DUNTROON EXPANSION QUARRY

ADAPTIVE MANAGEMENT PLAN ANNUAL SUMMARY REPORT

WALKER AGGREGATES INC.

PROJECT NO.: 111-53312-00
DATE: APRIL 27, 2018

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April 27, 2018

WALKER AGGREGATES INC.
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Attention: Mr. Matthew McMahon, Environmental Performance Lead - Aggregates

Dear Mr. McMahon

Subject: Duntroon Expansion Quarry Annual Summary Report

WSP Canada Inc. is pleased to present the enclosed adaptive management plan summary report for the Duntroon Expansion Quarry, documenting the monitoring data collected for the performance indicator trigger monitoring program, the long term trend groundwater and surface water monitoring program, the long term trend ecological monitoring program and the ecological enhancement and mitigation monitoring plan.

This summary report is for the period of January 1, 2017 through December 31, 2017. Historical data, where available, have been included to provide context to the observed values in 2017.

We trust that the information provided is sufficient for your needs at this time. Please contact the undersigned if you have any questions or comments.

Yours truly,

Sarah Watts, M.Sc.
Environmental Consultant

Michael Varty, P.Eng.
Director, Environment

SLW/ham

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1 EXECUTIVE SUMMARY

The Adaptive Management Plan (AMP) annual summary report is a requirement of the Aggregate Resources Act licensing of the expansion quarry. The licensed property of the existing quarry operates in accordance with Aggregate Resource Act (ARA) license number 3514. The expansion quarry is licenced to WAI under ARA licence number 607841, issued August 6, 2014.

Walker Aggregates environmental commitment is to manage its lands so that in the long term, the ecology is healthier than its current condition. This will be accomplished through environmental initiatives detailed on the ARA Site Plans and the AMP to ensure that protection, mitigation, and enhancement measures sustain local environmental resource features and functions for future generations.

Aggregate extraction in Phase 1 of the expansion quarry began in late June 2016 and 2016 was the first year of reporting for the adaptive management plan. 2017 marks the second year of adaptive management plan reporting.

The potential impacts for each phase of Quarry operations are outlined in the AMP with details on specific protection and monitoring measures. This annual summary report will focus on quarry operations in Phase 1 and the associated monitoring measures that were completed in support of the AMP in 2017.

Given the extraction that has occurred in the existing quarry, extraction in Phase 1 of the expansion quarry is not expected to result in any negative impacts to off-site water resources and/or ecological features and functions. Therefore, the monitoring and mitigation requirements during this phase of extraction are such that the response of the natural environment system will be monitored by means of the groundwater, surface water and wetland monitoring network, and results compared to predictions.

The AMP consists of four monitoring programs: the Performance Indicator Trigger Monitoring program (PITM), the Long Term Trend Groundwater and Surface Water Monitoring program (LTT), the Long Term Trend Ecological Monitoring program (LTTEM) and the Ecological Enhancement and Mitigation Monitoring program (EEMM). The AMP annual summary report is a consolidated summary report documenting the observations from each of the monitoring programs.

This annual report consists mainly of PITM and LTT monitoring data and reporting, as the LTTEM and the EEMM have limited monitoring and reporting within the first three years of operations at the expansion quarry.

Key findings of the PITM and LTT monitoring program in 2017 indicated that the interim trigger levels recorded in 2017 are attributed exclusively to the effects of the atypical climate conditions and not the initiation of extraction activities at the expansion quarry. For example, interim trigger level exceedances recorded in 2017 were less frequent than those reported in early 2016, before extraction activities had been initiated.

Key findings of the LTTEM and the EEMM in 2017 include the recommendation to assess the Hart's Tongue Fern population in 2018 and 2019 and the initiation of the first year of the LTTEM in 2018.

It is recommended that the interim trigger levels currently set out in the AMP be adjusted to reflect the 2016 and 2017 monitoring results.

Conclusions and recommendations are made based on the review of the 2017 monitoring data including the revision of the interim trigger levels.

2 INTRODUCTION

The Duntroon Expansion Quarry is located on County Road 91, west of the village of Duntroon on Lot 25, Concession XII in the Township of Clearview, County of Simcoe. The existing quarry property is located south of County Road 91 and the expansion quarry is located north of County Road 91. The expansion quarry property is located adjacent to the approved (August 24, 2012) MAQ Aggregates Inc. (MAQ) Highland Quarry, an independent third party. The locations of these quarry properties and of other lands owned by Walker Aggregates are shown on ***Figure 1***.

The Duntroon Quarry has been in operation since the early 1960s on the south side of County Road 91 (existing quarry). Since 1995 the quarry has been operated by Walker Aggregates Inc. (WAI), a wholly owned subsidiary of Walker Industries Holdings Ltd. The licensed property of the existing quarry operates in accordance with Aggregate Resource Act (ARA) license number 3514. The expansion quarry is licenced to WAI under ARA licence number 607841, issued August 6, 2014.

The Adaptive Management Plan (AMP) annual summary report is a requirement of the Aggregate Resources Act licensing of the expansion quarry. The reader is referred to the AMP document, dated December 6, 2013, for specific details of the AMP monitoring, mitigation and reporting requirements.

The high quality dolostone produced from the Duntroon Quarry is in demand as building material and also for use in agricultural, recreational and environmental projects. This demand initiated an expansion of the existing footprint of the quarry to include property north of County Road 91 (the expansion quarry). WAI received approval from the Consolidated Joint Board on June 18th, 2012, to expand their quarry operation into the expansion lands. The expansion quarry property comprises a licensed area of 65.9 ha (162.9 acres), within which 58.5 ha (144.5 acres) is approved for extraction. A sinking cut was made in early October 2015 and a tunnel was constructed under County Road 91 to link the existing and expansion quarry properties. Active extraction in the expansion quarry started on June 28, 2016, making 2016 the first year of reporting for the AMP.

Table 2.3 in the AMP document summarizes the expected timing for extraction in each Phase. The phasing is also detailed on the Site Plan 2B of 4 Operational Plan. Phase 1, Phase 2a and Phase 2b are identified on ***Figure 2a – Site Sketch.*** The site sketch is based on conditions in October 2017.

The potential impacts for each phase of Quarry operations are outlined in the AMP with details on specific protection and monitoring measures. This annual summary report will focus on quarry operations in Phase 1 and the associated monitoring measures that were completed in support of the AMP in 2017.

Given the extraction that has occurred in the existing quarry, extraction in Phase I of the expansion quarry is not expected to result in any negative impacts to off-site water resources and/or ecological features and functions. Therefore, the monitoring and mitigation requirements during this phase of extraction are such that the response of the natural environment system will be monitored by means of the groundwater, surface water and wetland monitoring network, and results compared to predictions.

As stated in Table 3.2 of the AMP, trigger monitoring criteria for water flows, water temperature and wetland water levels will apply during their respective trigger periods as soon as extraction proceeds beyond Phase 1. Interim trigger values have been developed for water flows and water temperature using historical monitoring data. These interim trigger values will be updated as further monitoring data become available during Phase 1.

Further site background details including more detailed information on the site, monitoring requirements, watershed aggregate extraction activities, monitoring program contact names and other activities in local watersheds, are provided in ***Appendix A***.

3 CLIMATE DATA

Climate data that is used as part of hydrogeological studies is generally obtained from an operational climate station with at least 30 years of data located in close proximity to the subject area. Environment Canada routinely publishes 30 Year Normals (or averages) for active climate stations with at least 30 years of climate data. The 30 Year Normal data is used as a historical baseline against which recent climate data are compared to determine if a particular year or month is wetter or drier than normal. The information is also used in the assessment of future conditions and impacts that may occur as a result of changes in land use.

Historically, climate data from the Thornbury Slama Station were used to assess annual water budget components as part of the Permit to Take Water monitoring programs. Justification for using the climate data from this station was provided in previous Permit to Take Water monitoring summary reports prepared for the Duntroon Quarry (Existing Quarry). Operation of the Thornbury Slama station was cancelled in May 2005.

After a detailed assessment of nearby climate stations (refer to previous PTTW Summary Reports prepared for the Duntroon Quarry), the Shanty Bay Climate Station, located on Lake Simcoe approximately 60 km east of the Duntroon Quarry, was assessed and provided a reasonable correlation with the climate data from the Thornbury Slama climate station.

In 2008, WAI established, an automatic weather station (the WAI station) in the vicinity of the existing quarry which provides the following local climate data:

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

There have historically been technical and operational issues with the weather station at the quarry, but the station has been operating consistently since July 2015. There is missing data on April 9th and 10th, 2017 and one hour of missing data on November 5th, 2017 and the climate data from April and November at the WAI station is qualified by these absences. The precipitation data at the end of December 2017 also appears incomplete at the WAI station. The WAI climate station does not report any precipitation for period from December 20th through December 31st, 2017. The WAI climate station reports 46 mm of precipitation for the month of December; comparatively, the Shanty Bay Environment Canada climate station reported 88 mm of precipitation for the same period. Anecdotally, a significant amount of snowfall occurred in the vicinity of Duntroon during the last two weeks of December. For example, the Environment Canada Thornbury Climate Station (Climate ID#6118240), which is located approximately 25 km north-west of the Duntroon Quarry, received 191.3 mm of precipitation over the month of December 2017, of which 70 mm fell over the period between December 24th to the 27th. This indicates that the WAI climate station may have been having issues recording precipitation during the month of December 2017. The December 2017 results are qualified by this observation.

The data from the weather station has been used to compile local daily, monthly and yearly climate information for the reporting year of 2017. The climate station data has been presented with the data from the Shanty Bay station in ***Appendix A***, so that the yearly climate information can be compared against the Environment Canada regional data.

For the purpose of this annual report, both the Shanty Bay and the WAI climate station data have been evaluated. Once a more consistent record of local climate conditions has been established, the local and regional climate data will be used exclusively to prepare seasonal and annual water budget assessments based on the Thornthwaite-Mather method, as used by Environment Canada. The information from the WAI climate station can be used to compile seasonal and annual water surplus/deficit amounts for consideration in surface water runoff and groundwater recharge evaluations and for comparison against quarry discharge volumes.

The 30-Year Climate Normal data and a calculated water budget for the Thornbury Slama Station are provided in ***Appendix A***, on Table A-1. The Shanty Bay climate data and the calculated water budget for 2015, 2016 and 2017 are provided in Tables A-2, A-3 and A-5, respectively. The WAI climate station data and the calculated water budgets for 2016 and 2017 are provided in Table A-4 and A-6. ***Figures A-1*** through ***A-5*** provide a graphical plot of the monthly precipitation and water surplus for each calculated water budget with the data for the 30-Year Climate Normal provided for comparison.

The 2017 climate data at the Shanty Bay station reports a slightly higher amount of precipitation than the WAI station (1115 mm vs. 1018 mm), although, as noted, the WAI is missing data in April and November and the precipitation results for December are lower than expected, which could be skewing these results. The mean monthly temperature at the Shanty Bay station is also warmer than the mean monthly temperature reported at the WAI station (7.9°C vs. 6.1°C). The mean monthly temperature for the Shanty Bay and WAI climate stations are plotted with the 30-Year normal mean monthly temperature in ***Figure A-6***. The total monthly precipitation for the Shanty Bay and WAI climate stations are plotted with the 30-Year normal total monthly precipitation in ***Figure A-7***.

3.1 AIR TEMPERATURE

At the Shanty Bay climate station, the monthly mean temperature in 2016 was 7.9°C, 1.1°C higher than the 30-Year Climate Normal value of 6.8°C. The monthly average temperature in December was 3.7°C lower than normal. The months of January, February, March, April, September and October were within 1.3°C to 3.9 °C warmer than normal. The months of May, June, July, August and November were within +/-1°C of the normal.

At the WAI climate station, the mean monthly temperature in 2017 was 6.1°C, 0.7°C cooler than the 30-Year Climate Normal value of 6.8°C. The average monthly temperature in January, February and October were within 1.5°C to 2.8°C warmer than normal. The months of March, May, July, August, November and December were within 1.5°C to 4.8°C colder than normal. April, June, and September were within +/- 1°C of the normal monthly temperature for their respective month.

Warmer than normal air temperatures contribute to increased evaporation from open water and increased evapotranspiration from plants, which then increase their water uptake from the soil, intensifying the effects of an already dry summer. Warmer than normal air temperatures also contribute to increased surface water temperatures.

3.2 PRECIPITATION

At the Shanty Bay climate station in 2017, the total amount of precipitation received was 1115 mm, or 150 mm (15 %) more than the calculated 30-Year Climate Normal (1971-2000) of 966 mm. The months of January, February, March, April, May and June received between 18% and 60% more precipitation than normal, while the months of July, August, September and November received between 12% and 40% less precipitation than normal. The months of October and December received a normal amount of precipitation (within 10% of the Normal). The second half of the year (July through December) received only 443 mm of precipitation, compared to a normal amount of 536 mm, a difference of 93 mm and a reduction of 17%. Precipitation in the summer months also tends to occur in intense precipitation events, like a thunderstorm. This type of intense rain event does not provide optimum conditions for precipitation to infiltrate and replenish the water table and a majority of the precipitation ends up as run off.

At the WAI climate station in 2017, the total amount of precipitation received was 1018 mm, or 52 mm (5%) more than the calculated 30-Year Climate Normal (1971-2000) of 966 mm. The months of April, May and June received between 73% and 115% more precipitation than normal, while the months of February, March, July and August received between 14% and 31% less precipitation than normal. The months of January, September, October and November received within 11% of the normal amount of precipitation, with October being slightly wetter than normal, and January, September and November, slightly drier. Similar to the data reported at the Shanty Bay climate station, the second half of the year at the WAI station was, for the most part, drier than normal. The second half of the year (July through November) received 390 mm of precipitation, compared to a normal amount of 439 mm, a difference of 49 mm and a reduction of 11%.

The abnormal distribution of precipitation over the late summer months and through the end of the year contributed to drier than normal conditions and resulted in lower than normal measured flow rates at several surface water monitoring stations.

3.3 ANNUAL WATER BUDGET

The climate data from the Shanty Bay and WAI stations (temperature and precipitation) are used to calculate a general water budget for the area that provides a measure of losses to evaporation of the precipitation. The difference between the monthly precipitation and the monthly evaporation (adjusted for daylight hours) yields the estimated water surplus or deficit for that month, and similarly for the annual totals. The estimated evaporation is based on the method originally developed by Thornthwaite, and incorporates a water holding capacity for the soil, which is taken into account in the calculation of the actual water surplus. The annual water surplus is a measure of the amount of water that is available for surface runoff and groundwater recharge. Results of the water balance are summarized on the following table. Shanty Bay and the WAI stations are both included in the analysis for 2017. The missing data for the WAI climate station was noted in section 3.0, above, and the water budget is qualified by this missing data.

Table 3-1 2017 Water Balance

PARAMETER	THORNBURY SLAMA (30-YEAR NORMAL)	SHANTY BAY	WAI
		2017	2017
Annual Precipitation (mm)	966	1115	1018
Potential Water Surplus (mm)	368	507	458
Actual Water Surplus (mm)	395	507	458

The water surplus represents the amount of water that is available on an annual basis for infiltration into the ground surface to recharge the groundwater flow system and for surface runoff to the creeks. Partitioning of the annual water surplus into the groundwater recharge and surface water runoff components is estimated based on the site's surface topography (or slope), soil or rock type and the type of vegetation that is present. The Ministry of the Environment has provided estimates of infiltration factors for various types of slope, soil and vegetation cover in their land development guidelines (MOE, 1996). For the general conditions present across the Duntroon Quarry and the surrounding area, the infiltration factor is estimated and presented on Table 3-2.

Table 3-2 Duntroon Quarry and Surrounding Area Infiltration Factor

FEATURE (RANGE OF INFILTRATION FACTORS)	SITE CHARACTERISTICS	CORRESPONDING INFILTRATION FACTOR
Slope (0.1-0.4)	Hilly land to rolling land	0.1 to 0.2
Soil Type (0.1-0.4)	Medium combinations of clay and loam to exposed fractured bedrock	0.2 to 0.4
Vegetation Cover (0.1-0.2)	Cultivated lands to woodland	0.1 to 0.2
OVERALL INFILTRATION FACTOR RANGE		**0.4 to 0.8**

Based on this likely range of infiltration values, the annual water surplus can be separated into groundwater recharge and surface runoff components as follows.

Table 3-3 Groundwater Recharge and Surface Water Runoff

ANNUAL SURPLUS	GROUNDWATER RECHARGE	SURFACE WATER RUNOFF
30 Year Normals	158 to 316 mm per year	237 to 79 mm per year
(395 mm)	0.050 to 0.100 L/s/ha	0.075 to 0.025 L/s/ha
2017 Shanty Bay Data	203 to 406 mm/year	304 to 101 mm/year
(507 mm)		
2017 WAI Data	183 to 366 mm/year	275 to 92 mm/year
(458 mm)		

In areas where the slope and/or nature of the land changes significantly (such as on the Escarpment slope or in low-lying wetland areas as extreme examples), the partitioning of recharge and runoff will vary from that indicated above. In addition, the presence of karst features at the ground surface, such as sinking stream channels and suffusion dolines, particularly near the brow of the Escarpment, will also affect the proportions of recharge and runoff that occur. In the vicinity of the Escarpment brow, the entire water surplus (or more) may recharge the local groundwater system above the Escarpment to become groundwater discharge springs at the Escarpment face that drain into local surface water courses on the Escarpment slope below. It should be noted that the calculated water surplus at the WAI climate station is zero for the months of July, August, September and October.

4 PERFORMANCE INDICATOR TRIGGER MONITORING PROGRAM

4.1 METHODS

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 levels, flows and temperature, and to initiate any actions necessary to adapt quarry operations so that the values of each of these parameters remain within their normal monthly patterns of seasonal variation. Any long term changes in prevailing climatic conditions will be incorporated into the AMP by developing statistical relationships between key AMP monitoring stations and two surface water flow and temperature control stations that are located in the Pretty River and Batteaux Creek drainage basins. These two control stations are situated beyond any possible influence of quarry operations or significant water users.

The PITM program provides for the monitoring of water resources that support natural heritage features. These are the features outside of the limit of extraction that potentially are sensitive to fluctuations in water regimes, such as provincially significant wetlands and fisheries.

These locations are monitored so that 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 natural heritage features, namely:

- Springs that discharge at the Niagara Escarpment east of the expansion quarry. 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 expansion quarry; and
- Surface water levels and flows and groundwater levels that support wetland features and functions.

It is recognized that, in some instances, there may be factors, such as atypical climate conditions, which have no connection to quarry operations that could affect flow and/or temperature conditions at some monitoring locations. The monitoring programs in the AMP are designed to assist in identifying cause and effect relationships. In order to incorporate any effects that long term trends in regional climatic conditions (i.e. climate change) have on local groundwater springs and/or surface water level and flow conditions that are monitored as part of the PITM, monitoring will be conducted at the surface water control sites in the Pretty River and the Batteaux Creek sub-watersheds.

For Phase I quarry operations, the potential for off-site water-related effects to any of the provincially significant wetlands and/or Escarpment springs is very low.

During Phase 1, interim trigger values are based on historic monthly measurements at each monitoring location, and will be updated annually and as part of the 5-year review of the AMP. 2017 data collected as part of the PITM monitoring program will be used to update the interim trigger values and to help incorporate the long term trends in regional climate on the groundwater springs and/or surface water level and flow conditions monitored as part of the PITM. It is noted that PITM trigger periods do not come into effect until Phase 1 is completed.

A description of the PITM regulatory monitoring stations is included in Table 3.3 of the AMP document. Please see Figure 4 for monitoring station locations.

The AMP specifies that upon initiation of extraction activities, the surface water Escarpment springs are to be monitored bi-weekly in July and August and monthly during other times of the year. Monitoring is to include as a minimum, temperature and a visual assessment of flow conditions. Where possible, measurements using an electromagnetic flow meter were completed. Surface water Escarpment spring monitoring stations include SW10, SW11, SW11A-E, SW21C, SW24A and SW77.

Water pumped into and out of the dewatering sumps and the water moving off-site as quarry discharge is monitored under the Permit to Take Water and the Environmental Compliance Approval. The quarry discharges into the RR6 wetland, west of the existing quarry. There is no specified monitoring requirement for the quarry discharge under the AMP. Field chemistry parameters (temperature, pH, dissolved oxygen and conductivity) are to be recorded quarterly at the dewatering sumps (Sump 1 and Sump 2 in the existing quarry and future Sump 3 on the expansion floor). Pumping rates and the metered flow of the quarry discharge are not specified as part of the AMP and are not reported on in this AMP Summary Report.

Temperature and surface water channel flow are to be monitored hourly at all surface water control stations excepting the existing and expansion quarry surface water features. PITM surface water monitoring stations include locations in three separate watersheds:

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

Pressure transducers and a staff gauge have been installed at stations: SW1, SW2, SW0-2, SW3, SW6A, SW9, SW15, SW16 and SW18. Staff gauges have been installed at stations: SW14, SW17, SW17A, RR3 Karst, PR Control and BC Control; these stations are real-time logger to web stations. Stream flow at the surface water control stations is to be measured quarterly, once the stage discharge relationships at these stations have been established. Flow measurements are to be taken with a Valeport electromagnetic flow velocity meter or manually. Field chemistry parameters (temperature, pH, dissolved oxygen and conductivity) are to be recorded monthly.

Upon initiation of extraction activities, drivepoint monitors in the wetlands are to be to be monitored bi-weekly for the months of May, June and July and monthly during other times of the year. Monitoring is to include measurements of groundwater level, ponded water depth and water temperature. The drivepoints are located in the following wetlands:

- ANSI A wetland: DP6 (vernal pool)
- ANSI B wetland: Bridson DP and DP9
- RR2 wetland: DP5 (vernal pool) and DP7 (vernal pool)
- RR3 wetland: DP10
- RR6 wetland: DP2, DP4 and DP8

During Phase I quarry operations, a reference wetland station will be established in either the Nottawasaga Lookout Provincial Park or the Pretty River Provincial Park with input from the Ministry of Natural Resources and Forestry (MNRF) and the Nottawasaga Valley Conservation Authority (NVCA).

4.2 MONITORING RESULTS

The results of the AMP performance indicator trigger monitoring program in 2017 are presented in the following section.

As stated in Table 3.2 of the AMP, trigger monitoring criteria for water flows, water temperature and wetland water levels will apply during their respective trigger periods as soon as extraction proceeds beyond Phase 1. Interim trigger values have been developed for water flows and water temperature using historical monitoring data. These interim trigger values will be updated as further monitoring data become available during Phase 1.

4.2.1 SURFACE WATER FLOW

For stream flow and/or flow at Escarpment springs, the interim red trigger value is set as the historic lowest monthly value recorded at a specific location. The interim yellow trigger value is calculated either by increasing the red value by 15%, or by using the third-lowest monthly flow value over the historic period of record, whichever is the higher value. Green interim trigger values are set above the yellow interim trigger value.

Interim flow trigger values are outlined in Table 3.5, ***Appendix B*** of the AMP document. Monitoring locations are outlined on ***Figure 3***. A brief description of the surface water locations is provided in Table B1, ***Appendix B***.

4.2.1.1 STREAM FLOW

Observations on the 2017 stream flow monitoring results are presented in Table 4-1, below:

Table 4-1 Surface Water Monitoring Stations - Results

MONITORING STATION	FIGURE	OBSERVATIONS
Pretty River Tributary System		
SW16	B-28	Stream flow values generally within previously reported range.
SW17	B-29	Stream flow values generally within previously reported range.
SW17A	B-30	Stream flow values generally within previously reported range.
SW18	B-32	Stream flow values generally within previously reported range.
PR Control	B-56	Stream flow values generally within previously reported range.
Batteaux Creek Tributary System		
SW9	B-15	Stream flow values generally within previously reported range.
SW14	B-26	Stream flow values generally within previously reported range.
SW15	B-27	Stream flow values generally within previously reported range.
BC Control	B-57	Stream flow values generally within previously reported range.
Beaver River Tributary System		
SW1	B-1	Stream flow values generally within previously reported range.
SW2	B-2	Stream flow values generally within previously reported range.
SW0-2	B-4	Stream flow values generally within previously reported range.
SW3	B-7	Stream flow values generally within previously reported range.
SW6A	B-12	Stream flow values generally within previously reported range.
SW3B ('RR3 Karst')	B-55	Stream flow values generally within previously reported range.

4.2.1.2 ESCARPMENT SPRINGS

The results of the 2017 AMP monitoring program at the Escarpment spring monitoring stations are summarized in Table 4-2.

Table 4-2 Escarpment Springs Monitoring Stations - Results

MONITORING STATION	FIGURE	OBSERVATIONS
SW10	B-16	Stream flow values generally within previously reported range.
SW11	B-17	Stream flow values generally within previously reported range.
SW11A	B-18	Stream flow values generally within previously reported range.
SW11B	B-19	Stream flow values generally within previously reported range.
SW11C	B-20	Stream flow values generally within previously reported range.
SW11D	B-21	New peak flow reported in April 2017.
SW11E	B-22	Stream flow values generally within previously reported range.
SW21C	B-38	Stream flow values generally within previously reported range.
SW24A	B-46	Stream flow values generally within previously reported range.
SW77	B-53	Stream flow values generally within previously reported range.

4.2.1.3 CONTROL STATIONS

During Phase I of quarry operations, the likelihood of quarry-related water effects off-site is extremely low. Walker Aggregates is currently in the process of developing statistically valid relationships for flow and temperature conditions between specified key AMP monitoring locations and control stations in the Pretty River sub-catchment drainage basin and in the Batteaux Creek sub-catchment drainage basin. Larger sample sizes generally lead to increased precision when developing relationships. The statistical validity of the relationships between flow and temperature conditions between the specified AMP monitoring locations and the control stations is expected to increase as data collection progresses.

The key AMP monitoring locations in the Pretty River sub-catchment drainage basin are SW17, SW17A and SW18 and the key AMP monitoring location in the Batteaux Creek sub-catchment drainage basin is SW14.

The control stations have been established at the following locations:

- Batteaux Creek Sub-watershed Station (“BC Control”) – surface water control station located at the north side of the road culvert on 21/22 Sideroad, Clearview Township, approximately 1350 m east of Concession 10.
- Pretty River Sub-watershed Station (“PR Control”) – surface water control station located at the north side of the road culvert on 30/31 Sideroad, Town of the Blue Mountains, approximately 390 m west of the boundary line between Clearview Township and Town of Blue Mountains.

Photo 1 - Batteaux Creek sub-watershed control station

Photo 2 – Pretty River sub-watershed control station

As part of the annual assessment of the surface water systems, patterns of flow and water temperature and general chemistry at the AMP control and surface water stations are compared to patterns at existing long term regional flow gauging stations. The long term gauging stations selected for comparison are the Mad River station at Avening and the Pretty River station at Collingwood.

The long term regional flow data for the Mad River station at Avening and the Pretty River station at Collingwood are presented in ***Appendix A*** as Figures A-6 and A-7. The data for these figures was obtained from the Government of Canada real-time hydrometric data web-site (https://wateroffice.en.gc.ca). Historical data for the Mad River station at Avening (02ED015) is available from 1988 through 2016. Instantaneous daily surface water flow data for 2017 was obtained from the real-time data set using the daily flow recorded at 10 am (incomplete daily data sets did not allow for a daily average value). Historical data for the Pretty River station at Collingwood (02ED031) is available from 2006 through 2016. Average daily surface water flow data for 2017 was obtained from the real-time data set.

The statistical relationships developed over time between the controls stations and quarry monitoring locations will be used to supplement and then replace the initial interim targets that are based on the historic monthly monitoring database. The methodology to establish the long term triggers based on the control station relationships will be established through the first 5-year review of the AMP.

4.2.1.4 TRIGGER EXCEEDANCES

As stated in Table 3.2 of the AMP, trigger monitoring criteria for water flows, water temperature and wetland water levels will apply during their respective trigger periods as soon as extraction proceeds beyond Phase 1. Interim trigger values have been developed for water flows and water temperature using historical monitoring data. These interim trigger values will be updated as further monitoring data become available during Phase 1.

Exceedances of the interim trigger values for stream flow are discussed below in chronological order. Monthly summary tables including measured stream flow and temperature values are included in ***Appendix B.***

4.2.1.4.1 JANUARY 2017

Surface water flow rates and temperatures at the Escarpment springs and the surface water monitoring stations, including SW1, SW2 and SW0-2, were collected during the January monthly monitoring event (January 24-26, 2017).

- Green zone stream flow measured at: all the Escarpment spring stations and the surface water stations with the exception of SW3 which was buried, and no flow measurement was taken.

There were no yellow or red zone interim stream flow trigger values that were exceeded in the month of January.

4.2.1.4.2 FEBRUARY 2017

Surface water flow and temperatures at the Escarpment springs and the surface water monitoring stations, including SW1, SW2 and SW0-2 were collected during the February monthly monitoring event (February 15-17, 2017).

Stream flow at the Escarpment springs and the surface water monitoring stations is interpreted to be influenced by the drier than normal climate in February, which was 20 mm drier than the 30 Year Climate Normal (WAI climate station).

- Green zone stream flow measured at: Escarpment springs stations, SW17 & SW17A.
- Yellow zone stream flow interim triggers measured at: SW6A.
- Red zone stream flow interim triggers measured at: SW2 & SW16.

The yellow and red zone interim stream flow trigger values that were exceeded in the month of February are attributed to the atypical climate conditions and are not attributed to the expansion quarry.

4.2.1.4.3 MARCH 2017

Surface water flow and temperature data at the Escarpment springs and the surface water stations were collected during the March monthly monitoring event (March 20-22, 2017).

March 2017 was drier than normal (measured at the WAI climate station). March is typically the month when the majority of the snow pack melts, resulting in higher stream flows. However, in 2017, the melt event was late, occurring after the March monthly monitoring event.

- Green zone stream flow measured at: SW10, SW11, SW21C, SW77, SW9, SW17A & SW18.
- Yellow zone stream flow interim triggers measured at: SW24A, SW3, SW6A, SW14, SW16 & SW17.
- Red zone stream flow interim triggers measured at: SW15.

The yellow and red zone interim stream flow trigger values that were exceeded in the month of March are attributed to the atypical climate conditions and are not attributed to the expansion quarry.

4.2.1.4.4 APRIL 2017

Surface water flow and temperature data at the Escarpment springs and the surface water stations were collected during the April monthly monitoring event (April 18-20, 2017).

- Green zone stream flow measured at: all surface water stations and Escarpment springs with the exception of SW2, SW6A & SW18.
- Yellow zone stream flow interim triggers measured at: SW2, SW6A & SW18.
- There were no red zone interim triggers for stream flow measured in April 2017.

The month of April 2017 received a higher than normal amount of precipitation (measured at Shanty Bay and WAI climate stations), however, a majority of this precipitation was at the beginning of the month (49 mm measured between April 3rd to the 6th).

The yellow zone stream flow trigger values are interpreted to be the result of climate conditions and are not attributed to the expansion quarry.

4.2.1.4.5 MAY 2017

Surface water flows and water temperature data were collected at the Escarpment springs and the surface water monitoring stations during the May monthly monitoring event (May 16-18, 2017).

- Green zone stream flow measured at: all Escarpment springs stations, except SW21C, and all surface water monitoring locations.
- Yellow zone stream flow interim triggers measured at: SW21C (3.5 L/s vs. trigger value of 3.7 L/s).
- There were no red zone interim triggers for stream flow measured in May 2017.

The yellow zone interim stream flow trigger value exceeded in the month of May is interpreted to be the result of the atypical climate conditions and are not attributed to the expansion quarry.

4.2.1.4.6 JUNE 2017

The surface water flow and temperature data were collected from the Escarpment springs and the surface water monitoring locations during the June monthly monitoring event (June 26 – 28, 2017).

- Green zone stream flow measured at: all Escarpment springs, with the exception of SW21C, and all surface water monitoring locations.
- Yellow zone stream flow interim trigger measured at: SW21C.
- There were no red zone interim triggers for stream flow measured in June 2017.

The interim trigger stream flow values for June are lower than those in May and appear to better represent the measured stream flows reported in June 2017. The only interim stream flow trigger value that was exceeded in June was at SW21C, located on private property.

The yellow zone interim stream flow trigger value exceeded in the month of June is not attributed to the expansion quarry.

4.2.1.4.7 JULY 2017

Surface water flow and temperature data were collected bi-weekly at the Escarpment springs in July 2017, as stipulated by the PITM. Monitoring events were completed on July 7th, 2017 and during the July monthly monitoring event on July 18-20, 2017. Surface water monitoring stations were measured during the monthly event only.

July 7th Event (Escarpment springs only)

- Red zone stream flow interim trigger measured at: SW24A.

July 18-20th Event

- Green zone stream flow measured at: all Escarpment spring stations, including SW24A, and all surface water monitoring stations.
- Yellow zone stream flow interim triggers measured at: None.
- Red zone stream flow interim triggers measured at: None.

The interim stream flow trigger values for July are generally lower than or equal to the interim trigger values developed for the month of June. The interim trigger values continue to be representative of the measured stream flow conditions at the Escarpment springs, with the exception of the red zone interim trigger stream flow measured at SW24A. The surface water flow measured at SW24A had recovered to the green zone level during the monthly stream flow monitoring event on the 18-20th of the month.

The red zone stream flow interim trigger recorded in July 2017 is not attributed to the expansion quarry.

4.2.1.4.8 AUGUST 2017

Surface water flow and water temperature data were collected during the August monthly monitoring event (August 14-18, 2017). An additional site visit was completed on August 2nd, 2017 to make observations at the Escarpment springs, as stipulated in the AMP.

August 2nd Event (Escarpment springs only)

— Green zone stream flow measured at: all Escarpment Spring stations.

August 14-18th Event

— Green zone stream flow measured at: all Escarpment spring stations, with the exception of SW24A, and all surface water monitoring stations.
— Yellow zone stream flow interim triggers measured at: SW24A.
— Red zone stream flow interim triggers measured at: None.

The interim stream flow triggers for August are generally lower than the interim trigger values established for July.

There was variation noted in the measured flows at the Escarpment springs between the two events in August, with surface water flow at SW21C increasing from 2.4 L/s to 7.2 L/s and the surface water flow at SW24A decreasing from the green zone (0.6 L/s) into the yellow interim trigger zone (0.1 L/s).

The exceedance of the yellow interim trigger value in August 2017 is not attributed to the expansion quarry.

4.2.1.4.9 SEPTEMBER 2017

Surface water flow measurements and water temperature data were collected at the Escarpment springs and the surface water monitoring stations during the September monthly monitoring event (September 17-19, 2017).

— Green zone stream flow measured at: all Escarpment spring stations, with the exception of SW24A, and all surface water monitoring stations.
— Yellow zone stream flow interim triggers measured at: SW24A.
— Red zone stream flow interim triggers measured at: None.

SW24A is located on private property, approximately one km north east of the expansion quarry. SW24A is fed from an Escarpment spring, which is located upstream of the stream flow monitoring station. Groundwater monitoring wells IW3 and IW4, located along the northeastern boundary of the Duntroon Expansion Quarry property, roughly in between the extraction face and the location of SW24A, have not shown any measurable drawdown effects over the last year and a half, since extraction activities began in June 2016. IW3 and IW4 groundwater hydrographs are presented in ***Appendix C***, Figure C-8 and C-9, respectively.

The exceedance of the yellow interim trigger value in September 2017 is not attributed to the expansion quarry.

4.2.1.4.10 OCTOBER 2017

Surface water flow measurements and water temperature at the Escarpment springs and the surface water monitoring stations were collected during the October monthly monitoring event (October 16-18, 2017).

- Green zone stream flow measured at: Escarpment spring stations, with the exception of SW21C, and all surface water monitoring stations.
- Yellow zone stream flow interim triggers measured at: SW21C.
- Red zone stream flow interim triggers measured at: None.

SW21C is located on private property, approximately one km north east of the expansion quarry. Similar to SW24A, SW21C is fed from an Escarpment spring located upstream of the stream flow monitoring station. Groundwater monitoring wells IW3 and IW4, located along the northeastern boundary of the Duntroon Expansion Quarry property, roughly in between the extraction face and the location of SW24A, have not shown any measurable drawdown effects over the last year and a half, since extraction activities began in June 2016. IW3 and IW4 groundwater hydrographs are presented in ***Appendix C, Figure C-8*** and ***C-9,*** respectively.

The flow at SW21C in the yellow interim trigger zone is not attributed to the aggregate extraction in Phase I of the expansion quarry.

4.2.1.4.11NOVEMBER 2017

Surface water flow measurements and air temperature data were recorded at the Escarpment springs and the surface water monitoring stations during the November monthly monitoring event (November 14-16, 2017).

- Green zone stream flow measured at: Escarpment spring stations, with the exception of SW24A, and all surface water stations.
- Yellow zone stream flow interim triggers measured at: SW24A.
- Red zone stream flow interim triggers measured at: None.

The measured flow rate at SW21C recovered from October into the green zone for November. Conversely, the measured flow rate at SW24A dropped from the green zone flow rate measured in October to the yellow interim trigger zone in November. For the reasons outlined in Section 3.2.4.9, above, the flow rate at SW24A in the yellow interim trigger zone is not attributed to the aggregate extraction in Phase I of the expansion quarry.

4.2.1.4.12DECEMBER 2016

Surface water flow measurements and water temperature data were collected at the Escarpment springs and most of the surface water monitoring stations during the December monthly monitoring event (December 11-13, 2017).

- Green zone stream flow measured at: Escarpment springs stations and all surface water monitoring stations with the exception of SW6A.
- Yellow zone stream flow interim triggers measured at: SW6A.
- Red zone stream flow interim triggers measured at: None.

Several of the surface water monitoring stations were frozen over during the monthly monitoring event in December 2017. Frozen conditions upstream of SW6A may have affected flow patterns thereby contributing to the lower than average flow rate reported in December. This interim stream flow trigger value is not attributed to the aggregate extraction activities occurring in Phase 1 of the expansion quarry.

4.2.1.5 MITIGATION MEASURES UNDERTAKEN

There were no mitigation measures undertaken in 2017. Mitigation measures are not anticipated to be required in Phase I, since extraction during Phase I is not expected to result in negative impacts to off-site water resources and/or ecological features and functions, given the extraction that historically has occurred in the Existing Quarry.

An overview of the proposed future mitigation measures that may be implemented if necessary, as outlined in the AMP document, is included in Sections 5.4.1 and 5.4.2, below.

4.2.1.5.1 ROUTINE WATER MANAGEMENT MEASURES

In addition to the Site Plans, and this AMP, routine water management and mitigation are regulated by approvals under the Ontario Water Resources Act (PTTW No. 7725-AACS54, dated September 22, 2016) and the Environmental Protection Act (ECA No. 1521-A4VJ4X, dated October 17th, 2016). These measures have, to the extent possible, been aligned with the monitoring requirements that exist under the AMP.

The AMP mitigation objectives are based on the release of the required volumes of water to the landscape in the vicinity of the wetlands without negatively affecting the surrounding environment. The initial discharge volumes, if and when required, will be based proportionately on the respective sizes of the surface drainage catchment areas extracted from the respective watersheds (Beaver River or Batteaux Creek), in each Phase.

The proportionate discharge to each watershed/wetland can be adjusted, as necessary, based on the results of the AMP Performance Indicator Trigger Monitoring Program. Discharge into the wetlands will be managed by adjusting pumping rates and/or by means of flow restrictor valves in discharge lines, as required. Discharge into individual wetlands will be adjusted as necessary to maintain target hydrographs in each wetland/watercourse.

For more information on the proposed discharge points and designs that will be implemented progressively during the excavation of the Phases of the expansion quarry, please see Section 2.3 of the AMP document.

Routine water management activities are fully expected to maintain quarry operations in compliance with the AMP trigger criteria, and protect the surrounding natural environment and water resources.

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.

4.2.1.5.2 CONTINGENCY MITIGATION MEASURES

Contingency mitigation measures are available to be implemented by Walker Aggregates when, and if, the AMP monitoring indicates such measures are necessary. As previously noted, the extraction of Phase I of the expansion Quarry is not expected to result in negative impacts to off-site water resources and/or ecological features and functions, given the extraction that historically has occurred in the Existing Quarry. No impacts are predicted during the first 5 years of operations and no contingency mitigation measures are required at this time. Contingency mitigation measures were not required to be implemented during the 2017 monitoring period.

The design of site specific discharge structures, or contingency mitigation measures located outside the area of extraction must be approved by the MNRF and included in the AMP prior to any construction (ARA Site Plan Hydrogeology Note 7E).

For a full list and detailed explanation of the contingency mitigation measures that could be implemented during operations please reference Section 2.4.1 in the AMP document.

Any potentially necessary contingency mitigation measures for the next 5 years of operation (not expected) and the subsequent 5 year periods will be designed and included in the AMP through the 5-Year Comprehensive Review process. The necessity for contingency mitigation measures will be identified based on the progress of extraction, monitoring results and the PITM program.

4.2.2 SURFACE WATER TEMPERATURE

For water temperature in streams and/or Escarpment springs, monthly interim trigger values are established for the months of June through September to reflect the period when warm surface water temperatures have the potential to affect sensitive fish habitat areas that are present downstream, below the Escarpment brow. The interim red zone trigger values are set as the highest monthly temperature that has been recorded through the historic period of record. The interim yellow zone trigger value is set at 10% below the interim red zone trigger value. The interim green zone trigger value is anything that is below the yellow zone trigger value.

Interim temperature trigger values are outlined in Table 3.6, ***Appendix B*** of the AMP document.

4.2.2.1 SURFACE WATER COURSES

The surface water monitoring stations are monitored once a month during the months of June, July, August and September and the surface water temperature is recorded and compared to the interim trigger values developed specifically for each surface water station.

Surface water monitoring stations are listed in Table 4-1 and 4-2, above.

4.2.2.2 ESCARPMENT SPRINGS

The Escarpment spring monitoring stations are monitored once a month during the months of June and September and bi-weekly in July and August. Surface water temperature is recorded and compared to the interim trigger values developed specifically for each Escarpment spring monitoring station.

4.2.2.3 CONTROL STATIONS

The Batteaux Creek (BC Control) and Pretty River (PR Control) control stations provide context to the recorded surface water temperature data. The control stations are discussed in section 3.2.1.3, above.

4.2.2.4 TRIGGER EXCEEDANCES

As outlined in Table 3.2 of the AMP, trigger monitoring criteria for water flows, water temperature and wetland water levels will apply during their respective trigger periods as soon as extraction proceeds beyond Phase 1. Interim trigger values have been developed for water flows and water temperature using historical monitoring data. These interim trigger values will be updated as further monitoring data become available during Phase 1.

Exceedances of the interim trigger values for water temperature are discussed below in chronological order. Monthly monitoring summary tables are included in ***Appendix B*** (Tables B17 - B 24).

4.2.2.4.1 JUNE 2017

Surface water temperature data were collected from the Escarpment springs and the surface water monitoring stations during the June monthly monitoring event (June 26-28, 2017).

The average monthly temperature in June was 16.0°C (WAI climate station). This is within 0.6°C of the 30 year climate normal average monthly temperature for June (16.6°C). The maximum daily temperature recorded at the WAI climate station for the five days leading up to the monitoring event ranges from 16°C to 23°C and the minimum air temperature does not drop below 10°C.

— Green zone temperature measured at: Escarpment spring stations and all surface water monitoring stations with the exception of SW77.

— Yellow zone temperature interim triggers measured at: None.

— Red zone temperature interim triggers measured at: SW77.

Surface water station SW77 is directly exposed to the afternoon sun, and the timing of the measurement of the surface water station will directly impact the temperature value. The maximum recorded air temperature at the WAI climate station on the day of the SW77 measurement was 21°C. The red and yellow zone temperature interim triggers recorded in June 2017 are attributed to the warm air temperature in the period leading up to the monthly monitoring event, and not to the expansion quarry.

4.2.2.4.2 JULY 2017

Surface water flow and temperature data were collected bi-weekly at the Escarpment springs in July 2017, as stipulated by the AMP. Monitoring events were completed on July 7th, 2017 and during the July monthly monitoring event on July 18-20, 2017. Surface water control stations were monitored during the monthly monitoring event only.

July 7th Event (Escarpment Springs only)

- Green zone temperature measured at: Escarpment springs with the exception of SW77.
- Yellow zone temperature interim triggers measured at: None.
- Red zone temperature interim triggers measured at: SW77.

July 18-20, 2017 Event

- Green zone temperature measured at: Escarpment springs, with the exception of SW77, and at all surface water stations.
- Yellow zone temperature interim triggers measured at: None.
- Red zone temperature interim triggers measured at: SW77.

The maximum air temperature on July 5th, at the WAI climate station, is recorded as 25°C. The maximum air temperature on July 20th, the day that SW77 was monitored, is recorded as 23°C. The red zone temperature interim triggers recorded in July 2016 are attributed to the warm air temperature in the period leading up to the monitoring events, and not to the expansion quarry.

4.2.2.4.3 AUGUST 2017

Surface water temperature data were collected during the August monthly monitoring event (August 14-18, 2017). An additional site visit was completed on August 2nd, 2017 to make observations at the Escarpment springs, as stipulated in the AMP.

August 2nd Event (Escarpment springs only)

- Green zone temperature measured at: SW11 & SW21C.
- Yellow zone temperature interim triggers measured at: SW10 & SW24A.
- Red zone temperature interim triggers measured at: SW77.

August 14-18th Event

- Green zone temperature measured at: SW10, SW11, SW21C and at all surface water monitoring stations with the exception of SW16.
- Yellow zone temperature interim triggers measured at: SW24A & SW16.
- Red zone temperature interim triggers measured at: SW77.

The maximum air temperature on August 2nd is not recorded at the WAI climate station. The settings at the climate station were changed in August and now only report an average temperature, and not the max/min. The average air temperature reported on August 2nd is 20.5°C. The average air temperatures during the monthly monitoring event are reported in the range of 16.7°C to 17.6°C. The low stream flow volume and shallow nature of the Escarpment springs water courses increase their sensitivity to warmer air temperatures. The yellow and red zone temperature interim triggers recorded in August 2017 are attributed to the warm air temperature in the period leading up to, and during the monitoring events, and not to the expansion quarry.

4.2.2.4.4 SEPTEMBER 2017

Surface water temperature data was collected at the Escarpment springs and the surface water monitoring stations during the September monthly monitoring event (September 17-19, 2017).

- Green zone temperature measured at: SW11, SW1, SW2 and SW0-2.
- Yellow zone temperature interim triggers measured at: SW21C, SW6A & SW15.
- Red zone temperature interim triggers measured at: SW10, SW24A, SW77, SW14, SW16, SW17, SW17A & SW18.

Surface water SW10 and SW24A originate as Escarpment springs, but the water travels over the ground surface 30 to 80 m before the cross-section where the water temperature and flow are recorded. The low stream volume and shallow nature of the Escarpment springs water courses increases their sensitivity to warmer air temperatures. Surface water station SW77, as previously discussed, is directly exposed to afternoon sun, and the timing of the measurement of the surface water station can directly impact the value. The average daily air temperature at the WAI climate station on September 17th, when SW0-2, SW6A, SW16, SW17, SW17A, SW18, SW24A and SW77 were monitored, was 20.3°C. The average daily air temperature on September 18th, when SW1, SW2 were monitored, was 18°C. The average daily air temperature on September 19th, when SW10, SW14, SW15 and SW21C were monitored, was 17°C.

The yellow and red zone temperature interim triggers recorded in September 2017 are attributed to the warm air temperature and reduced stream flows in the period leading up to, and during the monitoring events, and not to the expansion quarry.

4.2.2.5 MITIGATION MEASURES UNDERTAKEN

Mitigation measures are not expected to be required in Phase I, since extraction during Phase I is not expected to result in negative impacts to off-site water resources and/or ecological features and functions, given the extraction that historically has occurred in the Existing Quarry.

An overview of the proposed future mitigation measures that may be implemented if necessary are outlined in the AMP document and briefly described below.

4.2.2.5.1 ROUTINE WATER MANAGEMENT MEASURES

Routine water management measures are outlined in Section 4.2.1.5.1, above.

Routine water management mitigation measures or contingency mitigation measures were not required during the 2017 monitoring period.

4.2.2.5.2 CONTINGENCY MITIGATION MEASURES

Contingency mitigation measures are available to be implemented by Walker Aggregates when, and if, the AMP monitoring indicates such measures are necessary. As previously noted, the extraction of Phase I of the expansion Quarry is not expected to result in negative impacts to off-site water resources and/or ecological features and functions, given the extraction that historically has occurred in the Existing Quarry. No impacts are predicted during the first 5 years of operations and no contingency mitigation measures are required at this time. Contingency mitigation measures were not required to be implemented during the 2017 monitoring period.

The design of site specific discharge structures, or contingency mitigation measures located outside the area of extraction must be approved by the MNRF and included in the AMP prior to any construction (ARA Site Plan Hydrogeology Note 7E).

For a full list and detailed explanation of the contingency mitigation measures that could be implemented during operations please reference Section 2.4.1 in the AMP document.

Any potentially necessary contingency mitigation measures for the next 5 years of operation (not expected) and the subsequent 5 year periods will be designed and included in the AMP through the 5-Year Comprehensive Review process. The necessity for contingency mitigation measures will be identified based on the progress of extraction, monitoring results and the PITM program.

4.2.3 WETLAND WATER LEVEL

The wetlands are protected by the retention of the majority of their catchment areas, such that nearby wetland features will continue to receive direct precipitation, as well as snowmelt and storm-event surface runoff from the lands to the north and east, and in the case of Rob Roy Swamp Wetland Complex unit RR2 wetland, from the American Hart's-Tongue Fern and Butternut protection areas to the south.

When required, wetland water levels will be managed during the active extraction phases of the quarry through to final rehabilitation by discharging quarry water into the wetlands as required to maintain the seasonal hydro-periods and surface water outflows. Discharge water quality will be regulated by approvals under the Environmental Protection Act (ECA for discharge of sewage Works).

Design and pumping rates will be refined in consultation with the MNRF, MOECC and Conservation Authority staff through the Phase I extraction period as the monitoring database expands. Preliminary target hydrographs have been developed for the three major wetland types and include target ranges for wet, average and dry conditions.

During Phase I quarry operations, a reference wetland station will be established in either the Nottawasaga Lookout Provincial Park or the Pretty River Provincial Park with input from MNRF and the Nottawasaga Valley Conservation Authority. The reference wetland station will be located away from any potential quarry effects, so that the prevailing local/regional climate conditions are incorporated into the evaluation of site-specific local wetland water level data. Water levels in the reference wetland station will indicate whether the regional climate is experiencing wet, average or dry conditions. This information will be updated seasonally and used to determine which of the three lines in the target hydrographs (wet, average or dry) should be applied at any given time. Reference wetland stations have not yet been established.

The wetland target refinement process will be verified through the long term ecological monitoring of wetlands to obtain data on the trends in amphibian habitat conditions, wetland plant species diversity and percent cover, and other ecological indicators of healthy, functional wetlands.

Drivepoint water level and ponded water depth were recorded during the following monitoring events, as outlined in the PITM:

- May 10th, 2017 (bi-weekly event)
- May monthly monitoring event (May 25th, 2017)
- June 1st, 2017 (bi-weekly event)
- June monthly monitoring event (June 26th, 2017)
- July 7th, 2017 (bi-weekly event)
- July monthly monitoring event (July 17th, 2017)

Data from these events is included in Table B-31, Appendix B.

Hydrographs for the drivepoint monitors are presented in ***Appendix C (Figures C-63 through C-73)*** and include the water level inside the drivepoint as well as the elevation of the surface water that is ponded around the drivepoint, where it is present. Table C-8 in ***Appendix C*** includes water level elevations at the drivepoint locations. Occasionally over the winter the water inside the drivepoints freezes and a water level cannot be measured. The surface water ponded around the drivepoints also typically freezes over during the winter months. These events are noted in Table C-8 where they were observed during the monitoring event. Drivepoint and wetland locations are provided on ***Figure 3 – Monitoring Locations***. Trends and observations for drivepoint monitoring stations are outlined in Table 4-3.

Table 4-3 Drivepoint Monitoring Stations - Results

MONITORING STATION	FIGURE	OBSERVATIONS
Bridson DP	C-73	Seasonal variation within previously reported values.
DP2	C-64	Water levels stable since 2010-2011.
DP4	C-66	Water levels relatively stable since 2011.
DP5	C-67	Seasonal variation within previously reported values.
DP6	C-68	Seasonal variation within previously reported values.
DP7	C-69	Limited data set.
DP8	C-70	Limited data set.
DP9	C-71	Limited data set.
DP10	C-72	Limited data set.

4.2.3.1 VERNAL BREEDING POOLS WATER LEVELS

Rob Roy PSW#2 is located north of the expansion quarry. Drivepoints DP5 and DP7 are located north of the expansion quarry in vernal pools that are part of Rob Roy PSW #2. DP5 was installed in the summer of 2007 and has been monitored monthly, when accessible, since then. Water levels at DP5 in 2016 reflect the atypically dry conditions of the summer of 2016, and a new low water level was recorded at the drivepoint in October 2016 (508.6 m ASL). This water level is lower than the previous minimum water level recorded at DP5 in September 2011 (508.8 m ASL). Water levels at DP5 in 2017 reflect seasonal variation within previously reported values. DP7 was installed in the summer of 2014 and water level monitoring has been completed monthly since the end of 2015. Water levels at DP7 in 2016 and 2017 show seasonal variation, with peak water levels recorded in the spring of 2016.

The ANSI A wetland is located north of the expansion lands (Figure 3). Drivepoint DP6 is located in a vernal pool in the ANSI A wetland. Water levels at DP6 have been monitored on a monthly frequency since the end of 2007 and show typical seasonal variation. Peak water elevations are reported in the spring. DP6 is often reported as “dry” over the summer months, which shows up in the hydrograph as gaps between the recorded data points.

4.2.3.2 SOIL GROUNDWATER TABLE LEVELS

Rob Roy PSW#6 is located west of the Existing Quarry. DP2 is located in the wetland area where the existing quarry currently discharges water pumped from the quarry floor to dewater the excavation area. DP4 is located west of SW1, immediately downstream of the twin culverts that pass under Grey County Road 31. DP8 is located in PSW#6 in between SW2 and the quarry discharge line. DP2 has been monitored monthly since the fall of 1999, when accessible. Water levels at DP2 have been very consistent since approximately 2011. Water levels in 2017 showed a slight increase over previously recorded water levels. The discharge from the Existing Quarry is directed into this wetland area, which is west of the quarry. The quarry discharge provides a buffer for the wetland water levels, which keeps them consistent. Water levels at DP4 have been monitored monthly since the fall of 1999, when accessible and have been consistent over the past 5 years. There was no significant change to water levels at DP4 in 2017. The quarry discharge also provides a buffer to water levels at DP4. DP8 was installed in 2014 and has been monitored on a monthly frequency since the end of 2015. Water levels at DP8 are also buffered by the quarry discharge and show little variation over the course of 2017.

Rob Roy PSW#3 is located west of the expansion quarry, across Grey County Road 30 and immediately north of the MAQ quarry property ***(Figure 3)***. Drivepoint DP10 is located in the wetland thicket swamp of RR PSW#3.

Monthly monitoring at DP10 has been ongoing since the end of 2015. Water levels at DP10 show slight seasonal variation over the course of 2017.

The ANSI B wetland is located east and north east of the expansion quarry (***Figure 3***). The drivepoint designated Bridson DP is on the former Bridson property (now owned by WAI), just east of the expansion quarry in the buffer lands. Groundwater levels at Bridson DP show seasonal fluctuation, with a seasonal low water elevation typically in the late summer or early fall. Bridson DP was reported as "dry" during monitoring events in August, September and October of 2016, which is attributed to the atypically dry summer weather conditions. Bridson DP was reported as dry in July 2017.

Drivepoint DP9 was installed in 2014 and is located north-east of the expansion quarry footprint, in the ANSI B buffer lands owned by WAI. DP9 was reported as "dry" during the October and December monitoring events in 2016. In 2016, water levels at DP9 peaked in the spring of 2016 and then declined into the late summer/fall. The magnitude of seasonal variation in water levels at DP9 was reduced in 2017 compared to 2016.

4.2.3.3 REFERENCE WETLANDS

During Phase 1 of quarry extraction, a reference wetland is to be established in the Nottawasaga Lookout Provincial Park or the Pretty River Provincial Park with input from the Ministry of Natural Resources and Forestry and the Nottawasaga Valley Conservation Authority. This wetland will be designated as Reference Wetland 1.

The reference wetland has not yet been established, but will be established during Phase 1 quarry operations.

4.2.3.4 TRIGGER EXCEEDANCES

As per Table 3.2 in the AMP, the trigger period for the wetland water levels is spring and early summer (June/July) as soon as extraction proceeds beyond Phase 1. There are no interim triggers for the wetland water levels. Trigger levels based on wetland vegetation and amphibian habitat will be developed and refined through the Phase 1 extraction period as the monitoring database expands and with input from agency staff.

4.2.3.5 MITIGATION MEASURES UNDERTAKEN

Mitigation measures are not expected to be required in Phase I, since extraction during Phase I is not expected to result in negative impacts to off-site water resources and/or ecological features and functions, given the extraction that historically has occurred in the Existing Quarry.

An overview of the proposed future mitigation measures that may be implemented if necessary, as outlined in the AMP document, is included in Sections 3.2.4.5.1 and 3.2.4.5.1, below.

4.2.3.5.1 ROUTINE WATER MANAGEMENT MEASURES

Routine water management measures are outlined in Section 4.2.1.5.1, above.

Routine water management mitigation measures or contingency mitigation measures were not required during the 2017 monitoring period.

4.2.3.5.2 CONTINGENCY MITIGATION MEASURES

Contingency mitigation measures are available to be implemented by Walker Aggregates when, and if, the AMP monitoring indicates such measures are necessary. As previously noted, the extraction of Phase I of the expansion Quarry is not expected to result in negative impacts to off-site water resources and/or ecological features and functions, given the extraction that historically has occurred in the Existing Quarry. No impacts are predicted during the first 5 years of operations and no contingency mitigation measures are required at this time. Contingency mitigation measures were not required to be implemented during the 2017 monitoring period.

The design of site specific discharge structures, or contingency mitigation measures located outside the area of extraction must be approved by the MNRF and included in the AMP prior to any construction (ARA Site Plan Hydrogeology Note 7E).

Contingency mitigation measures that are available during operations could include an earthen buttress to act as a hydraulic barrier; temporary grouting techniques used locally to reduce hydraulic conductivity of the rock mass; pumping from deeper, cooler water for discharge; modifying the outflow characteristics of surface water from a wetland; recharge injection wells etc. For a full list and detailed explanation of the contingency mitigation measures that could be implemented during operations please reference Section 2.4.1 in the AMP document.

Any potentially necessary contingency mitigation measures for the next 5 years of operation (not expected) and the subsequent 5 year periods will be designed and included in the AMP through the 5-Year Comprehensive Review process. The necessity for contingency mitigation measures will be identified based on the progress of extraction, monitoring results and the PITM program.

4.3 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the 2017 performance indicator trigger monitoring program the following conclusions and recommendations are made:

- Certain deficiencies that were apparent with the implementation of the program in 2016, including the flow and temperature interim trigger level values that were adopted for the PITM Escarpment spring and surface water monitoring stations, continued to be evident in the 2017 program. The performance indicator interim triggers for surface water flow and surface water temperature should be re-evaluated to incorporate the conditions observed in 2016 and 2017. Those values recorded in 2016 and 2017 as having exceeded a specific seasonal maximum or minimum interim “trigger” value occurred as a result of atypical climatic conditions, and not as a result of quarry operations in Phase 1. The interim trigger values should be re-evaluated to include the monitoring data obtained in 2016 and 2017, and modified where appropriate to better reflect existing conditions.
- A late spring melt resulted in lower than normal surface water flows reported in March 2017.
- A wetter than normal April, May and June resulted in most surface water flows for those months being reported in the green zone.
- Surface water stations SW21C, SW24A and SW77 show sensitivity to high air temperatures due to their low flow and shallow nature. These high surface water temperatures are interpreted to be due to climate conditions and are not related to the active extraction in the expansion quarry. The potential for off-site water-related effects to any of the provincially significant wetlands and/or Escarpment springs during Phase 1 is considered to be very low.
- Higher than normal temperatures in September 2017 contributed to warmer than usual water temperatures recorded at the Escarpment spring and surface water monitoring stations. These warmer temperatures translated to interim trigger value temperatures being recorded at several of the Performance Indicator Trigger monitoring stations. These interim trigger occurrences are interpreted as being reflective of the atypical local climatic conditions, and not due to the active extraction in the expansion quarry.
- During Phase 1 of quarry extraction, a reference wetland is to be established in the Nottawasaga Lookout Provincial Park or the Pretty River Provincial Park with input from the Ministry of Natural Resources and Forestry and the Nottawasaga Valley Conservation Authority. This wetland will be designated as Reference Wetland 1.
- Temperature readings in the standing water (if present) were completed as part of the PITM in 2017. The results are presented on Table C-9 in ***Appendix C***.

5 LONG TERM GROUNDWATER AND SURFACE WATER MONITORING PROGRAM

The Long Term Trend (LTT) groundwater and surface water monitoring program is ongoing for the existing and expansion quarry properties, and a version of this monitoring program will continue through the active life of both quarries through to their final rehabilitation as lakes.

Long term trend monitoring 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 existing quarry winds down and the expansion quarry extraction operation continues over the next 20 to 30 years, followed by several decades of rehabilitation to lakes. The LTT monitoring program will provide data that will update the environmental baseline conditions as new data become available, and identify short-term and long-term climate trends.

5.1 METHODS

The surface water drainage divides and local catchment areas for the Pretty River, Batteaux Creek, Beaver River and Mad River systems are illustrated on Figure 3. Monitoring stations that are part of the LTT monitoring program are also illustrated on ***Figure 3***. The long term trend monitoring program includes selected PITM stations, as well as additional groundwater and surface water stations. The surface water and groundwater monitoring stations that are included in the PITM program are integral to this LTT monitoring program, such that monitoring results from those stations are incorporated into the assessment of long term trends.

The LTT monitoring program for the groundwater monitoring stations includes monthly manual groundwater level measurements and a network of pressure transducers that record hourly or twice daily water levels at selected groundwater monitoring wells.

Long term trend monitoring stations are listed, along with a description, in Table 4.1 of the AMP document. The location of the long term trend monitoring stations is presented on ***Figure 3***. A summary of the well information is included in Table C-1 in ***Appendix C.***

Long term trend monitoring stations include groundwater monitoring wells in the following locations:

- Existing quarry: 98-8, 98-9, 98-12 and PW99-1;
- Expansion quarry (injection wells): IW1, IW2, IW3 and IW4;
- Expansion 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;
- Osprey quarry property: 101-B, 102-C, 103-D, 104-A, OW1-4, OW3-1 (not accessible), OW5-2 and OW6-3;
- Carmarthen Lake Farms property: CLF1 (not accessible), CLF2, CLF3, CLF4 and CLF5.

On the Osprey property, monitoring well OW1-6 was historically part of the monitoring program on the Osprey Property, but the well was damaged and is no longer accessible for monitoring purposes. Additionally, monitoring well OW3-1 has not been accessible for monitoring since November 2015. The removal of these two wells from the monitoring program does not affect the overall integrity of the program.

There are several private domestic water wells located around the periphery of the predicted drawdown zone of influence of the expansion quarry (Jagger Hims, 2007). Locations of the groundwater supplies are identified on Figure 3 as 'RW' (residential wells). Selected monitoring wells are monitored in the AMP under the Long Term Trend Groundwater and Surface Water Monitoring Program:

- East of existing and expansion quarry: RW1, RW2, RW5, RW6, RW7, RW8, RW16 (owned by WAI), RW18 (owned by WAI, to be removed by extraction) and RW19 (owned by WAI, to be removed by extraction).
- North of expansion quarry: RW3, RW4, RW17
- West of expansion quarry: RW9 (MAQ Aggregates property)

The Long Term Trend monitoring program for residential wells includes the monthly measurement of groundwater levels and the installation of pressure transducers in selected residential wells to record hourly or twice daily groundwater levels. A limited number of residential wells are also sampled annually for general chemistry, major and minor ion constituents, nutrients, total petroleum and hydrocarbons, BTEX, total suspended solids and bacteriological parameters.

Monitoring well RW20, the water supply well for the old quarry office, is listed as part of the Long Term Trend monitoring program in the AMP document. RW20 was removed with extraction activities and is no longer available for monthly groundwater levels.

Additional residential monitoring wells that have historically been part of the monitoring program for the expansion quarry but that are not part of the Long Term Trend monitoring program include RW10, RW11, RW12, RW13, RW14, RW15 and RW20. RW10 and RW11 are residential wells that are no longer included in the monitoring program on the request of the home-owners. RW12 and RW13 are currently included in the monitoring events but are not part of the Long Term Trend monitoring program. RW14 and RW15 are monitoring wells that were historically part of the monitoring network at the existing quarry, but have been decommissioned.

The LTT monitoring program also includes drivepoints that are located in the following wetlands:

- ANSI A: DP6 (vernal pool)
- ANSI B: Bridson DP, DP9
- RR2: DP5 (vernal pool), DP7 (vernal pool), Staff Gauge 1 and Staff Gauge 2 (BH03-7 SG1/ SG2)
- RR3: DP11
- RR6: DP1, DP2, DP4, DP8
- CLF wetland: DP3

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. Selected drivepoint monitors also have pressure transducers installed which record twice daily groundwater levels.

The surface water monitoring program under the LTT monitoring program includes monthly stream flow and temperature measurements at the surface water monitoring stations, with the exception of station QFSW2, which is measured weekly. Pressure transducers are to be installed at selected surface water stations to record hourly water level stage. Annual water measurement of field chemistry parameters (temperature, pH, conductivity and dissolved oxygen) and water quality sampling also occurs at selected surface water stations.

The LTT surface water monitoring program includes monitoring stations located in the following watersheds:

- The Pretty River tributary system: SW20
- The Batteaux Creek tributary system: SW7, SW8, SW10, SW11E, SW13, SW19, SW21A-C, SW22, SW22A and SW22C
- The Beaver River tributary system: SW3C (‘RR3 Out’)
- Existing quarry floor: QFSW2 and dewatering sump

The additional surface water stations with data included in this AMP summary report that are not PITM or LTT monitoring stations are the following: SWB-1, QFSW1, SW3A, SW4, SW5, SW6, SW12, SW12A, SW17B, SW21D, SW22B, SW23, SW24, SW24B, SW24C, SW25, SW26, SW26A, and SW27. The data for these additional stations is included in the report to provide context to the monitoring results for 2017 and to provide a historical record of the data collected in support of the Duntroon Quarry expansion. A description of each surface water monitoring station is provided in Table B-1, ***Appendix B***.

5.2 NEW MONITORS INSTALLED

New groundwater monitoring wells and drivepoints were installed in 2014, as required by the Site Plan for the expansion quarry. The groundwater monitoring wells include NW1 through NW10 and the injection wells IW1 through IW4.

The details of the monitor installation and packer testing at the groundwater monitoring wells completed in 2014 will be submitted under separate cover.

5.3 MONITORING RESULTS

5.3.1 GROUNDWATER LEVELS

5.3.1.1 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 snow pack 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.

5.3.1.1.1 WETLANDS

Wetland water levels showed the effects of seasonal variation to different degrees. Wetland water levels are discussed in more detail in section 3.2.3, above.

5.3.1.1.2 BEDROCK

Groundwater monitoring wells in the long term trend monitoring network showed a varying degree of influence due to seasonal climate conditions. The seasonal variation of groundwater levels in the bedrock is discussed in more detail in the following section, where it applies to selected monitors.

5.3.1.2 EXISTING QUARRY PROPERTY

The following table outlines the observations made in 2017 at the groundwater monitoring wells that are part of the Long Term Trend groundwater monitoring network on the Existing Quarry property.

Table 5-1 Existing Quarry - Results

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
98-8	Stable water levels throughout 2017. Water levels have gradually increased at monitoring well 98-8 over time with the operation of the main reservoir at the west end of the Existing Quarry.	C-2
98-9	Water levels show seasonal fluctuations comparable to previous monitoring years. Water levels in 2016 and 2017 may be showing influence from the tunnel construction.	C-3
98-12	Water levels at 98-12 have been relatively stable since 2008.	C-4
PW99-1	Stable water levels throughout 2017. The operation of the main reservoir helps to buffer water levels at PW99-1.	C-5

Monitoring data from groundwater monitoring well MW6 ***(Figure C-1)*** has also been included in ***Appendix C*** to supplement the AMP data set, although this monitor is not included in the LTT monitoring program.

A majority of the historical groundwater monitors on the Existing Quarry property have been removed as part of aggregate extraction activities. The groundwater hydrographs for monitoring wells that were not accessed in 2017 have not been included in this report. These include monitoring wells RW14, RW15 and RW20, which, respectively, are a decommissioned old hand pump well, a decommissioned residential well and the former quarry office supply well which was removed with extraction activities at the Existing Quarry.

5.3.1.3 OSPREY QUARRY PROPERTY

The following table summarizes the observations made in 2017 at the groundwater monitoring wells that are part of the Long Term Trend groundwater monitoring network on the Osprey Property.

Groundwater monitoring well OW1-6 has been destroyed and there were no groundwater levels recorded at this monitor in 2017. Groundwater monitoring well OW3-1 has not been accessible for monitoring since November 2015. Removal of these two monitoring wells does not affect the integrity of the overall program. A groundwater hydrograph with data up until November 2015 has been provided in Appendix C.

Table 5-2 Osprey Quarry - Results

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
101-B	Water levels within previously recorded seasonal variations.	C-35
102-C	Water levels within previously recorded seasonal variations.	C-36
103-D	Water levels within previously recorded seasonal variations.	C-37
104-A	Water levels within previously recorded seasonal variations.	C-38
OW1-4	Water levels within previously recorded seasonal variations.	C-39
OW3-1	No water level data recorded in 2016.	C-40
OW5-2	Water levels within previously recorded seasonal variations.	C-41
OW6-3	Water levels within previously recorded seasonal variations.	C-42

Groundwater levels on the Osprey Property in 2017 were within previously recorded seasonal variations.

5.3.1.4 EXPANSION QUARRY PROPERTY

The following tables summarize the observations made in 2017 at the groundwater monitoring wells that are part of the Long Term Trend groundwater monitoring network on the expansion quarry property.

Table 5-3 Expansion Quarry Injection Wells – Results

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
IW1	Water levels within previously recorded seasonal variations. Over 10 m difference between peak and low water levels.	C-6
IW2	Water levels within previously recorded seasonal variations.	C-7
IW3	Water levels within previously recorded seasonal variations. Over 10 m difference between peak and low water level elevations.	C-8
IW4	Peak water level observed in March 2016. Water levels show fluctuations related to seasonal climate variation over the course of 2017.	C-9

Water levels at the injection wells show fluctuations related to seasonal climate variation over the course of 2017. Due to the limited period of record for the injection wells (<2 years), further monitoring is required before more conclusions can be reached with respect to long term trends at these wells.

Table 5-4 Expansion Quarry Monitoring Wells - Results

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
BH02-1	Overall declining trend in water levels from 2003 to present.	C-10
BH02-2	Water levels declining after August 2016.	C-11
BH02-3	Monitor is reported as dry in 2017 with the exception of April and May.	C-12
BH02-4	Water levels declining after August 2016.	C-13
BH02-5 nest	Water levels within previously recorded seasonal variations.	C-14
BH02-6	Water levels declining since October 2015. Monitor is immediately adjacent to the sinking cut made for tunnel construction.	C-15
BH03-7 nest	Water levels within previously recorded seasonal variations.	C-16
BH03-8	Water levels declined August through November 2016, but recovered in 2017 to previously recorded seasonal variation.	C-17
BH08-1	Water levels within previously recorded seasonal variations.	C-18
BH08-2	Water levels within previously recorded seasonal variations.	C-19
BH08-3	Water levels within previously recorded seasonal variations.	C-20
NW1	Water levels declining after July 2016. New low water level recorded in November 2017.	C-21
NW2	Peak water level recorded in April 2016. Water levels in 2017 were within the previously reported range.	C-22

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
NW3	Peak water level recorded in March 2016. Water levels in 2017 were within the previously reported range.	C-23
NW4	Peak water level recorded in April 2017.	C-24
NW5	Water levels declined in late 2016, showed some recovery in 2017, but not to the same peak spring elevation reported in 2016.	C-25
NW6	Water levels within previously recorded seasonal variations.	C-26
NW7	Water levels within previously recorded seasonal variations.	C-27
NW8	Water levels within previously recorded seasonal variations.	C-28
NW9	Water levels within previously recorded seasonal variations.	C-29
NW10 nest	DP water levels remain relatively constant. NW10 shallow and deep monitoring well water levels show variation due to seasonal climactic influence.	C-30
BH03-9	New minimum water elevation reported in November 2016. Water levels in 2017 are within previously recorded seasonal variations.	C-31
TW04-1	New minimum water elevation reported in November 2016. Water levels in 2017 are within previously recorded seasonal variations.	C-32
TW04-2	New minimum water elevation reported in November 2016. Water levels in 2017 are within previously recorded seasonal variations.	C-33
TW04-3	New minimum water elevation reported in November 2016. Water levels in 2017 are within previously recorded seasonal variations.	C-34

Groundwater levels on the expansion quarry property in 2017 are showing the influence of seasonal variation, as well as influence at some locations from the tunnel excavation and aggregate extraction activities. The influence of the tunnel excavation and aggregate extraction activities are limited to local influence at monitoring wells BH02-6 (immediately next to the tunnel excavation) and BH02-4, BH02-1, NW1 and NW4 which are in close proximity to the active aggregate extraction area. The influence of the quarry activities on the groundwater levels at those wells that are in in the footprint of Phase I and in the vicinity of the current extraction activities was anticipated.

Groundwater levels at the monitors on the expansion quarry property will continue to be monitored as part of the Long Term Trend monitoring program.

5.3.1.5 CARMARTHEN LAKE FARM PROPERTIES

The following table summarizes the observations made in 2017 at the groundwater monitoring wells that are part of the Long Term Trend groundwater monitoring network on the Carmarthen Lake Farms property.

As noted previously, monitoring well CLF1 is no longer accessible to obtain water levels. The water levels at CLF2, which is in close proximity to CLF1, have historically shown similar trends to the water levels at CLF1. The historical groundwater hydrograph for CLF1 is included in ***Appendix C*** as ***Figure C-43.***

Table 5-5 Carmarthen Lake Farm Properties - Results

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
CLF2	Water levels within previously recorded seasonal variations.	C-44
CLF3	Water levels within previously recorded seasonal variations.	C-45
CLF4	Water levels within previously recorded seasonal variations.	C-46
CLF5	Water levels within previously recorded seasonal variations.	C-47

5.3.1.6 RESIDENTIAL WELLS

Table 5-6 Residential Wells - Results

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
RW1	Water levels within previously recorded seasonal variations.	C-48
RW2	Water levels within previously recorded seasonal variations.	C-49
RW3	Water levels within previously recorded seasonal variations.	C-50
RW4	New minimum water level recorded in August 2017. Remaining water levels within previously recorded seasonal variations.	C-51
RW5	Water levels within previously recorded seasonal variations.	C-52
RW6	Water levels within previously recorded seasonal variations.	C-53
RW7	Water levels within previously recorded seasonal variations.	C-54
RW8	RW8 is located on a local topographical high north of the existing and expansion quarries and outside of their influence. Water levels within previously recorded seasonal variations.	C-55
RW9	RW9 is located on the CBM quarry property and has not been accessed for monitoring since September 2014.	C-56
RW16 (Bridson)	Water levels within previously recorded seasonal variations.	C-59
RW17 (owned by WAI)	Water levels within previously recorded seasonal variations.	C-60
RW18 (owned by WAI)	Water levels within previously recorded seasonal variations.	C-61
RW19 (owned by WAI)	Water levels within previously recorded seasonal variations.	C-62

Residential wells that are currently monitored but that are not part of the Long Term Trend monitoring program include: RW12 ***(Figure C-57)*** and RW13 ***(Figure C-58).*** Groundwater hydrographs for these residential wells, as indicated in parenthesis, have been included to supplement the 2017 AMP summary report.

Residential wells that were historically part of the monitoring program at the Duntroon Quarry but are no longer currently monitored include: RW10, RW11 (drilled and dug), RW14, RW15 and RW20. These wells are not included in the 2017 AMP Summary Report.

The minimum water levels reported at several residential wells in the late summer/early fall of 2016 recovered in 2017 to within previously recorded seasonal variations. The dry climate conditions in 2016 did not allow for the typical seasonal recovery of groundwater levels in the fall; water levels were slow to recover from the dry summer and the new minimums were recorded. Climate conditions in 2017 were more typical, which allowed the water levels to recover.

5.3.1.7 DRIVEPOINTS

A majority of the drivepoint monitors are included in the PITM program and have already been discussed. Drivepoints that are exclusively part of the Long Term Trend monitoring program include DP1, DP3 DP11 and the staff gauges at BH03-7.

Table 5-7 Drivepoint Monitoring - Results

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
DP1	Water levels within previously recorded seasonal variations.	C-63
DP3	Water levels within previously recorded seasonal variations.	C-65
DP11	Monitored by Highland Quarry	N/A
BH03-7 SG1 / SG2	Minimal staff gauge readings (multiple records of station being “dry” or “buried in snow”)	C-74

Water levels at the drivepoints that are exclusively monitored under the Long Term Trend monitoring program were within previously recorded seasonal variations. DP11 is monitored under the joint monitoring agreement that WAI holds with the owner of the adjacent quarry (MAQ Highland Quarry).

The staff gauges at BH03-7 are monitored on a monthly frequency, as outlined in the AMP, but there is minimal water elevation data due to the stations being reported as “dry” or “buried in snow”.

Drivepoint water elevation data is presented in Table C-8 in ***Appendix C***.

5.3.1.8 GROUNDWATER CONFIGURATION

The borehole monitors and the residential water wells are constructed as open-holes that extend into and sometimes through the dolostone rock strata of the Amabel Formation and the Fossil Hill Formation. The exceptions are BH03-7-I, BH03-7-II, BH02-5 (mid) and NW10 (mid) on the expansion lands which are shallow monitoring wells. For more information on each monitoring well, please see Table C-1, ***Appendix C***.

In the open-hole monitors, the overburden soil, where present, is cased off with metal casing that is seated into the buried surface of the rock. The water levels that are obtained in the monitors and water wells provide a general measure of the water table and groundwater conditions through the rock column, rather than the piezometric pressure head at a specific elevation within the rock mass that would be provided by a monitor that is screened across a specific horizon in the borehole. Since the open holes extend above and below the groundwater table, the water levels in the holes represent general water table conditions within the rock.

Groundwater level elevations at the monitors were contoured for April 2016 ***(Figure 4)***, October 2016 ***(Figure 5)***, April 2017 ***(Figure 6)*** and October 2017 ***(Figure 7)***. April contours represent spring conditions and October contours represent fall conditions. The groundwater contours are presented to illustrate the local groundwater configuration and general flow directions within the Amabel aquifer. These figures illustrate that the groundwater configuration and flow pattern remain generally the same regardless of the change in water levels associated with seasonal climatic conditions.

The interpreted groundwater configuration beneath the expansion quarry exhibits an elliptical radial pattern that is centred upon the areas of higher ground formed by local bedrock hills. A groundwater divide is present in the expansion lands. The groundwater movement beneath the eastern section of the quarry expansion lands is towards the Escarpment and generally to the Batteaux Creek sub-catchment. Beneath the western part of the quarry expansion lands, the groundwater movement 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 existing quarry is also present in the vicinity of BH02-6. The presence of the tunnel beneath County Road 91 and the small extraction area in the expansion quarry (floor elevation approximately 501 m ASL) lowers the groundwater levels in the rock adjacent to the extraction area.

South of the existing quarry, groundwater movement is interpreted to be radially away from the higher ground and towards Edward Lake. Edward Lake is interpreted to be a local groundwater discharge area, as well as a collection area for local surface water run-off.

5.3.1.9 QUANTIFICATION OF DRAWDOWN INFLUENCE ZONE

In order to estimate the magnitude and the lateral extent of the zone of influence, and the distance drawdown effects of the existing quarry, expansion quarry and the MAQ Highland Quarry on the local groundwater system, the historical and recent groundwater level data obtained from the long term trend groundwater monitoring network have been evaluated.

Figure 8 provides a summary of the distance-drawdown relationships obtained at individual monitoring well locations. The figure illustrates a lower boundary influence envelope and an upper boundary influence envelope which identify the interpreted minimum and maximum extent of the distance-drawdown relationship.

5.3.1.9.1 EXISTING QUARRY

Within the extraction area of the existing quarry there has been a progressive drawdown influence of 12 m to 20 m on the local water table. As the size of the extracted area has increased, so has the zone of influence of the existing quarry on the local groundwater system. The magnitude of the drawdown influence is greatest within the extraction area at the existing quarry, and decreases relatively quickly with distance away from the extraction faces. The magnitude and lateral extent of the drawdown zone of influence is also variable around the quarry due to the variable hydraulic conductivity in the rock mass.

5.3.1.9.2 EXPANSION QUARRY

Select monitors on the expansion lands have shown influence from tunnel construction and extraction activities that were initiated in 2016. Groundwater monitors NW1, NW2, NW4 and NW7 have been included on ***Figure 8*** to update the distance-drawdown figure for 2017. These monitoring wells are all located on property owned by WAI and the draw-down effects at these on-site monitors was anticipated. NW4 is showing approximately 5 m of drawdown at a distance of approximately 100 m from the quarry face.

5.3.1.9.3 MAQ HIGHLAND QUARRY

The distance-drawdown effects of the MAQ Highland Quarry on the groundwater monitors on the expansion lands is still being developed. The groundwater monitoring wells along the south-west corner of the expansion property showed slower than usual recovery in the fall of 2016, but the water levels recovered by the spring of 2017. Water levels reported in 2017 were within previously recorded seasonal variations. Further investigation of the groundwater levels at NW9 and TW03-1, 2 and 3 is warranted as data are collected in 2018.

5.3.1.10 GROUNDWATER QUALITY

Annual sampling for the following parameters is required under the Long Term Trend Monitoring Program for two selected residential wells, RW1 and RW2:

- General chemistry,
- Major and minor ion constituents and nutrients,
- Total petroleum hydrocarbons and BTEX,
- Total suspended solids, and
- Bacteriological (E.coli, total coliform, heterotrophic plate count).

The samples from the groundwater monitoring locations were obtained from the two residential properties adjacent (RW1) and downgradient (RW2) from the existing and expansion properties on May 2nd, 2017. The samples were collected from outside taps at each property to try and bypass the water treatment systems. Field chemistry parameters (temperature, pH, conductivity and dissolved oxygen) were recorded at the time of sampling and observations on the appearance of the sampled groundwater were noted. Water quality samples were placed in a cooler with loose ice and shipped to an accredited laboratory for analysis (Caduceon Laboratories). The groundwater quality results are presented in Table C-10, ***Appendix C***.

The analytical results from the groundwater quality sampling are compared to the Ontario Drinking Water Quality Standards, Objectives and Guidelines (ODWQS, June 2006) and meet this guideline, with the exception of the following:

- The total coliform counts in the samples obtained from RW2 were elevated compared to the ODWQS. The home-owners were notified by phone once the sample results were received from the lab. These results are attributed to sampling conditions and the well water is not expected to be compromised. A re-sample for bacteriological parameters only was completed at RW2 on May 16th, 2017. These results had a reduced total coliform count, but did not meet the ODWQS.
- The sodium concentration in the samples obtained from RW1 and RW2 do not meet the aesthetic guideline range specified in the ODWQS. Sodium has an aesthetic objective of 200 mg/L and a suggested maximum concentration of 20 mg/L under the ODWQS. In the case of RW1, it is expected that the outside tap that was used to collect the water sample is not completely isolated from the water treatment system and that the sampled water has been softened (sodium 107 mg/L and hardness <1 mg/L). The water quality at RW2 is interpreted to be representative of local groundwater quality, which is naturally hard (sodium 60.6 mg/L).
- The hardness in the sample obtained from RW2 does not meet the aesthetic or operating guideline ranges specified in the ODWQS. Hardness has an operating guideline range of 80-100 mg/L indicated in the ODWQS. The water quality at RW2 is interpreted to be representative of local groundwater quality, which is naturally hard.

The concentration of hardness is an operational guideline and is not health related. Operational guidelines are established for parameters that, if not controlled, may negatively affect the efficient and effective treatment, disinfection and distribution of the water.

The concentration of sodium at RW1 (107 mg/L) and RW2 (60.6 mg/L) is higher than the maximum suggested concentration of 20 mg/L. These results are expected to be due to the water softening process (RW1) and naturally occurring groundwater quality (RW2). Sodium is not toxic. Consumption of sodium in excess of 10 grams per day by healthy adults does not result in any apparent adverse health effects. In addition, the average intake of sodium from water is only a small fraction of that consumed in a normal diet. A maximum acceptable concentration for sodium in drinking water has, therefore, not been specified. Persons suffering from hypertension or congestive heart disease may require a sodium-restricted diet, in which case, the intake of sodium from drinking water could become significant. Public drinking water systems are required to sample for sodium on a regular basis and report to the Medical Officer of Health when sodium levels exceed 20 mg/L, so that this information may be passed on to local physicians.

WSP recognizes the possibility that the water sampled from the outside tap at RW1 was not representative of raw water quality due to the following reasons:

- Temperature of the water sampled was elevated (20.3°C) compared to the expected temperature of groundwater (5-8° C).
- The hardness was low.
- The sodium concentration was elevated.

Residential well sampling at RW1 and RW2 will be completed annually as part of the Long Term Trend monitoring program under the AMP.

5.3.2 SURFACE WATER SETTING

5.3.2.1 SURFACE WATER CHARACTERISTICS

The following sections outline the observations and monitoring results collected in 2017 at the surface water stations that are included in the Long Term Trend monitoring program. Several of these stations are also included in the Performance Indicator Trigger monitoring program, and have been discussed previously in this report.

This section provides an overview of the trends observed at each LTT surface water station in 2017. Long term data are available for selected surface water stations. Where data are available, it has been included for discussion and to provide context to the 2017 results.

Surface water monitoring data are presented in ***Appendix B***, which includes: surface water hydrographs, field chemistry parameters and laboratory analysis results.

5.3.3 SURFACE WATER MONITORING STATIONS

Table 5-8 Surface Water Monitoring - Results

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
QFSW2 & Dewatering Sump(s)	Flows are within previously recorded seasonal variations. QFSW2 flows into the main sump (Sump 1). Excess water from the expansion quarry is being directed to the sumps in the existing quarry.	B-6
SW7	New peak flow recorded in March 2017. Remaining flows are within previously recorded seasonal variations.	B-13
SW8	Station reported as “Dry” in 2017.	B-14
SW10	Flows are within previously recorded seasonal variations.	B-16
SW11E	Flows are within previously recorded seasonal variations.	B-22
SW13	Flows are within previously recorded seasonal variations.	B-25
SW19	Flows are within previously recorded seasonal variations.	B-33
SW20	Flows are within previously recorded seasonal variations.	B-34
SW21	Flows are within previously recorded seasonal variations.	B-35
SW21A	Flows are within previously recorded seasonal variations.	B-36
SW21B	Flows are within previously recorded seasonal variations.	B-37

MONITORING STATION	OBSERVATIONS IN 2017	FIGURE
SW21C	Flows are within previously recorded seasonal variations.	B-38
SW22	Flows are within previously recorded seasonal variations.	B-40
SW22A	Flows are within previously recorded seasonal variations.	B-41
SW22C	Flows are within previously recorded seasonal variations.	B-43
SW3C ('RR3 OUT')	Flows are within previously recorded seasonal variations.	B-54

Additional surface water monitoring data are presented for surface water stations: SWB-1, QFSW1, SW3A, SW4, SW5, SW6, SW12, SW12A, SW17B, SW21D, SW22B, SW23, SW24, SW24B, SW24C, SW25, SW26, SW26A, and SW27 in Appendix B. These stations are included in the report because, in most cases, they provide context for the results obtained at the Long Term Trend surface water stations. For example, SW24A is a seep channel flow that, together with the flow at SW24B, flows into the channel measured at SW24C before entering a pond. SW24 also flows into the same pond.

Table B-4 in ***Appendix B*** summarizes the high, low and seasonal flows for all of the surface water stations (PITM and LTT), for 2017 and, where available, includes historical data.

Table B-5, ***Appendix B***, tabulates the field chemistry parameters that were collected during each stream flow monitoring event in 2017, and, where available, includes historical data.

Overall, the results of the Long Term Trend monitoring program in 2017 fit within previously measured results for both surface water flow and water temperature. Please see ***Figure A-2*** for the monthly precipitation and water balance calculated for 2017 compared to the 30 year normal.

5.3.3.1 BEAVER RIVER SUBCATCHMENT

The Beaver River Tributary North is an intermittent watercourse in the vicinity of the expansion quarry property. The Beaver River Tributary South is a perennial watercourse downstream (west) of Grey County Road 31. Flows to the Beaver River north and south tributary systems are continued through maintenance of wetland hydrology and associated discharge flow from Rob Roy Swamp PSW Complex units RR2 and RR6, respectively, including the pumping of excess quarry water during quarry operation and in the future by rehabilitation lake overflow (expansion quarry and existing quarry, respectively) after quarry closure.

The Beaver River sub-catchment is identified on ***Figure 3.***

5.3.3.2 BATTEAUX CREEK SUBCATCHMENT

Tributaries of the Batteaux Creek that arise from springs below the Escarpment brow also support fisheries within approximately 1 km of their emergence (i.e. 1800 m to 2000 m southeast of the approved expansion quarry extraction area). Constructed online ponds and a golf course occur between the springs and the main areas of known fish habitat. Spatial separation and the presence of online ponds, including water withdrawal for irrigation occurring from the Batteaux Creek on-line ponds at the golf course, limit any potential impact of minor changes to flows from these springs on downstream fish habitat arising from quarry operations.

The Batteaux Creek sub-catchment is identified on ***Figure 3.***

5.3.3.3 PRETTY RIVER SUBCATCHMENT

The lands between the quarry extraction area and the brow of the Escarpment continue to receive direct precipitation that contributes a substantial part of the recharge to the groundwater system in the dolostone aquifer that sustains local water supplies at residential wells and the seasonal flows at the Escarpment springs. This will continue throughout the extraction period and through to final rehabilitation.

Tributaries of the Pretty River that arise from springs below the Escarpment brow support fisheries within 300 m to 500 m of their emergence (approximately 1300 m to 1500 m northeast of the approved expansion quarry extraction area). A constructed pond occurs between some of the springs and the fish habitat in the Pretty River system.

The Pretty River sub-catchment is identified on ***Figure 3***.

5.3.3.4 MAD RIVER SUBCATCHMENT

The Mad River sub-catchment is located south of the existing quarry and is identified on ***Figure 3***. The Mad River sub-catchment does not overlap the expansion quarry property.

5.3.4 SURFACE WATER QUALITY

5.3.4.1 DEWATERING SUMPS

Surface water stations QFSW2 and the Dewatering Sump (Sump 1 and Sump 2, proposed Sump 3) are sampled quarterly for water quality. In 2017, the sampling for QFSW2 was included as the results for Sump 1 (QFSW2 flows into Sump 1). Sump 3 is planned for the quarry floor in the expansion quarry and will be included in the water quality sampling program when it is completed.

Field parameters are collected during the sampling event and are recorded in the dedicated project field book. Surface water quality samples are collected in dedicated, pre-labelled containers, placed in coolers filled with loose ice and then shipped to an accredited laboratory for the following analysis:

- General chemistry,
- Major and minor ion constituents and nutrients,
- Total petroleum hydrocarbons and BTEX,
- Total suspended solids, and
- Bacteriological (E.coli, total coliform, heterotrophic plate count).

Water quality samples were obtained from Sump 1 and Sump 2, in the Existing Quarry, on February 1st, April 5th, July 17th and October 4th, 2017. Duplicates were collected at Sump 2 in April and October. The results of the quarterly water quality sampling at the dewatering sumps are included in Table B-6, ***Appendix B***.

The water quality samples obtained in the first, second, third and fourth quarter at Sump 1 and Sump 2 met the Provincial Water Quality Objectives, with the exception of the field pH measured at Sump 1 and Sump 2 during the February 2017 monitoring event (8.6 and 8.7, respectively) and the concentration of zinc at Sump 1 in July 2017 (0.16 mg/L).

The relative percent difference (RPD) was calculated for the duplicate results taken during each monitoring event. The RPD was within 20% for a majority of the parameters, with the exception of the following parameters in one or more of the sampling events: heterotrophic plate count, ammonia, total kjeldahl nitrogen, colour, aluminum, boron, and tungsten. Surface water sampling does not include filtering during the sampling for metals, which can influence the water chemistry results. Neither the Sump nor the DUP results exceeded the PWQO values over the course of the 2017 sampling events. Based on the RPD values, certain parameters must be interpreted with caution, but the majority of the water quality results are considered acceptable in terms of quality assurance and controls.

Bacteriological results for the water quality analysis at Sump 1 and Sump 2 in February, April, July and October indicate that there were total coliform present in the dewatering sumps. E.coli was present in Sump 1 and Sump 2 in the February (Sump 1 only), July and October. The bacteriological results for total coliform and E. coli in the samples obtained from Sump 1 and Sump 2 in October are reported as "NDOGT" (no data overgrown with target) which indicates that the bacterial plate used for this analysis was overgrown. The presence of bacteriological parameters in the sumps is expected, since the sumps exist as surface water ponds in the bottom of the existing quarry and as such are subject to surface water runoff from the quarry floor and are subject to use as temporary waypoints for waterfowl. There is no specific objective for bacteriological parameters under the PWQO.

The water sampled from the dewatering sumps on the Existing Quarry floor has hardness concentrations ranging from 218 - 327 mg/L, which is expected since a portion of the water collected in the sumps is from groundwater inflow to the quarry floor. The quarry floor in the Existing Quarry is excavated to a level that is below the local groundwater table. The lower range of hardness, which is reported in samples collected from Sump 1 and Sump 2 in April 2017 could indicate an influx of rainwater and surface water runoff into the sumps, after a precipitation event. Rainwater is naturally soft and would reduce the natural hardness of the water in the sumps.

5.3.4.2 SURFACE WATER STATIONS

The AMP monitoring program stipulates that annual sampling be completed at the Escarpment springs and the surface water monitoring stations as listed in Tables 3.3 and 4.2 of the AMP document. The samples are to be analyzed for the following list of parameters:

- General chemistry,
- Major and minor ion constituents and nutrients,
- Total petroleum hydrocarbons and BTEX and
- Total suspended solids.

The following Escarpment spring monitoring stations SW10, SW11A, SW11B, SW11C, SW11D, SW11E and SW21C also require laboratory analysis for bacteriological parameters (E.coli, total coliform, heterotrophic plate count).

The annual water quality sampling event was completed for the surface water monitoring stations on May 8-10th, 2017.

The surface water samples were obtained using standard surface water sampling procedures. Duplicate samples were obtained at SW3 and PR Control. 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. Water quality samples were placed in a cooler with loose ice and shipped to an accredited laboratory for analysis (Caduceon Laboratories).

The relative percent difference (RPD) was calculated for the duplicate results obtained at SW3 and PR Control. The RPD was within 20% for a majority of the parameters with the exception of colour, ammonia, phosphorus, calcium, antimony and lead. Surface water sampling does not include field filtering of the sampled water, which can influence the water chemistry results. Neither the original nor the duplicate results exceeded the PWQO values. Based on the RPD values, certain parameters are interpreted with caution; however, the majority of the 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, July 1994). The water quality samples obtained in the fourth quarter at the designated surface water stations met the PWQO with the exception of the following:

- The concentration of total phosphorus in the DUP1 sample obtained at the PR Control surface water station.

Phosphorus occurs naturally in rocks and other mineral deposits and is an essential nutrient for all plant and animal life. Phosphates are not toxic to people or animals unless they are present in very high levels. The reason for the PWQO limit of 0.03 mg/L is to prevent excessive plant growth in rivers and streams.

5.4 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the 2017 long term trend monitoring program the following conclusions and recommendations are made:

- Climate conditions in 2017 allowed for the recovery of groundwater levels in the late fall/early winter, which was not observed in 2016 (a very dry year).
- Localized drawdown effects are occurring at groundwater monitors BH02-6, BH02-4 and BH02-1 as well as NW1 and NW4. Localized drawdown within the expansion quarry property was anticipated.
- Quarterly sampling at QFSW2 should be completed in addition to the quarterly water quality sampling at the dewatering sumps.
- The following monitoring wells should be removed from the monitoring program and abandoned in accordance with O.Reg 903, where applicable: OW3-1, OW6-1, RW14, RW15 and RW20.

6 LONG TERM TREND ECOLOGICAL MONITORING PROGRAM

6.1 METHODS

The long term trend ecological monitoring program is used to supplement the information from the long term trend groundwater and surface water monitoring program with information about the health and functioning of the natural heritage features in the vicinity of the expansion quarry.

The long term trend ecological monitoring program has established Phase 1 baseline monitoring as part of the quarry start-up, which includes the time period from start-up to three years (June 2016 through to June 2019).

6.2 CONCLUSIONS AND RECOMMENDATIONS

The following activities are planned for 2018 and 2019.

1. Establish one or more reference wetlands to support the PITM program (page 32 of the AMP)
2. Set up and monitor the first year for the Long Term Trend Ecological Monitoring Program (section 5.0 of the AMP)
3. Assess the Hart's Tongue Fern Population

7 ECOLOGICAL ENHANCEMENT AND MITIGATION MONITORING PROGRAM

7.1 METHODS

The ecological enhancement and mitigation measures monitoring (EEMM) program includes mitigation and enhancement measures not directly related to 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 remaining EEMM tasks required no action in 2017.

7.1.1 WOODLAND PROGRAM

The Woodland Program was initiated in 2015 in order to mitigate the impacts of woodland removal associated with later phases.

The Duntroon Quarry Reforestation Plan and planting quantities table are included in Appendix E. These documents track what species of tree have been planted and identifies which areas have been planted in what year.

The proposed planting was completed in 2017 and ongoing monitoring indicates that the materials planted in 2015 and 2016 have acceptable survival rates. The monitoring and maintenance of materials planted in 2016 will wrap up in 2018 and material planted in 2017 will be monitored until 2019.

8 OPERATIONS IMPROVEMENT WORKSHOP FOR 2017

The operations improvement workshop was completed on July 14th, 2017.

As part of its commitment to working with the community, Walker Aggregates will hold an Annual Operations Improvement Workshop for neighbours and other interested stakeholders again in 2018. The 2017 AMP Summary Report will be an agenda item at the Workshop.

9 SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Based on our review of the monitoring data collected to support the Adaptive Management Plan groundwater and surface water monitoring program in 2017, we offer the following conclusions:

- The Adaptive Management Plan Performance Indicator Trigger Monitoring program and the Long Term Trend groundwater and surface water monitoring program was completed in 2017.
- The operational plan is being implemented as designed.
- A late spring melt resulted in lower than normal surface water flows reported in March 2017.
- A wetter than normal April, May and June resulted in most surface water flows for those months being reported in the green zone.
- Surface water stations SW21C, SW24A and SW77 show sensitivity to high air temperatures due to their low flow and shallow nature. These high surface water temperatures are interpreted to be due to climate conditions and are not related to the active extraction in the expansion quarry. The potential for off-site water-related effects to any of the provincially significant wetlands and/or Escarpment springs during Phase 1 is considered to be very low.
- Higher than normal temperatures in September 2017 contributed to warmer than usual water temperatures recorded at the Escarpment spring and surface water monitoring stations. These warmer temperatures translated to interim trigger value temperatures being recorded at several of the Performance Indicator Trigger monitoring stations. These interim trigger occurrences are interpreted as being reflective of the atypical local climatic conditions, and not due to the active extraction in the expansion quarry. The potential for off-site water-related effects to any of the provincially significant wetlands and/or Escarpment springs during Phase 1 is considered to be very low.

Based on our review of the monitoring data collected to support the Adaptive Management Plan groundwater and surface water monitoring program in 2017, we offer the following recommendations:

- Certain deficiencies that were apparent with the implementation of the program in 2016, including the flow and temperature interim trigger level values that were adopted for the PITM Escarpment spring and surface water monitoring stations, continued to be evident in the 2017 program. The performance indicator interim triggers for surface water flow and surface water temperature should be re-evaluated to incorporate the conditions observed in 2016 and 2017. Those values recorded in 2016 and 2017 as having exceeded a specific seasonal maximum or minimum interim "trigger" value occurred as a result of atypical climatic conditions, and not as a result of quarry operations in Phase 1. The interim trigger values should be re-evaluated to include the monitoring data obtained in 2016 and 2017, and modified where appropriate to better reflect existing conditions.
- The outline of the Annual Summary Report suggested in Appendix C of the AMP document should be revised to reflect this report structure.
- The following monitoring wells should be removed from the monitoring program and abandoned in accordance with O.Reg 903, where applicable: OW3-1, OW6-1, RW14, RW15 and RW20.
- During Phase 1 of quarry extraction, reference wetlands are to be established in the Nottawasaga Lookout Provincial Park or the Pretty River Provincial Park with input from the Ministry of Natural Resources and Forestry and the Nottawasaga Valley Conservation Authority. This wetland will be designated as Reference Wetland 1.
- Quarterly sampling at QFSW2 should be completed in addition to the quarterly water quality sampling at the dewatering sumps.
- Certain inconsistencies between the AMP document and the Site Plan should be resolved through consultation with the MNRF. These include certain aspects of wetland monitoring, annual reporting dates and the

requirement of monthly reporting during Phase 1, when no adverse influences are expected. These should be addressed prior to the 5-year report.

- The Hart's Tongue Fern population will be assessed in 2018 and 2019 as part of the long term trend ecological monitoring program.
- The first year of the Long Term Trend Ecological Monitoring Program will be set up and monitored in 2018 and 2019 as part of the long term trend ecological monitoring program.

We trust that the information provided is sufficient for your needs at this time. Please contact the undersigned if you have any questions or comments.

Respectfully Submitted,

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10 LIMITATIONS

This report has been prepared for the exclusive use of Walker Aggregates Inc. WSP Canada Inc. (WSP), Stantec and Hims GeoEnvironmental Ltd. accept no responsibility for any damages incurred by any third party as a result of decisions made or actions taken based upon the information contained within this report.

All background information utilized in the preparation of this performance report has been relied upon in good faith, and WSP does not accept any responsibility for any mis-statements, inaccuracies, or deficiencies contained in those documents or records. The information contained in this report should be evaluated, interpreted and implemented only in the context of the assignment.

The findings and conclusions included in this report are valid only at the date of issuance. If additional information is provided in the future, such as the results of additional site-specific monitoring or observations, WSP will be pleased to re-evaluate our conclusions.

11 BIBLIOGRAPHY

- Jagger Hims. 2007. Level 2 Hydrogeological Assessment Addendum Cumulative Impact Assessment Proposed Expansion and Proposed MAQ Highland Quarry Computer Groundwater Modeling Response to Agency Review Comments.
- 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.
- Stantec Consulting Ltd and Hims GeoEnvironmental. 2013. Adaptive Management Plan - Duntroon Expansion Quarry.