the recharge trenches is anticipated to be submitted to the Ministry in summer 2022.

Contingency Mitigation Measures

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.

7.7 OPERATIONS IMPROVEMENT WORKSHOP

The operations improvement workshop was not completed in 2021 due to COVID restrictions.

As part of its commitment to working with the community, WAI tentatively plans to hold an annual Operations Improvement Workshop for neighbours and other interested stakeholders in 2022, dependent on the pandemic outlook. The 2021 Annual Summary and Performance Report will be 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

- ➔ Discontinue monitoring at locations which are not included in the PITM or LTTWM. The revised monitoring program is shown in **Table 1** and **Figure 6** of the 5-Year Comprehensive Report.
- ➔ Develop stage-discharge relationships for surface water stations so logger water levels can be converted to flow rates.
- ➔ Escarpment seep trigger station SW21C is situated on private property. It is understood that this feature was modified by the property owner in 2019 and the gauge is no longer situated within the watercourse. It is therefore recommended to remove station SW21C from the PITM and continue to assess trigger exceedances at downstream station SW15.
- ➔ 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. It is therefore recommended to remove station SW24A from the PITM and continue to assess trigger exceedances at downstream stations SW17 / SW17A.
- ➔ Confirm top of pipe elevation and integrity of drivepoint DP10 in 2022.

- ➔ 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 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 2021.
  - No water well interference complaints were received by WAI in 2021.
  - 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.
  - 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 2021 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 2022 with no changes.
- The quarry has been operated in compliance with the ECA (Sewage) in 2021.
  - It is recommended that the outstanding ECA clarifications as mentioned in **Section 1.2** be discussed with the MECP.
  - It is recommended that the monitoring program outlined in the ECA (Sewage) should be continued in 2022 with no changes.
- The quarry has been operated in compliance with the AMP in 2021.
  - A number of PITM trigger exceedances were observed in 2021. 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 2021. The trigger exceedances are therefore attributed to the deviation of 2021 climatic conditions in comparison to the baseline monitoring period.
  - 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 2021 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 are attributed to the deviation of climatic conditions in comparison to the baseline monitoring period.

- The LTTEM 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 woodland monitoring results suggest that the reforestation areas are contributing to local forest function and 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.
  - The EEMM amphibian monitoring of the new Millar Pond was initiated in 2021. The first year results are indicative of an active pond environment that is anticipated to increase in diversity as the created pond becomes established on the landscape.
  - A surface water discharge system is required as part of the routine water management measures in the AMP. The design of the recharge trenches is anticipated to be submitted to the MNDMNRF in summer 2022.
  - Contingency mitigation measures (including the injection wells) were not required in 2021. 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 2021 Annual Summary and Performance Report should be submitted to the District Manager by April 30, 2022 per Section 1.8.1 of the AMP.

9 REFERENCES

- Chapman, L.J., and Putnam, D.F., 1984: The Physiography of Southern Ontario. Third Edition. Ontario Geological Survey Special Volume 2.
- Duntroon Quarry Environmental Compliance Approval Industrial Sewage No. 1521-A4VJ4X. Issue Date: October 17, 2016
- Environment Canada, 2005: Recent and Historical Climate Data Thornbury Slama Climatological Station.
- Environment Canada, 2021: Recent and Historical Climate Data Shanty Bay Climatological Station.
- Jagger Hims Limited. 2005. Duntroon Quarry Expansion Geological Report and Level 2 Hydrogeological Assessment. Prepared for Georgian Aggregates and Construction Inc.
- Jagger Hims Limited. 2007. Level 2 Hydrogeological Assessment Addendum Cumulative Impact Assessment Proposed Expansion and Proposed MAQ Highland Quarry Computer Groundwater Modeling Response to Agency Review Comments.
- Marcus J. Buck Karst Solutions & Worthington Groundwater, 2007: Karst Investigation of the Duntroon Quarry Expansion Lands.
- Ministry of the Environment, 1978: Major Aquifers in Ontario. Guelph – Amabel Aquifer Hydrogeologic Map 78-4 Orangeville to Markdale and Map 78-5 Markdale to Owen Sound.
- Ministry of the Environment and Climate Change (January 2015 e-Laws currency date). Ontario Water Resources Act, R.S.O.1990 and periodic amendments.
- Ministry of the Environment and Climate Change (January 1999). Protocol for the sampling and analysis of industrial/municipal wastewater.
- Ministry of Northern Development and Mines, 1992: Geology of Ontario. Ontario Geological Survey Special Volume 4.
- Stantec Consulting Ltd and Hims GeoEnvironmental. 2013. Adaptive Management Plan - Duntroon Expansion Quarry.
- Stantec. 2010. Duntroon Quarry Expansion Consolidated Natural Environment Report. Lot 25, Concession 12, Township of Clearview.
- WSP and Stantec. 2021a. Duntroon Extension Quarry, Adaptive Management Plan Summary Report 2020. Prepared for Walker Aggregates, Inc., April 2021.
- WSP and Stantec, 2021b. Duntroon Quarry Extension, Adaptive Management Plan Five Year Comprehensive Review Report. Prepared for Walker Aggregates Inc., September 2021.