

THE NEW KEPPEL QUARRY

Final

Adaptive Management Plan

Project Location: Proposed New Keppel Quarry Harold Sutherland Construction Part Lots 26, 27 and 28 Concession 10, Township of Georgian Bluffs Grey County, Ontario

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1.0 INTRODUCTION

Harold Sutherland Construction Ltd. (HSCL) has applied for a Category 2, Class "A" Quarry License under the Aggregate Resources Act (ARA). This proposed quarry is to be located on Part Lots 26, 27, and 28, Concession 10, in the Township of Georgian Bluffs, County of Grey, hereby referred to as the 'New Keppel Quarry'.

There have been extensive technical studies completed for the New Keppel Quarry to establish baseline data and to assess the potential for environmental impacts due to the development of the New Keppel Quarry. This information has been used to develop a plan for the extraction that minimizes the potential for environmental impacts to the surrounding area. This plan includes monitoring, mitigation, and contingency measures that will be used to prevent, minimize, or, if necessary, mitigate environmental impacts. This plan is called an Adaptive Management Plan (AMP).

The AMP will be used to ensure there are no negative impacts to the natural environment while the New Keppel Quarry operates and through final rehabilitation as a lake. The AMP shall become a condition on the license when issued under the ARA and shall be referred to throughout the approved ARA Site Plans. In so doing, the AMP can be enforced under the ARA until the license is eventually surrendered. The AMP is intended to be a dynamic plan that is continually evolving based on data collected via the monitoring program. The monitoring program is site-specific and designed to track the performance of the New Keppel Quarry. It is intended to minimize potential impacts on water resources, ecological features and monitor the effects of noise and blasting on site to ensure that proposed mitigation measures are sufficient.

1.1 Overview

HSCL has applied for an extension of its existing Keppel Quarry, which has been in operation since 1989. The existing Keppel Quarry (License number 4882) is located east of the proposed New Keppel Quarry on Part Lot 28, Concession 10, in the Township of Georgian Bluffs, Grey County. Figure 1 shows the location of the Existing and the New Keppel Quarry. The New Keppel Quarry will have a licensed area of 35 hectares. It will be mined in four areas as described in Section 2 and as shown on ARA Site Plan Drawing 2 entitled "Operational Plan" by Wm. Bradshaw, P.Eng. The plan for extraction is described in detail on ARA Site Plan Drawing 3 entitled "Sequence of Operations" (Appendix A).

The aggregate resource proposed for extraction is the high quality dolostone of the Amabel Formation. The aggregate reserve in the New Keppel Quarry is approximately 14,110,000 tonnes that will require approximately 29 years to extract, depending on market conditions. The ARA license permits a maximum annual extraction of 600,000 tonnes.

Development of the New Keppel Quarry will include the dewatering of the extraction area. Dewatering will be done in a manner similar to the method used for the existing Keppel Quarry. Currently, water captured in the existing Keppel Quarry collects in the southwest corner where it settles into a "Discharge Sump Pond" that is approximately 0.4 hectares in areal extent. Water is then pumped from the existing Keppel Quarry through a pipe under County Road 17, and discharged onto Lot 27, Concession 10. The discharge water flows south towards Concession 10, also known as "Gun Club Road", where it eventually sinks into a discrete karst system within the underlying bedrock, as shown on Figure 2.

Due to the presence and function of the karst, a holding provision has been placed on the area known as Area 3. The boundaries of the holding provision are shown on Figure 2 extending 375 m west and 250 m north from the southeast corner of the New Keppel Quarry.

The New Keppel Quarry will continue to utilize the karst while dewatering the extraction area so that any features that have been receiving the existing Keppel Quarry discharge water will continue to receive water via the karst from the New Keppel Quarry. Extraction in this area, known as Area 3, is not to be undertaken for a minimum period of twelve (12) years from the issuance of the ARA license. Extraction shall be permitted in Area 3 after 12 years provided the monitoring and triggers of the Adaptive Management Plan clearly indicate that there will be no significant negative impact as determined by the Ministry of the Natural Resources (MNR) and the Ministry of the Environment (MOE).

Comprehensive monitoring as well as mitigation and contingency measures are proposed in the AMP to ensure there are no negative impacts resulting from the development of the New Keppel Quarry and the dewatering associated with it. The operational sequence presented on ARA Site Plan Drawing 3 by Wm. Bradshaw, P.Eng. entitled "Sequence of Operations" (Appendix A) has been developed using a precautionary approach characterized within this AMP. For example, the New Keppel Quarry will expand first into lands located on Lot 27, Concession 10, abutting the existing Keppel Quarry. This "wedge" is farthest away from adjacent receptors to allow for water resources, ecological features and blasting receptors to be monitored. With all the monitoring practices securely in place and functional during the time when the potential for impacts is lowest, future mitigation measures and contingency plans can be developed and implemented, if required.

Final rehabilitation of the New Keppel Quarry will include the creation of a large open water feature with a diversity of aquatic habitats including but not limited to deepwater habitat, shoals, littoral shelf zones, near shore habitat/shallow wetlands and terrestrial edge plantings. Mitigation/contingency measures will continue to be monitored and actively maintained as needed for up to five years after filling of the extraction area is complete to ensure that rehabilitation is successful.

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1.2 Purpose of the AMP

The purpose of the AMP is to provide HSCL with the information needed to verify that the quarry is operating without causing any significant negative impacts to the natural environment. The AMP establishes a process to monitor operations and make operational adjustments if necessary. The monitoring results will be reported to the Ministry of Natural Resources (MNR), the principal reviewing/approval agency responsible for ensuring that the operator complies with the terms and conditions of the aggregate license, including enforcing the contents of the AMP. All other interested parties (including the First Nations) will have an opportunity to review and comment on monitoring data through their participation in the Stakeholders Liaison Committee (SLC). Details regarding the SLC are provided in Section 9.2. Based on their comments, the SLC will be able to make recommendations to revise the monitoring and, if required, the AMP itself.

The AMP will allow for strategic decision-making with respect to quarry operations so that potential impacts to the natural environment can be fully assessed and mitigated prior to any adverse impact. To be effective, the AMP:

- **Identifies receptors** to be monitored during extraction, lake filling and a period of time after final rehabilitation has been completed;
- Facilitates the collection of monitoring data on the natural environment so that it can be used to evaluate the environmental impact of the New Keppel Quarry on the function of natural features;
- Identifies trigger values that, if exceeded, will trigger action by HSCL so that mitigation can occur before any negative effects to the natural environment can occur;
- Establishes a link between HSCL, the public, stakeholders, and government ministries so that the monitoring data collected can be shared in a transparent and understandable manner;
- **Defines the roles and responsibilities** of HSCL, stakeholders, and governing agencies; and
- Outlines the reporting requirements under the AMP.

1.3 AMP Outline

The following provides a brief description of the various sections of the AMP:

- Section 2 of the AMP reviews the sequence of operations for the New Keppel Quarry.
- Section 3 of the AMP discusses the roles and responsibilities of the various governing agencies with respect to the governance and enforcement of the AMP and the agreement that will be drafted to ensure that the decommissioning and rehabilitation components of the quarry life cycle will be implemented.

- Section 4 of the AMP introduces the Water Resources Monitoring Program that will be used to collect data on environmental receptors including the Bedrock Groundwater System, the Shouldice Wetland and the Glen Management Area while the quarry is operating. The section identifies how each environmental receptor may be affected, the key indicators that will be used to evaluate the environmental impact of the New Keppel Quarry, and the limits or "trigger values" that, if breeched will be used to trigger action or mitigation measures.
- Section 5 of the AMP introduces the monitoring program that will be used to collect data on ecological features in the vicinity of the New Keppel Quarry while it is operating.
- Section 6 of the AMP introduces the monitoring program that will be used to collect data on private wells in the vicinity of the New Keppel Quarry while it is operating and the limits or "trigger values" that, if breeched will be used to trigger action or mitigation measures.
- Section 7 of the AMP introduces the Blast Impact Analysis that was completed for the New Keppel Quarry and discusses how blasting will be monitored.
- Section 8 of the AMP discusses the closure phase of the New Keppel Quarry, including a discussion of the monitoring program to be used while the quarry extraction area is filling with water.
- Section 9 of the AMP identifies the reporting requirements of the AMP, including the development of a Stakeholders Liaison Committee (SLC) and modifications to the AMP.

A detailed outline and summary of the monitoring program including monitoring locations, triggers, and actions is presented in Appendix B.

2.0 SEQUENCE OF OPERATIONS

The following is a general description of the ARA Site Plan for the New Keppel Quarry. For a detailed description, see ARA Site Plan Drawing 3 by Wm. Bradshaw, P.Eng. entitled "Sequence of Operations" completed by Wm. Bradshaw, P.Eng., dated May, 2012 (Appendix A). The Sequence of Operations describes the extraction from the four areas of the quarry (Area 1A, Area 1B, Area 2 and Area 3). The Phases (1 to 6) describe the combination of events within each Area.

Depending on market conditions, aggregate extraction in the New Keppel Quarry is expected to take approximately 29 years to complete. This timeframe is based on an estimated annual tonnage of 500,000 tonnes per year. As previously mentioned, the maximum allowable annual tonnage under the ARA license is 600,000 tonnes per year. As a result, any environmental changes are also expected to be gradual. Successive quarrying over a long timeframe will allow for baseline data collection in advance of any measurable impacts. Background data is important for comparison purposes to ensure adequate environmental protection is maintained.

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2.1 Area 1A

Extraction of the New Keppel Quarry will begin in Area 1A (Figure 2), which is an extension of the existing Keppel Quarry and is located east of County Road 17. This relatively small area is the farthest away from any environmental receptors, such that data collected while this area is being extracted will be considered to represent baseline conditions.

Dewatering from the existing Keppel Quarry and Area 1A will be directed to the existing Sump Pond found in the southwest corner of the existing Keppel Quarry and then discharged onto Lot 27 Concession 10.

2.2 Area 1B

Extraction of Area 1B on the west side of Country Road 17 will begin in the northeast quadrant and proceed in westerly and southerly directions. A tunnel will be constructed underneath County Road 17 so that aggregate can be conveyed through the tunnel to Area 1A for processing. All processing equipment must be removed from Area 1A within seven years from the issuance of the ARA license for the New Keppel Quarry to allow for the existing Keppel Quarry and Area 1A to start filling with water. At this point, there will be enough room in Area 1B to accommodate the processing equipment and the tunnel will be decommissioned.

Dewatering from Area 1B will initially be directed through the tunnel to the Sump Pond found in the southwest corner of the existing Keppel Quarry when necessary. After seven years, the tunnel will be decommissioned and a new Sedimentation Pond ("Sedimentation Pond 1") will be constructed in Area 2 to which discharge water from Area 1B will be directed (Figure 2). It will be 0.4 ha in areal extent to provide adequate settling capability. The treated discharge water from Sedimentation Pond #1 will be directed to the rip rap zone located adjacent to the northeast corner of Area 3 and allowed to flow overland to the currently utilized active karst. A new Environmental Compliance Approval (ECA) will be required from the MOE to permit construction of Sedimentation Pond #1. This new ECA will describe the works needed to dewater the New Keppel Quarry and include provisions for the use of temporary sumps, altered forcemain location(s), and location(s) of future sedimentation ponds (i.e. Sedimentation Pond 2) so that it will serve to regulate the discharges for the life of the quarry.

2.3 Area 2

Extraction in Area 2 will proceed in a southeasterly direction to Area 3. The rock resource around Sedimentation Pond #1 will be the last area in Area 2 to be excavated, at which point Sedimentation Pond #1 will be transferred to the floor of the quarry.

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2.4 Area 3

When Condition 26 of the Development Permit is met, the holding provision for Area 3 will be removed by the MNR. Once permitted, extraction will begin in the northwesterly part of Area 3 and will proceed in a southerly direction. All processing operations will be moved into Area 3. Sedimentation Pond #2 will be constructed at existing grade in the southeast corner of Area 3 along the boundary with Concession 10.

The active karst openings nearest Gun Club Rd that currently infiltrate discharge water from the existing Keppel Quarry are located within the setback distance (Figure 2). As such, those karst infiltration areas will not be extracted so that any downstream karst pathways will remain unaffected and will continue to infiltrate rainfall, snowmelt, and eventually the seasonal discharge from the final quarry lake.

Depending on the monitoring results, as outlined in this AMP, an infiltration pond may be constructed to maximize recharge to the lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond should impacts related to the development of the New Keppel Quarry be observed. Figure 3 shows the location of the Infiltration pond, which is found in the headwater recharge area for spring s13. Treated discharge from Sedimentation Pond #1, Sedimentation Pond #2, or Sedimentation Pond #3 will be directed to the infiltration pond as required.

Once extraction is complete in Areas 1B, 2 and 3, the New Keppel Quarry will be allowed to fill with water.

3.0 ROLES AND RESPONSIBILITIES

The environmental management and monitoring of the New Keppel Quarry is a multistakeholder task. Therefore, the roles and responsibilities of all regulatory agencies involved with the New Keppel Quarry is outlined below as well as the enforcement actions available to ensure the monitoring and mitigation measures, as may be required, are fully implemented over the life cycle of the quarry including rehabilitation.

In general, the MNR is responsible for administering Ontario's aggregate resources under the ARA. As such, the MNR will be responsible for issuing and enforcing the aggregate license issued for the New Keppel Quarry under the ARA. Since the AMP will become a condition referenced on the approved ARA Site Plans, it will be enforceable under the license until surrendered, thereby making the MNR the regulatory agency responsible for the AMP. The MNR shall enforce all conditions of the aggregate license issued under the ARA. In the event of non-compliance, the MNR has the authority to revoke the license.

In general, the MOE is responsible for administering the water of Ontario under the Ontario Water Resources Act (OWRA) and the Environmental Protection Act (EPA). As such, the MOE will be responsible for issuing and enforcing the conditions of the Permit

to Take Water (PTTW) for the quarry dewatering under section 34 and 98 of the OWRA and the Water Taking Regulation O. Reg. 387/04. The MOE will also be responsible for issuing and enforcing the conditions of the Environmental Compliance Approval (ECA) for the treatment and discharge of quarry water as per Section 53 of the OWRA. The MOE will also be responsible for issuing and enforcing the conditions of the ECA for air emissions from the crusher under the O. Reg. 419/05 of the EPA.

The Niagara Escarpment Commission (NEC) will be responsible for issuing and enforcing the Development Permit for the New Keppel Quarry under the Niagara Escarpment Planning and Development Act. NEC shall enforce all conditions of the Development Permit

An agreement has been put in place that grants HSCL access to lands owned by the Grey Sauble Conservation Authority to monitor environmental receptors.

HSCL will be responsible for meeting the requirements set forth in the aggregate license, PTTW, ECA, and Development Permit including coordinating the monitoring requirements set forth in the AMP, and ensuring that the rehabilitation phase of the New Keppel Quarry is completed.

Provided in Appendix C is a chart that details the roles and responsibilities of relevant agencies, stakeholders, and the general public with respect to enforcement of the AMP (i.e. who, what, where, when, how).

3.1 Memorandum of Understanding

HSCL will seek to enter into a Memorandum of Understanding (MOU) with the Township of Georgian Bluffs. HSCL understands it is prudent and desirable to have an agreement with a financial assurance provision in place to ensure that potential impacts to the natural environment can be fully addressed in the event of any unforeseen circumstances.

4.0 WATER RESOURCES MONITORING PROGRAM

The Water Resources Monitoring Program for the New Keppel Quarry is designed to track the performance of the New Keppel Quarry and the potential impacts on water resources. The Water Resources Monitoring Program including monitor locations, triggers, and actions is summarized in Appendix B. The Water Resources Monitoring Program will track changes at each of the following environmental receptors:

- The bedrock groundwater system;
- The Shouldice Wetland; and
- The Glen Management Area.

This section will review the form and function of each environmental receptor and its potential to be impacted by the New Keppel Quarry. Monitoring plans have been designed for each environmental receptor, which will be used to collect data that will track the potential impacts of the New Keppel Quarry on the environmental receptors. If the data collected shows patterns that are different than expected, then mitigation measures will be implemented so that environmental receptors are protected.

As mentioned in Section 2.0, the quarry operation is expected to take on the order of 29 years to complete. As such, environmental changes to the receptors, if any, would also be expected to be very gradual. The first environmental change will be the lowering of groundwater levels around the quarry. Therefore, monitoring of the bedrock groundwater system will be a critical early signal to any potential negative effects on natural features.

As indicated by the MNR in correspondence dated October 1, 2010, groundwater levels may experience change even when extraction of the upper bedrock begins in Area 1A. However, the change is expected to be small since this area has already been influenced by the dewatering of the existing Keppel Quarry. Nevertheless, monitoring as per the AMP will be initiated prior to any extraction occurring. A database showing seasonal trends in groundwater chemistry (specific conductance and temperature), water levels, and flows has been established dating back to 2003 for the water level data and to 2009 for the chemistry and flow data. This database will be used as baseline data for comparison to data collected following commencement of extraction.

Key indicators have been chosen for each environmental receptor that will provide the focal points for each receptor listed above. These key indicators are intended to act as "canaries" and provide an early warning, so that mitigation measures can be implemented in advance of any negative effects to any of the environmental receptors.

While private water supply wells are related to water resources, the Private Well Monitoring Program is described separately in Section 6.0.

4.1 The Bedrock Groundwater System

The New Keppel Quarry will create a groundwater "sink" that will draw in groundwater from the surrounding bedrock thus creating a cone of influence. The extent of the cone of influence has been predicted using empirical data collected from observation wells installed around the existing Keppel Quarry (MTE, 2009a and 2009b). The data collected was used to predict how the bedrock groundwater system would be affected by the New Keppel Quarry. The Water Resource Monitoring Program will be used to verify these predictions.

The bedrock groundwater system includes three distinct components:

- 1. The epikarst.
- 2. The shallow bedrock.
- 3. The deeper bedrock.

The epikarst component is groundwater found in fractures in the uppermost portion of the bedrock, which are exposed at the surface and widened by solution weathering. The epikarst is discontinuous across the site but where present is contained within the upper 5 m. The shallow bedrock component represents groundwater found in shallow bedrock fractures approximately 5 m to 10 m deep. The deeper bedrock component is groundwater found in fractures that are approximately 10 m to 22 m deep.

The purpose of monitoring the bedrock groundwater system is to observe trends in groundwater levels over time, confirm the lateral extent of the cone of influence and avoid potential impacts related to interfering with larger water-bearing fractures (if present), which may cause issues with local natural functions and/or water management issues in the quarry. Key indicators that will be used to monitor the performance of the groundwater system are listed in Table 1. A detailed description of each of the key indicators is provided in Appendix D.

Component	Key Indicator	Method to Obtain	Purpose	Minimum Monitoring
		Dulu		Frequency ¹
Epikarst	Quarry Face Fractures	Observe flows from epikarst zone (depth = 5m or less) on quarry face	To ensure the quarry doesn't redirect water to the quarry from surface water features via epikarst. If higher flows are observed (e.g. turbulent) then may be intercepting water from surface features.	Daily or as needed. Most notable during snowmelt periods and following storm events and following blasting events
	Flows at s8 and s13	As shown in Table 2	As shown in Table 2	As shown in Table 2
Shallow bedrock	Quarry Face Fractures	Observe flows from shallow bedrock zone (depth = 5m to 10m) on quarry face	To ensure the quarry doesn't interfere with water- bearing zones via shallow fractures or bedding planes	Daily or as needed. Most notable during snowmelt periods and following storm events
	Groundwater levels	Manual measurements from all observation wells installed in the shallow bedrock	Confirm seasonal trends are comparable to background conditions	Monthly during the extraction season
		Data logger measurements obtained every 8 hrs using a data logger at Sentry wells ²	Confirm seasonal trends are comparable to background conditions	Monthly data logger downloads during the extraction season
	Groundwater vertical gradients	Calculated using water level measurements from observation wells installed in the shallow and deep bedrock	Confirm seasonal norms are comparable to background conditions	Monthly during the extraction season

Table 1: Key Indicators for Monitoring the Bedrock Groundwater System

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Component	Key Indicator	Method to Obtain Data	Purpose	Minimum Monitoring Frequency ¹
		Calculated using data logger measurements obtained every 8 hrs at Sentry wells ²	Confirm seasonal norms are comparable to background conditions	Monthly data logger downloads during the extraction season
Shallow bedrock (Cont'd)	Water management issues	Pumping Records	Identification of an interference with a shallow bedrock water-bearing fracture	Daily when pumping is occurring
	Cone of influence	Measured from observation wells installed in the shallow bedrock	Confirm the shallow bedrock groundwater is not being influenced beyond 40 m of the working face	Monthly during the extraction season
		Observed using lines of observation wells (lines 1 through 9) installed in the shallow bedrock.	Confirm the pattern of the cone of influence is comparable month to month and that the cone of influence is not extending into Zone 2 or under the Shouldice Wetland	Monthly during the extraction season
Deep Bedrock	Quarry Face Fractures	Observe flows from deep bedrock zone (depth = 10m to 22m) on quarry face	To ensure the quarry doesn't interfere with water- bearing zones via deep fractures or bedding planes	Daily or as needed. Most notable during snowmelt periods and following storm events
	Groundwater levels	Measured from observation wells installed in the deep bedrock plus measurements obtained every 8 hrs using a data logger at Sentry wells ²	Confirm seasonal trends are comparable to background conditions	Monthly during the extraction season
		Data logger measurements obtained every 8 hrs using a data logger at Sentry wells ²	Confirm seasonal trends are comparable to background conditions	Monthly data logger downloads during the extraction season

Table 1: Key Indicators for Monitoring the Bedrock Groundwater System(cont'd...)

Component	Key Indicator	Method to Obtain	Purpose	Minimum
		Data		Monitoring Frequency ¹
Deep Bedrock (Cont'd)	Groundwater vertical gradients	Calculated using water level measurements from observation wells installed in the shallow and deep bedrock	Confirm seasonal norms are comparable to background conditions	Monthly during the extraction season
		Calculated using data logger measurements obtained every 8 hrs at Sentry wells ²	Confirm seasonal norms are comparable to background conditions	Monthly data logger downloads during the extraction season
	Water management issues	Pumping Records	Identification of an interference with a deep bedrock water- bearing fracture	Daily when pumping is occurring
	Cone of influence	Mapped using groundwater levels measured from observation wells installed in the deep bedrock	Confirm the deep bedrock groundwater is not being influenced beyond approx. 400 m	Monthly during the extraction season
		Delineated using lines of observation wells (lines 1 through 9) installed in the deep bedrock.	Confirm the pattern of the cone of influence is comparable month to month and that the cone of influence is not extending into Zone 3 or under the Shouldice wetland	Monthly during the extraction season

Table 1: Key Indicators for Monitoring the Bedrock Groundwater System (cont'd...)

¹ Monitoring frequency will increase as required as per the AMP

² Sentry wells = OW8s, OW8d, OW9s, OW9d, OW12s, OW12d, OW13s, OW13d, OW33s, OW33d, OW45, OW47s, OW47d, OW51, OW67s, OW67d, OW71s, OW71d.

4.2 The Shouldice Wetland

The Shouldice Wetland is a Provincially Significant Wetland. Current interpretations (MTE, 2009) show that the Shouldice Wetland is outside the predicted cone of influence of the New Keppel Quarry, which essentially eliminates the potential for the New Keppel Quarry to impact recharge to the wetland through the groundwater system. At its closest point, the extraction is approximately 520 m away from the wetland boundary to the west and approximately 420 m away from the lobe of the wetland containing spring s13 and the dugout pond that protrudes southwest of the Site. The maximum extent of the predicted cone of influence is approximately 400 m from the face of the extraction. Despite its distance from the New Keppel Quarry, the wetland has been identified as an environmental receptor due to its ecological importance and its unique hydraulic and hydrogeologic characteristics (MTE, 2009).

The key indicators that will be used to ensure protection of this feature are summarized in Table 2. A detailed description of each of the key indicators is provided in Appendix D. The Water Resources Monitoring Program is designed to collect data on the Shouldice Wetland while the New Keppel Quarry proceeds.

Key Indicator	Method to Obtain Data	Purpose	Minimum
			Monitoring
Shouldice	Measured from using	Confirm seasonal trends are	Frequency Monthly during
Wetland water	minipiezometers installed in the	comparable to background	the extraction
levels	wetland - MP55, MP56, MP57	conditions	season
Groundwater	Measured from observation wells	Confirm seasonal trends are	Monthly during
levels	installed in the wetland – OW58s,	comparable to background	the extraction
	OW58d, OW59s, OW59d, OW60s, OW60d	conditions	season
	Measured from minipiezometers	Confirm vertical movement of	Monthly during
	installed in the wetland – MP55,	groundwater into the wetland	the extraction
	MP56, MP57		season
	Measured from test pits (with stand	Confirm seasonal trends are	Monthly during
	within 100m of the wetland boundary	conditions	season
	– TP16, TP17, TP18, TP19		occorr
Groundwater	Calculated using water level	Confirm seasonal trends are	Monthly during
vertical	measurements from observation wells	comparable to background	the extraction
gradients	installed in the shallow and deep	conditions	season
	Calculated using surface water and	Confirm seasonal trends are	Monthly during
	groundwater levels from	comparable to background	the extraction
	minipiezometers installed in the	conditions	season
<u> </u>	wetland		
Cone of	Mapped using groundwater levels	Confirm the cone of influence is	Monthly during
Innuence	installed in the shallow and deen	under the Shouldice wetland	season
	bedrock		5005011
	Delineated using lines of observation	Confirm the cone of influence	Monthly during
	wells (lines 3 through 8) installed in	pattern is comparable month to	the extraction
	the shallow and deep bedrock	month and that the cone of	season
		Zone 3 or under the Shouldice	
		wetland	

 Table 2: Key Indicators for Monitoring the Shouldice Wetland

Key Indicator	Method to Obtain Data	Purpose	Minimum
			Monitoring
			Frequency ¹
Flow condition at Spring s8	Flow observed as 'flowing', 'no apparent flow' or 'dry' along with changes in water levels as measured by a data logger in a minipiezometer installed directly into the spring	Confirm length of hydroperiod and compare to background hydroperiod/data	Monthly manual observations plus monthly data logger downloads during the extraction season
	Temperature and specific conductivity measured using a data logger installed in the spring	Monitor the source of water to s8	Monthly data logger downloads during the extraction season
Flow condition at Spring s13	Flow observed as 'flowing', 'no apparent flow' or 'dry' along with changes in water levels as measured by a data logger in a minipiezometer installed directly into the spring	Confirm length of hydroperiod and compare to background hydroperiod/data	Monthly manual observations plus monthly data logger downloads during the extraction season
	Temperature and specific conductivity measured using a data logger installed in the spring	Monitor the source of water to s13	Monthly data logger downloads during the extraction season
Water levels in the dugout pond	Water levels measured using a data logger installed at a staff gauge in the dugout pond	Monitor the seasonal trends are comparable to background conditions	Monthly data logger downloads during the extraction season
	Temperature and specific conductivity measured using a data logger installed in the spring	Monitor the source of water to the dugout pond	Monthly data logger downloads during the extraction season
Flow condition from the dugout pond	Flow rates measured in the downstream channel combined with the development of a stage discharge curve using the staff gauge installed in the dugout pond	Confirm length of hydroperiod and compare to background hydroperiod/data	Monthly during the extraction season

Table 2: Key Indicators for Monitoring the Shouldice Wetland (cont'd...)

	Table 2. Ney indicators for Monitoring the Onoundice Wetland (cont d)				
Key Indicator	Method to Obtain Data	Purpose	Minimum Monitoring Frequency ¹		
Flow condition at the Shouldice Wetland culverts	Flow observed as 'flowing', 'no apparent flow', 'dry'	Confirm length of hydroperiod and compare to background hydroperiod/data	Monthly during the extraction season		
Flow condition at the Beaver Dam sinkhole	Flow observed as 'flowing', 'no apparent flow', 'dry'	Confirm length of hydroperiod and compare to background hydroperiod/data	Monthly during the extraction season		
	Temperature and specific conductivity measured	Confirm source of water to sinkhole	Monthly during the extraction season		

Table 2: Key Indicators for Monitoring the Shouldice Wetland (cont'd...)

¹ Monitoring frequency will increase as required as per the AMP

4.3 The Glen Management Area

The Glen Management Area contains springs (s1-s3) located on the top of the Amabel Plateau that are derived from infiltrating water at the Beaver Dam Sinkhole. They are located 550 m north of the existing Keppel Quarry along the Niagara Escarpment (Figure 3). The current interpretation is that these springs will not be impacted by the New Keppel Quarry. However, water emanating from these springs is dependent on water sinking at the Beaver Dam Sinkhole and so natural changes may occur while the New Keppel Quarry is operating. As a result, springs s1-s3 are included in the Water Resources Monitoring Program so that natural changes can be noted (if any) while extraction occurs. The key indicators that will be used to monitor these springs are summarized in Table 3. A detailed description of each of the key indicators is provided in Appendix D.

Key Indicator	Method to Obtain Data	Purpose	Minimum Monitoring Frequency ¹
Cone of influence size	Mapped using groundwater levels measured from observation wells installed in the shallow and deep bedrock	Confirm the cone of influence pattern is comparable month to month and not extending into Zone 3 or towards the Glen Management Area	Monthly during the extraction season
Flow condition at Springs s1 and s2	Flow observed as 'flowing', 'no apparent flow', 'dry' in combination with flow rate measurements at Mud Creek Channel A	Quantify and confirm length of hydroperiod and compare to background hydroperiod/data	Monthly during the extraction season
	Temperature and specific conductivity measured	Monitor the source of water to spring	Monthly during the extraction season

Table 3: Key Indicators for Monitoring the Glen Management Area

Key Indicator	Method to Obtain Data	Purpose	Minimum Monitoring Frequency ¹
Flow condition at Springs s3	Flow rate estimates using time- distance measurements	Quantify and confirm length of hydroperiod and compare to background hydroperiod/data	Monthly during the extraction season
	Temperature and specific conductivity measured	Monitor the source of water to spring	Monthly during the extraction season
Flow condition at the Mud Creek Channel A	Flow rates measured using velocity and cross-sectional area of the channel.	Quantify and confirm length of hydroperiod and compare to background hydroperiod/data	Monthly during the extraction season
Flow condition at the Beaver Dam Sinkhole	Flow observed as 'flowing', 'no apparent flow' or 'dry'	Confirm length of hydroperiod and compare to background hydroperiod/data	Monthly during the extraction season
	Visual inspection of Beaver Dam condition, measured average height of Beaver Dam, and photographic evidence of condition	Confirm changes in condition of Beaver Dam	Monthly during the extraction season
	Temperature and specific conductivity measured	Confirm flow to springs s1-s3 is occurring	Monthly during the extraction season

Table 3: Key Indicators for Monitoring the Glen Management Area (cont'd...)

¹ Monitoring frequency will increase as required as per the AMP

4.4 Ephemeral Pond

There is an ephemeral pond on Lot 26 Concession 10 which will be adjacent to the extraction area of the New Keppel Quarry (EMA-5 on Figure 5). This feature is <u>not</u> deemed significant wildlife habitat as per the submitted Natural Environmental Technical Report (NETR) (AWS, 2007) but this ephemeral pond is important for amphibian breeding activity (AWS, 2012) and finding were accepted by MNR (2012).

Due to its proximity to the New Keppel Quarry, water levels in the ephemeral pond may be impacted. Therefore, water levels may need to be replenished during the active amphibian breeding season, which extends from April 1 to June 30, to ensure that sufficient water levels are maintained for amphibian breeding.

This feature has been added to the Ecological Monitoring Program. Water level monitoring will occur weekly on the downstream end of this feature using a staff gauge to ensure that there is adequate water for amphibian breeding activity while the New Keppel Quarry operates.

Key Indicator	Method to Obtain Data	Purpose	Monitoring Frequency
Water levels in the ephemeral pond	Water levels measured manually at a staff gauge, located within the central area of the ephemeral pond	Confirm sufficient water levels are maintained throughout amphibian breeding season, which extends from April 1 to June 30	weekly during amphibian breeding season

Table 4: Key Indicators for Monitoring the Ephemeral Pond

The water level data collected through the Water Resources Monitoring Program will be incorporated into the assessment of amphibian breeding activity as per the Ecological Monitoring Program (Appendix E).

Prior to extraction occurring within Area 1B, baseline water level data shall be collected for a minimum of three years. Throughout the active quarry operations within Area 1B and Area 2, water levels in the ephemeral pond shall not be permitted to go below 20% of the historic monthly average, for that month, during the amphibian breeding season. Any water level reading below this trigger value will require a yellow action to augment water levels within the ephemeral pond.

Yellow actions may also include construction of a new ephemeral pond if augmentation of water levels proves to be ineffective. If required, then the new pond shall be constructed as per Natural Environment Recommendation Number 1.3 described on ARA Site Plan Drawing 4 entitled "Consultant Recommendations" by Wm. Bradshaw, P.Eng. (Appendix A). The recommended design details have been summarized below:

If required, the new ephemeral pond:

- Shall be constructed using soils that have low permeability or with a liner.
- Shall be constructed in suitable terrain conditions approved by MNR.
- Include and maintain continuous forest cover around the pond perimeter and a direct linkage to the forested ANSI lands. No fencing or berms shall be placed around the pond perimeter.
- Maintain a minimum of 10:1 slope, with 20 cm of native topsoil deposited over the pond bottom so that natural hydrophilic plants can be established.
- Constructed with varying widths and depths but should not exceed 10 m in width or exceed 0.7 m in depth and a minimum length of 50 m.
- The terrain around the approved location should allow for natural snowmelt runoff to the pond.
- Should maintain (within 20% of historic monthly average for that month) surface waters within the pond between the spring snowmelt periods to late June, during the life of the quarry operations and rehabilitative period.

4.5 Trigger Values

Trigger values were determined based on the evaluation presented in MTE 2009 (Figure 4). That evaluation predicted the maximum extent of the cone of influence once the New Keppel Quarry is fully extracted. By defining the maximum extent of the cone of influence, suitable trigger values were set that will activate mitigation measures if the observed values collected through the Water Resources Monitoring Program are lower than predicted.

Figure 4 shows three zones related to the deep groundwater system:

- Zone 1 is where water levels are expected to show the largest impact (from 4 to 10 meters);
- Zone 2 is where some drawdown is expected but not as much as in Zone 1; from 0 to 4 m; and
- Zone 3 is expected to show water levels that are comparable to background conditions and so no measurable impact is expected in this zone.

Observation wells installed along the border of Zone 2 and Zone 3 will act as sentinels for environmental receptors, especially the Shouldice Wetland. These critical wells have been called 'Sentry Wells' and include:

- OW8s, OW8d, OW9s, OW9d;
- OW12s, OW12d, OW13s, OW13d;
- OW33s, OW33d, OW45, OW47s, OW47d; and
- OW51, OW67s, OW67d, OW71s, OW71d.

Observation wells OW67s and OW67d have not yet been installed. These wells will be installed after the New Keppel Quarry obtains an Aggregate License under the ARA. The location of the Sentry Wells is shown on Figure 3.

As previously mentioned, data loggers will be programmed to measure a water level every 8 hours. The data loggers will be downloaded and reviewed monthly. This frequency of water level measurements at these locations will provide data to determine whether or not the cone of influence is migrating further than predicted. Other important features that have trigger values include spring s8 and spring s13.

The AMP will implement actions if a trigger value is exceeded at the Sentry Wells and springs s8 and s13. The trigger values are designed to be proactive and allow for mitigation in advance of an adverse impact. Trigger values for the sentry wells, s8, and s13 are shown in Appendix B. Trigger values for spring s8 and s13 are not applicable when these springs are not flowing (i.e. at times when the springs are dry and / or under frozen ground or snow-covered winter conditions).

If no trigger values are exceeded, the Water Resources Monitoring Program will continue to proceed as planned.

Green Trigger Values

Green trigger values are set at 15 cm above the observed seasonal lows (spring, summer, autumn, and winter) for each of the Sentry Wells and for springs s13 and s8. An exceedence of a green trigger value indicates no significant negative impacts have been observed and water levels are still within the normal historical range, but are used to indicate that water levels are approaching historic seasonal lows. This will trigger a 'Green Action' as an early response action (i.e. increase monitoring frequency and investigate) rather than positive mitigation actions that will be used to prevent impacts.

For example, if a green trigger is triggered at a Sentry Well, then an analysis will be undertaken that will include checking climatological records and comparing groundwater levels in the triggered Sentry Well to other wells in close proximity. Additional water levels may be collected and water level trends assessed to validate the exceedence of the Green Trigger Value.

Yellow Trigger Values

Yellow trigger values are equal to historic seasonal lows for each location. An exceedence of a yellow trigger value indicates water levels are slightly below historic seasonal lows, but no significant negative impacts have been observed. This is used to trigger a 'Yellow Action' or a precautionary mitigation measure. If an exceedence is tied to climatic conditions (e.g. dry year), then the changes are expected to result in widespread low values and will be validated in similar water level trends in additional monitoring wells. In contrast, impacts related to the quarry are expected to initially occur in one or two wells due to the behavior of groundwater in fractured media responding to preferential pathways.

Red Trigger Values

Red trigger values are set at 15 cm below historic seasonal lows. Fifteen centimetres was selected since this amount of change may result in the extension of the cone of influence into Zone 3, which could result in a negative impact to the Shouldice Wetland. That said, the extraction process is methodical and relatively slow and so there will be time to implement corrective actions before an adverse impact occurs in the Shouldice Wetland or the Glen Management Area.

An exceedence of a red trigger value is used to trigger 'Red Actions' or immediate responses in the event that the yellow actions fail to correct or reverse the impact. Mitigative measures will be required if:

1) The groundwater levels drop below the seasonal lows by 15 cm as determined by water levels measured at any one of the Sentry Wells.

- 2) The overall groundwater pattern in the observation well in question showed a decreasing trend over time.
- 3) Other nearby groundwater monitors, especially along the same line, show similar groundwater trends.
- 4) The climatological data obtained from the on-site weather station did not show drier than normal conditions within six months of the groundwater measurements.

4.6 Mitigation Measures

Mitigation measures are shown as a sequence of green, yellow and red actions in Appendix B. Whether green, yellow, or red actions are enacted depends on the observed values and if triggers are exceeded at each of the Sentry Wells, spring s8 and/or spring s13. In all three cases, the first step is to notify the quarry operator if there are any exceedences of green, yellow and red trigger values so that the appropriate action can be taken.

Green Action

The purpose of a green action is to identify changes prior to impacting groundwater and surface water features and implement investigative actions. If green trigger values are breeched, the first step is to notify the quarry operator. The Hydrogeologist and the Ecologist/Biologist shall also be notified so that proper actions can be implemented to determine the reason for the exceedence.

Actions involve increased monitoring frequency and recommendations for further investigation such as the installation of new observation wells. The purpose of the investigation is to confirm the validity of the field data and, using pumping records, precipitation records, and additional water level data, determine the reason for the breech.

Green actions may include but may not be limited to:

- Increased frequency of monitoring;
- Further investigation using pumping records and site-specific precipitation records from an on-site weather station;
- Mapping the cone of influence using the most recent round of water levels;
- Installing new observation wells, if required, to more accurately define the cone of influence of the quarry with respect to a certain receptor;
- Retaining an Hydrogeologist to complete an analysis/evaluation of the data collected such as:
 - Assess and interpret water levels and flows measured against historical patterns, seasonal lows, trigger values, pumping records and precipitation records on a monthly basis;
 - Compare monitoring data against trigger values on a monthly basis and make recommendations for monitoring program alterations if required;

- Map cone of influence on a monthly basis and assess its size and shape; and
- Provide an annual monitoring report and make recommendations for future monitoring.

Through this analysis, the intent is to track changes in water levels against the trigger limits and follow the progression of the cone of influence as the quarry develops. If through the analysis, it is deemed that a mitigation measure is required then, they will be implemented in close consultation with MNR.

Yellow Action

The purpose of the yellow action is to implement preventative measures to protect environmental receptors from being negatively impacted. If yellow trigger values are breeched, the first step is to notify the quarry operator. The Hydrogeologist and the Ecologist/Biologist shall also be notified so that proper actions can be implemented to mitigate the exceedence. The MNR and NEC will be notified within 72 hours and informed as to the Yellow Actions that will be implemented.

Yellow actions include mitigation measures such as preparation associated with augmenting flows or modifying ARA Site Plans. Once a mitigation measure has been implemented, the goal is to allow the environmental receptor to return to its background condition before the New Keppel Quarry proceeds any further in the direction of the environmental receptor.

Yellow actions may include but may not be limited to:

- Initiating an internal interdisciplinary review of the monitoring data and the monitoring programs;
- Reviewing the Operation Plan for possible alterations, which may include but may not be limited to:
 - Changing or ceasing quarry operations in a certain direction; and/or
 - Changing the quarry floor elevation.
- Preparing to augment flows¹ to springs in the Shouldice Wetland or Glen Management Area;
 - flow augmentation shall be done in consultation with the Hydrogeologist to ensure adequate protection;
- Grouting fractures exposed by the quarry along active quarry faces immediately after a blast (as required);
- Continuing to monitor weekly until the system recovers² as determined by a Hydrogeologist; and/or

¹ Augmentation of flows to springs may be in the form of a pipe that directs water or an infiltration pond (as discussed in Section 4.8) that allows water to recharge the groundwater system.

² Recovered water levels means that water levels in the affected observation well(s) has returned above green trigger values for at least three monitoring events spaced one week apart.

• Reporting the results of the Yellow Actions and make recommendations for the operation of the quarry (See Section 9.0 for more details regarding reporting requirements).

If Yellow Actions prove to be working whereby water levels in affected area have recovered² and there is no observed impact to the Shouldice Wetland and/or the springs in the Glen Management Area, then quarry activities can resume. Flows at the springs in these areas should occur naturally as determined by the Hydrogeologist and the Biologist/Ecologist.

Red Action

The purpose of the red action is to reverse an observed impact to the bedrock groundwater system before an adverse effect is observed to the Shouldice Wetland or the Glen Management Area. If red trigger values are breeched, the first step is to notify the quarry operator. The Hydrogeologist and the Ecologist/Biologist shall also be notified so that proper actions can be implemented to mitigate the exceedence. The MNR and NEC will be notified within 24 hours and informed of the Red Actions that will be implemented.

Red actions include mitigation measures such as augmenting flows and stopping the quarry development until a sign off of acceptance has been obtained from the MNR indicating that the quarry can proceed once again. Once a mitigation measure has been implemented, the goal is to allow the environmental receptor to return to its background condition before the New Keppel Quarry restarts.

Red actions may include but may not be limited to:

- Initiating an internal interdisciplinary review of the monitoring data and the monitoring programs;
- Stopping quarry operations until signoff is obtained by the MNR indicating the quarry may restart;
- Augmentation of flows to springs in the Shouldice Wetland, Glen Management Area or the affected area;
- Monitoring to determine the effectiveness of flow augmentation; and/or
- Reporting the results of the Red Actions and making recommendations for the operation of the quarry (See Section 9.0 for more details regarding reporting requirements).

If it is deemed that flow augmentation is effective³, then quarry activities may resume in a direction that will not exacerbate the impact, provided that a sign-off acceptance from the MNR. If it is deemed by the Hydrogeologist, the Biologist/Ecologist, the owner/operator and the MNR that the quarry cannot operate without negatively

³ Groundwater levels in the impacted observation well(s) in Zone 3 have returned above green trigger values as determined by at least three monitoring events spaced one week apart.

impacting water levels in the Shouldice Wetland and/or the springs in the Glen Management Area then the need to close the quarry should be assessed.

Note: Red Actions are only to be implemented after assessment of climatological data to confirm that effects are caused by quarry operations, and not by unseasonably low precipitation.

4.7 Area 3 Monitoring

No extraction shall be permitted in Area 3 during the first twelve years of issuance of the ARA license. Extraction shall be permitted in Area 3 after twelve years provided the monitoring and triggers of the AMP clearly indicate that there will be no significant negative impact to the Shouldice Wetland as determined by the MNR and MOE. Once the holding provision on Area 3 has been lifted, extraction will proceed with caution and the monitoring and mitigation program described above will continue with emphasis on three main considerations:

- 1. The active karst (Figure 2) receiving discharge from the New Keppel Quarry will be monitored to ensure that discharge water continues to infiltrate into the bedrock and is not impacted by extraction in Area 3.
- 2. Quarry face fractures will be monitored to ensure that discharge water infiltrating into the karst is not simply recirculating back to the quarry. If relatively high flows are observed from the quarry face in the vicinity of the karst or if discharge pumping is at maximum allowable rate under the PTTW and is still unable to manage inflows, then the quarry face may be intercepting water from the karst.
- 3. The key indicators of the Shouldice Wetland will continue to be monitored to ensure that the extraction of Area 3 is not negatively impacting this feature.

If the monitoring of Area 3 reveals the quarry is intercepting water from the karst, mitigative measures will be undertaken to stop the flow of groundwater into the quarry. These measures may include grouting the quarry wall or constructing berms near the quarry face to create a pool of discharge water that will serve as a hydraulic barrier. By stopping the flow of infiltrating discharge water into the quarry, groundwater flow can be redirected to the Shouldice Wetland before negative impacts occur.

Overall, the Water Resources Monitoring Program and mitigation measures for the extraction of Area 3 will be similar to those for the remainder of the New Keppel Quarry. However, the quarry operator should be aware of the increased potential for impacts for this area to ensure that environmental receptors are protected and discharge water is not needlessly recirculated.

4.8 Infiltration Pond Monitoring

Flow augmentation to springs in the Shouldice Wetland may be required depending on the monitoring results of the AMP. One form of flow augmentation is the construction of an infiltration pond, which will maximize recharge to the lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond. Figure 3 shows the location of the infiltration pond, which is found in the headwater recharge area for spring s13. Should impacts related to the development of the New Keppel Quarry be observed, treated discharge from Sedimentation Pond #1, Sedimentation Pond #2, or Sedimentation Pond #3 will be directed to the infiltration pond as required. Further details regarding the construction of the infiltration pond is found in Section 7.0 of Appendix H.

If it is determined that the infiltration pond is required as a mitigation measure, then an Environmental Compliance Approval (ECA) from the Ministry of the Environment will be required to construct the works associated with the infiltration pond. Through the approval process, the details associated with the monitoring program for the infiltration pond will be determined in close consultation with the MOE to ensure protection of the wetland and proper function of the infiltration pond. The following lists some of the items that may be included in the performance monitoring program associated with the ECA:

- Recording the volumes of water discharged into the infiltration pond;
- Measuring water levels in the dugout pond and from nearby observation wells (i.e. OW71);
- Correlating water levels measured from observation wells with water levels in the dugout pond, while accounting for precipitation, to ensure water is being received by the system; and
- Obtaining grab samples from the settling pond before water is discharged to the infiltration pond to ensure compliance with Provincial Water Quality Objectives.

The intent of this performance monitoring is to ensure that the infiltration pond is functioning properly and to monitor for potentially detrimental impact (i.e. biotic impact to the wetland(s) if too much water reaches one area).

5.0 ECOLOGICAL MONITORING PROGRAM

An Ecological Monitoring Program has been developed to evaluate the ecological health of selected natural features throughout the life cycle of the quarry and ensure that their ecological function is maintained. The Ecological Monitoring Program relies upon an understanding of changes observed through the Water Resources Monitoring Program because ecological receptors tend to respond more slowly to impacts compared to the hydrogeologic regime. Therefore, the Water Resources Monitoring Program will be a critical early warning system for detecting potential impacts to ecological health. The program will be carried out by an Ecologist/Biologist and is described in detail in Appendix E.

The Ecological Monitoring Program will be focused on features in the woodlands of the Area of Natural and Scientific Interest (ANSI), the Shouldice Wetland and the upper Glen Management Area. Ecological monitoring areas (EMA) are shown on Figure 5.

Monitoring activities will be conducted in both terrestrial ecological features (EMA-1 and EMA-2) and wetland ecological features (EMA-2 through EMA-6) as outlined below:

- EMA-1: Woodland Tree Health, Woodland Regeneration and Woodland Flora Species Diversity;
- EMA-2: Woodland Breeding Birds;
- EMA-3: The Glen area s1 to s3 groundwater discharge feature;
- EMA-4: The Shouldice Wetland at the s8 groundwater discharge feature;
- EMA-5: The Woodland Ephemeral Pond amphibian breeding surface water feature; and
- EMA-6: The lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond and the upper headwater channel for the East Branch of Park Head Creek.

Ecological Monitoring (EMA1-EMA6)

The Ecological Monitoring Program outlined in Appendix E will be used to collect baseline data (pre-quarry conditions) as wells as long-term data while the New Keppel Quarry proceeds. This program is the minimum allowable frequency and scope of ecological monitoring. It will continue throughout the life of the quarry and rehabilitation phase. No additional ecological actions will be required if ecological receptors do not display any adverse impacts, the ecological features/functions remain within anticipated normal parameters and the Water Resources Monitoring Program and/or Ecological Monitoring Program reveals no trigger exceedences.

As per the Memorandum of Agreement between SON and HSCL signed on July 31, 2014, baseline data shall be collected during year one of the Ecological Monitoring Program and reported on in the first annual report. Year one reporting shall be considered "normal" for flora community diversity and be used to establish trigger threshold levels for comparison to future monitoring results. Baseline data collection shall be undertaken during late spring and late summer period.

Green Action

In the event the Water Resources and/or Ecological Monitoring Program reveal a <u>green</u> <u>trigger exceedence</u>, the Ecologist/Biologist will be informed, but no changes will be made to the Ecological Monitoring Program. No additional actions are required because the ecological health of the natural features has not been negatively impacted and water levels are still above historical seasonal lows.

Yellow Action

A "Yellow Action" precautionary mitigation response is triggered if:

- 1. The Water Resources and/or Ecological Monitoring Program has revealed a <u>vellow trigger value exceedence</u> that can be attributed to the quarry operations; and/or
- 2. Early indicators of ecological impacts are observed that can be attributed to the quarry operations and can be corroborated with changes in the hydrogeologic regime.

A Yellow Action will include an internal interdisciplinary review of all monitoring programs, which could recommend changes to the Ecological Monitoring Program (i.e. more frequent site visits to collect more information), additional investigative works, further analysis of abiotic factors, and/or mitigative measures added to the New Keppel Quarry ARA Site Plan.

Red Action

A "Red Action" immediate response is triggered if:

- 1. The Water Resources and/or Ecological Monitoring Program has revealed a <u>red</u> <u>trigger value exceedence</u> that can be attributed to the quarry operations.
- 2. Evidence of negative ecological impacts are observed that can be attributed to the quarry operations and can be corroborated with changes in the hydrogeologic regime.
- 3. The mitigative measures initiated during the Yellow Action failed to correct or reverse the impact.

Quarry operations will cease until signoff is obtained from the MNR, indicating the quarry may restart. An internal interdisciplinary review of all monitoring programs and Yellow Action activities to date shall be undertaken. The review might recommend significant changes to the Ecological Monitoring Program (i.e. expanded number of monitoring sites), the ARA Site Plan and/or the augmentation of flows to natural features to ensure all ecological impacts are addressed.

6.0 TREE PRESERVATION PLAN

Along County Road 17 and Concession Road 10, there are three zones of existing trees that will be maintained as part of the Tree Preservation Plan (TPP) for the New Keppel Quarry. These zones, hereby referred to as the TPP Corridor, are to be preserved so that the New Keppel Quarry has sufficient visual screening and buffering along County Road 17 Concession Road 10. Figure 6 of the AMP shows the location of the TPP Corridor. ARA Site Plan Drawing 2 entitled "Sequence of Operations" and ARA Site

Plan Drawing 8 entitled "Landscaping Details" identifies the TPP Corridor as the "Existing Forest Setback" (Appendix A).

- **Zone 1** of the TPP Corridor is the front line of existing trees in Area 1A as per the drip line survey by Hewett and Milne Limited⁴. This front line of trees is approximately 5 m wide and serves to protect successive trees, which visual screen Area 1A along County Road 17.
- **Zone 2** of the TPP Corridor is a stand of existing trees that shall remain at least 20 m wide to visually screen Areas 1B, Area 2 and Area 3 along County Road 17.
- **Zone 3** of the TPP Corridor is a stand of existing trees that shall remain at least 30 m wide to visually screen Areas 2 and Area 3 along Concession Road 10.

HSCL understands that, in addition to the New Keppel Quarry, there are natural threats that must be considered when implementing the TPP (i.e. the Emerald Ash Borer [EAB]). HSCL further understands that a large percentage of the TPP Corridor is currently populated by Ash. As such, two protocols - the Tree Monitoring Protocol and the Tree Replacement Protocol - were designed to ensure that neither the New Keppel Quarry nor natural threats (i.e. the EAB) will compromise the health of the TPP Corridor. These two protocols are described in Appendix F.

7.0 PRIVATE WELL MONITORING PROGRAM

As stipulated in the General Conditions of an Ontario Water Resources Act (OWRA) Section 34 Permit to Take Water (PTTW), if the taking of water at the New Keppel Quarry is predicted to cause any negative impact, or is observed to cause any negative impact to other water supplies obtained from any proven adequate sources that were in use prior to initial issuance of a Permit for this taking, the Permit Holder shall take such action necessary to make available to those affected, a supply of equivalent in quantity and quality to the normal takings. If the water taking at the New Keppel Quarry causes permanent interference, the Permit Holder shall restore the water supplies of those permanently affected.

In light of this general condition and to ensure that the New Keppel Quarry does not interfere with private water supplies, a Private Well Monitoring Program has been developed to monitor the water quantity of private water supplies while the New Keppel Quarry operates. Private wells will be separated into two categories based on the potential to be impacted.

⁴ The Hewett and Milne Limited survey was completed April 27, 2012 in order to define the drip line of the existing trees in Area 1A. This was done to determine the placement of the protective fencing to protect the trees from the extraction. The protective fence is 5 m from the drip line and the excavation is to be 5 m from the fence. Surveying was accomplished using GPS and Total Station equipment.

7.1 Category A Private Wells

Category A private wells will include those within or just outside the predicted cone of influence for the deep bedrock aquifer when the New Keppel Quarry is at its full extent (Zones 1 and 2). These wells include:

- Private well no. 7253 (the Cramp well);
- Private well no. 3447 (owned by HSCL McGregor);
- Private well no. 3345 (the Ritchie well); and
- Private well no. 5197 (the Ruthven well).

These four wells have been identified as environmental receptors given their location and proximity to the New Keppel Quarry. The locations of the private wells are shown on Figure 3.

Private wells no. 7253 and no. 3447 are found within Zone 1 (4 to 10m predicted drawdown) of the predicted cone of influence. Private well no. 3345 is found within Zone 2 (0 to 4 m predicted drawdown) of the predicted cone of influence. Private well no. 5197 is found just outside the predicated cone of influence.

Well inspections were completed on wells no. 7253, 3345 and 5197 by a MOE License Well Technician. Through the inspections, the well details were noted, which included the pump depth, static water level and the maximum drawdown (when the pump is operating).

Since private well no. 7253, which is owned by Mr. Cramp, is expected to be within Zone 1 of the predicted cone of influence, his water supply may be impacted as extraction enters into Area 2. The MOE has indicated in their letter dated May 4, 2011 that an acceptable alternate water supply should be in place prior to dewatering in the New Keppel Quarry. Therefore, HSCL will take a proactive approach and has deemed that this well is a candidate for well replacement in advance of the New Keppel Quarry starting extraction.

A replacement water supply well for well no. 7253 will be drilled towards the easterly boundary of Mr. Cramp's property in Zone 2 of the potential cone of influence. This location will minimize the potential for well interference while the New Keppel Quarry develops. To avoid the potential for any impacts to this water supply, it will be recommended that Mr. Cramp begin using the new well immediately after construction and that the old well be decommissioned in accordance with Ontario Regulation 903 (as amended). Construction of the new well and decommissioning of the old well will be done at the expense of HSCL.

Well no. 3447 remains inaccessible and so an inspection has not been completed. MTE understands that this dwelling is uninhabited and will remain vacant if the New Keppel Quarry is licensed and begins extraction. Therefore, well no. 3447 should be decommissioned in accordance with Ontario Regulation 903 (as amended) once extraction begins.

Water levels at each of the Category A private wells will be measured manually on a monthly basis. Additionally, water levels at wells no. 7253 and 5197 will be measured using a data logger, programmed to measure a water level every eight hours. The data loggers will be downloaded by a qualified person hired by HSCL and reviewed monthly by a Hydrogeologist. The data logger at well no. 7253 will be moved to the new water supply well on Mr. Cramp's property once he begins using the new well and a baseline water quality sample will be collected and analyzed for various water quality parameters, including hardness, alkalinity, pH, conductivity, chloride, nitrite, nitrate, calcium, magnesium, iron, ammonia and sodium.

7.2 Category B Private Wells

Category B private wells will include those within 1 km of the New Keppel Quarry license boundaries but outside the predicated cone of influence. Letters will be sent to owners of each of the Category B private wells inviting them to be part of the Private Well Monitoring Program. A baseline well survey will need to be completed for all Category B wells that will be added to the monitoring program (pending permission from the owner and access to the well) including sampling the well for analysis of various water quality parameters, including hardness, alkalinity, pH, conductivity, chloride, nitrite, nitrate, calcium, magnesium, iron, ammonia and sodium.

Water levels will be measured manually from each of the participating Category B private wells on a seasonal basis (4 times per year).

7.3 Private Well Trigger Values and Mitigation Measures

Using the pump setting and the water levels measured from well no. 3345, a yellow trigger limit has been established. The lowest water level measured from well no. 3345 was 238.84 metres above mean sea level (m AMSL) and the pump setting is 216.16 m AMSL. Using these two values, a yellow trigger of 227.5 m AMSL has been established, which is half way between the lowest recorded water level and the pump setting, which leaves in excess of 11 m water column above the pump setting. This trigger value is considered adequate given that the static water level should not be affected by the New Keppel Quarry (MTE, 2009). Water levels in this well may have already been affected by the existing Keppel Quarry. This well has been added to the monitoring program for verification purposes.

A trigger value for the replacement water supply well on Mr. Cramp's property will be established following its installation. An inspection of well no. 5197 occurred in April, 2011 by an MOE Licensed Well Technician. A trigger value will be established once the well head has been surveyed for elevation. Once these trigger values have been established, the tables in Appendix B will be updated so these two wells are incorporated into the AMP.

A baseline well inspection of each of the Category B private wells will occur prior to extraction. Provided access to the wells is granted by the owners, a trigger value will be established upon completion of each well inspection, which will include an elevation survey of wellhead, a water level measurement, and confirmation of the pump setting.

Since well no. 3447 is expected to be decommissioned if the New Keppel Quarry is licensed and begins extraction, a trigger value is not required.

If a yellow trigger value is exceeded for any of the Category A or Category B private wells, then the following mitigation measures will be initiated:

- 1) The quarry operator shall report to the local MOE District Office within 72 hours the exceeded trigger values and Mitigative Actions that will be implemented.
- 2) Inform the resident and enquire about well yield.
- 3) If well yield is affected, then the quarry operator shall retain an MOE licensed plumber to inspect the well and mechanical components thereof and confirm whether mechanical issues (i.e. the pump and/or plumbing system) are the cause, and to validate the decrease in well yield.
- 4) If the cause is not mechanically related, then:
 - The quarry operator will provide a temporary supply of water within 24 hours (if required);
 - The quarry operator will make arrangements to provide a suitable alternative water supply; and
 - Provisions for the affected resident could include all or part of the costs associated with water delivered to fill a temporary water system and associated costs, lowering the pump, drilling a new well, well-deepening, abandonment of the old well.

The mitigation measures are also outlined in Appendix B.

A well interference complaint from a private well owner will constitute a red trigger breech. A private well interference complaint response procedure has been established for all Category A and Category B private wells. The procedure will allow for the owner of each well to report a well interference or any other concern related to their water supply well. If a red trigger is breeched, then the following private well interference complaint response procedure will be initiated:

- 1) Report to MOE within 24 hrs the Mitigative Actions to be implemented.
- 2) The quarry operator will call a MOE licensed plumber immediately upon receipt of the complaint to confirm that the problem is not mechanical (i.e. pump malfunction) and to validate the complaint.
- 3) If the complaint is determined not to be mechanically related (i.e. plumbing), the quarry operator will provide a temporary water supply within 24 hours for the affected resident and make arrangements to investigate (hydrogeological consultant) the cause of the interference.

- 4) Where the results of the investigation indicate that the interference is legitimately from dewatering the New Keppel Quarry, the quarry operator will make arrangements to provide compensation. Compensation must be acceptable to the home owner and the quarry operator, and could include all or part of the costs associated with drilling of a new well, well deepening, and abandonment of the old well.
- 5) Where the results of the investigation do not indicate interference from dewatering of the New Keppel Quarry, the quarry operator will provide a letter report summarizing the results of the investigation to the property owner. In this case, the quarry operator shall maintain the temporary water supply (provided under item 3) for at least an additional 24 hours to allow the resident to make alternate water supply arrangements.

The mitigation measures are also outlined in Appendix B.

8.0 BLAST IMPACT ANALYSIS

A Blast Impact Analysis for the New Keppel Quarry was completed by DST Consulting Engineers Inc. in June 2012 to assess the potential impacts to water resources from blasting in response to comments received from the MOE in their letter dated May 4, 2011.

A copy of the Blast Impact Analysis report is provided in Appendix G.

8.1 Report and Recommendations

The purpose of the Blast Impact Analysis report was to provide recommendations to ensure that the blasting operations are carried out in a safe and productive manner and to ensure that no possibility of damage exists to any buildings, structures or residences surrounding the New Keppel Quarry.

The Blast Impact Analysis was based on observations made during a site visit to the New Keppel Quarry, a review of drawings, MOE Guidelines for Blasting in Mines and Quarries, Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters and the worst case scenario for potential blast damage to surrounding structures from blasting operations.

Dwellings located in proximity to the New Keppel Quarry blasting site and included as receptors in the analysis included the Cramp property (Blasting Receptor 1) and Ritchie property (Blasting Receptor 2) (Figure 6). The McGregor property owned by HSCL is also in close proximity to the New Keppel Quarry blasting site; however, the dwelling is uninhabited and will remain vacant if the New Keppel Quarry is licensed and begins extraction. Therefore, the McGregor dwelling was not considered as a receptor for the purposes of the Blast Impact Analysis. Since surface water features such as the

Shouldice Wetland are not prone to vibration and noise induced by the blasting, as such they were not considered as receptors for the purpose of the Blast Impact Analysis.

The recommendations of the Blast Impact Analysis report included designing blasts so that the seismic activity (vibrations) and noise induced by the blasting operations will remain well within the MOE guidelines, and monitoring all blasts for vibration and overpressure at the Cramp and Ritchie properties with digital seismographs. Blasting monitoring locations are shown on Figure 6.

8.2 Blast Monitoring and Response Program

In compliance with the MOE requirements and as a due diligence, a routine monitoring program of the blasting operations should be implemented. HSCL staff will be trained by a blasting consultant to properly install, monitor, record and report the blast induced vibrations and overpressure. In addition, the following triggering system will be implemented after each blast:

<u>Green</u>

Seismograph readings are within the MOE guidelines for vibration and overpressure, there is no flyrock generated beyond the blast area, there are no complaints from the public, and there is no negative report in the water tested from the quarry.

Remedial Action - No remedial action is necessary.

<u>Yellow</u>

Seismograph readings exceeded the MOE guidelines for vibration and/or overpressure, there is no flyrock generated beyond the blast area, there are no reported damage complaints, there may be complaints from noise or vibration, and slight elevated nitrates and/or other chemicals associated with explosives in the discharge water tested from the quarry as part of the ECA requirements.

Remedial Action – Review the environmental conditions and blast design parameters. Make reasonable adjustments for subsequent blasts. Report the findings and remedial measures to be taken for subsequent blasts to complainants and affected residents.

<u>Red</u>

Seismograph readings exceeded the MOE guidelines for vibration and/or overpressure and/or there is flyrock generated beyond the blast area, there are reported damage complaints, there are complaints from noise or vibration, and there is an elevated level of nitrates and/or other chemicals associated with explosives used for blasting in the discharge water tested from the quarry as part of the ECA requirements.

Remedial Action – Stop any further blasting until a full investigation has taken place into the reasons for the unexpected results. Make appropriate changes and report these changes before commencement of the blasting operation.

8.3 Blasting Impacts to Private Wells

Based on observations and research, it is the professional opinion of DST that the blastinduced vibrations at the New Keppel Quarry will not affect the water wells in the area since the vibration levels must be maintained below 12.5 mm/s in accordance with the MOE guidelines. However, as a precautionary measure and due diligence, DST recommended that water wells be tested periodically for drinking water quality in accordance with the MOE guidelines and regulations.

Therefore, private well no. 3345 (the Ritchie well) and the replacement water supply well on Mr. Cramp's property will be sampled annually for analysis of various water quality parameters as part of the Private Well Monitoring Program due to their close proximity to the New Keppel Quarry. The water quality parameters will include hardness, alkalinity, pH, conductivity, chloride, nitrite, nitrate, calcium, magnesium, iron, ammonia and sodium.

9.0 QUARRY CLOSURE

The AMP will continue into the rehabilitation phase of the New Keppel Quarry to ensure protection of natural features while the quarry extraction area is replenished. If required, some features (i.e. spring s13 and the dugout pond) may require active water replenishment while the quarry is operating. In these cases, it will be important to continue monitoring these features while the quarry extraction area is filling with water and up to five years after filling is complete to ensure that rehabilitation is successful.

9.1 Rehabilitation Phase

Upon completion of extraction in all areas, all equipment and buildings shall be removed from the site. Groundwater shall be allowed to rise to its natural level which is expected to be an elevation of approximately 240 m AMSL.

The filling of the extraction area of the New Keppel Quarry is expected to take between 17 and 26 years. Water balance calculations were used to estimate the fill time for the New Keppel Quarry (Appendix H).

9.2 Requirement for Post-Closure Monitoring

As described in Section 4.8, depending on the results of the AMP, an infiltration pond may be constructed to return water to the lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond in the event that impacts related to the development of the New Keppel Quarry are observed. If required, water will continue to be shunted to the infiltration pond during the post-closure period.

However, if no significant impacts are observed to natural features during the operational period, then there is no potential for impacts post-closure. Therefore, if no

mitigation measures were required to support any natural features (i.e. spring s13 and the dugout pond) then no monitoring will be required post-closure.

No significant impacts are anticipated at any natural features both during operations and post-closure. This is due to the preventative measure of modifying the licensed boundary from the original 68 ha to the current 34 ha that HSCL has already undertaken to ensure that natural features are not impacted.

If the post-closure Water Resources Monitoring Program indicates negative impacts to water resources, a post-closure Ecological Monitoring Program will be implemented to ensure ecological health of the natural features.

9.3 Post-Closure Monitoring Program

The MNR has indicated that there is a lag time associated with the development of a cone of influence and that it could still be expanding when the quarry ceases operations (MNR, 2012). As such, if it is deemed warranted by MNR that a post-closure monitoring program is warranted (i.e. to monitor potential lag-time effects or to monitor the performance of an infiltration pond or any other flow augmentation device) then one shall be initiated. The requirements of the post-closure monitoring program will be revisited towards the end of the operating life of the quarry. If mitigation measures are required for any environmental receptors during the operational period, or if the results of the post-closure monitoring program indicate the need to monitor any other natural features then the post-closure monitoring program can be adapted and expanded as necessary. Environmental receptors may include those features monitored during the operational period:

- The bedrock groundwater system;
- Shouldice Wetland springs s8 and s9;
- The lobe of the Shouldice Wetland encompassing s13 and the Dugout pond;
- The Glen Management Area springs s1-s3 and the Beaver Dam and sinkhole; and
- The ephermeral pond.

Mitigation/contingency measures may continue to be monitored and actively maintained as needed during extraction and up to five years after filling of the extraction area is complete to ensure that rehabilitation is successful. As previously mentioned, the level of detail required for the post-closure monitoring program, and the exact length of time required, will be revisited towards the end of the operating life of the quarry.
10.0 REPORTING REQUIREMENTS

10.1 Annual Reports

Reporting will be used to provide the reviewers/agencies with interpretations of the data collected and make recommendations to modify the monitoring programs and/or the ARA Site Plan for the New Keppel Quarry, as required. Annual reports detailing the results of the monitoring program will be provided to the MNR, MOE, NEC and SON by a Qualified Person⁵ (QP). In addition to the annual reporting, interim reports will be submitted by a QP to MNR, MOE, NEC and SON if trigger values are exceeded as listed under the "Green", "Yellow" and "Red" actions in the AMP (Appendix B).

The annual reports are intended to document the results of the monitoring program and any mitigation measures that were undertaken during the previous year. Annual reporting will involve data compilation, presentation and evaluation of the performance monitoring data, including the trend analysis. The reports will determine if the AMP is effectively monitoring the site conditions.

Since extraction in Area 1a is an extension of the existing Keppel Quarry, data collected while this area is being extracted will be considered to represent baseline conditions. As such, the first annual report should be completed at the initiation of operations in Area 1b to summarize the baseline data. All subsequent annual reports will include a discussion on:

- The quarry's influence on the bedrock groundwater system, specifically describing the progression of the cone of influence and any changes to the 'epikarst aquifer';
- The effect on the Shouldice Wetland including an assessment of the hydroperiod, ecology, and flows at spring s8, s9, s13 and the dugout pond;
- The effect on the Glen Management Area and its associated springs (s1-s3) including an assessment of the hydroperiod and ecology; and
- The effect on local private wells that have agreed to participate in the Private Well Monitoring Program.

Subject to approval from MNR, the AMP shall be updated periodically approximately every five years. Annual reports can be used to provide recommendations for changes to the AMP programs, should they be necessary based on observed results, but changes can only be implemented with approval from MNR, typically as part of the five year review process.

The AMP shall be updated every five years based on a consolidation of monitoring / mitigation results obtained during the previous five year period, and incorporation of any recommendations that are provided in the annual reports. This consolidation will not

⁵ See Section 10 – Glossary of Terms for definition of Qualified Professional

involve the development of a totally new AMP, but rather the revision of specific aspects or components of the AMP monitoring / mitigation measures. Each time the AMP is revised, the entire document should be re-issued so that there is only one "current" AMP document that defines the entire program that has to be undertaken.

Annual reports shall be used to make changes to the following aspects so that the AMP reflects the quarry condition at that time:

- Details of the monitoring program (i.e. protocols for data collection frequency, location, and/or method);
- Trigger values used by the AMP; and/or
- Mitigation measures used to prevent impacts.

Annual monitoring reports will serve as stand-alone documents that report and interpret the results of that year's monitoring activities relative to historical data and report on the effectiveness of the AMP's monitoring programs and trigger levels. If any <u>significant</u> changes to operations, including the AMP, are required then a Site Plan amendment will be required. The anticipated changes needing a Site Plan amendment are listed in Section 9.3 of the AMP.

10.2 Stakeholders Liaison Committee

Public consultation and liaison will be incorporated to encourage open dialogue between HSCL and the community. To facilitate this process, a Stakeholders Liaison Committee (SLC) will be assembled that is composed of agency / government staff, and citizens groups that have a stake in the operation of the New Keppel Quarry. The SLC will act as a sounding board and adviser to the operator in regards to the implementation of the AMP. The participants that will be considered for the SLC may include but not limited to:

- The Niagara Escarpment Commission (NEC);
- The Ministry of Natural Resources (MNR);
- The Ministry of the Environment (MOE);
- The Grey Sauble Conservation Authority;
- Township of Georgian Bluffs;
- County of Grey;
- The Grey Association for Better Planning (GABP);
- Coalition on the Niagara Escarpment (CONE);
- Saugeen Ojibway Nation (SON);
 - Chippewas of Nawash First Nation; and
 - Saugeen First Nation
- Métis Nation of Ontario;
- Two (2) representatives of the community; and
- Two (2) representatives of HSCL.

A representative of HSCL will act as chair and guide the meetings to ensure that they are focused and orderly. The committee will be required to appoint a co-chair alongside HSCL. In so doing, there will be a direct transfer of information from the SLC to HSCL. The role of the appointed co-chair will be to offer guidance for the committee and presentation of issues to HSCL that they might not be aware of. The chair and co-chair will set the agenda and then conduct the meeting proceedings.

The stakeholder and community representatives will serve on the SLC for a term of two years. To ensured there is consistency year to year, the two year term of appointment will overlap so that there is no time at which all the members are new (saving, of course, for the initial appointment). Overlapping appointment terms will provide continuity of participation among the committee members.

A Terms of Reference shall be developed for affirmation by the committee itself. To expedite the process, HSCL will draft the initial Terms of Reference and present it to the committee during their first meeting. Based on discussions, it shall be modified and circulated for final comment prior to implementation. Once finalized, the Terms of Reference can be ratified by the committee members. Any Terms of Reference developed for affirmation shall include a minimum of two meetings per year.

The Draft Terms of Reference shall include but not be limited to the following:

- 1. The SLC shall meet a minimum of two times per year.
- 2. The SLC has an important liaising role and will be required to comment on the effectiveness of the AMP (monitoring programs and mitigation measures). The SLC will also be encouraged to table other relevant issues related to the operation of the New Keppel Quarry.
- 3. Based on their review of the AMP, the SLC shall make recommendations to the operator. The recommendations shall not be viewed as a platform for dictating or directing how HSCL operates the quarry. Rather, the recommendations must be in accordance with relevant Acts and Regulations.
- 4. The committee will be established and administered by HSCL:
 - a. HSCL will provide the venue for the meetings and will provide administrative staff to record the minutes and action items.
 - b. HSCL will provide specialists to interpret data and offer expert opinion on discussion points and monitoring reports.
 - c. HSCL will provide a website to post information for the committee members to share by way of confidential pass words as well as to post information for the general public.

The suggested participants and format of the SLC is detailed further in a memo in Appendix I.

10.3 Site Plan Amendments

If significant changes are required to the operation plan for the New Keppel Quarry due to the results of the AMP, then a Site Plan amendment may be required that will require MNR approval. The NEC, under Condition 32 of the Development Permit Conditions have required any Site Plan amendments to be passed through them prior to being sent to MNR for modification to the license. As such, Site Plan amendments will be done in consultation with the NEC.

A Site Plan amendment may be required as a result of:

- Unanticipated mitigations measures required;
- Multiple Trigger value amendments; and/or
- Adding new monitoring programs for natural features not included in original AMP.

All of which is respectively submitted,

MTE CONSULTANTS INC.

Jay Flanagan, B.E.S. Project Manager

JBF: plw



Peter A. Gray, P.Geo., QP_{ESA} VP., Senior Hydrogeologist

11.0 GLOSSARY OF TERMS

Bedrock (epikarst) - The epikarst is a zone of bedrock openings enhanced by solution weathering that directs flow to local surface features located on the top of the Amabel Plateau. Epikarst found in the Study Area is typically three to five metres deep and is highly efficient at redirecting recharge water (i.e. snow melt water and/or precipitation) infiltration laterally to natural features, such as the Shouldice Wetland. The epikarst component has been described in detail by Daryl W. Cowell & Associates Inc. (Cowell, 2009).

Bedrock (shallow) - Groundwater in the shallow bedrock has shown a delayed response to the presence of the existing Keppel Quarry. Current evaluations showed that shallow groundwater remained unaffected until the existing Keppel Quarry face was within approximately 40 m of an observation well (MTE, 2010). The reduced effect in the shallow bedrock may be, in part, due to recharge received through the epikarst system.

Bedrock (deep) - Current interpretations (MTE, 2009) have shown that the extreme outer edge of the cone of influence for the deep bedrock groundwater was observed up to approximately 400 m away from the face of the existing Keppel Quarry (MTE, 2009 and WGC, 2009). The hydraulic properties (Hydraulic Conductivity and Transmissivity) of the bedrock at the New Keppel Quarry are similar to those surrounding the existing Keppel Quarry will exert a similar drawdown on the surrounding deep bedrock groundwater system.

Biologist/Ecologist – A scientist who studies living organisms and their relationship to their environment.

Blast Induced Peak Particle Velocity – The rate of change of the velocity amplitude usually measured in mm/sec or in/sec. This is the excitation of the particles in the ground resulting from vibratory motion induced by the blasting operations.

Blast Induced Overpressure – A compression wave in air caused by:

- a) The direct action of the unconfined explosive; or
- b) The direct action of the confining material subjected to explosive loading.

Co-dominant Tree – a tree that extends its crown into the canopy and receives direct sunlight from above but limited sunlight from the sides. One or more sides of a co-dominant tree are crowded by the crowns of dominant trees.

Cone of Influence – a pumping cone or cone of depression formed in an aquifer around a pumping well as the water level declines. In the case of a quarry, the excavation acts similar to a large well in that surrounding water levels decline in proximity to the quarry resulting in a depressed groundwater surface.

Coniferous Tree – any tree that produces seeds in cones.

Crown – the uppermost branches and foliage of a tree.

Cumulative Caliper – calculated by adding the DBH of several smaller trees planted to replace a Preservation Tree.

Deciduous Tree – shedding or losing leaves annually; the opposite of evergreen. Trees such as maple, ash, cherry, and larch are deciduous.

Diameter at Breast Height (DBH) – is a standard method of expressing the diameter of the trunk of a standing tree, usually taken at 4 1/2 feet above the ground.

Crown Class – see: Co-dominant Tree, Dominant Tree, Intermediate Tree, and Suppressed Tree.

Dominant Trees – trees that extend above surrounding individuals and capture sunlight from above and around the crown.

Emerald Ash Borer – is a green beetle native to Asia and Eastern Russia. Outside its native region, the emerald ash borer (also referred to as EAB) is an invasive species, and emerald ash borer infestation is highly destructive to ash trees in its introduced range. The emerald ash borer was first discovered in America in June 2002 in Michigan. It is believed to have been brought to America unintentionally in ash wood which was used to stabilize crates during shipping.

Environmental Receptor – a groundwater or surface water feature where the quarry influence may have an effect.

Groundwater Sink – a depression in the water table that causes water to be drawn from surrounding groundwater resources.

Hydraulic Conductivity – the rate of flow of water through a porous medium such as bedrock fractures or bedding planes.

Hydraulic Gradient – is the change in static head per unit of distance in a given direction.

Hydrogeologist - a professional geoscientist or a licensed professional engineer specializing in hydrogeology.

Hydroperiod – the flow period over which surface water features such as a springs or water courses receives inputs from groundwater and/or overland runoff from surrounding lands.

Infiltration Gallery – a pond or nest of wells drilled into the bedrock that allows water back into the bedrock groundwater system.

Intermediate Crown Class – trees with crowns that extend into the canopy with dominant and codominate trees. These trees receive little direct sunlight from above and none from the sides. Crowns generally are small and crowded on all sides.

Karst Flow – the movement of groundwater through preferentially-enhanced fracture zones within the overall bedrock mass. Typically flow rates (as expressed by the hydraulic conductivity) are significantly greater than within non-karst areas of the bedrock aquifer.

Key Indicator – a feature or thing that is used to help evaluate the performance of the quarry with respect to the natural environment.

Live Crown – is the top part of a tree, the part that has green leaves (as opposed to the bare trunk, bare branches, and dead leaves). The ratio of the size of a tree's live crown to its total height is used in estimating its health and its level of competition with neighboring trees.

Long-Term Monitoring Program – a sequence of regular field activities carried out on a monthly basis to collect data on groundwater and surface water to ensure that there are no significant negative impacts to natural features while the quarries proceeds.

'Natural' Spring Flow – water coming from a spring without being artificially augmented. The spring must be flowing in its natural state or in a manner that is comparable to pre-quarry conditions.

Performance Monitoring – an evaluation of the extent of the quarry influence on the surrounding environment. New data collected through the groundwater/surface water monitoring program will be compared to baseline conditions (data collected before extraction started).

Pathway – a karst conduit, fracture or bedding plane of bedrock that potentially connects a receptor to the quarry.

Preservation Tree – a tree found in the TPP Corridor that has a minimum DBH of 15 cm or a minimum crown height of 5 m.

Qualified Person (for the Water Resources Monitoring Program) – an independent Hydrogeologist.

Qualified Person (for the Ecological Monitoring Program) – an independent biologist or person specializing in ecology.

Qualified Person (for the Blasting Monitoring Program) – a blasting specialist.

Qualified Person (for the Tree Preservation Plan) – an Ecologist, Landscape Architect, arborist, or forester.

Replacement Tree – A tree(s) found in the TPP Corridor (planted or natural) counted as a replacement for a lost Preservation Tree. The Replacement Tree(s) shall have a minimum DBH of 15 cm or a cumulative caliper DBH of at least 15 cm.

Recovery – water level(s) in an observation well(s) that are equal to or higher than green trigger values for at least three monitoring events space one week apart.

Suppressed Tree – a tree condition characterized by low growth rate and low vigor as a result of competition with overtopping trees.

Transmissivity – the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

Water Table – is the water surface in an unconfined aquifer at which the pressure is atmospheric. It is defined by the levels at which water stands in wells that penetrate the aquifer. In wells penetrating the aquifer to greater depths, the water level will stand above or below the water table if an upward or downward component of groundwater flow exists. It should be noted that the technical standards defined in the *Aggregate Resource Act* for reporting Hydrogeological Information define the water table as the static level or surface that the water rises to within any aquifer (confined or unconfined aquifer), which is also referred to as the potentiometric level, and the upper surface as the potentiometric surface.

Water-bearing Fracture – high or turbulent flows from a fracture or bedding plane. Turbulent flow from a water-bearing fracture may be an indication that water is being intercepted from surface water features such as springs. Signs of groundwater inputs in the form of minor leakage and wetted surfaces are not considered turbulent flow.

Well Interference – an unacceptable reduction in groundwater quantity and/or degradation in water quality to a private well caused by dewatering the quarry.

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FIGURES

Project: 33862-100 CAD: P:\P\33862\EV\33862-100-EV15.DWG





MTE Project No.

33862-100

<u>Date</u>

July 2012

<u>Layout No.</u>

EV4.4

<u>Scale.</u>

1:50,000







Project Name Keppel Quarry										
Site Blu	ffs, Ontario	Clier Harold Sutherland Co	onstruction Limited							
	MTE Project No. 33862-100	Date December 2014	Layout No. EV2.1							



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December 22, 2014 - 10:37 a.m. - Plotted By: kmadsen











December 22, 2014 - 10:26 a.m. - Plotted By: kmadsen





SITE PLAN







NOTES:

1. THESE SITE PLANS ARE PREPARED FOR SUBMISSION TO THE MINISTRY OF NATURAL RESOURCES TO COMPLY WITH THE STANDARDS FOR A CATEGORY 2, CLASS A (QUARRY BELOW WATER) LICENCE UNDER THE AGGREGATE RESOURCES ACT AND REGULATIONS.

2. ALL DIMENSIONS ARE IN METRIC UNITS. ELEVATIONS ARE GEODETIC, ASL. REFERENCE WAS MADE TO ONTARIO BASE MAP 10 17 4950 49400 & 10 17 5000 49400, REGISTERED PLAN 16R-3903, A DRAFT PLAN OF SURVEY BY HEWETT AND MILNE LIMITED, ONTARIO LAND SURVEYORS AND THE FOLLOWING REPORTS: - HYDROGEOLOGICAL REPORTS, ADDENDUMS, RESPONSES BY WATERLOO GEOSCIENCE LIMITED, NOVATERRA ENVIRONMENTAL LIMITED, MTE CONSULTANTS INC.

- ADAPTIVE MANAGEMENT PLAN BY MTE CONSULTANTS INC.

- NATURAL ENVIRONMENT STUDIES, ADDENDUMS AND RESPONSES BY AQUATIC WILDLIFE SERVICES - NOISE AND BLASTING STUDIES BY AERCOUSTICS ENGINEERING LTD. AND DST CONSULTING ENGINEERS INC.

- ARCHAEOLOGICAL STUDIES BY SCARLETT JANUSAS

- "LANDSCAPING DETAILS" & "VEGETATION INVENTORY & PRESERVATION PLAN" BY L. PORTER. 3. SITE SURVEYS AND INSPECTION BY WM. BRADSHAW, P.ENG. (OCTOBER, 2003) & ACI SURVEYS LTD. (KITCHENER), OCTOBER, 2006.

4. THE PROPOSED LICENSED AREA IS LOCATED IN THE NIAGARA ESCARPMENT AREA.

5. THE WATER TABLE ELEVATION VARIES FROM APPROXIMATELY 240m TO 247m AND WAS DETERMINED FROM FIGURE 60 OF THE HYDROGEOLOGICAL INVESTIGATION BY MTE CONSULTANTS (OCT. 14, 2009). 6. FOR CROSS-SECTION INFORMATION, SEE DRAWING 7, CROSS-SECTIONS & DETAILS.

7. THE PROPOSED LICENSED AREA IS 35.0 HECTARES.

CONCESSION 10 LEG LINE BETWEEN LOTS 27 8-28-. EXISTING ROAD ALLOWANCE BETWEEN CONCESSIONS 9 & 10 LOT 28 RESIDENCE LINE BETWEEN LOTS 27 & 28 -LOT 28 LOT 27/ CONCESSION 9 CONCESSION 9 WOODLOT CONCESSION 9 WOODLOT \sim -LINE BETWEEN LOTS 26 & 27 HAR



Wm. Bradshaw, P.Eng. Kitchener, Ontario

PXVII SUBJECT LANDS

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TEMPORARY PRESERVATION FENCING SHALL BE INSTALLED PRIOR TO CONSTRUCTION.

SITE PLAN OVERRIDES OF THE OPERATIONAL STANDARDS

1. STANDARD 5.1 -

a.) The licensed boundaries shall not be fenced on the west or north side of the pond access corridor in the SW corner. Marker posts, minimum height 1.2m, shall be placed at the corners and at intervisible distances not to exceed 60m on any unfenced boundaries.

b.) The part of Area 1A that abuts the adjacent, existing Keppel quarry shall not be fenced. Marker posts shall be placed at the most northerly and most southerly corners of the unfenced boundary.

2. STANDARD 5.10.1 - Regulatory setbacks have been reduced to zero metres adjacent to lands owned by the 3. STANDARD 5.13.1 - Stockpiling within 30m of the north and west boundaries adjacent to lands owned by the

SPILLS CONTINGENCY PLAN

In case of accidental spill of petroleum based products the following contingency plan will be activated: 1. All spills of petroleum based products regardless of the quantity will be cleaned up immediately following the spill. 2. A supply of absorbent material suitable for use on spilled petroleum products (e.g., sand, "Stay-Dry") will be maintained on site. The absorbent material will be stored in a easily accessible location in bags or containers that can be moved by hand. The absorbent material will be kept dry by protective coverings or containers. 3. The quantity of absorbent material stored on site will be sufficient to meet the supplier's recommendations for absorbing petroleum products. If using sand, the owner will maintain a reasonable volume (3cu. m to 5 cu. m.) on site. 4. The owner will first contain the spill using the absorbent material and block any crack or route by which a spilled product could enter the rock or soil on and around the site. After containment, the owner will proceed to clean up the spill using additional absorbent materials as necessary. 5. All contaminated material will be removed from the site and placed in an approved landfill site. 6. The adjacent property owners will be notified of any spill that occurs on site as per the Environmental Protection Act. 7. For spills in excess of 20 L that are cleaned up immediately, the owner will also notify the local offices of the Ministry of the Environment and of the Ministry of Natural Resources of the occurrence and of the procedures followed including the disposal location.

notified when cleanup is complete.

8. For any spill regardless of quantity which can not be immediately cleaned up, the owner will notify the local offices of the Ministry of the Environment and of the Ministry of Natural Resources and the adjacent land owners of the problem. Action to clean up the spill will be undertaken as soon as possible and all parties will be

OPERATIONAL NOTES

1. SETBACKS: Extraction setbacks shall be 40m along the County Road 17 road allowance boundary, 30m adjacent to the south boundary of Area 2 & Area 3 and as shown along the northwesterly side of Area 1B and in the southeasterly corner adjacent to Area 3. There shall be no disturbance, i.e. no tree removal, no stripping, no stockpiling within the buffer zone shown between the licence boundary and the ANSI. The extraction setback in Area 1A is 5m from the surveyed dripline and shall be fenced.

2. VEGETATED BUFFER: A "20m Existing Forest Setback" shall be maintained and enhanced adjacent to the County Road 17 boundary. Similarly, a "30m Existing Forest Setback" shall be maintained and enhanced within the southern 30m setback area adjacent to the road allowance between Concessions 9 & 10. Refer to drawing 8, "Landscaping Details" and drawing 9, "Vegetation Inventory & Preservation Plan by L. Porter for details.

3. MAXIMUM DEPTH OF EXTRACTION: The maximum depth of extraction shall be to the bottom of the Amabel Formation at the approximate elevations shown (228m to 230m in Area 1B, 2 & 3, 234 in Area 1A). The perimeter area adjacent to the extraction limit along the northerly boundary of Area 1B shall only be extracted to 242m where shown in order to allow backfilling and the creation of 3:1 slopes adjacent to the 100m ANSI setback line. The slope will be constructed from the limit of extraction to +/-1 metre below the final water level of the future pond of +/-244m.

4. SIDE SLOPES: Perimeter side slopes to elevation 244m adjacent to the 100m ANSI setback and the SE corner of Area 3 shall be created by backfilling with onsite overburden and topsoil and clean inert fill. Final perimeter slopes adjacent to the 100m ANSI setback and the SE corner of Area 3 shall be constructed no steeper than 3(horizontal) to 1(vertical). All other boundaries shall have vertical faces at the limit of extraction. Final slopes adjacent to the 100m ANSI setback and the SE corner of Area 3 shall be spread with a minimum of 0.15 metres (6 inches) of topsoil and shall be seeded and planted as outlined on Drawing 6, Progressive Rehabilitation & Final Rehabilitation Plans and Drawing 7, Cross—Sections and Details. Where the slopes adjacent to the 100m Ansi setback boundary and the SE corner of Area 3 reach the 243 metre level the "slopes" will be vertical to the bottom of the guarry.

5. ENTRANCE/EXIT/GATE: The entrance to the quarry shall be on the eastern boundary of Area 1B as shown to Grey County Road #17. Any required turning lanes, deceleration lanes or tapers shall be constructed to Grey County Standards and according to Grey County procedures. The entrance area treatment including grading, planting, gates, signage and lighting shall be constructed as outlined drawing 9, "Vegetation Inventory & Preservation Plan by L. Porter for details. Area 1A shall be accessed through the existing Keppel quarry entrance. A gate (minimum height 1.2m) with a lock shall be installed and maintained at the entrances. The entrance shall be closed & locked when the quarry is not operating.

6. FENCING: Post & wire fencing (minimum height 1.2 metres) shall be repaired or installed on the proposed licence boundary, where shown. Marker posts at intervisible intervals not to exceed 60m shall replace fences on the west and north side of the 50m infiltration pond access corridor. Warning signs shall be posted on the marker posts and along the fence at 20 metre intervals. Fences, marker posts and signs shall be maintained for the life of the guarry.

7. TOPSOIL/OVERBURDEN STORAGE: Stripped topsoil and overburden, and imported inert fill shall be used to construct the proposed berms where shown. These berms shall be constructed to the recommended heights as indicated in the Sequence of Operations notes. Also see note #27. After the required berms have been constructed, any further stripped materials not used immediately for rehabilitation, may be stored separately in berms in the perimeter areas and eventually used for perimeter backfilling. Stripped topsoil & overburden shall be graded to stable side slopes. Berms shall be seeded with perennial grasses. Vegetation on the berms and stockpiles shall prevent erosion.

8. VEGETATION: Vegetation on all berms, stockpiles, vegetated buffers and rehabilitated areas that dies or is otherwise damaged shall be reseeded or replanted in accordance with drawing 9, "Vegetation Inventory & Preservation Plan by L. Porter.

9. STOCKPILES: No stockpiles of aggregate or stripped materials shall be located within 30 metres of the licence boundary, north and west boundaries excepted. See overrides. Stockpiles shall not exceed a height that is greater than 2m below the top height of the accoustical berms.

10. PROCESSING EQUIPMENT: Processing equipment to be utilised on this site shall include scrapers, bulldozers, loaders, excavators, rock drills, drill rigs, round stall be dried and sold for uses such a sagi-lime on farm fields or other clay products. Ponds may be laid out in various configurations and may be relocated from time to time as dictated by operations.

11. DUST CONTROL: Dust control shall be maintained through the application of water when necessary.

12. NOISE, DUST OR GROUNDWATER INTERFERENCE PROBLEMS: Should noise, dust or groundwater interference complaints be received, the licensee shall take appropriate measures as deemed necessary by the Ministry of the Environment to rectify the problem(s).

13. DEWATERING: Sumps and dewatering facilities shall be located on the quarry floor and may be relocated from time to time as extraction progresses. Ground water and precipitation shall be pumped as outlined in the sequence of operations. See the Adaptive Management Plan summary on Drawing 5, 'Adaptive Management Plan". The final water elevation in the pond is anticipated to be +/-244m.

14. SCRAP STORAGE: There shall be no scrap permanently stored on this site.

15. PETROLEUM STORAGE: Petroleum storage facilities shall be relocated to the vicinity of the shop in the new quarry from the old quarry when pumping to the old quarry commences. All petroleum storage shall be in above ground containers that meet the requirements of the Technical Standards and Safety Act 2000 and the Liquid Fuel Handling Code 2001 as may be amended. Any spills shall be removed and disposed of at a facility approved by the Ministry of the Environment. See the Spills Contingency Plan on this page. Mobile fuel tanks shall be the new generation engineered double-tanked variety with vacuum sealed

16. BUILDINGS: Operational buildings shall be located within the areas shown in Phase 1B.

17. DRAINAGE: Surface drainage and ground water shall be captured in temporary sumps and removed as indicated in Note 13 above.

18. HOURS OF OPERATION: The hours of operation for this site shall be: Shipping: from 7am to 6pm Monday to Friday. No shipping on Saturday or Sunday, except in emergency situations. Processing: from 7am to 6pm Monday to Friday.

19. EXTRACTION AREA: The area to be extracted is 26.85 hectares

20. TONNAGE CONDITION: The maximum number of tonnes to be removed from this site in any calendar year is 600,000. Note that while old Keppel quarry is still operating, the combined tonnage of this site and old Keppel quarry shall not exceed 600,000 tonnes.

21. TREE REMOVAL: Trees cut during stripping operations shall be marketed for lumber where possible or shall be cut up for fire wood. Stumps shall be stored for future use on the edges of the future quarry pond. All ash (fraxinus) tree removal and disposal shall be in accordance with CFIA regulations.

22. RECYCLING: Asphalt and concrete may be imported into this site for recycling and stored in the area shown.

23. TUNNEL: A tunnel, if required, shall be constructed between Area 1A and Area 1B for the transport of material between Areas. The tunnel, if required, shall consist of a precast and pre-engineered concrete culvert and shall be constructed and installed to meet the requirements of the Grey County Engineering Department.

24. ARCHAEOLOGICAL RECOMMENDATIONS (by Scarlett Janasus, Archaeological & Heritage Consulting, Tobermory, Ontario): Should deeply buried archaeological material be found on the property during excavation activities, the Ministry of Citizenship, Culture and Recreation (MCCR) shall be notified immediately (519-675-7742). In the event that human remains are encountered during excavation, the proponent shall immediately contact both the MCCR and the Registrar or Deputy Registrar of the Cemeteries Regulation Unit of the Ministry of Consumer & Commercial Relations (416-326-8392)

25. NATURAL ENVIRONMENT RECOMMENDATIONS (by Aquatic and Wildlife Services, Shallow Lake, Ontario): See Drawing 4 of 8: "Consultant Recommendations" Drawing 5 "Adaptive Management Plan" and Drawing 7, "Cross—sections and Details".

26. HYDROGEOLOGICAL RECOMMENDATIONS: (by MTE Consultants Inc., Kitchener, Ontario): See Drawing 4: "Consultant Recommendations", Drawing 5, "Adaptive Mangement Plan".

27. NOISE CONTROL RECOMMENDATIONS: (by Aercoustics Engineering Limited, Toronto, Ontario) See Drawing 4: "Consultant Recommendations". 28. BLASTING CONTROL RECOMMENDATIONS: (by Aercoustics Engineering Limited, Toronto, Ontario and DST Consulting Engineers Inc., Sudbury, Ontario) See Drawing 4: "Consultant Recommendations"

29. SECTIONS AND DETAILS: See Drawing 7: "Cross-sections and Details".

30. IMPORTATION OF FILL: Only topsoil, subsoil and overburden meeting the definition of inert fill under Regulation 347 of the Environmental Protection Act shall be imported into this site for the purposes of constructing berms or conducting rehabilitation. Incoming loads of fill shall be monitored by staff and as per NEC 2.2.1.1.1.5.

31. PRESERVATION FENCING: Prior to the commencement of tree removal and topsoil stripping temporary preservation fencing shall be installed along the dripline of the vegetation within: 1) the 20m setback forested zone abutting County Road 17, 2) the 30m setback forested zone along the Road Allowance between Concessions 9 & 10, and 3) the area 1A vegetated area that is to be retained. The installed fencing shall be inspected by the consulting Landscape Architect and a confirmation letter shall be submitted to NEC.

32. WILDLIFE SIGNAGE: In consultation with the County of Grey Roads Department and under the Highway Traffic Act, the licensee shall erect "ANIMAL CROSSING" signs at the locations shown. In addition, the licensee shall erect a "CAUTION, WILDLIFE CROSSING" sign at the quarry entrance. The licensee shall also request of the OPP and the County to forward any incident reports from their monitoring of any increased collisions along County Road 17 for 1 kilometre in both directions from the Keppel Quarry, for the inclusion in the reports to the Stakeholders Liason Committee and subject to other actions of posting signage or additional preventative measures.

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	••••	REFORESTATION AREAS		-

No.

ROLD SUTHERLAND CONSTRUCTION LTD. R.R. #2, KEMBLE, ONTARIO, NOH1SO

NEW KEPPEL QUARRY

ARTS LOTS 26, 27 & 28, CONCESSION 10 SHIP OF GEORGIAN BLUFFS (formerly Keppel Twp) COUNTY OF GREY

OPERATIONAL PLAN DRAWING 2 of 9

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IN GENERAL:

1. Prior to the commencement of operations in Area 1A, all required fencing and signs shall be constructed and the limits of extraction surveyed and clearly marked where shown. Unfenced boundaries shall be marked at intervisible distances not to exceed 60m with marker posts and signs. All fencing and markers shall be maintained for the life of the licence.

2. Prior to the commencement of operations in Area 1B, 2 and 3, all required fencing and signs shall be constructed and the limits of extraction surveyed and clearly marked where shown. Unfenced boundaries in these areas shall be marked and maintained as per Note 1.

3. Prior to the commencement of extraction and processing in any areas or any parts of areas, acoustical attenuation berms shall be constructed as shown on drawing 4, "Consultant Recommendations". The accoustical berm elevations shall be confirmed by survey to ensure that stockpile elevations remain a minimum of 2m below the accoustical berm elevations.

4. Once the acoustical attenuation berms are completed and the elevations confirmed by survey the planting of the tree/shrub screening plantings will be installed within the first year of operations. 5. The calculation to determine the phasing timeline is based on using 500,000 tonnes per year for extraction and a conversion of 1 cubic meter of rock to 2.5 tonnes. The timelines associated with the phases could be longer or shorter depending on yearly sales volumes. The MNR tonnage limit is 600,000 tonnes per calendar year.

6. Drainage sumps will be created within the licensed area to support the dewatering operation in various areas. Pumps and associated piping will routinely be relocated within the licensed area as the sumps are created. The creation of any new sumps or the movement of the associated pumps and piping will not require any additional permitting.

7. Area 3 shall not be excavated for a period of 12 years from the issuance of a license under the Aggregate Resources Act. The excavation of Area 3 may only proceed if it is determined acceptable by the MNR and MOE through the results of the Adaptive Management Plan (AMP) developed for this site.

8. The maximum depth of extraction shall be to the elevation of the bottom of the Amabel Formation and in the general direction of the arrows shown.

9. If it is determined from the Natural Environment monitoring and the Adaptive Management Plan shown on drawing 5 that the existing ephemeral pond has had unacceptable impacts, then an ephemeral pond shall be constructed and maintained as directed by the Natural Environment consultant or by MNR.

10. Prior to the commencement of tree removal and topsoil stripping temporary preservation fencing shall be installed along the dripline of the vegetation within: 1) the 20m setback forested zone abutting County Road 17, 2) the 30m setback forested zone along the Road Allowance between Concessions 9 & 10, and 3) the area 1A vegetated area that is to be retained. The installed fencing shall be inspected by the consulting Landscape Architect and a confirmation letter shall be submitted to NEC.

Phase 1 (The period when excavation focus is in Area 1A-Year 1 to 3)

AREA 1A

1. Area 1A shall be operated as an extension of the existing Keppel quarry with processing of aggregates taking place in the adjacent Keppel quarry. The depth of extraction shall be to +/-234m. The limit of extraction on the west side of the quarry will be set at 5m from the existing tree line. A fence is to be installed 5m from the trees to denote the limit of extraction. Phase 5 (The period when excavation focus is in Area 2-Year 19 to 26) AREA 1A 2. Tunnel construction under County Road 17 can commence when Area 1A reaches the 242m level

3. Extraction to the 234m level shall then be completed in Area 1A.

4. The asphalt plant is to be removed from the existing Keppel guarry by December 31, 2014.

AREA 1B

1. Construct access to Area 1B in accordance with landscape drawings.

2. Commence clearing and stripping operations in the north and north easterly portions of Area 1B and construct the required berms in the berm area along County Road 17 and in the berm area adjacent to the north boundary

3. Execute the planting program for the 20m wide buffer strip between Area 1B and County Road 17.

4. Commence removal of aggregate in the proposed tunnel area to the 242m level and truck to the existing Keppel auarry for processing.

5. Complete tunnel construction from Area 1A.

6. Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped to the "Sump Pond" located in the southeast corner of the Existing Keppel Quarry (as per ECA no. 3515—8M4PWM) when necessary. Associated pumps and piping shall also be moved within the licence area accordingly AREA 2

1. Commence stripping in the proposed berm area between Area 2 and County Road 17 and construct the proposed berm.

2. Execute the planting program for the 20m wide buffer strip between Area 2 and County Road 17.

Area 3

1. Commence stripping in the proposed berm area between Area 3 and County Road 17 and construct the proposed berm

2. Execute the planting program for the 20m wide buffer strip between Area 2 and County Road 17.

3. Execute the planting program for the 30m wide buffer strip between Area 3 and Concession 10.

4. Area 3 shall be surveyed and the line between Area 2 and Area 3 shall be marked with highly visible marker posts at a minimum height of 2m.

Phase 2 (The period when excavation focus is in Area 1B-Year 3 to 7)

AREA 1A

1. Processing equipment shall be located in Area 1A until sufficient working area is established in Area 1B.

2. Commence moving aggregate from Area 1B to Area 1A through the tunnel for processing in Area 1A.

3. All processing equipment must be removed from Area 1A and rehabilitation commenced a maximum of seven (7) years after the issuance of the ARA licence.

4. Remove pumping equipment from Area 1A to Area 2.

5. Move existing stockpiles in Area 1A and from the old quarry floor to Area 1B as required.

shall be graded to a 3:1 slope. The process shall be repeated in 50m increments moving northeasterly to the eastern extraction limit. AREA 1B 5. Step number 4 shall be repeated until all of the quarry rock is mined out from the northern perimeter area to elevation 243m. 1. Establish the quarry floor working area at the 242m level in the north eastern part of Area 1B and relocate the primary crusher to Area 1B. Continue at elevation 242m until work area is made large enough to accommodate operational equipment. Once the 242m working area has been created, commence extraction to the lower bench levels. shown on Drawing 7, "Cross-Sections and Details."

2. Once the primary crusher has been established in Area 1B, crushed rock shall be transported through the tunnel for further processing in Area 1A.

3. Continue to clear and grub in the directions of the arrows shown.

4. Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped to the "Sump Pond" located in the southeast corner of the Existing Keppel Quarry (as per ECA no. 3515—8M4PWM). Associated pumps and piping within the licensed area shall be moved/relocated within the licensed area when necessary.

5. Re-locate all processing equipment in the eastern part of Area 1B to the 230m level and commence all processing operations in Area 1B.

AREA 2

1. Clear the minimum required area and construct Sedimentation pond #1 (0.4 ha in size) on the north east side of Area 2. Construct the rip rap outlet south of sedimantation pond #1. AREA 3

1. No action required.

Infiltration Pond

1. Subject to the results of the AMP the infiltration pond may be constructed and clear water pumped to it during this phase.

Phase 3 (The period when excavation focus is in area 1B-Year 8 to 14)

AREA 1A

1. Commence perimeter and entrance rehabilitation in Area 1A.

- 2. Rehabilitation starts in year 8 as the old quarry starts to fill with water.
- 3. Decommission the tunnel under County Road 17.

AREA 1B

1. Continue excavation to a depth of approximately 228m to 230m (to the bottom of the Amabel Formation).

2. Complete clearing and stripping operations in the southerly portion of Area 1B to Area 2.

3. Temporary sumps shall be created where necessary to catch precipitation and ground water which will then be pumped or trenched to the Sedimentation Pond #1 in Area 2. Associated pumps and piping shall be relocated where necessary

4. Extraction in Area 1B continues south easterly.

AREA 2

1. Commence clearing and stripping in the rest of Area 2.

2. Pump clear water from sedimentation pond 1 to the riprap area so it can drain naturally to the karst openings.

AREA 3

1. No action required

Infiltration Pond

1. Subject to the results of the AMP the infiltration pond may be constructed and clear water pumped to it during this phase.

1. Once all operations are completed the quarry shall be allowed to fill with water

Phase 4 (The period when excavation focus is in Area 1B-Year (15 to 18) AREA 1A

1. Perimeter slope and entrance rehabilitation has been completed. The old quarry is filling with water AREA 1B

1. Continue all processing operations in Area 18.

2. Extraction in the southern part of Area 1B shall continue south easterly to a depth of approximately 228m to 230m (the bottom of the Amabel Formation). 3. Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped to Sedimentation Pond #1 located in Area 2. The water shall then be pumped to the rip rap in Area 2 and allowed to flow naturally to the observed karst openings. Associated pumps and piping within the licensed area shall be moved/relocated when necessary. AREA 2

1. Complete clearing and stripping operations in Area 2.

2. Extraction shall commence in Area 2 in the direction of the arrows shown (south easterly) to a depth of approximately 229m to 230m (the bottom of the Amabel Formation) 3. Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped or trenched to Sedimentation Pond #1 located in Area 2. Clear water shall then be

pumped to the riprap in Area 2 and allowed to flow naturally to the observed karst openings. AREA 3

1. No action required.

Infiltration Pond

1. Subject to the results of the AMP the infiltration pond may be constructed and clear water pumped to it during this phase.

1. Perimeter rehabilitation has been completed. The old quarry is filling with water.

1. Area 1B will accommodate stockpiles

2. Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped or trenched to Sedimentation Pond #1 located in Area 2. Clear water shall then be pumped to the rip rap in Area 2 and allowed to flow naturally to the observed karst openings. Associated pumps and piping within the licensed area shall be moved/relocated when necessary. AREA 2

1. Extraction and production shall continue in Area 2 in the direction of the arrows shown to a depth of approximately 229m to 230m (the bottom of the Amabel Formation). 2. Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped to Sedimentation Pond #1 in Area 2 and clear water shall be pumped to the rip rap in Area 2 and allowed to flow naturally to the observed karst openings. AREA 3

AREA 1B

1. The excavation of Area 3 may only proceed if it is determined acceptable by the MNR and MOE through the results of the Adaptive Management Plan (AMP). 2. Upon authorization to excavate Area 3 being granted by MNR and MOE, - commence clearing and grubbing the area in preparation for extraction. Extraction from Area 2 can proceed through into Area 3. 3. Construct Sedimentation Pond #2 in the location shown on the plans in the south east corner of Area 3 along Concession 10 and construct the riprap area. 4. Temporary sumps shall be created where necessary to catch precipitation and groundwater which shall then be pumped to Sedimentation Pond #2 in Area 3. The water will make its way into the riprap and be released into the adjacent observed karst openings. Associated pumps and piping shall be moved/relocated when necessary. Infiltration Pond

1. Depending on the results of the AMP the infiltration pond may be constructed and clear water pumped to it during this phase.

Phase 6 (The period when excavation focus is in Area 3-Year (27 to 29)

AREA 1A

AREA 2

1. Perimeter rehabilitation has been completed. The old quarry is filling with water.

AREA 1B

1. Area 1B may accomodate stockpiles.

2. Temporary sumps shall be created where necessary to catch precipitation and groundwater which shall then be pumped to Sedimentation Pond #2 in Area 3. The water will make its way into the riprap and be released into the adjacent observed karst openings. Associated pumps and piping shall be moved/relocated when necessary.

3. Upon completion of extraction in Area 2 and Area 3, all operational buildings and structures shall be removed from the 242 level in Area 1B and that area shall be excavated to 230m (the bottom of the Amabel Formation) 4. As part of the rehabilitation works the berm along the ANSI boundary shall be removed in sections of 50 metres. The bedrock will be stripped to the extraction limit, drilled and blasted to the 243m level as shown in "Rehabilitation Shoreline Detail to 100m ANSI Setback" on Page 7. The blasted rock is to be cast to the quarry floor and the berm material placed into the excavated notch. The backfill material 6. The remaining perimeter berm on the roadside boundary shall also be excavated and used to finish the rehabilitation along the northern perimeter. The final perimeter rehabilitation shall be completed as

7. Once all final rehabilitation has been completed the quarry shall be allowed to fill with water from groundwater and precipitation.

1. Complete extraction in Area 2.

2. Area 2 may accomodate stockpiles

3. Temporary sumps shall be created where necessary to catch precipitation and groundwater which shall then be pumped to Sedimentation Pond #2 in Area 3. The water will make its way into the riprap and be released into the adjacent observed karst openings. Associated pumps and piping shall be moved/relocated when necessary. AREA 3

1. Move all processing operations into Area 3 when sufficient space becomes available. Processing equipment shall be located on the quarry floor at elevation 230m. 2. Continue excavtion south easterly to 230m (the bottom of the Amabel Formation).

3. Temporary sumps shall be created where necessary to catch precipitation and groundwater which shall then be pumped to Sedimentation Pond #2 in Area 3. The water will make its way into the riprap and be released into the adjacent observed karst openings. Associated pumps and piping shall be moved/relocated when necessary.

4. Relocate the sedimentation pond to the quarry floor and contine extraction to the 230m level. Temporary sumps, previously created to catch precipitation and groundwater, shall pump to the relocated sedimentation pond and then to the old quarry or to the Infiltration pond if it has been created. Associated pumps and piping shall be moved/relocated when necessary. 5. Create a 3:1 slope in the southeast corner as shown on Drawing 6.

Infiltration Pond

1. If, based on the results of the AMP, the infiltration pond has been previously constructed and clear water pumped to it during operations, then once operations are completed and the infiltration pond is no longer needed as per the results of the post-closure monitoring program described in the AMP, the pond shall be regraded to form a shallow depressed area that shall naturally form a small marsh area.

Final

No.

NATURAL ENVIRONMENT RECOMMENDATIONS (BY Aquatic Wildlife Services, Shallow Jake, Ontario)

1 Mitigation Measures

These measures are recommended to maintain the ecological functioning role and natural heritage features that have been identified within this study area and are in keeping with provincial and municipal policies and auidelines.

1.1 The proposed licensed boundary is to maintain a minimum setback distance of 120 m from the Provincially Significant Shouldice Wetland boundary and a minimum setback of 100m from The Glen ANSI boundary.

1.2 The setback lands from the identified significant features are to be considered 'buffer lands' to these features; as such no site development is to occur including noise attenuation berms, aggregate stockpiling or buildings. Buffer lands are to remain in a natural vegetation condition though minor site alterations through reforestation; boundary fencing, and property internal road/trail upkeep is acceptable. The setback/buffer lands compliance monitoring shall be incorporated into the Aggregate Resources Act-Annual Compliance Assessment Reports.

1.3 In conjunction with the approved 'Adaptive Management Plan' if a yellow threshold level mitigative action requires construction of a new seasonal ephemeral pond, said pond shall be constructed with a low permeable bottom/lining, in suitable terrain conditions prior and location approved by reviewing agencies. Said ephemeral pond design & construction shall reflect the following design guidelines:

- Continuous forest cover around the pond perimeter to be maintained with direct linkage to the forested ANSI lands. No fencing or berm placement around the pond perimeter.

- Pond to maintain a minimum of 10:1 slope, with 20cm of native topsoil deposited over the pond bottom for the establishment of natural hydrophilic plants. Pond to be constructed with varying widths and depths but should not exceed 10m in width or exceed 0.7m in depth and a minimum length of 50m

- The ephemeral pond construction site should maximize natural terrain snowmelt runoff to the site. Pond design parameters should try to maintain surface waters within the pond between the spring snowmelt periods to late June, during the remaining life of the guarry operations and rehabilitative period.

1.4 The identified 'Significant-Rare' plant mitigation relocation measures within the 2012 extraction lands, shall be undertaken prior to extraction phase 1B start up and carried out by or under the direct supervision of a gualified person. Annual monitoring shall be undertaken by a qualified person during the flora growing season of relocated flora for survival rates, for 3 years post planting year relocation efforts.

1.5 Any and all equipment storage, stock piled material, out buildings etc. in relation to this aggregate extraction proposal shall be contained within the 'limit of extraction' area.

1.6 No vegetation clearing or overburden stripping should occur during the months of April, May or June in any given year, for the maintenance and protection of forest nesting birds, in accordance to the Migratory Birds Convention Act. The site clearing compliance monitoring aspects shall be incorporated into the Aggregate Resources Act-Annual Compliance Assessment Reports.

1.7 Required advanced tree and vegetation removal should be undertaken only 1-2 years prior to required extraction for that 'phase area' during the previous year's summer, fall or winter seasons. Land clearing should not occur beyond what can be utilized within the quarry for a 2-year period, other than those lands identified as being used for the settling/infiltration ponds.

1.8 The final rehabilitation plan is to include a 'Naturalized Shoreline' fronting the ANSI boundary incorporating the following design recommendations, but not limited to:

- Shoreline to be stabilized to a 3:1 slope out to a minimum water depth point of 1.0 m

- Removal of berm and any fence fronting the ANSI boundary with material utilized to slope shoreline and provide suitable growing substrate (above and below water).

- Reforestation phase shown on operational plan, with native tree/shrub species, sizes and density planting guideline.

- Final 'water's edge' of quarry environment fronting the ANSI boundary to be restored to a natural environment, with an irregular shoreline providing habitat cover creation (rock piles, logs, stumps, boulders), varying water depths through deposition of topsoil (berm material from overburden clearing) out to the quarry vertical face (approx. 1.5 m water depth zone).

1.9 A 'Stewardship Management Plan' focused on wildlife habitat and woodland ecology shall be completed for Lot 25, 26 and 27, Concession 10, geographic Township of Keppel, for the lands HSC Aggregates Ltd. owned lands which occur beyond the quarry extraction boundary. This Stewardship Plan shall follow the format of the Ontario 'Guide to Stewardship Planning for Natural Areas' and shall be submitted for review to the Ontario Ministry of Natural Resources, Niagara Escarpment Commission, SON, the Grey Sauble Conservation Authority and the Stakeholders Liaison Committee, prior to Extraction Phase 1B start up.

1.10 10. Reforestation mitigation zones that occur outside the licensed boundary area have been shown on the "REFORESTATION AREAS" figure on the Operational Plan, drawing 4. Said reforestation measures shall follow provincial standards outlined on the public document OMNRF Extension Notes AGCEX 322-Tree Planting' for planting plan, tree densities and native species to Grey County, with draft planting plan submission to SON for review and commenting with reforestation to be completed prior to extraction phase 1B start up. Annual reforestation monitoring shall be undertaken by a qualified person for 3 years post planting, during the flora growing season, with survival target rates of 80% and restoration plans if deemed necessary. Said monitoring activities shall be reported to provincial agencies, SON, Grey Sauble Conservation Authority and the Stakeholders Liaison Committee by calendar years end for that reporting year.

1.11 The Natural Environment Ecological Monitoring Plan requirements have been incorporated into the Keppel Quarry Adaptive Management Plan which shall be considered a mitigative measure for both short-term and long-term environmental monitoring activity with adaptive management strategies, threshold levels, remedial action works and contingency plans if deemed necessary. Said monitoring activities shall be reported to all reviewing agencies in a timely manner as per the 'AMP' monitoring program outline.

1.12. Terrestrial Invasive Plant Species Monitoring will be undertaken once a year between June 15th to September 15th within the Licence area (non-operating lands in that year), and Natural Environment Buffer Zones, plus an additional 30 meters in adjacent lands owned by HSC Aggregates Ltd. Said monitoring shall be conducted by a qualified person as 'general visual observations' of terrestrial invasive species, numbers, location and mapping with annual recommendations and reporting by calendar years end for that reporting year to the Stakeholder Liaison Committee, during the Quarry active operational period.

NETR NOTES:

1) The 2007 Natural Environment Technical Reporting figures are based upon the draft extraction lands at that time, which have be significantly reduced to-date through the agency review/commenting process. The current licence lands and extraction area is still within the original 2007 Natural Environment Technical Reporting 'study lands' and as such environmental data analysis, impact asses and conclusions are valid and consistent with the current licence/extraction lands and operational design.

2) The 2007 Natural Environment Technical Reporting for 'Mitigation Measures' and 'Ecological Monitoring Program' have been modified revised above, to address the current 2012 licence boundary, extraction lands, Adaptive Management Plan and supplementary technical reporting on hydrology and hydrogeological assessment.

3) The 2007 Natural Environment Technical Reporting for the 'Recommendations' section associated with Mr. Sutherlands land holding 30, Concession 10 of the former Keppel Township are no longer deemed applicable to this current and significantly reduced extraction area.



NOISE CONTROL RECOMMENDATIONS (By Aercoustics Engineering Ltd.)

1) The Area 2 and Area 3 extraction shall have the working face moving towards the R1 receptor.

2) In Area 2 and Area 3, the secondary processing plant crushers and screens shall be positioned at a maximum distance of 60m from the auarry face in the direction towards the R1 receptor.

1.1 GENERAL CONTROLS

1.1.1 Equipment used in site preparation and other construction activities shall satisfy the noise emission levels of MOE NPC-115 "Noise due to Construction Equipment"

1.1.2 Quarry equipment shall satisfy the reference power levels listed in Table 1.

1.1.3 The drilling, extraction and processing (crushing, washing and/or screening) operations shall be limited to the daytime hours of 07:00 - 18:00.

Table 1: Reference Sound Power Levels of Quarry Equipment

Equipment	Reference Sound Power Level (dB(A))						
Rock Drill	111						
Primary Crusher	121						
Secondary Processing Plant	129						
Extraction Loader or Shovel	114						
Pit Trucks (40 passes/hr, 100m section. 25km/hr)	104						
Loader for shipment, loading trucks	109						

1.2 AREA 1A (see Figure 1) - The following noise controls in addition to the general controls are recommended.

1.2.1 Extraction should proceed in a northwesterly direction. See Figure 1 below.

1.3 AREA 1B - (See Figure 2) The following noise controls in addition to the general controls are recommended.

1.3.1 Extraction shall proceed in a south or south-easterly direction.

1.3.2 Acoustic barriers (6m high) in the form of an earth berm, acoustic fence, or combination of these shall be constructed on the north and east perimeter of the guarry area as shown in Figure 2. This 6m perimeter acoustic barrier shall remain for the life of the guarry.

1.3.3 The primary plant shall travel with the working face positioned such that the working face provides shielding towards receptor R1.

1.3.4 When operating in Area 1B the secondary processing plant shall be located on the quarry floor at EL242m or less and shielded from the R1 and R2 receptors by an acoustic barrier. The barrier shall have minimum height of 8m and be positioned at a maximum distance of 50m from the processing plant crushers and screens. The acoustic barrier must be solid without gaps or openings and satisfy an area density of 20 kg/m2.

1.4 AREA 2 and AREA 3 (See Figure 3) - The following noise controls in addition to the general controls are recommended.

1.4.1 Extraction shall proceed in a southeasterly direction with the working face moving towards the R1 receptor. **1.4.2** The primary plant shall travel with the working face positioned such that the working face provides shielding towards receptor R1.

1.4.3 The secondary processing plant shall be positioned on the quarry floor +/-EL230m and be shielded from the R2 receptor with an acoustic barrier. The barrier shall have a minimum height of 8m and be positioned at a maximum distance of 50m from the processing plant crushers and screens. The acoustic barrier must be solid without gaps or openings and satisfy an area density of 20 kg/m2. An acoustic barrier can take the form of a stockpile, an un-extracted rock face, stacked ISO containers. or anything else satisfying the requirements of an acoustic barrier.

1.4.4 In Area 2 and Area 3, the secondary processing plant crushers and screens shall be positioned at a maximum distance of 60m from the guarry face in the direction towards the R1 receptor.

1.4.5 When operating in Areas 2 or 3, the secondary processing plant shall be positioned on the guarry floor +/-EL230m and be shielded from the R2 receptor with an acoustic barrier. The barrier shall have a minimum height of 8m and be positioned at a maximum distance of 50m from the processing plant crushers and screens. The acoustic barrier must be solid without gaps or openings and satisfy an area density of 20 kg/m2. An acoustic barrier can take the form of a stockpile, an un-extracted rock face, stacked ISO containers, or anything else satisfying the requirements of an acoustic barrier.

	o) The result and calculated value of Peak Sound Pressure Level in dB (L) and Peak Particle Velocity in mm/s.
FIGURE 1: RECOMMENDED NOISE CONTROLS-AREA 1A	p) Applicable limits.
contained	q) The excess, if any, over the prescribed limits.
ed and ANSI AREA 1A SECONDARY PROCESSING PLANT LOCATED IN EXISTING QUARRY	The blast parameters described within this report will provide a good basis for the initial blasting operations at this quarry. However, it may be necessary to refine these parameters once site—specific vibration and overpressure data from the blasting operations become available.
R2	Blasting procedures such as drilling and loading should be monitored or audited on an occasional basis by an independent blasting consultant to ensure full compliance with governing guidelines and regulations.
n land	HYDROGEOLOGICAL RECOMMENDATIONS (by MTE Consultants Inc., Kitchener, Ontario)
SECONDARY PROCESSING PLANT FOR AREA 1B - FIRST PART OF EXTRACTION, TO OPERATE IN AREA 1A	The hydrogeological recommendations have been included within the Adaptive Management Plan on Drawing 5, "Adaptive Management Plan".
	HAROLD SUTHERLAND CONSTRUCTION LTD. R.R. #2, KEMBLE, ONTARIO, NOH1SO NEW KEPPEL QUARRY
AREA 18 SECONDARY PROCESSING PLANT BOTTOM EL=2422m (OR LESS) SHOLL BARDIEDS	TOWNSHIP OF GEORGIAN BLUFFS (formerly Keppel Twp) COUNTY OF GREY
MAX DIST FROM PLANT TO BARRIER=50m	DRAWING 4 of 9
MAX DIST FROM PLANT TO BARRIER-50m MAX DIST FROM PLANT TO BARRIER-50m AREA 3 MAXBLAST WEDRIT PER DELAY WEDRIT PER DELAY WEDRIT PER DELAY WEDRIT PER DELAY WEDRIT PER DELAY WEDRIT PER DELAY	R1
(PERIMETER BERMING, PLANT LOCATION)	2 & 3
(PERIMETER BERMING, PLANT LOCATION)	No. AMENDMENT DATE

D	ETAILS	OF	RECO	MMENDED	BL	.AS	TING	P	ROCED	URES	(by	DST	Consulting	Engineers	Inc.,	Sudbury,	On)
	Sequent	ial I	blasting	techniques	will	be	used	to	ensure	minimu	m e	xplos	ives per				

delay period initiated. These include: - Non-electric blasting systems such as the EZ-Det / Handi-Det / Snap-Det systems or.

- Electronic initiation system with remote detonation.

- Drilling pattern for initial quarry blasting will be maximum 3.05 m (10') Burden by 3.66 m (12'). The pattern may be adjusted for subsequent blasts in order to achieve the required fragmentation.

- Maximum drill-hole diameter for initial quarry blasting will be 102 mm (4"). Vibration and overpressure data acquired during initial blasting may allow for an increase in drill-hole diameter. The pattern will be adjusted to accommodate for the increase in drill-hole diameter.

- Minimum collar will be 1.2 m (4 ft.) for 102 mm (4") diameter drill-holes.

- Bench height will not exceed 15.24 m (50') for initial auarry blastina.

- Clear crushed stone will be used for stemming.

- Primary and secondary dust collectors will be employed on the rock drills to keep the level of dust to a minimum.

- Blasting should be avoided during heavy overcast and temperature inversions when possible.

- Blast-hole detonation will be limited to a single hole per delay period.

- The amount of explosives per delay period for initial quarry blasting shall not exceed 141.9 kg.

BLAST IMPACT ANALYSIS RECOMMENDATIONS (by DST Consulting Engineers Inc., Sudbury, Ontario)

All blasts should be monitored for both vibration and overpressure (noise) at two of the closest third-party properties adjacent the site (Receptors 1 and 2) with digital seismographs. Compilation of the initial data should be used to establish a site specific vibration and noise attenuation araphs. The values of the Scaled Distance obtained from the graphs will assist in planning subsequent blasting operations. This will also allow blasts to be designed specifically for this location which should ideally induce vibration and noise levels within the MOE Guidelines. All subsequent blasts should also be monitored by the guarry operator at the closest third party building or facility to the blast site. The blasting operations should be audited periodically by an independent blasting consultant.

The seismographs must be self-triggering units and calibrated on an annual basis, or as recommended by the manufacturer. Seismogram copies as well as blast reports for each blast should be filed for future reference.

Detailed blast records should be maintained. The MOE (1985) recommended that the body of blast reports should include the following information:

a) Location, date and time of the blast.

b) Dimensional sketch including photographs, if necessary, of the location of the blasting operation, and the nearest point of reception (vibration receptor).

c) Physical and topographical description of the ground between the source and the receptor location.

d) Type of material being blasted.

e) Sub-soil conditions, if known.

f) Prevailing meteorological conditions including wind speed in m/s, wind direction, air temperature in degrees Celcius, relative humidity, degree of cloud cover and around moisture content.

h) Pattern and pitch of drill holes.

i) Size of holes.

i) Depth of drilling.

a) Number of drill holes.

k) Depth of collar.

1) Depth of toe-load.

m) Weight of charge per delay period

n) Number and time of delays.

<form></form>	ATER RESOURCES MONITORING PROGRAM rpose: To track the performance of the New Keppel Quarry and the potential impacts on water resources	Water Resources/Ecological Green Actions Purpose: Identify changes prior to impacting groundwater and surface water features and	PRIVATE WELL MONITORING PROGRAM	TREE PRESERVATION PLAN (TPP)					
<form></form>	ablish a weather station so that site-specific climate data can be obtained ain a person qualified to:	implement investigative actions In the event there is a green trigger exceedence in the Water Resources and/or the Ecological	Private Well Trigger Values Monitoring Station Green Green Vellow Vellow Rod	Purpose: To preserve trees in the TPP Corridor so that sufficient visual screening and buffering is achieved along CR 17 and Con Rd 10.					
<form></form>	- Conduct monthly measurements of water levels at the observation wells, minipiezometers, and test pits listed below, and the private wells listed in the Private Wells Monitoring Program;	Monitoring Program: a) Report the exceedence to the quarry owner/operator within 24 hrs;	Well No. 3345 None 227.5 mAMSL Complaint Received Well No. 3447 None TBD Complaint Received	The health of the TPP Corridor will be monitored on an annual basis by a qualified					
<form></form>	- Conduct monthly measurements of flows at springs, the Beaver Dam sinkhole, culverts, mud creek channel A, the Ephemeral Pond and the dugout pond listed below; - Conduct monthly measurements of specific conductivity and temperature at springs listed below, the Beaver Dam sinkhole, culverts listed below, Mud Creek (Channel A) and the	 b) Report the exceedence to the Ecologist/Biologist within 24 hrs; c) Report the exceedence to the Hydrogeologist within 24 hrs and increase monitoring frequency to 	Well No. 5197 None TBD Complaint Received New Cramp Well None TBD Complaint Received	Trees in the TPP Corridor for the following:					
<text><text></text></text>	Dugout Pond; - Install and maintain data loggers in 'Sentry Wells' listed below and download the data loggers monthly;	weekly at: - Observation wells along Lines 1 and 2, at Spring s1, s2, s3, and at the Beaver Dam Sinkhole	Category B Wells None TBD Complaint Received TBD = To Be Determined <	 b) Tree species and Diameter at Breast Height (DBH); c) Number of stems and total tree height; 					
<form></form>	 Install and maintain data loggers in miniplezometers to be installed in spring s8, spring s13, and the dugout pond and download the data loggers monthly; Download precipitation data and pumping records monthly or as needed; 	IF a green trigger value is exceeded at OW33s, OW33d, or OW51 - confirm that water is entering Beaver Dam sinkhole and that spring s3 is flowing	* = Seasonal values and subsequent trigger values shall be based on at least three years of monitoring data collected while extracting in Area 1B	d) Crown class; e) Percentage live crown;					
	 Complete monitoring data and compare it to precipitation data and pumping records monthly; Inspect for water bearing fractures along active quarry faces immediately after a blast; Check infiltration pand (if installed) leasted page of 2 foregroups from the page of 2 foregroups and 2 foregr	- confirm that groundwater seepage along the north quarry face has not increased - Observation wells along Lines 3, 4, 5, at Spring s8, at Test Pits TP15, TP16, TP17, TP18, and at Minipiagematers MD55, MD56, and MD57, J5 a group to the second second second second second second second	Private Well Yellow Actions Purpose: To implement mitigation measures that will prevent impacts to private water supply wells thus preventing the need for Red	 f) Evidence of twig dieback, branch dieback, defoliation, and discoloration; g) Evidence of wounds, signs/symptoms of insect infestation, and any other health 					
<text></text>	- Check infinitration pond (if installed) located near \$13 for proper function on a weekly basis. in an independent Hydrogeologist to: - Assess and interpret water levels and flows measured against historical patterns, seasonal lows, trigger values, pumping records and precipitation records on a monthly basis.	OW67s, OW67d, OW12s, OW12d, OW8s, OW8d	Actions. If impacts to private wells are not related to quarry activities then Yellow Actions may not be required. If a yellow trigger value is exceeded for any of the Category A or Category B private wells, then the following mitigation measures will be initiated:	stressors; and h) Overall growing conditions and general tree health.					
Name Nam Name Name Name	- Compare monitoring data against trigger values on a monthly basis and make recommendations for monitoring program alterations if required; - Man cone of influence on a monthly basis and assess its size and shape;	 Observation wells along Lines 6, 7, 8, Spring s13, the Dugout Pond (water levels and flow) <u>IF</u> a green trigger value is exceeded at OW9s, OW9d, OW71k, OW71s, OW71d, OW47s, OW47d, OW45 	a) Report the exceedence to the quarry owner/operator within 24 hrs;	 h) Overall growing conditions and general tree health. Monitoring shall be completed during the growing season (June 1 to September 15) of every year. 					
	- Provide an annual monitoring report and make recommendations for future monitoring.	d) Consult with a Hydrogeologist to review the extra data collected and make recommendations for changes to the monitoring program as required. Changes may include but not limited to:	b) The quarry operator shall report to the local MOE District Office within 72 hours the exceeded trigger values and Mitigative Actions that will be implemented;	Pre-quarry (baseline conditions) of the TPP Corridor shall be established: - Baseline monitoring data in Zone 1 of the TPP Corridor data shall be collected prior to					
No. 0 <	vation Wells Line 1: OW36 OW37 OW49 OW50 OW51 OW52	- Increased frequency of monitoring	 c) Inform the resident and enquire about well yield; d) If well yield is affected, then the quarry operator shall retain an MOE licensed plumber to inspect the well and mechanical components thereof and confirm if mechanical issues (i.e. the pump and/or plumbing system) are the same and to validate the decreases in well yield. 	any site alterations commencing in Area 1A. - Baseline monitoring data in Zone 2 and Zone 3 of the TPP Corridor shall be collected					
	Line 2: OW14s OW14d OW28s OW28d OW32s OW32d 3345 OW33s OW33d Line 3: OW34 OW35 OW36 OW14s OW14d OW41s OW41d OW67s OW67d OW68s OW68d OW58k OW58s OW58d	 Mapping the cone of influence using the most recent round of water levels; Installing new observation wells, if required to more accurately define the cone of influence. 	a) If the cause is not mechanically related, then:	Tree Replacement Protocol					
	Line 4: OW39 OW65s OW65d OW66s OW66d OW12s OW12d OW25s OW25d OW59s OW59d Line 5: OW39 OW40 OW42s OW42d OW63s OW63d OW64s OW64d OW8s OW8d OW69s OW69d OW24	of the quarry with respect to a certain receptor; - Retaining an Hydrogeologist to complete an analysis/evaluation of the data collected	- The quarry operator will provide a temporary supply of water within 24 hours (if required); - The quarry operator will make arrangements to provide a suitable alternative water supply:	if monitoring in the TPP Corridor identifies a Preservation Trees in "Fair-Health", then implement an action plan within one year to: a) Encourage the growth of a Beplacement Tree(c) by promoting the growth of					
	Line 6: OW39 OW40 OW61s OW61d OW62k OW62s OW62d OW9s OW9d OW70s OW70d OW27s OW27d Line 7: OW39 OW7s OW7d OW43s OW43d OW11s OW11d OW46s OW46d OW47s OW47d OW48s OW48d	Water Resources/Ecological Yellow Actions	- Provisions for the affected resident could include all or part of the costs associated with water delivered to fill a temporary water system and associated costs, lowering the pump, drilling a new well, well-deepening, abandonment of the old well.	surrounding immature tree(s) and/or promoting the expansion of the crown of adjacent trees; or					
	Line 8: OW30s OW30d OW39 OW10s OW10d OW44s OW44d OW45 Line 9: OW40 OW7s OW7d OW29s OW29d	Purpose: Implement mitigation measures that will prevent impacts to groundwater, the Shouldice Wetland, or the springs s1-s3 in the Glen Management Area thus preventing the need for Red	Private Well Red Actions Purpose: To implement mitigation measures that will minimize the impact to private water supply wells due to the guarry. If changes to	b) If there is no suitable Replacement Tree(s) is within 6 m, then plant two native stock samplings (one Deciduous [not Ash] and one Coniferous tree) that are at least 1.5 m in					
	Zone 1: OW3 OW4 OW7s OW7d OW10s OW10d OW11s OW11d OW14s OW14d OW29s OW29d OW30s OW30d OW34 OW35 OW36 OW37 OW38 OW39 OW40 OW42s OW42d OW43s OW43d OW61s OW61d OW63s OW63d OW65s OW65d Zone 2: OW15s OW15d OW31s OW31s OW32s OW32d OW41d OW44d	Actions. If changes to natural features are related to climatological influences or non-quarry related activities then Yellow Actions may not be required.	private wells are not related to quarry activities then Red Actions may not be required.	height; one on each side and in close proximity to the identified Fair-Health tree(s).					
	Zone 2: OW for OW 203 OW 204 OW 314 OW 325 OW 326 OW 446 OW 446 <th< td=""><td>A "Yellow Action" precautionary mitigation response is triggered if: 1. A yellow trigger value has been exceeded in the Water Resources Monitoring Program that can be attributed to the guarry operations; and/or</td><td>Well Interference Complaint Response Procedure Upon receipt of a well interference complaint the receiver shall immediately notify the owner/operator by calling Harold Sutherland (Owner/Operator), at the following number(a):</td><td>If monitoring in the TPP Corridor identifies a Preservation Tree(s) in "Poor-Health", then a) Determine the effectiveness of any previous efforts implemented to encourage the</td></th<>	A "Yellow Action" precautionary mitigation response is triggered if: 1. A yellow trigger value has been exceeded in the Water Resources Monitoring Program that can be attributed to the guarry operations; and/or	Well Interference Complaint Response Procedure Upon receipt of a well interference complaint the receiver shall immediately notify the owner/operator by calling Harold Sutherland (Owner/Operator), at the following number(a):	If monitoring in the TPP Corridor identifies a Preservation Tree(s) in "Poor-Health", then a) Determine the effectiveness of any previous efforts implemented to encourage the					
	OW45 OW47s OW47d OW48 OW51 OW52 OW53 OW58k OW58s OW58d OW59s OW59d OW60s OW60d OW67s OW67d OW68s OW68d OW69s OW69d OW70s OW70d OW71k OW71s OW71d	 Early indicators of ecological impacts are observed that can be attributed to the quarry operations. In the event of a yellow trigger exceedence in the Water Resources and/or the Ecological Monitoring 	Working Hours Contact After Hours Contact: Phone: 519-376-5698 Mobile: 226-668-4495	growth of Replacement Trees (natural or planted); and b) If Replacement Tree efforts are deemed ineffective, then plant two additional native					
	Sentry Wells OW8s OW8d OW9s OW9d OW12s OW12d OW13s OW13d OW33s OW33d OW45s OW47d OW51 OW67s OW67d OW71k OW71s OW71d OW71d OW51 OW67s OW67d OW67s OW67d OW67d OW	a) Report the exceedence to the quarry owner/operator within 24 hrs;	Fax: 519-371-6121 Mobile: 226-668-4495	stock saplings (not Asn), that are at least 1.5 m in height, in close proximity to the identified "Poor-Health" tree(s).					
	Image: score and score	b) Report the exceedence to the Ecologist/Biologist within 24 hrs;c) Report the exceedence to the Hydrogeologist within 24 hrs; and	Email: jennifer@hsc-ltd.com	 a) Remove the dying/dead tree(s) without harming adjacent Replacement Trees(s), otherwise leave the dying/dead tree standing and remove the upper branches and tree 					
	s s1 s2 s3 s8 s13 Dam Sinkhole flow into sinkhole	 d) Report the exceedence to MNR, MOE, NEC, and SON within 72 hours and Yellow Actions that will be implemented. 	A well interference complaint from a private well owner will constitute a red trigger breech, and the response procedure will be initiated: 1) Report to MOE within 24 hours the Mitigative Actions to be implemented;	top for safety reasons; b) Look for a Replacement Tree(s) (planted or natural) that is at least 15 cm DBH and					
	eek Channel A eral Pond water levels	1) Initiation of an internal interdisciplinary review of all monitoring programs and the data available (i.e.	 The quarry operator will call a MOE licensed plumber immediately upon receipt of the complaint to inspect the well and mechanical systems to confirm that the problem is not mechanical (i.e. pump malfunction) and to validate the complaint; 	number them as the new Replacement Tree; c) If a Replacement Tree(s) cannot be found, then plant enough saplings in proximity to					
	Pond water levels outflows	 2) Reviewing the Operational Plan for possible alterations, which may include but may not be limited to: 	 If the complaint is determined not to be mechanically related (i.e. plumbing), the quarry operator will provide a temporary water supply within 24 hours for the affected resident and make arrangements to investigate (Hydrogeologist) the cause of the interference; 	the dying/dead tree to achieve the cumulative caliper (at least 15 DBH) of a Replacement Tree so that the future trees(s) will provide similar buffering and visual screening: and					
	Resources Triggers Trigger Values	- Changing of ceasing quarry operations in a certain direction, and/or, - Changing the quarry floor elevation. 2) Preservice to superstant flows 1 to the service of the flow	4) Where the results of the investigation indicate that the interference is legitimately from dewatering the New Keppel Quarry, the quarry operator will make arrangements to provide compensation. Compensation must be acceptable to the home owner and the quarry operator, and could include all or part of the costs associated with drilling of a new well, well deepening, abandonment of the old well.	screening; and d) Include the Replacement Trees(s) in future monitoring.					
	summer autumn green green green green green green green green jellow yellow yellow red red red red red red red itoring Station spring low low low winter low (spring) (summer) (autumn) (winter) (spring) (summer) (autumn) (winter) (spring) (summer) (autumn) (winter)	a) Preparing to augment flows' to the springs in the Shouldice Wetland or Glen Management Area; - flow augmentation shall be done in consultation with the Hydrogeologist to ensure adequate protection;	5) Where the results of the investigation do not indicate interference from dewatering of the New Keppel Quarry, the quarry operator will provide a letter report summarizing the results of the investigation to the property owner. In this case, the quarry operator shall maintain the temperature water						
	March 21 - June 21 - Sept 21 - Dec 21 - March 21 - June 21 - Sept 21 - Dec 21 - March 21 - June 21 - Sept 21 - Dec 21 - March 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 - Sept 21 - Dec 21 - June 21 -	4) Grouting fractures exposed by the quarry along active quarry faces immediately after a blast (as	supply (provided under item 3) for at least an additional 24 hours to allow the resident to make alternate water supply arrangements; 6) The guarry operator shall document the interference complaint and its resolution and keep the results on file in the event that they be requested						
	Observation Wells OW8s 243.77 243.23 243.07 243.89 243.92 243.22 244.04 243.77 243.23 243.07 243.89 243.62 243.08 242.92 243.74	 5) Continuing to monitor weekly until the system recovers as determined by a Hydrogeologist; 6) If Yellow Actions prove to be working whereby water levels in affected area have recovered² and there is 	by a Ministry Inspector.						
	OW8d 243.19 242.45 242.31 243.46 243.34 242.60 242.46 243.61 243.19 242.45 242.31 243.46 242.30 242.16 243.31 OW9s 242.83 242.20 242.25 242.93 242.93 242.45 242.31 243.46 243.04 242.30 242.16 243.31	no observed impact to the Shouldice Wetland springs and/or the springs in the Glen Management Area then:	Purpose: To ensure that the blasting operations are carried out in a safe and productive manner and to ensure that no possibility of damage exists to any buildings, structures or residences surrounding the New Keppel Quarry. The Blasting Monitoring Program is						
A A A A A A A A A A A A A A A A A	OW9d 243.01 241.99 242.23 243.23 243.16 242.14 242.38 243.38 243.01 241.99 242.23 243.23 242.86 241.84 242.08 243.08 OW12s 243.65 243.36 243.30 243.72 243.80 243.51 243.45 243.87 243.65 243.30 243.72 243.15 243.57	 Quarry activities in the direction of the affected area can resume; Extraction in the direction of s8 and/or s13 can continue only when their flows are observed to 	described in detailed in the AMP report Blasts should be designed so that the seismic activity (vibrations) and noise induced by the blasting operations will remain well within the MOE						
Image: Normality in the state of the s	OW 12d 243.47 242.89 242.76 243.68 243.62 243.04 242.91 243.83 243.47 242.89 242.76 243.68 242.74 242.61 243.53 OW 13s 244.58 243.67 243.40 244.80 244.73 243.82 243.55 244.95 244.58 243.67 243.40 244.43 243.52 243.25 244.65 OW 13d 244.00 244.40 244.73 243.82 243.55 244.95 244.58 243.60 244.43 243.52 243.25 244.65	occur naturally as determined by the Hydrogeologist and the Biologist/Ecologist. 7) Summarize the results of any Yellow Actions in a report to the MNR, MOE, NEC and SON and make	guidelines. HSCL staff will be trained by a Blasting Consultant to properly install, monitor, record and report the blast induced vibrations and overpressure. All blasts will be monitored for vibration and overpressure at the Ritchie Property (R1) and Cramp Property (R2) with digital						
	OW 13d 241.99 241.42 241.32 242.48 242.14 241.57 241.47 242.63 241.99 241.42 241.32 242.48 241.84 241.27 241.17 242.33 OW 33s 243.47 243.09 243.62 243.62 243.25 243.24 243.77 243.47 243.09 243.62 243.32 242.95 242.94 243.47 OW 33s 243.47 243.09 243.62 243.62 243.25 243.24 243.77 243.47 243.09 243.62 243.32 242.95 242.94 243.47 OW 33d 239.25 239.55 239.50 239.55 <t< td=""><td>NOTES:</td><td>Green Blast Trigger</td></t<>	NOTES:	Green Blast Trigger						
	OW 45 243.93 243.22 243.83 244.13 244.08 243.37 243.98 244.28 243.93 243.22 243.83 244.13 243.68 243.93 243.22 243.83 244.13 243.68 243.93 243.22 243.83 244.13 243.68 243.98 243.24 243.93 243.24 243.83 244.13 243.78 243.07 243.68 243.98 OW 47s 243.45 243.00 243.14 243.47 243.60 243.15 243.29 243.62 243.45 243.00 243.14 243.29 243.29 243.45 243.00 243.14 243.29 243.29 243.45 243.00 243.14 243.29 243.29 243.45 243.00 243.14 243.29 243.29 243.45 243.00 243.14 243.29 243.29 243.45 243.00 243.14 243.29 243.29 243.45 243.00 243.14 243.29 243.29 243.45 243.00 243.14 243.29 243.29 243.45 243.00 243.14 243.29 243.29 243.45 243.00 243.14	Augmentation of flows to springs may be in the form of a pipe that directs water or an infiltration pond that allows water to recharge the groundwater system.	Seismograph readings are within the MOE guidelines for vibration and overpressure, there is no flyrock generated beyond the blast area, there are no complaints from the public, and there is no negative report in the water tested from the quarry.						
	OW47d 243.36 242.71 243.27 243.42 243.51 242.86 243.42 243.57 243.36 242.71 243.42 243.26 243.27 OW51 239.75 239.00 238.97 240.08 239.15 239.12 240.23 239.75 239.00 238.85 238.85 238.82 239.93	Recovered water levels means that water levels in the affected observation well(s) has returned above green trigger values for at least three monitoring events spaced one week apart.	Remedial Action - No remedial action is necessary.						
	OW53 241.65 242.39 243.45 244.38 241.80 242.54 243.60 244.53 241.65 242.39 243.45 244.38 241.24 243.30 244.23 OW67s* TBD TB	Water Resources/Ecological Red Actions	Seismograph readings exceeded the MOE guidelines for vibration and/or overpressure, there is no flyrock generated beyond the blast area, there are no reported damage complaints, there may be complaints from noise or vibration, and slight elevated nitrates and/or other chemicals associated						
 with <u>t</u> <u>t</u> <u>t</u> <u>t</u> <u>t</u> <u>t</u> <u>t</u> <u>t</u> <u>t</u> <u>t</u>	OW67d* TBD	the quarry. If changes to natural features are related to climatological influences or non-quarry related activities then Bed Actions may not be required	with explosives in the discharge water tested from the quarry as part of the ECA requirements.						
	OW71d* TBD	A "Red Action" immediate response is triggered if: 1) A red trigger value has been exceeded in the Water Besources Monitoring Program that can be	Remedial Action – Review the environmental conditions and blast design parameters. Make reasonable adjustments for subsequent blasts. Report the findings and remedial measures to be taken for subsequent blasts to complainants and affected residents.						
	IS IN INC. INC. INC. INC. INC. INC. INC. I	attributed to the quarry operations; 2) Evidence of negative ecological impacts are observed that can be attributed to the quarry operations;	Red Blast Trigger Seismograph readings exceeded the MOE guidelines for vibration and/or overpressure and/or there is flyrock generated beyond the blast area, there						
	s13 Water Levels 242.86 242.33 242.35 242.93 243.01 NA 242.50 243.08 242.86 NA 242.35 242.93 242.71 NA 242.20 242.78	and/or 3) The mitigative measures initiated during the Yellow Action failed to correct or reverse the impact. In the event of a red trigger exceedence in the Water Besources and/or the Ecological Monitoring	associated with explosives used for blasting in the discharge water tested from the quarry as part of the ECA requirements.						
	SG1 243.09 243.01 243.07 243.06 243.24 243.16 243.22 243.21 243.09 243.01 243.07 243.06 242.94 242.86 242.92 242.91 eral Pond	Program:	Remedial Action – Stop any further blasting until a full investigation has taken place into the reasons for the unexpected results. Make appropriate changes and report these changes before commencement of the blasting operation.						
	Staff Gauge TBD TBD <t< td=""><td> b) Report the exceedence to the Ecologist/Biologist within 24 hrs; c) Report the exceedence to the Hydrogeologist within 24 hrs; </td><td>REPORTING REQUIREMENTS</td><td></td></t<>	 b) Report the exceedence to the Ecologist/Biologist within 24 hrs; c) Report the exceedence to the Hydrogeologist within 24 hrs; 	REPORTING REQUIREMENTS						
The shore plane base is plane base in pla	sonal values and subsequent trigger values shall be based on at least three years of monitoring data collected while extracting in Area 1B	 d) Report the exceedence to MNR, MOE, NEC, and SON within 24 hours the exceeded trigger values and Red Actions that will be implemented. 	Annual reports detailing the results of the monitoring program will be provided to the MNR, MOE, NEC, and SON by a Qualified Person (QP). Annual reporting will involve data compilation, presentation and evaluation of the						
And the set of the	e: To evaluate the ecological health of selected natural features throughout the life cycle of the quarry and ensure that their ecological function is maintained.	Red Actions may include but may not be limited to:	First Annual Report performance monitoring data, including the trend analysis. The reports will determine if the AMP is effectively monitoring the site conditions. The first annual report will be completed at the initiation of operations to						
	ad to the hydrogeologic regime. Therefore, the Water Resources Monitoring Program will be a critical early warning system for detecting potential impacts to ecological health. The Ecological Monitoring Program will be a critical early warning system for detecting potential impacts to ecological health. The Ecological Monitoring Program will be a critical early warning system for detecting potential impacts to ecological health. The Ecological Monitoring Program will be a critical early warning system for detecting potential impacts to ecological health. The Ecological Monitoring Program will be a critical early warning system for detecting potential impacts to ecological health. The Ecological Monitoring Program will be as the system for detecting potential impacts to ecological health.	 2) Stopping quarry activities until signoff is obtained by the MNR indicating the quarry may restart; 2) Augmenting¹ flows to the hedroek system in the same of the sheepend line. 	summarize the baseline data (Water Resources and Ecological) collected pre-quarry. All subsequent annual reports, written by a QP, will include a discussion on:						
difference difference <td>e of the Ecological Monitoring Program and reported on in the first annual report. Year one reporting shall be considered "normal" for flora community diversity and be used to establish trigger threshold or comparison to future monitoring results. Baseline data collection shall be undertaken during late spring which is considered by SON as the "high" water level season.</td> <td> 4) Monitoring to determine the effectiveness of flow augmentation; 5) If it is deemed that flow augmentation is effective² then guarry activities may require in a direction that </td> <td>Subsequent Annual Reports - The results of The Ecological Monitoring Program - The results of The Ecological Monitoring Program</td> <td></td>	e of the Ecological Monitoring Program and reported on in the first annual report. Year one reporting shall be considered "normal" for flora community diversity and be used to establish trigger threshold or comparison to future monitoring results. Baseline data collection shall be undertaken during late spring which is considered by SON as the "high" water level season.	 4) Monitoring to determine the effectiveness of flow augmentation; 5) If it is deemed that flow augmentation is effective² then guarry activities may require in a direction that 	Subsequent Annual Reports - The results of The Ecological Monitoring Program - The results of The Ecological Monitoring Program						
ent worden werden voor in de binder voor gewachen voor in de binder voor gewachen voor gewachen voor in de binder voor gewachen	ical Monitoring Areas (EMA)	 will not exacerbate the impact, provided that a sign-off acceptance from the MNR has been obtained; fit is deemed by the Hydrogeologist, the Biologist/Ecologist, the owner/operator and the MNR that the 	- The results of The Blasting Monitoring Program						
LWA-2W workshow destrong findary: 7) Runname to the value of all value of	restrial ecological features (EMA-1 and EMA-2) and wetland ecological features (EMA-2 through EMA-6). EMA-1: Woodland Tree Health, Woodland Regeneration and Woodland Flora Species Diversity;	quarry cannot operate without negatively impacting water levels in the Shouldice Wetland and/or the springs in the Glen Management Area then the need to close the quarry should be assessed; and	Interim Reports Interim reports, written by a QP, will be submitted to MNR and NEC if trigger values are triggered as listed under the "Green", "Yellow" and "Red" actions in the AMP						
Every fit the schedule during that will also the strengt status will be used at the schedule during status at the schedule schedu	EMA-2: Woodland Breeding Birds; EMA-3: The Glen area s1 to s3 groundwater discharge feature;	Summarize the results of any Red Actions in a report to the MNR, MOE, NEC, and SON along with the recommendations for the operation of the quarry.							
EVA-S: The dde of the binulus webshole documents age to gate a gate de part lead of ear lead	EMA-4: The Shouldice Wetland at the s8 and s9 groundwater discharge feature; EMA-5: The Woodland Ephemeral Pond amphibian breeding surface water feature; and	NOTES: ¹ Augmentation of flows may involve direct discharges to the affected spring(s) or the construction of an							
HAROLD SUTHERLAND CONSTRUCTION R.R. #2, KEMBLE, ONTARIO, NOHISO NEW KEPPEL QUARRY PARTS LOTS 26, 27 & 28, CONCESSION TOWNSHIP OF GEORGIAN BLUFFS (formerly Kepper COUNTY OF GREY	EMA-6: The lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond and the upper headwater channel for the East Branch of Park Head Creek.	infiltration pond that allows water to recharge the groundwater system. ² Groundwater levels in the impacted observation well(s) in Zone 3 have returned above green trigger							
HAROLD SUTHERLAND CONSTRUCTION R.R. #2, KEMBLE, ONTARIO, NOHISO NEW KEPPEL QUARRY PARTS LOTS 26, 27 & 28, CONCESSION TOWNSHIP OF GEORGIAN BLUFFS (formerly Keppe COUNTY OF GREY		values as determined by at least three monitoring events spaced one week apart.							
HAROLD SUTHERLAND CONSTRUCTION R.R. #2, KEMBLE, ONTARIO, NOHISO NEW KEPPEL QUARRY PARTS LOTS 26, 27 & 28, CONCESSION TOWNSHIP OF GEORGIAN BLUFFS (formerly Kepper COUNTY OF GREY									
HAROLD SUTHERLAND CONSTRUCTION R:R: #2, kemble, ontario, nohiso NEW KEPPEL QUARRY PARTS LOTS 26, 27 & 28, concession Township of georgian bluffs (formerly keppe COUNTY OF GREY									
R.R. #2, KEMBLE, ONTARIO, NOH1SO NEW KEPPEL QUARRY PARTS LOTS 26, 27 & 28, CONCESSION TOWNSHIP OF GEORGIAN BLUFFS (formerly Keppe COUNTY OF GREY				HAROLD SUTHERLAND CONSTRUCTION LT					
NEW KEPPEL QUARRY Parts lots 26, 27 & 28, concession township of georgian bluffs (formerly keppe COUNTY OF GREY				R.R. #2, KEMBLE, ONTARIO, NOH1SO					
PARTS LOTS 26, 27 & 28, CONCESSION Township of georgian bluffs (formerly Kepp COUNTY OF GREY				NEW KEPPEL QUARRY					
TOWNSHIP OF GEORGIAN BLUFFS (formerly Kepp COUNTY OF GREY				PARTS LOTS 26, 27 & 28, CONCESSION					
COUNTY OF GREY				TOWNSHIP OF GEORGIAN BLUFFS (formerly Keppel					
				COUNTY OF GREY					

NOTE: The tables above were taken from the Adaptive Management Plan by MTE Consultants Inc., August 14, 2014

AMENDMENT

No.

December 11, 2014

DATE



LEGEND:	
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<del>465</del>	5m CONTOUR
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<b>※</b>	CONIFEROUS TREE
	WET AREA

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тс	OPSOIL AND OVERBURDEN 1:1	1.5:1 6m		POS	SIBLE 5.18m ROAD WIDENIN COUNTY ROAD 17	
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<b>T</b> (	<b>YPICAL BERM DETAIL (ROAL</b> NOT TO SCALE)	0 17 SIDE)				





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emporary Preservation Fencing shall consist of ge barrier safety fencing such as "Tenax 1.2m Orange Barrier Guardian Safety Fence".

HAR PA TOWNS CI

No.

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Scientific Name Pinus strobus Thuja occidentalis Populus tremuloides Populus grandidentata Betula papyrifera Acer saccharum Prunus serotina

Prunus pennsylvanica Prunus virginiana Cornus racemosa Sambucus canadensis

Viburnum lentago

R.R. #2, REMOLE, UNTARIO, NUTISU
NEW KEPPEL QUARRY
ARTS LOTS 26, 27 & 28, CONCESSION 10
SHIP OF GEORGIAN BLUFFS (formerly Keppel Twp) COUNTY OF GREY
ROSS-SECTIONS & DETAILS
DRAWING 7 of 9

AMENDMENT

DATE





December 11, 2014





# TRIGGER LIMITS AND MITIGATION MEASURES

ADAPTIVE MANAGEMENT PLAN - NEW KEPPEL QUARBY	APPENDIX B: TRIGGER LIMITS AND MITIGATION	MEASURES			
WATER RESOURCES MONITORING PROGRAM	Water Resources/Ecological Green Actions	PRIVATE WELL MONITO			
Purpose: To track the performance of the New Keppel Quarry and the potential impacts on water resources	Purpose: Identify changes prior to impacting groundwater and surface water features and	Private Well Locations	Category A Wells: 3345, 3447, 5	197, New Cramp Well	Category B Wells: TBD
1) Establish a weather station so that site-specific climate data can be obtained	implement investigative actions	Private Well Trigger Val	lues		
2) Retain a person qualified to:	In the event there is a green trigger exceedence in the Water Resources and/or the Ecological	Monitoring Station	Green	Yellow	Red
- Conduct monthly measurements of water levels at the observation wells, minipiezometers, and test pits listed below, and the private wells listed in the Private Wells Monitoring	Monitoring Program:	Well No. 3345	None	227.5 mAMSL	Complaint Received
Program;	a) Report the exceedence to the quarry owner/operator within 24 hrs;	Well No. 3447	None	IBD	Complaint Received
- Conduct monthly measurements of flows at springs, the Beaver Dam sinkhole, culverts, mud creek channel A, the Ephemeral Pond and the dugout pond listed below;	<ul> <li>D) Report the exceedence to the Ecologist/Biologist within 24 hrs;</li> <li>c) Beport the exceedence to the Hydrogeologist within 24 hrs and increase monitoring frequency to</li> </ul>	New Cramp Well	None		Complaint Received
- Conduct monthly measurements of specific conductivity and temperature at springs listed below, the Beaver Dam sinkhole, culverts listed below, Mud Creek (Channel A) and Dudout Pond:	weekly at:	Category B Wells	None	ТВД	Complaint Received
- Install and maintain data loggers in 'Sentry Wells' listed below and download the data loggers monthly:	- Observation wells along Lines 1 and 2, at Spring s1, s2, s3, and at the Beaver Dam Sinkhole	TBD = To Be Determined			
- Install and maintain data loggers in minipiezometers to be installed in spring s8, spring s13, and the dugout pond and download the data loggers monthly;	IF a green trigger value is exceeded at OW33s, OW33d, or OW51				
- Download precipitation data and pumping records monthly or as needed;	- confirm that water is entering Beaver Dam sinkhole and that spring s3 is flowing	* = Seasonal values and subs	equent trigger values shall be based or	n at least three years of monitoring da	ata collected while extracting in Area 1B
- Compile monitoring data and compare it to precipitation data and pumping records monthly;	- confirm that groundwater seepage along the north quarry face has not increased	Private Well Yellow Act			
- Inspect for water bearing fractures along active quarry faces immediately after a blast;	- Observation wells along Lines 3, 4, 5, at Spring s8, at Test Pits TP15, TP16, TP17, TP18,	Purpose: To implement mitig	gation measures that will prevent im	pacts to private water supply wells	thus preventing the need for Red
- Check infiltration pond (if installed) located near s13 for proper function on a weekly basis.	and at Miniplezometers MP55, MP56, and MP57, IF a green trigger value is exceeded at OW67s, OW67d, OW12s, OW12d, OW8s, OW8d	Actions. If impacts to privat	te wells are not related to quarry acti	vities then Yellow Actions may not	be required.
3) Retain an independent Hydrogeologist to:	Observation wells along Lines C. 7. 9. Christ at 2, the Durgeut Band (water levels and flow)	If a yellow trigger value is exce	eeded for any of the Category A or Cate	egory B private wells, then the followi	ng mitigation measures will be initiated:
- Assess and interpret water levels and nows measured against historical patterns, seasonal lows, trigger values, pumping records and precipitation records on a monthly basis	IF a green trigger value is exceeded at OW9s, OW9d, OW71k, OW71s, OW71d, OW47s,	a) Papart the evenedan	and to the quarry owner/operator within	24 bro	
- Compare monitoring data against trigger values on a monthly basis and make recommendations for monitoring program alterations in required,	OW47d, OW45	b) The quarry operators	shall report to the local MOF District Of	fice within 72 hours the exceeded tric	neer values and Mitigative Actions that will
- Provide an annual monitoring report and make recommendations for future monitoring	d) Consult with a Hydrogeologist to review the extra data collected and make recommendations for	be implemented;			
Water Resources Monitoring Locations	changes to the monitoring program as required. Changes may include but not limited to:	c) Inform the resident a	nd enquire about well yield;		
Observation Wells	- Increased frequency of monitoring	d) If well yield is affected	d, then the quarry operator shall retain	an MOE licensed plumber to inspect	the well and mechanical components
Line 1: OW36 OW37 OW49 OW50 OW51 OW52	- Further investigation using pumping records and site-specific precipitation records	thereof and confirm if m	nechanical issues (i.e. the pump and/or	plumbing system) are the cause and	to validate the decrease in well yield;
Line 2: OW14s OW14d OW28s OW28d OW32s OW32d 3345 OW33s OW33d	<ul> <li>Mapping the cone of influence using the most recent round of water levels;</li> </ul>				
Line 3: OW34 OW35 OW36 OW14s OW14d OW41s OW41d OW67s OW67d OW68s OW68d OW58k OW58s OW58d	- Installing new observation wells, if required, to more accurately define the cone of influence	e) If the cause is not me	echanically related, then:		
Line 4: OW39 OW65s OW65d OW66s OW66d OW12s OW12d OW25s OW25d OW59s OW59d	of the quarry with respect to a certain receptor;	- The quarry operator w	ill provide a temporary supply of water v	within 24 hours (if required);	
Line 5: OW39 OW40 OW42s OW42d OW63s OW63d OW64s OW64d OW8s OW8d OW69s OW69d OW24	- Retaining an Hydrogeologist to complete an analysis/evaluation of the data collected	- The quarry operator w	cted resident could include all or part of	the costs associated with water deliver	vered to fill a temporary water system and
Line 6: $0W39$ $0W40$ $0W618$ $0W610$ $0W62k$ $0W62s$ $0W62d$ $0W9s$ $0W9d$ $0W70s$ $0W70d$ $0W27s$ $0W27d$	Water Resources/Ecological Vellow Actions	associated costs, lower	ing the pump, drilling a new well, well-d	eepening, abandonment of the old w	ell.
Line 8: $OW30s$ $OW30d$ $OW30s$ $OW10s$ $OW10s$ $OW43s$ $OW44s$ $OW46s$ $OW46s$ $OW46d$ $OW47s$ $OW47d$ $OW46s$ $OW46d$	Purpose: Implement mitigation measures that will prevent impacts to groundwater, the Shouldice	Private Well Red Action	)S		
Line 9: OW40 OW7s OW7d OW29s OW29d	Wetland, or the springs s1-s3 in the Glen Management Area thus preventing the need for Red	Purpose: To implement miti	is gation measures that will minimize th	he impact to private water supply y	vells due to the quarry. If changes to
<b>Zone 1:</b> OW3 OW4 OW7s OW7d OW20s OW20d OW10s OW10d OW11s OW11d OW14s OW14d OW29s OW29d OW30s OW30d OW34 O	Actions. If changes to natural features are related to climatological influences or non-quarry related	private wells are not related	to quarry activities then Red Actions	s may not be required.	tens due to the quarry. It onanges to
OW36 OW37 OW38 OW39 OW40 OW42s OW42d OW43s OW43d OW61s OW61d OW63s OW63d OW65s OW65d	activities then Yellow Actions may not be required.			.,	
Zone 2: OW15s OW15d OW28s OW28d OW31s OW31d OW32s OW32d OW41s OW41d OW44s OW44d OW46s OW46d OW49 O	A "Yellow Action" precautionary mitigation response is triggered if:	Well Interference Complaint	Response Procedure		
OW62k OW62s OW62d OW64s OW66d OW66s OW66d	1. A yellow trigger value has been exceeded in the Water Resources Monitoring Program that can be	Upon receipt of a well interfere	ence complaint the receiver shall imme	diately notify the owner/operator by c	alling Harold Sutherland (Owner/Operator),
Zone 3: OW8s OW8d OW9s OW9d OW12s OW12d OW13s OW13d OW24 OW25s OW25d OW26 OW27s OW27d OW33s O	attributed to the quarry operations; and/or	at the following number(s):			
0W45 0W4/s 0W4/d 0W48 0W51 0W52 0W53 0W58k 0W58s 0W58d 0W59s 0W59d 0W60s 0W60d 0W6/s 0 0W68s 0W68d 0W69s 0W69d 0W70s 0W70d 0W71k 0W71s 0W71d	2. Early indicators of ecological impacts are observed that can be attributed to the quarty operations.	Working Hours Contact	After Hours Contact: Mobile: 226-668-4495		
Sentry Wells OW8s OW8d OW9s OW9d OW12s OW12d OW13s OW13d OW33s OW33d OW45 OW47s OW47d OW51 OW67s O	<u>Program:</u>	Fax: 519-371-6121	WODIE. 220-000-4433		
OW71k OW71s OW71d	a) Report the exceedence to the quarry owner/operator within 24 hrs;	Mobile: 226-668-4495			
Minipiezometers MP54 MP55 MP56 MP57	b) Report the exceedence to the Ecologist/Biologist within 24 hrs;	Email: jennifer@hsc-ltd.com			
Test Pits TP16 TP17 TP18 TP19	c) Report the exceedence to the Hydrogeologist within 24 hrs; and				
<b>Springs</b> s1 s2 s3 s8 s13	d) Report the exceedence to MNR, MOE, NEC, and SON within 72 hours and Yellow Actions that will be implemented.	A well interference complaint f	from a private well owner will constitute	a red trigger breech, and the respon	se procedure will be initiated:
Beaver Dam Sinkhole flow into sinkhole		1) Report to MOE within 24 ho	burs the Mitigative Actions to be implem	iented;	
Culverts         1         2         3         4         5         5a         6         6a         7	Yellow Actions may include but may not be limited to:	2) The quarry operator will call confirm that the problem is not	t mechanical (i.e. nump malfunction) ar	upon receipt of the complaint to insp od to validate the complaint:	ect the well and mechanical systems to
Mud Creek Channel A	ecological monitoring data, water resources monitoring data, and blasting monitoring data).	2) If the complaint is determine	ad not to be mechanically related (i.e.	humbing) the quarry operator will pro	wide a temperaty water supply within 24
Ephemeral Pond Water levels	2) Beviewing the Operational Plan for possible alterations, which may include but may not be limited to:	bours for the affected resident	t and make arrangements to investigate	(Hydrogeologist) the cause of the in	terference:
Dugout Pond water levels outliows	- Changing or ceasing quarry operations in a certain direction: and/or	4) Where the results of the inv	estigation indicate that the interference	is legitimately from dewatering the N	lew Kennel Quarry, the quarry operator will
Water Resources Triggers	- Changing the quarry floor elevation	make arrangements to provide	e compensation. Compensation must b	be acceptable to the home owner and	the quarry operator, and could include all
Seasonal Values	3) Preparing to augment flows ¹ to the springs in the Shouldice Wetland or Glen Management Area:	or part of the costs associated	d with drilling of a new well, well deepen	ing, abandonment of the old well;	
summer autumn green green green green yellow yellow yellow red red red	ed - flow augmentation shall be done in consultation with the Hydrogeologist to ensure adequate	5) Where the results of the inv	vestigation do not indicate interference	from dewatering of the New Keppel C	Quarry, the quarry operator will provide a
Monitoring Station spring low low low winter low (spring) (summer) (autumn) (winter) (spring) (summer) (autumn) (winter) (spring) (summer) (autumn)	nter) protection;	letter report summarizing the r	results of the investigation to the proper	ty owner. In this case, the quarry ope	erator shall maintain the temporary water
March 21 - June 21 - Sept 21 - Dec 21 - March 21 - June 21 - Sept 21 - Dec 21 - March 21 - June 21 - Sept 21 - Dec 21 - March 21 - June 21 - Sept 21 - I	21 -	supply (provided under item 3)	) for at least an additional 24 hours to a	llow the resident to make alternate w	ater supply arrangements;
June 21 Sept 21 Dec 21 March 21 June 21 Sept 21 Dec 21 March 21 June 21 Sept 21 Dec 21 March 21 June 21 Sept 21 Dec 21 M	ch 21 4) Grouting fractures exposed by the quarry along active quarry faces immediately after a blast (as	6) The quarry operator shall de	ocument the interference complaint and	d its resolution and keep the results o	n file in the event that they be requested
Sentry Observation Wells	5) Continuing to monitor weekly until the system recovers as determined by a Hydrogeologist;	by a Ministry inspector.			
OW8s 243.77 243.23 243.07 243.89 243.92 243.38 243.22 244.04 243.77 243.23 243.07 243.89 243.62 243.08 242.92	6) If Yellow Actions prove to be working whereby water levels in affected area have recovered ² and there is	BLASTING MONITORIN	G PROGRAM		
OW8d 243.19 242.45 242.31 243.46 243.34 242.60 242.46 243.61 243.19 242.45 242.31 243.46 243.04 242.30 242.16	3.31 no observed impact to the Shouldice Wetland springs and/or the springs in the Gien Management Area	Purpose: To ensure that the	blasting operations are carried out i	n a safe and productive manner ar	Id to ensure that no possibility of
OW9s 242.83 242.20 242.25 242.93 242.98 242.35 242.40 243.08 242.83 242.20 242.25 242.93 242.68 242.05 242.10	2.78 Utert. 0.00 Outerty activities in the direction of the effected area can resume:	damage exists to any buildin	ngs, structures or residences surrou	nding the New Keppel Quarry. The	Blasting Monitoring Program is
OW90         243.01         241.99         242.23         243.10         242.14         242.35         243.36         243.01         241.99         242.23         243.23         242.06           OW100         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00         0.00 00	- Guarty activities in the direction of the anected area can resume, - Extraction in the direction of s8 and/or s13 can continue only when their flows are observed to	Blasts should be designed so	that the seismic activity (vibrations) and	h noise induced by the blasting opera	tions will remain well within the MOF
OW128 243.03 243.00 243.72 243.80 243.71 243.43 243.67 243.83 243.00 243.50 243.50 243.72 243.30 243.21 243.13	occur naturally as determined by the Hydrogeologist and the Biologist/Ecologist.	guidelines. HSCL staff will be	trained by a Blasting Consultant to pro	perly install, monitor, record and repo	ort the blast induced vibrations and
OW126 244.58 243.67 243.40 244.80 244.73 243.82 243.55 244.95 244.58 243.67 243.40 244.80 244.43 243.52 243.25	4.65 7) Summarize the results of any Yellow Actions in a report to the MNR, MOE, NEC and SON and make	overpressure. All blasts will be	e monitored for vibration and overpress	sure at the Ritchie Property (R1) and	Cramp Property (R2) with digital
OW13d 241.99 241.42 241.32 242.48 242.14 241.57 241.47 242.63 241.99 241.42 241.32 242.48 241.84 241.27 241.17	2.33 recommendations for the operation of the quarry.	seismographs.			
OW33s 243.47 243.10 243.09 243.62 243.62 243.25 243.24 243.77 243.47 243.10 243.09 243.62 243.32 242.95 242.94	3.47 <b>NOTES</b> :	Green Blast Trigger			
OW33d 239.25 238.59 238.73 239.92 239.40 238.74 238.88 240.07 239.25 238.59 238.73 239.92 239.10 238.44 238.58	9.77 ¹ Augmentation of flows to springs may be in the form of a pipe that directs water or an infiltration pond that	Seismograph readings are with	hin the MOE guidelines for vibration an	d overpressure, there is no flyrock ge	enerated beyond the blast area, there are
OW45 243.93 243.22 243.83 244.13 244.08 243.37 243.98 244.28 243.93 243.22 243.83 244.13 243.78 243.07 243.68	3.98 allows water to recharge the groundwater system.	no complaints from the public,	, and there is no negative report in the v	water tested from the quarry.	
OW47s 243.45 243.00 243.14 243.47 243.60 243.15 243.29 243.62 243.45 243.00 243.14 243.47 243.30 242.85 242.99	3.32 ² Recovered water levels means that water levels in the affected observation well(s) has returned above	Romodial Action - No romodia	al action is nocossary		
OW47d 243.36 242.71 243.27 243.42 243.51 242.86 243.42 243.57 243.36 242.71 243.27 243.42 243.21 242.56 243.12	3.27 green trigger values for at least three monitoring events spaced one week apart.		2. autor 13 neuessary.		
OW51         239.75         239.00         238.97         240.08         239.90         239.15         239.12         240.23         239.75         239.00         238.97         240.08         239.60         238.85         238.82	9.93	Yellow Blast Trigger			
OW53         241.65         242.39         243.45         244.38         241.80         242.54         243.60         244.53         241.65         242.39         243.45         244.38         241.50         242.24         243.30	4.23 Water Resources/Ecological Red Actions	Seismograph readings exceed	ued the NUCE guidelines for vibration an	u/or overpressure, there is no flyrock	generated beyond the blast area, there
OMAZ IT TED TED TED TED TED TED TED TED TED TE	BD         Purpose: To implement mitigation measures that will minimize the impact on groundwater due to           BD         the ground of the purpose to solve the impact on groundwater due to	with explosives in the dischard	ge water tested from the quarry as part	of the ECA requirements.	
UW6/0^ IBU IBU IBU TBD	BD the quarry. If changes to natural features are related to climatological influences or non-quarry				
OW/1s* TBD	BD A "Dod Action" immediate reasonable triggered if:	Remedial Action – Review the	e environmental conditions and blast de	sign parameters. Make reasonable a	djustments for subsequent blasts. Report
OW71d* TBD	BD A neu Action infinediate response is triggered IT: 1) A red trigger value has been exceeded in the Water Resources Monitoring Program that can be	the findings and remedial mea	asures to be taken for subsequent blast	s to complainants and attected reside	ents.
OW71k* TBD	BD attributed to the quarry operations;	Red Blast Trigger			
Springs	2) Evidence of negative ecological impacts are observed that can be attributed to the quarry operations;	Seismograph readings exceed	the MOE guidelines for vibration an	a/or overpressure and/or there is flyr	ock generated beyond the blast area, there
Spring s8 Water Levels         239.82         239.51         239.63         239.89         239.77         NA         239.78         240.04         239.82         NA         239.63         239.67         NA         239.48	9.74 and/or	are reported damage complain	ed for blasting in the discharge water to	vioration, and there is an elevated leverated from the quarry as part of the E	cer or nurates and/or other chemicals
Spring \$13 Water Levels 242.86 242.33 242.35 242.93 243.01 NA 242.50 243.08 242.86 NA 242.35 242.93 242.71 NA 242.20	2.78 3) The mitigative measures initiated during the Yellow Action failed to correct or reverse the impact.	accounted with explosives US	ee to shoung in the discharge water le	nom no quany as part of the E	
Dugout Pond	In the event of a red trigger exceedence in the water Resources and/or the Ecological Monitoring	Remedial Action – Stop any fu	urther blasting until a full investigation h	as taken place into the reasons for th	ne unexpected results. Make appropriate
SG1 243.09 243.01 243.07 243.06 243.24 243.16 243.22 243.21 243.09 243.01 243.07 243.06 242.94 242.86 242.92	a) Penert the evenedence to the superior events within 0.1 hours	changes and report these cha	inges before commencement of the blas	sting operation.	
Epnemeral Pond	a) neport the exceedence to the quarry owner/operator within 24 hrs;		MENTO		
Staff Gauge TBD	BD b) Report the exceedence to the Ecologist/Biologist within 24 hrs;	REPORTING REQUIREM	MENIS		
IBD = 10 Be Determined NA = Not Applicable	c) Report the exceedence to the Hydrogeologist within 24 hrs; and	Report Type	Annual ranata datallar att	Reporting Requirements	avided to the MND MOT NEO LOOK
= Seasonal values and subsequent trigger values shall be based on at least three years of monitoring data collected while extracting in Area 1B	values and Red Actions that will be implemented		by a Qualified Person (OP) Appu	al reporting will involve data compilet	ion, presentation and evaluation of the
ECOLOGICAL MONITORING PROGRAM		First Annual Report	performance monitoring data. inclu	uding the trend analysis. The reports	will determine if the AMP is effectively
Purpose: 10 evaluate the ecological health of selected natural features throughout the life cycle of the quarry and ensure that their ecological function is maintained.	Hea Actions may include but may not be limited to:		monitoring the site conditions. The	e first annual report will be completed	at the initiation of operations to
Ine Ecological Monitoring Program relies upon an understanding of changes observed through the Water Resources Monitoring Program because ecological receptors tend to respond more slowly to import to the hydrogeologic regime. Therefore, the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to acceptors tend to respond more slowly to import to the hydrogeologic regime. Therefore, the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to acceptors the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to acceptor the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to acceptor the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to acceptor to accept the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to accept the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to accept the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to accept the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to accept the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to accept the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to accept the Water Resources Monitoring Program will be a critical carly werping system for detecting potential imports to accept the Water Resources werping system for detecting potential imports to accept the Water Resources werping system for detecting potential imports to accept the Water Resources werping system for detecting potential imports to accept the Water Resources werpin	<ul> <li>1) Initiation of an internal interdisciplinary review of all monitoring programs and the data available;</li> <li>Oring</li> <li>2) Stapping substrate activities with size of the last of th</li></ul>		summarize the baseline data (Wat	ter Resources and Ecological) collect	ed pre-quarry.
Program shall be carried out by a Biologist/Ecologist. The Ecological Monitoring Program is described in detail in the AMP report. Trigger values for the Ecological Monitoring Program will be established in detail in the AMP report.	2) Stopping quarry activities until signoff is obtained by the MNR indicating the quarry may restart;		All subsequent annual reports, wr	itten by a QP, will include a discussion	on on:
year one of the Ecological Monitoring Program and reported on in the first annual report. Year one reporting shall be considered "normal" for flora community diversity and be used to establish trigger thr	3) Augmenting' flows to the bedrock system in the area of the observed impact;		- The results of The Water	nesources Monitoring Program	
levels for comparison to future monitoring results. Baseline data collection shall be undertaken during late spring which is considered by SON as the "high" water level season.	4) Monitoring to determine the effectiveness of flow augmentation;	Subsequent Annual Report	- The results of The Ecolog	gical Monitoring Program	
	5) It it is deemed that flow augmentation is effective ² , then quarry activities may resume in a direction that		- The results of The Private	e weii Monitoring Program	
Ecological Monitoring Areas (EMA) The Ecological Monitoring Program will be focused on features in the woodlands of the Area of Natural and Scientific Interest (ANSI), the Shouldies Method and the upper Clan Management Area and in	will not exacerbate the impact, provided that a sign-on acceptance from the MNR has been obtained;		- The results of The Blastin	y monitoring Frografii	
both terrestrial ecological features (EMA-1 and EMA-2) and wetland ecological features (EMA-2 through EMA-6).	guarry cannot operate without negatively impacting water levels in the Shouldice Wetland and/or the		Interim reports, written by a OP	ill be submitted to MNR and NEC if th	inner values are triggored as listed upder
FMA-1: Woodland Tree Health Woodland Regeneration and Woodland Flora Sposice Diversity:	springs in the Glen Management Area then the need to close the quarry should be assessed: and	Interim Reports	the "Green". "Yellow" and "Red" a	tions in the AMP	igger values are inggered as listed UNDer
ENA-1. Woodland Reeding Birds.	7) Summarize the results of any Red Actions in a report to the MNR_MOF_NFC_and SON along with the		and around, renow and neu at		
EIVIA-2. Woould IN DIEEUIIIY DINS, FMA-3: The Glen area st to s3 aroundwater discharge feature:	recommendations for the operation of the quarry.				
EMA-4: The Shouldice Wetland at the s8 and s9 groundwater discharge feature.	NOTES:				
EMA-5: The Woodland Ephemeral Pond amphibian breeding surface water feature: and	¹ Augmentation of flows may involve direct discharges to the affected spring(s) or the construction of an				
EMA-6: The lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond and the upper headwater channel for the East Branch of Park Head Creek	infiltration pond that allows water to recharge the groundwater system.				
	² Groundwater levels in the impacted observation well(s) in Zone 3 have returned above areen triager				

values as determined by at least three monitoring events spaced one week apart.

ADAPTIVE MANA	GEMEN	T PLAN	- NEW K	EPPEL C	QUARRY									APPENDIX B: TRIGGER LIMITS AND MITIGATION	I MEASURES			
WATER RESOURCE	S MONIT	ORING P	ROGRAM											Water Resources/Ecological Green Actions	PRIVATE WELL MONITO	RING PROGRAM		
Purpose: To track the pe	rformance	of the Nev	Keppel Qu	arry and the	potential impa	cts on water re	sources							Purpose: Identify changes prior to impacting groundwater and surface water features and	Private Well Locations	Category A Wells: 3345, 3447, 5	5197, New Cramp Well	Category B Wells: TBD
1) Establish a weather station so that site-specific climate data can be obtained													implement investigative actions	Private Well Trigger Valu	es Croon	Vollow	Pod	
2) Retain a person qualifie	d to: Conduct r	nonthly mo	curomonto	of water lovel	e at the abcorve	tion wells minir	iozomotoro	and tast pite	listed below	and the private	welle listed in	the Drivete M	Iolle Monitoring	Monitoring Program:	Well No. 3345	None	227.5 mAMSL	Complaint Received
	Program;		ISUIEINEINS	n waler iever			iezometers,			and the private		life i fivale vi	rens wontoning	a) Report the exceedence to the quarry owner/operator within 24 hrs;	Well No. 3447	None	TBD	Complaint Received
	- Conduct r	nonthly mea	surements	of flows at sp	rings, the Beave	r Dam sinkhole	culverts, mu	ud creek char	nnel A, the Ep	hemeral Pond	and the dugou	It pond listed	below;	b) Report the exceedence to the Ecologist/Biologist within 24 hrs;	Well No. 5197	None	TBD	Complaint Received
	- Conduct r	nonthly mea	surements	of specific co	nductivity and te	mperature at sp	rings listed b	pelow, the Be	aver Dam sin	khole, culverts	listed below, N	Aud Creek (Cl	hannel A) and the	c) Report the exceedence to the Hydrogeologist within 24 hrs and increase monitoring frequency t weekly at:	New Cramp Well	None		Complaint Received
	- Install and	iu; I maintain c	ata loggers	n 'Sentry We	lls' listed below	and download ti	ne data logge	ers monthly.						- Observation wells along Lines 1 and 2, at Spring s1, s2, s3, and at the Beaver Dam Sinkh	ble TBD = To Be Determined	None		Complaint necelved
	- Install and	l maintain c	ata loggers	n minipiezon	neters to be insta	alled in spring st	8, spring s13	, and the dug	out pond and	I download the	data loggers n	nonthly;		IF a green trigger value is exceeded at OW33s, OW33d, or OW51				
	- Download	precipitatio	n data and p	umping reco	rds monthly or a	is needed;			·					- confirm that water is entering Beaver Dam sinkhole and that spring s3 is flowing	* = Seasonal values and subse	quent trigger values shall be based o	on at least three years of monitoring da	a collected while extracting in Area 1B
	- Compile r	nonitoring d	ata and com	pare it to pre	cipitation data a	nd pumping rec	ords monthly	<i>ι</i> ;						<ul> <li>confirm that groundwater seepage along the north quarry face has not increased</li> </ul>	Private Well Yellow Action	ns		
	- Inspect fo	r water bea	ring fracture	along active	e quarry faces in	nmediately after	a blast;							- Observation wells along Lines 3, 4, 5, at Spring s8, at Test Pits TP15, TP16, TP17, TP18, and at Minipiczometers MP55, MP56, and MP57, J5 a group triager value is evaluated at	Purpose: To implement mitig	ation measures that will prevent in	npacts to private water supply wells	thus preventing the need for Red
2) Detain an independent	- Check infi	Itration pon	d (if installed	) located nea	ar s13 for proper	function on a w	eekly basis.							OW67s, OW67d, OW12s, OW12d, OW8s, OW8d	Actions. If impacts to private	wells are not related to quarry act	tivities then yellow Actions may not	be required.
3) Retain an independent	- Assess ar	nd interpret	water levels	and flows me	easured against	historical patter	ns. seasonal	l lows. triager	values. pumi	oina records ar	d precipitation	records on a	monthly basis:	- Observation wells along Lines 6, 7, 8, Spring s13, the Dugout Pond (water levels and flow	in a yellow ingger value is excee	ded for any of the Category A of Ca	aregory of private wells, then the following	g miligation measures will be initiated.
	- Compare	monitoring	data against	trigger value	s on a monthly b	basis and make	recommenda	ations for mo	nitoring progr	am alterations	if required;		, , , , , , , , , , , , , , , , , , ,	IF a green trigger value is exceeded at OW9s, OW9d, OW71k, OW71s, OW71d, OW47s,	a) Report the exceedenc	e to the quarry owner/operator within	1 24 hrs;	
	- Map cone	of influenc	e on a month	ly basis and	assess its size a	and shape;					•			OW47d, OW45	b) The quarry operator sh	all report to the local MOE District O	Office within 72 hours the exceeded trig	ger values and Mitigative Actions that will
	- Provide a	n annual m	nitoring rep	ort and make	recommendatio	ons for future mo	nitoring.							d) Consult with a Hydrogeologist to review the extra data collected and make recommendations fo	be implemented;			
Water Resources Monito	ring Locat	ions												changes to the monitoring program as required. Changes may include but not limited to:	c) Inform the resident and	l enquire about well yield;	a an MOE liganced plumber to increat	he well and machanical companying
Observation wells	0.11/26	0\\/27	0\\/49	0\\/50		0								- Increased frequency of monitoring	thereof and confirm if me	chanical issues (i.e. the pump and/or	or plumbing system) are the cause and	to validate the decrease in well yield;
Line 1:	OW30 OW14s	OW37 OW14d	OW28s	OW28d (	OW31 OW3	2d 3345	OW33s	OW33d						- Mapping the cone of influence using the most recent round of water levels:		、 · · ·		· · ·
Line 3:	OW34	OW 140	OW263	OW14s (	OW14d OW4	1s OW41d	OW67s	OW67d (	OW68s O	W68d OW5	3k OW58s	OW58d		- Installing new observation wells, if required, to more accurately define the cone of influence	e e) If the cause is not med	hanically related, then:		
Line 4:	OW39	OW65s	OW65d	OW66s	OW66d OW1	2s OW12d	OW25s	OW25d (	OW59s O	N59d				of the quarry with respect to a certain receptor;	- The quarry operator will	provide a temporary supply of water	r within 24 hours (if required);	
Line 5:	OW39	OW40	OW42s	OW42d	OW63s OW6	3d OW64s	OW64d	OW8s (	O b8WC	W69s OW6	d OW24			- Retaining an Hydrogeologist to complete an analysis/evaluation of the data collected	- The quarry operator will	make arrangements to provide a sui	litable alternative water supply;	
Line 6:	OW39	OW40	OW61s	OW61d (	DW62k OW6	2s OW62d	OW9s	OW9d (	OW70s OV	N70d OW2	7s OW27d			Water Descures / Foolegical Valley, Actions	- Provisions for the affect associated costs lowerin	ed resident could include all or part of the pump drilling a new well well-	of the costs associated with water delived and the old we	ered to fill a temporary water system and
Line 7:	OW39	OW/30d	OW/20	OW43s (		1s OW11d	OW 46S	OW460 (	JW4/s O	W4/d OW4	BS OW480			Water Resources/Ecological Yellow Actions Purpose: Implement mitigation measures that will prevent impacts to groundwater, the Shouldice	Brivate Well Bed Actions	g the partie, anning a new well, well a	deepening, abandonment of the old we	
Line 9:	OW305 OW40	OW300 OW7s	OW39 OW7d	OW29s	DW29d	45 011440	01145							Wetland, or the springs s1-s3 in the Glen Management Area thus preventing the need for Red	Purpose: To implement mitig	ation measures that will minimize t	the impact to private water supply w	ells due to the guarry. If changes to
Zone 1:	OW3	OW4	OW7s	OW7d (	OW10s OW1	0d OW11s	OW11d	OW14s (	OW14d O	W29s OW2	d OW30s	OW30d	OW34 OW35	Actions. If changes to natural features are related to climatological influences or non-quarry relat	d private wells are not related t	o quarry activities then Red Action	ns may not be required.	
	OW36	OW37	OW38	OW39 0	OW40 OW4	2s OW42d	OW43s	OW43d (	OW61s O	W61d OW6	3s OW63d	OW65s	OW65d	activities then Yellow Actions may not be required.				
Zone 2:	OW155	OW15d	OW28s	OW28d (	DW31s OW3	10 OW32s	OW32d	OW41s (	JW41d O	W44s OW4	1d OW46s	OW46d	OW49 OW50	A "Yellow Action" precautionary mitigation response is triggered it:	Well Interference Complaint F	esponse Procedure	ediately notify the owner/operator by ca	lling Harold Sutherland (Owner/Operator)
Zone 3:	OW8s	OW825 OW8d	OW020 OW9s	OW9d (	OW12s OW1	2d OW13s	OW13d	OW24 (	OW25s O	N25d OW2	6 OW27s	OW27d	OW33s OW33	attributed to the quarry operations; and/or	at the following number(s):		control of the owner/operator by of	
20110 01	OW45	OW47s	OW47d	OW48	OW51 OW5	2 OW53	OW58k	OW58s	OW58d O	W59s OW5	OW60s	OW60d	OW67s OW67	2. Early indicators of ecological impacts are observed that can be attributed to the quarry operations.	Working Hours Contact	After Hours Contact:		
	OW68s	OW68d	OW69s	OW69d (	OW70s OW7	0d OW71k	OW71s	OW71d				0.1454		In the event of a yellow trigger exceedence in the Water Resources and/or the Ecological Monitori	Phone: 519-376-5698	Mobile: 226-668-4495		
Sentry Wells	OW8s OW71k	OW8d OW71s	OW9s OW71d	OW9d (	JW12s OW1	2d OW13s	OW13d	OW33s (	OM339 O	W45 OW4	/s OW4/d	OW51	OW6/s OW6/	a) Report the exceedence to the quarry owner/operator within 24 hrs.	Fax: 519-371-6121 Mobile: 226-668-4495			
Minipiezometers	MP54	MP55	MP56	MP57										b) Report the exceedence to the Ecologist/Biologist within 24 hrs;	Email: jennifer@hsc-ltd.com			
Test Pits	TP16	TP17	TP18	TP19										c) Report the exceedence to the Hydrogeologist within 24 hrs; and				
Springs	s1	s2	s3	s8 s	s13									d) Report the exceedence to MNR, MOE, NEC, and SON within 72 hours and Yellow Actions that	vill A well interference complaint fro	om a private well owner will constitute	e a red trigger breech, and the respons	e procedure will be initiated:
Beaver Dam Sinkhole	flow into sir	hole						-						be implemented.	1) Report to MOE within 24 hou	rs the Mitigative Actions to be impler	mented;	at the well and mechanical systems to
Culverts Mud Crook	1 Channol A	2	3	4	5 5a	6	6a	/						1) Initiation of an internal interdisciplinary review of all monitoring programs and the data available (i.e.	confirm that the problem is not	nechanical (i.e. pump malfunction) a	and to validate the complaint:	ct the well and mechanical systems to
Ephemeral Pond	water levels	3												ecological monitoring data, water resources monitoring data, and blasting monitoring data);	3) If the complaint is determined	I not to be mechanically related (i.e.	plumbing), the quarry operator will pro	vide a temporary water supply within 24
Dugout Pond	water levels	s outflows												2) Reviewing the Operational Plan for possible alterations, which may include but may not be limited to:	hours for the affected resident a	nd make arrangements to investigat	te (Hydrogeologist) the cause of the int	erference;
														- Changing or ceasing quarry operations in a certain direction; and/or,	4) Where the results of the inve	stigation indicate that the interferenc	ce is legitimately from dewatering the N	ew Keppel Quarry, the quarry operator will
Water Resources Tri	ggers													- Changing the quarry floor elevation.	or part of the costs associated	compensation. Compensation must with drilling of a new well well deeper	be acceptable to the home owner and	the quarry operator, and could include all
Seasonal Values		summer	autumn		green	en green	areen	vellow	vellow	vellow vel	ow red	red	red rec	3) Preparing to augment flows' to the springs in the Shouldice Wetland or Glen Management Area; - flow augmentation shall be done in consultation with the Hydrogeologist to ensure adequate	5) Where the results of the inve	stigation do not indicate interference	e from dewatering of the New Keppel Q	uarry, the quarry operator will provide a
Monitoring Station	spring low	low	low	winter low	(spring) (sum	imer) (autumn)	(winter)	(spring)	(summer) (a	autumn) (win	ter) (spring	) (summer)	(autumn) (winte	protection;	letter report summarizing the re	sults of the investigation to the prope	erty owner. In this case, the quarry ope	rator shall maintain the temporary water
	March 21	June 21	Sept 21 -	Dec 21 -	March 21 - June	e 21 - Sept 21	Dec 21 -	March 21 -	June 21 - S	ept 21 - Dec	21 - March 2	1 - June 21 -	Sept 21 - Dec 2	1-	supply (provided under item 3)	or at least an additional 24 hours to	allow the resident to make alternate wa	ater supply arrangements;
	June 21	Sept 21	Dec 21	March 21	June 21 Sep	ot 21 Dec 21	March 21	June 21	Sept 21	Dec 21 Marc	h 21 June 2	1 Sept 21	Dec 21 March	4) Grouting fractures exposed by the quarry along active quarry faces immediately after a blast (as	6) The quarry operator shall do	cument the interference complaint an	nd its resolution and keep the results o	n file in the event that they be requested
Sentry Observation Well	S		0.40.07					0.40.77	0.40.00					5) Continuing to monitor weekly until the system recovers as determined by a Hydrogeologist;		PROOPAN		
OW8s	243.77	243.23	243.07	243.89	243.92 243	3.38 243.22 2.60 242.46	244.04 243.61	243.77	243.23	243.07 243 242.31 243	.89 243.62	243.08	242.92 243.	6) If Yellow Actions prove to be working whereby water levels in affected area have recovered and there no observed impact to the Shouldice Wetland springs and/or the springs in the Glen Management Area	BLASTING MONITORING	PROGRAM	in a safe and productive manner an	d to ensure that no possibility of
OW9s	242.83	242.20	242.25	242.93	242.98 242	2.35 242.40	243.08	242.83	242.20	242.25 242	.93 242.68	242.05	242.10 242.	$\frac{5}{78}$ then:	damage exists to any building	s, structures or residences surrou	unding the New Keppel Quarry. The	Blasting Monitoring Program is
OW9d	243.01	241.99	242.23	243.23	243.16 242	2.14 242.38	243.38	243.01	241.99	242.23 243	.23 242.86	241.84	242.08 243.	- Quarry activities in the direction of the affected area can resume;	described in detailed in the A	MP report		
OW12s	243.65	243.36	243.30	243.72	243.80 243	3.51 243.45	243.87	243.65	243.36	243.30 243	.72 243.50	243.21	243.15 243.	- Extraction in the direction of s8 and/or s13 can continue only when their flows are observed to	Blasts should be designed so th	at the seismic activity (vibrations) ar	nd noise induced by the blasting operative	ions will remain well within the MOE
OW12d	243.47	242.89	242.76	243.68	243.62 243	3.04 242.91	243.83	243.47	242.89	242.76 243	.68 243.32	242.74	242.61 243.	53 Occur naturally as determined by the Hydrogeologist and the Biologist/Ecologist.	overpressure. All blasts will be	monitored for vibration and overpres	ssure at the Ritchie Property (R1) and (	Cramp Property (R2) with digital
OW 13S	244.58	243.67	243.40	244.80	244.73 243	3.82 243.55	244.95	244.58	243.67	243.40 244	.80 244.43	243.52 241.27	243.25 244.	recommendations for the operation of the guarry.	seismographs.	·····		······································
OW 180	243.47	243.10	243.09	243.62	243.62 243	3.25 243.24	243.77	243.47	243.10	243.09 243	.62 243.32	242.95	242.94 243.4	17 <b>NOTES:</b>	Green Blast Trigger			
OW33d	239.25	238.59	238.73	239.92	239.40 238	3.74 238.88	240.07	239.25	238.59	238.73 239	.92 239.10	238.44	238.58 239.	¹ Augmentation of flows to springs may be in the form of a pipe that directs water or an infiltration pond to	at Seismograph readings are with	n the MOE guidelines for vibration ar	nd overpressure, there is no flyrock ge	nerated beyond the blast area, there are
OW45	243.93	243.22	243.83	244.13	244.08 243	3.37 243.98	244.28	243.93	243.22	243.83 244	.13 243.78	3 243.07	243.68 243.	allows water to recharge the groundwater system.	no complaints from the public, a	nd there is no negative report in the	water tested from the quarry.	
OW47s	243.45	243.00	243.14	243.47	243.60 243	3.15 243.29	243.62	243.45	243.00	243.14 243	.47 243.30	242.85	242.99 243.3	² Recovered water levels means that water levels in the affected observation well(s) has returned above	Remedial Action - No remedial	action is necessary.		
OW47d	243.36	242.71	243.27	243.42	243.51 242	2.86 243.42	243.57	243.36	242.71	243.27 243	.42 243.21	242.56	243.12 243.3	green trigger values for at least three monitoring events spaced one week apart.				
OW51	239.75	239.00	238.97	240.08	239.90 23	9.15 239.12 2.54 243.60	240.23	239.75	239.00	238.97 240	38 241 50	238.85	238.82 239.3	Water Besources/Ecological Bed Actions	Seismograph readings exceede	d the MOE quidelines for vibration a	and/or overpressure, there is no flyrock	generated beyond the blast area, there
OW67s*	 TBD		TBD	TBD	TBD TI	3D TBD	TBD	TBD	TBD	TBD TE	D TBD	, <u>242.24</u> TBD	TBD TBI	D Purpose: To implement mitigation measures that will minimize the impact on groundwater due to	are no reported damage compla	ints, there may be complaints from r	noise or vibration, and slight elevated r	itrates and/or other chemicals associated
OW67d*	TBD	TBD	TBD	TBD	TBD TI	<u>BD</u> TBD	TBD	TBD	TBD	TBD TE	D TBD	TBD	<u>T</u> BD TBI	the quarry. If changes to natural features are related to climatological influences or non-quarry	with explosives in the discharge	water tested from the quarry as part	t of the ECA requirements.	
OW71s*	TBD	TBD	TBD	TBD	TBD TI	BD TBD	TBD	TBD	TBD	TBD TE	D TBD	TBD	TBD TBI	related activities then Red Actions may not be required.	Remedial Action - Review the	environmental conditions and blast d	lesign parameters. Make reasonable a	ljustments for subsequent blasts. Report
OW71d*	TBD	TBD	TBD	TBD	TBD TI	3D TBD	TBD	TBD	TBD	TBD TE	D TBD	TBD	TBD TBI	A "Red Action" immediate response is triggered if:	the findings and remedial meas	ures to be taken for subsequent blas	sts to complainants and affected reside	nts
OW71k*	TBD	TBD	TBD	TBD	TBD TI	BD TBD	TBD	TBD	TBD	TBD TE	D TBD	TBD	TBD TBI	<ul> <li>I) A red trigger value has been exceeded in the Water Resources Monitoring Program that can be</li> <li>attributed to the quarry operations:</li> </ul>	Red Blast Trigger			
Springs		A			000.0=	IA * *	A · · ·	005			<u></u>		-	2) Evidence of negative ecological impacts are observed that can be attributed to the quarry operations;	Seismograph readings exceede	d the MOE guidelines for vibration a	and/or overpressure and/or there is flyre	ck generated beyond the blast area, there
Spring s8 Water Levels	239.82	239.51	239.63	239.89	239.97 N	IA 239.78	240.04	239.82		239.63 239	.89 239.67	NA NA	239.48 239.	(4 and/or 28 2) The mitigative measures initiated during the Vellow Anti- Anti- Anti- Anti-	are reported damage complaint associated with explosives used	s, mere are complaints from hoise of I for blasting in the discharge water t	tested from the quarry as part of the Fo	A requirements.
Spring S13 Water Levels	242.86	242.33	242.35	242.93	243.UI N	in 242.50	243.08	242.86	INA	242.30 242	. <del>ອ</del> ວ   242./1	NA	<u>242.20</u> 242.	<ul> <li>3) The miligative measures initiated during the Yellow Action failed to correct or reverse the impact.</li> <li>In the event of a red trigger exceedence in the Water Resources and/or the Ecological Monitoring</li> </ul>				• -
	243 00	242 01	243 07	243.06	243.24 240	3 16 2/2 22	<u>24</u> 2 21	243 00	243.01	243.07 243	06 2/2 0/	242 86	242 92 242	Program:	Remedial Action – Stop any fur	ther blasting until a full investigation	has taken place into the reasons for th	e unexpected results. Make appropriate
Ephemeral Pond	240.09	240.01	240.07	240.00	240.24 240	5.10 245.22	240.21	240.00	240.01	240.07 240	.00 242.34	- 242.00	242.32 242.	a) Report the exceedence to the quarry owner/operator within 24 hrs;	changes and report these chan	des before commencement of the bla	asting operation.	
Staff Gauge	TBD	TBD	TBD	TBD	TBD TI	3D TBD	TBD	TBD	TBD	TBD TE	D TBD	TBD	TBD TBI	b) Report the exceedence to the Ecologist/Biologist within 24 hrs;	<b>REPORTING REQUIREM</b>	ENTS		
TBD = To Be Determined				I	VA = Not Applica	able					•			c) Report the exceedence to the Hydrogeologist within 24 hrs; and	Report Type		Reporting Requirements	
* = Seasonal values and s	ubsequent	trigger valu	es shall be b	ased on at le	ast three years	of monitoring da	ta collected	while extracti	ng in Area 1E	3				d) Report the exceedence to MNR, MOE, NEC, and SON within 24 hours the exceeded trigger		Annual reports detailing the result	Its of the monitoring program will be pro	ovided to the MNR, MOE, NEC, and SON
ECOLOGICAL MONI	TORING	PROGRA	M											values and ned Actions that will be implemented.	First Annual Report	performance monitoring data inclusion	lual reporting will involve data compilation cluding the trend analysis. The reports	will determine if the AMP is effectively
Purpose: To evaluate the	ecologica	I health of	selected na	tural feature	s throughout th	ne life cycle of	the quarry a	Ind ensure th	hat their eco	logical functio	n is maintain	ed.		Red Actions may include but may not be limited to:		monitoring the site conditions. The	he first annual report will be completed	at the initiation of operations to
I ne Ecological Monitoring	Program re	elles upon a	n understan	ang of chang	es observed thr	ougn the Water	Resources N	vionitoring Pr	ogram becau	se ecological r	eceptors tend t	o respond mo	pre slowly to impacts	<ul> <li>1) Initiation of an internal interdisciplinary review of all monitoring programs and the data available;</li> <li>2) Stopping quarty activities uptil signoff is obtained by the NND indicating the supervised states.</li> </ul>		summarize the baseline data (Wa	ater Resources and Ecological) collecte	ed pre-quarry.
Program shall be carried	out by a Bic	logist/Ecolo	gist. The E	cological Mor	nitoring Program	is described in	detail in the	AMP report.	Trigger values	s for the Ecolog	ical Monitoring	g Program will	be established dur	ng 3) Augmenting ¹ flows to the bodrock ovetom in the cross of the observed impact.		All subsequent annual reports, w	vritten by a QP, will include a discussio er Resources Monitoring Program	1 on:
year one of the Ecological	Monitoring	Program ai	d reported	n in the first	annual report.	/ear one reporti	ng shall be c	onsidered "no	ormal" for flor	a community d	versity and be	used to estab	olish trigger thresho	d 4) Monitoring to determine the effectiveness of flow augmentation:		- The results of The Foolo	ogical Monitoring Program	
levels for comparison to fu	ture monito	ring results	Baseline c	ata collectior	shall be undert	aken during late	spring which	n is considere	ed by SON as	the "high" wat	er level seasor	۱.		5) If it is deemed that flow augmentation is effective ² , then guarry activities may resume in a direction that	Subsequent Annual Reports	- The results of The Privat	te Well Monitoring Program	
Ecological Monitoring A	eas (EMA)													will not exacerbate the impact, provided that a sign-off acceptance from the MNR has been obtained;		- The results of The Blasti	ing Monitoring Program	
The Ecological Monitoring	Program w	ill be focuse	d on feature	s in the wood	dlands of the Are	ea of Natural an	d Scientific Ir	nterest (ANSI	), the Should	ice Wetland ar	d the upper Gl	en Managemo	ent Area and includ	6) If it is deemed by the Hydrogeologist, the Biologist/Ecologist, the owner/operator and the MNR that the				
pour terrestrial ecological f	eatures (El	wa-i and E	via-2) and w		yıcaı reatures (E	wiA-∠ through E	wA-b).	roit:						quarry cannot operate without negatively impacting water levels in the Shouldice Wetland and/or the springs in the Glen Management Area then the need to close the quarry should be assessed; and	Interim Reports	Interim reports, written by a QP, w	will be submitted to MNR and NEC if tri	gger values are triggered as listed under
	EIVIA-1: WC	odland Fre	e Health, Wo	ooland Rege	eneration and W	oodiand Flora S	pecies Diver	isity;						7) Summarize the results of any Red Actions in a report to the MNR_MOF_NEC_and SON along with the	· · ·	the Green, renow and Reo" a		
	EMA-3: Th	e Glen area	s1 to s3 are	undwater die	charge feature.									recommendations for the operation of the quarry.				
	EMA-4: The	e Shouldice	Wetland at	he s8 and s	9 groundwater di	scharge feature	•							NOTES:				
	EMA-5: Th	e Woodland	Ephemeral	Pond amphik	bian breeding su	rface water feat	ure; and							¹ Augmentation of flows may involve direct discharges to the affected spring(s) or the construction of an				
	EMA-6: The	e lobe of the	Shouldice	Vetland enco	ompassing sprin	g s13 and the D	ugout Pond a	and the uppe	r headwater o	channel for the	East Branch o	f Park Head (	Creek.	infiltration pond that allows water to recharge the groundwater system.				

# ADDENIDIV D. TDIOOED I IMITO AND MITIOATION MEACUIDEO

# TREE PRESERVATION PLAN (TPP)

### Purpose: To preserve trees in the TPP Corridor so that sufficient visual screening and buffering is achieved along CR 17 and Con Rd 10.

Tree Monitoring Protocol

The health of the TPP Corridor will be monitored on an annual basis by a qualified professional. The qualified professional shall identify and monitor the health of Preservation

- Trees in the TPP Corridor for the following: a) Individual tree numbering for long-tern identification;
- b) Tree species and Diameter at Breast Height (DBH);
- c) Number of stems and total tree height;
- d) Crown class;
- e) Percentage live crown;

f) Evidence of twig dieback, branch dieback, defoliation, and discoloration; g) Evidence of wounds, signs/symptoms of insect infestation, and any other health stressors; and

h) Overall growing conditions and general tree health.

Monitoring shall be completed during the growing season (June 1 to September 15) of every year.

Pre-quarry (baseline conditions) of the TPP Corridor shall be established:

- Baseline monitoring data in Zone 1 of the TPP Corridor data shall be collected prior to any site alterations commencing in Area 1A.

- Baseline monitoring data in Zone 2 and Zone 3 of the TPP Corridor shall be collected prior to site alterations in Area 1B, Area 2, and Area 3.

Tree Replacement Protocol

If monitoring in the TPP Corridor identifies a Preservation Trees in "Fair-Health", then implement an action plan within one year to:

a) Encourage the growth of a Replacement Tree(s) by promoting the growth of surrounding immature tree(s) and/or promoting the expansion of the crown of adjacent trees; or

b) If there is no suitable Replacement Tree(s) is within 6 m, then plant two native stock samplings (one Deciduous [not Ash] and one Coniferous tree) that are at least 1.5 m in height; one on each side and in close proximity to the identified Fair-Health tree(s).

If monitoring in the TPP Corridor identifies a Preservation Tree(s) in "Poor-Health", then a) Determine the effectiveness of any previous efforts implemented to encourage the growth of Replacement Trees (natural or planted); and

b) If Replacement Tree efforts are deemed ineffective, then plant two additional native stock saplings (not Ash), that are at least 1.5 m in height, in close proximity to the identified "Poor-Health" tree(s).

If monitoring in the TPP Corridor identifies a Preservation Tree(s) as dying/dead, then a) Remove the dying/dead tree(s) without harming adjacent Replacement Trees(s), otherwise leave the dying/dead tree standing and remove the upper branches and tree top for safety reasons;

b) Look for a Replacement Tree(s) (planted or natural) that is at least 15 cm DBH and number them as the new Replacement Tree;

c) If a Replacement Tree(s) cannot be found, then plant enough saplings in proximity to the dying/dead tree to achieve the cumulative caliper (at least 15 DBH) of a Replacement Tree so that the future trees(s) will provide similar buffering and visual screening; and

d) Include the Replacement Trees(s) in future monitoring.





# **ROLES AND RESPONSIBILITIES CHART**

# Roles and Responsibilities Chart

Relevant Act:	Aggregate Resources Act (ARA)	Niagara Escarpment Planning and Development Act (NEPDA)	Ontario Water Res	sources Act (OWRA)		Environmental Protection Act		Conservation Authorities Act (CAA)	
ltem:	Aggregate License	Development Permit	Permit to Take Water (PTTW)	Environmental Comp	Diance Approval (ECA)	Dust Issues	Blast Monitoring	Access Agreement	
	To be approved prior to extraction, followed and	d To be approved prior to extraction, followed and	To be approved prior to extraction and renewed	To be approved prior to extraction and renewed	To be approved prior to extraction and renewed	Issues to be addressed based on complaints	Monitoring to be done in -line with the blasting		
Schedule: Quarry Activity	enforced throughout life of quarry Extraction	enforced throughout life of quarry Extraction of NEC Regulated Lands	prior to the deadline shown on the Permit. Dewatering	prior to the deadline shown on the ECA. Water and Sewage Works	prior to the deadline shown on the ECA. Air and noise	received Dust Suppression	schedule Blasting	To be approved prior to extraction Access to Monitors on GSCA Lands	
Operator - Harold Sutherland Construction Ltd. Contact: Harold Sutherland and Jennifer Prentice Phone Number: 519-376-5698 Email: jennifer@hsc-ltd.com	Shall operate their site in accordance with the Aggregate Resources Act (ARA), the License and site plan and the conditions of the licence. The AMP shall become a condition on the license and enforced under the ARA. Shall retain a QP (i.e. Hydrogeologist) to review the results of the water resources monitoring program under the AMP to ensure that there are no adverse impacts to the natural environment or private water supply wells. Shall retain a Qualified Person (i.e. Biologist/Ecologist) to review the results of the ecological monitoring program under the AMP to ensure that there are no adverse impacts to the natural environment. The QPs shall report to the Operator.	Shall operate their site in accordance with the comply with the Niagara Escarpment Planning and Development Act (NEPDA), the terms and conditions of the Development Permit.	Shall strictly follow the terms and conditions of the PTTW when conducting water-taking activities. Must record the amount of water taken each day and report this information to the MOE for each calendar year (January to December), on or before March 31st of the following year using the MOE's Water Taking Reporting System (WTRS). Conditions may include monitoring as detailed in the AMP.	Shall strictly follow the terms and conditions of the ECA when discharging water to the environment. Conditions may include monitoring as detailed in the AMP.	Shall strictly follow the terms and conditions of the ECA when air or noise pollutants are emitted to environment.	Shall respond to any dust complaints. Investigate and mitigate as appropriate.	Shall retain a blasting consultant to train personnel to properly install, monitor, record and report the blast induced vibrations and overpressure and to implement the trigger system outlined in the AMP. Shall perform occasional audits of blasting procedures to ensure compliance with MOE guidelines. Shall respond to any blast complaints. Investigate and mitigate as appropriate.	Shall adhere to the access agreements put in place to allow the operator access to lands owned by the Grey Sauble Conservation Authority to monitor environmental receptors as per the AMP.	
Ministry of Natural Resources (MNR) Contact: Aggreagte Inspector, Owen Sound Office Phone Number:(519) 371-8470	Shall ensure the operator complies with terms and conditions of the aggregate license, including enforcing the contents of the AMP. In the event of non-compliance, the MNR has the authority to issue suspension notices, rehabilitation orders, revocations and charges. Shall review applications and amendment requests with respect to the protection of natural heritage features, and ensure that adverse impacts of aggregate operations on the environment are minimized.	As a participant in the SLC, ensure compliance with the Development Permit by reviewing the results of the environmental monitoring program in the AMP and provide comments and recommend changes, if required. MNR may be consulted by the NEC to review technical material related to monitoring programs or mitigation measures.	As a participant in the SLC, review the results of work done to meet the conditions of the PTTW and provide comments and recommend changes, if required.	As a participant in the SLC, review the results of work done to meet the conditions of the ECA and provide comments and recommend changes, if required.	As a participant in the SLC, review the results of work done to meet the conditions of the ECA and provide comments and recommend changes, if required.	As a participant in the SLC, review the results of work done to address any complaints and provide comments and recommend changes to the response actions taken, if required.	As a participant in the SLC, review the results of work done to address any complaints and provide comments and recommend changes to the response actions taken, if required.	MNR may be consulted by the GSCA to review technical material related to monitoring programs or mitigation measures.	
Ministry of the Environment (MOE) Contact: Owen Sound District Office Phone Number: 519-371-2901 or (519) 1-800-265-3783	As a participant in the SLC, review the results of the environmental monitoring program in the AMP and provide comments and recommendations for changes, if required. Shall provide technical support to the MNR as needed.	e As a participant in the SLC, ensure compliance with the Development Permit by reviewing the results of the environmental monitoring program in the AMP and provide comments and recommend changes, if required. MOE may be consulted by the NEC to review technical material related to monitoring programs or mitigation measures.	Ensure fair sharing of water resources and prevent interferences among water users by administering and strictly enforcing all terms and conditions of the PTTW. Shall review reports submitted by HSCL and provide guidance as required to improve monitoring programs included in the PTTW. Shall amend (or revoke) the PTTW as directed by the Director Section 34 of OWRA.	Administer and enforce all terms and conditions of the ECA as they relate to Section 53 of the OWRA. Shall set conditions on approval such as performance conditions (temperatures, effluent criteria/limits, loadings, concentrations). Shall set monitoring, recording and reporting requirements. Shall set operation and maintenance requirements. Shall review reports submitted by HSCL as per the conditions of the ECA. Shall amend (or revoke) the ECA as required by the Director Section 53 of OWRA.	Administer and enforce all terms and conditions of the ECA as they relate to the EPA. Shall set conditions on approval such as performance conditions. Shall set monitoring, recording and reporting requirements. Shall set operation and maintenance requirements. Shall review reports submitted by HSCL as per the conditions of the ECA. Shall amend (or revoke) the ECA as required by the Director of EPA.	Respond to any dust complaints as per MOE policies, procedures or guidelines. Investigate and follow-up as appropriate. Inform and advise HSCL as appropriate.	Respond to any blast complaints as per MOE policies, procedures or guidelines. Investigate and follow-up as appropriate. Inform and advise HSCL as appropriate.	MOE may be consulted by the GSCA to review technical material related to monitoring programs or mitigation measures.	
Niagara Escarpment Commission (NEC) Contact: NEC Planner Phone Number: (519) 599-3340	As a participant in the SLC, review the results of the environmental monitoring program in the AMP and provide comments and recommendations for changes, if required. NEC shall review applications and amendment requests and provide comment to MNR with respect to the protection of natural heritage features, and ensure that adverse impacts of aggregate operations on the environment are minimized	e Administer and enforce all terms and conditions of the Development Permit.	As a participant in the SLC, review the results of work done to meet the conditions of the PTTW and provide comments and recommend changes, if required.	As a participant in the SLC, review the results of work done to meet the conditions of the ECA and provide comments and recommend changes, if required.	As a participant in the SLC, review the results of work done to meet the conditions of the ECA and provide comments and recommend changes, if required.	As a participant in the SLC, review the results of work done to address any complaints and provide comments and recommend changes to the response actions taken, if required.	As a participant in the SLC, review the results of work done to address any complaints and provide comments and recommend changes to the response actions taken, if required.	NEC may be consulted by the GSCA to review technical material related to monitoring programs or mitigation measures.	
<b>Grey Sauble Conservation Authority</b> ( <b>GSCA</b> ) Contact: Community Relations Coordinator: Phone Number: (519) 376-3076	As a participant in the SLC, review the results of the environmental monitoring program in the AMP and provide comments and recommendations for changes, if required.	e As a participant in the SLC, ensure compliance with the Development Permit by reviewing the results of the environmental monitoring program in the AMP and provide comments and recommend changes, if required. GSCA may be consulted by the NEC to review technical material related to monitoring programs or mitigation measures.	As a participant in the SLC, review the results of work done to meet the conditions of the PTTW and provide comments and recommend changes, if required. GSCA may be consulted by MOE to review material submitted in support of a new PTTW in the context of the Conservation Authorities Act.	As a participant in the SLC, review the results of work done to meet the conditions of the ECA and provide comments and recommend changes, if required. GSCA may be consulted by MOE to review material submitted in support of a new ECA in the context of the Conservation Authorities Act.	As a participant in the SLC, review the results of work done to meet the conditions of the ECA and provide comments and recommend changes, if required.	As a participant in the SLC, review the results of work done to address any complaints and provide comments and recommend changes to the response actions taken, if required.	As a participant in the SLC, review the results of work done to address any complaints and provide comments and recommend changes to the response actions taken, if required.	Shall ensure the operator complies with access agreements put in place to allow access to lands owned by the Grey Sauble Conservation Authority to monitor environmental receptors as per the AMP. Work in partnership with other agencies to manage GCCA lands .	
<b>Township of Georgian Bluffs</b> Contact: Township Clerk Phone Number: (519) 376-2729									
County of Grey Contact: County Clerk Phone Number: 1-866-266-7569 Grey Association for Better Planning (GABP) Contact: Bill Celhoffer Phone Number: 519-794-2860 Coalition on the Niagara Escarpment (CONE) Contact: Phone Number: (905) 257-4585 e-mail: cone@niagaraescarpment.org Saugeen Ojibway Nation (SON) Contact: Chief Vern Roote (Saugeen First Nations); Chief Arlene Chegahno (Chippewas of Nawash) Phone Number: 1-800-680-0744 email: contactadmin@saugeenfirstnation.ca Métis Nation of Ontario Phone Number: 1-800-263-4889 Member(s) of the General Public Selected to Serve on the SLC Phone Number: TBA	Responsible for electing one representative from ea Reference after reviewing and providing comment of by the AMP. The committee will be respon	ach group to participate in the Stakeholder's Liaison Co on the first draft prepared by HSCL and presented durin nsible for reviewing annual reports for the New Keppel C	mmittee (SLC). The Committee would still function if ng the first meeting. The purpose of the SLC will be Quarry and comparing the results to regulatory require Recommendations made by the SLC that are consid	one or more of the groups declined to send a repres to encourage information sharing so that input may b ements; and will make recommendations to HSCL on lered fair and meaningful will be given honourable co	entative. HSCL will be responsible for establishing ar the considered from agency and stakeholder organizat how to improve monitoring programs, as required. T insideration by HSCL in light of their business plan. T	nd administering the SLC. The SLC will be an adviso tions regarding the operation of the New Keppel Qua The committee will also have the freedom to bring for The committee shall meet at least two times per year.	rry group to the operator. The committee will be requi rry. The SLC will be asked to review the results of the ward any other operational matter for discussion with	ired to appoint a co-chair, and will affirm the Terms of e monitoring programs and mitigation measures used HSCL and other members of the committee.	





# KEY INDICATORS FOR WATER RESOURCES MONITORING PROGRAM

## Key Indicators of the Bedrock Groundwater System

### Key Indicator: Quarry Face Fractures

The purpose of monitoring fractures in the face of the New Keppel Quarry is to observe any interaction with the epikarst zone of the bedrock groundwater system. One of the key moments to inspect the face of the quarry will be immediately after a blast. The intent is to ensure that the quarry does not interfere with potential epikarst pathways that might otherwise deliver water to surface water features such as springs found in the Shouldice Wetland (s8 and s13). Currently, the existing Keppel Quarry shows signs of groundwater inputs in the form of minor leakage and wetted surfaces (MTE 2010a). However, If high flows are observed (e.g. turbulent) or if discharge pumping is at maximum allowable rate under the PTTW and is still unable to manage inflows, then this may be an indication that water is being intercepted from surface water features such as springs found in the Shouldice Wetland (i.e. s8 and s13).

These fractures will be most active during spring melt periods and after heavy precipitation events. Visual inspection of the quarry faces during these times will be important for collecting the information required.

### *Key Indicator: Shouldice Wetland Spring Flows (s8 and s13)*

Spring s8 is located along the edge of the Shouldice Wetland approximately 500m northwest of the proposed extraction area for the New Keppel Quarry (Figure 3). Spring s13 is located approximately 420 m southwest of the proposed extraction area on Lot 26, Concession 9 (Figure 2).

The localized epikarst flows from the bedrock groundwater system has been identified as the unit that directs water to the area of spring s13 (Cowell, 2009). As a result, this feature is a potential target if fractures are observed channeling turbulent water into the New Keppel Quarry. Monitoring flows at s13 will ensure that the New Keppel Quarry is not interfering with epikarst pathways to these locations.

Groundwater to s8 likely receives some contribution from epikarst; however, the glacial deposits immediately adjacent to this spring have also been identified as a source. The research undertaken indicates that this spring will not be impacted by quarrying; however, s8 will be monitored and treated similarly to s13 in the event of high flows into the quarry along fractures.

## Key Indicator: Groundwater Levels and Groundwater Vertical Gradients

MTE has been monitoring groundwater levels in the shallow and deep bedrock using observation wells since 2004, so a database has been created showing background conditions at many locations in the Study Area. This database will be expanded during the first several years of the life of the New Keppel Quarry as Area 1A is being completed. This data has been useful for depicting the range in seasonal fluctuations
such as seasonal highs, lows, and averages and will be useful for comparison to groundwater levels measured when the New Keppel Quarry is operating. Groundwater levels measured at observation wells will continue to be measured monthly before and during extraction.

The number of observation wells will be increased prior to extraction occurring. Proposed observation wells (OW61 through OW71) are shown on Figure 2. It should be noted that OW62 and OW71 were installed in April, 2011. These locations were chosen to fill in gaps so that monitoring lines (lines 1 through 9) could be established that will track future drawdown to the north, west and south of the New Keppel Quarry.

To augment the manual monthly measurements, data loggers will be installed in critical observation wells including: OW8s, OW8d, OW9s, OW9d, OW12s, OW12d, OW13s, OW13d, OW33s, OW33d, OW45, OW47s, OW47d, OW51, OW67s, OW67d, OW71K, OW71s, and OW71d. These wells have been identified as 'Sentry Wells' because they are located along the boundary where water level impacts due to the cone of influence of the quarry are not expected to occur (Figure 3). Data loggers will be programmed to measure a water level every 8 hours. At a minimum, data loggers will be downloaded and reviewed monthly, however, downloads and review may occur on a more frequent basis depending on the results of the AMP. This greater frequency of water level measurements at these locations will provide data to show that the cone of influence is not migrating further than predicted. As noted by MNR in their October 1, 2010 correspondence, a greater frequency of water levels at these critical locations is required in order to detect changes related to precipitation and pumping records during trigger exceedences.

Groundwater levels measured from observation wells are also used to calculate vertical hydraulic gradients to evaluate the potential for vertical movement of groundwater from the shallow to the deep bedrock or vice versa. Trends will be monitored on a monthly basis, while extraction is occurring, as an indicator of the performance of the groundwater systems while the quarry is operating. More frequent measurements will be obtained using the data loggers at the Sentry Wells. Groundwater levels and vertical gradients are expected to change near the face of the New Keppel Quarry (less than 400 m), but beyond this distance, they are expected to remain comparable to background conditions.

#### Key Indicator: Cone of Influence

The shape and size of the observed cone of influence compared to the predicted cone of influence shown on Figures 62, 63 and 64 of the MTE 2009 report is indicative of the New Keppel Quarry's impact on groundwater resources. Figure 63 (MTE 2009) shows a predicted cone of influence for the New Keppel Quarry at its maximum size. For convenience, this figure has been re-published in this report as Figure 4. On the west and south sides of the New Keppel Quarry, the groundwater contours are fairly evenly spaced and form concentric rings. For example, if groundwater patterns around the New Keppel Quarry show deviations, then this irregularity could indicate that

preferential groundwater flow paths have been intercepted. These preferential flow paths may indicate the presence of a new or unknown water-bearing fracture.

Likewise, if the size of the observed cone of influence is larger than anticipated, then potential impacts associated with the effect of the New Keppel Quarry on groundwater resources will need to be reassessed. Mitigation measures associated with changes to seasonal water levels, changes to vertical gradients, unexpected size and shape of the New Keppel Quarry's cone of influence, and excessive pumping from the New Keppel Quarry due to interaction with a large water-bearing fracture are discussed in Section 4.0.

The cone of influence for the New Keppel Quarry (Figure 4) is expected to extend a maximum of approximately 400 m for the edge of the quarry face. Observation wells installed in the deep bedrock will be used to verify the shape and size of the cone of influence while the quarry operates. The cone of influence for the shallow bedrock groundwater is expected to be much less extensive and only extend on the order of 40 m beyond the quarry face (MTE, 2009). Observation wells installed in the shallow bedrock will be used to verify its size while the quarry operates.

Figure 4 shows three zones where the cone of influence is predicted to have varying degrees of impacts to water levels in the deep bedrock:

- Zone 1 is where water levels are expected to show the largest impact (from 4 to 10 meters). This zone extends 100 m to 300 m from the edge of the existing quarry, 200 m on average.
- Zone 2 is where some drawdown is expected but not as much; from 0 to 4 m. The boundary for Zone 2 extends to the groundwater divide 310 m west of the New Keppel Quarry, with a boundary of approximately 400 m on average.
- Zone 3 is expected to show water levels that are comparable to background conditions and so no measurable impact is expected in this zone.

Upon commencement of extraction, the cone of influence will be monitored using water levels measured at the observation wells. This data will be used to map the cone of influence on a monthly basis. In addition, distance-water elevation plots will be used to track future drawdown to the north, west and south of the New Keppel Quarry along monitoring lines 1 through 9 shown on Figure 3. Future drawdown will be compared line to line and zone to zone to verify predictions and also trigger mitigation measures (if required) to ensure protection of natural heritage features.

#### Key Indicator: Water Management Issues

Dewatering pumping records will indicate if the face of the quarry intercepts a large water-bearing fracture. If excessive amounts of water are observed in exceedence of typical volumes pumped during the time of pumping then this anomaly may indicate that a water-bearing fracture has been intercepted, which may require mitigation before water management issues arise. A digital flow meter was incorporated into the

dewatering system at the existing Keppel Quarry in 2010. This type of flow meter will also be incorporated into the dewatering system at the New Keppel Quarry. This flow meter allows for the retrieval of accurate data.

#### Key Indicators of the Shouldice Wetland

#### Key Indicator: Shouldice Wetland Water Levels

Water level fluctuations in the Shouldice Wetland will be monitored using measurements taken at minipiezometers MP55, MP56, and MP57. Manual monthly measurements will show seasonal trends in water levels fluctuations. Since the Shouldice Wetland is expected to remain outside the cone of influence then water levels will be comparable to background conditions and reflect natural seasonal and year-to-year fluctuations. No significant impact related to the quarry to water levels in the Shouldice Wetland is expected.

#### Key Indicator: Groundwater levels and Groundwater Vertical Gradients

Groundwater levels and groundwater vertical gradients from observation wells in Zone 3 will be important for monitoring the status of the bedrock groundwater system near the Shouldice Wetland (within 200m of the wetland boundary). These wells are expected to exhibit water levels that are comparable to background conditions throughout the life of the New Keppel Quarry because they are expected to remain outside the cone of influence. Measuring water levels will help confirm that seasonal norms are maintained before and after extraction, while vertical gradients will ensure that potential recharge to the wetland is not affected.

Groundwater levels and groundwater vertical gradients from minipiezometers MP54, MP55, and MP57 installed in the wetland deposits will be important for monitoring the vertical movement of groundwater into the Shouldice Wetland. Measuring water levels and the vertical movement of groundwater will help identify changes in the wetland system while extraction is occurring.

Groundwater levels from test pits equipped with standpipes (TP16, TP17, TP18 and TP19) will be important for monitoring groundwater levels in the glaciofluvial overburden materials found on Lot 25, Concession 10. Monitoring groundwater levels in this overburden is important because it has been identified as a potential source of recharge for the Shouldice Wetland springs, particularity spring s8 (Cowell, 2009).

Groundwater levels from OW71k will be used to track water movement in the epikarst unit near the lobe of the Shouldice Wetland encompassing spring s13 and the dugout pond.

An epikarst observation well will also be installed near the OW58 location, and designated OW58k. This well will be installed slightly east of OW58s and OW58d to track water movement in the epikarst unit in proximity to spring s8. The main source of

recharge to this spring is interpreted to be through drainage from the glaciofluvial overburden materials on Lot 25, Concession 10 (Cowell, 2009, WGC, 2009). A secondary source of recharge comes from the adjacent epikarst within the Area of Natural Scientific Interest (ANSI), to the east and northeast of the spring.

#### Key Indicator: Cone of Influence

The cone of influence, as it relates to the Shouldice Wetland, will be monitored while extraction proceeds at the New Keppel Quarry using observation wells along lines 3 through 8. Water levels at the Sentry observation wells as well as those observation wells in Zone 3 will be used to ensure that the cone of influence for the deep bedrock groundwater does not come within 200 m of the Shouldice Wetland, with the exception of the lobe of the wetland encompassing spring s13 where the cone of influence could extend to within 50 m.

The Sentry Wells will act as early warning monitors as they are located on the margin of the predicted cone of influence when the New Keppel Quarry is at its maximum size (Figure 4). Using these observation wells, mitigation measures can be implemented in advance of an adverse effect.

As previously mentioned the cone of influence for the shallow bedrock groundwater is expected to be less extensive than that for the deep bedrock and only extend on the order of 40 m beyond the quarry face (MTE, 2009). As a result, impacts associated with the cone of influence for the shallow bedrock are not expected. Nevertheless, observation wells OW25s, OW27s, OW58s, OW59s, OW60s, OW68s, OW69s, OW71s, and OW70s will be used to confirm that the cone of influence for the shallow bedrock does not advance under the Shouldice Wetland, while the Sentry Wells will act as early warning devices. It should be noted that OW68s, OW69s and OW70s are proposed locations and planned to be installed prior to extraction.

#### Key Indicator: Flow Conditions at Shouldice Wetland Spring s8

Two springs along the Shouldice Wetland have been identified as flowing springs (Spring s8, and s9). The main source of recharge to these springs is interpreted to be through drainage from the glaciofluvial overburden materials on Lot 25, Concession 10 (Cowell, 2009, WGC, 2009). A secondary source of recharge comes from the adjacent epikarst within the Area of Natural Scientific Interest (ANSI), to the east and northeast of the spring. Only flows at spring s8 are considered a key indicator because s9 stops flowing by mid-spring (MTE, 2009). In contrast, s8 was observed flowing into the summer.

Given the setback distance from the extraction area of the New Keppel Quarry (>500 m) and the fact that water contributions to s8 appear to be from local shallow groundwater in areas that will remain undisturbed (Cowell, 2009), it is anticipated that there will be no potential for impacts related to the New Keppel Quarry. As a precaution however, flow characteristics will be obtained through the long-term monitoring program.

Since spring s8 discharges below the wetland surface, flow rates cannot be measured without the construction of a concrete structure around the spring, which would be intrusive to the wetland. As a result, flow characteristics at spring s8 will be detailed using 'flow', 'no apparent flow', 'dry' observations in combination with temperature and specific conductivity measurements. As noted by the MNR in their correspondence dated October 1, 2010, a very minimal flow would constitute a 'flow' yet may not be adequate to maintain the function of the wetland. However, to ensure that spring s8 will be fully monitored a minipiezometer will be installed into the discrete fracture where spring s8 is observed flowing from. A data logger will be installed in the minipiezometer and programmed to measure a water level every eight hours. Using a data logger in spring s8 to detect changes in head caused by flowing conditions will define its hydroperiod. In addition, water levels measured at observation wells OW58s, OW58d, OW59s, OW59d, OW60s, OW60d, as well as, minipiezometers MP55, MP56, and MP57 will be used to relate the water levels in the wells to flow observations. То augment this data, temperature and specific conductivity measured at the minipiezometers will help differentiate inputs from groundwater and surface water to further our understanding of this feature's performance.

#### Key Indicator: Flow Conditions at Spring s13 and the Dugout Pond

As previously mentioned, spring s13 and the dugout pond are located approximately 420 m southwest of the extraction area for New Keppel Quarry on Lot 26, Concession 9 (Figure 3). The dugout pond is sustained by snowmelt, rainfall, and groundwater inputs from spring s13 (up to 2L/s), and to a lesser extent from other smaller springs east of the dugout pond. A poorly defined stream channel is present about 70 m downstream from the pond that eventually merges with Park Head Creek, located 800 m to 900 m southwest of the dugout pond. Trigger values for the s13 spring and the dugout pond are provided in Appendix B.

Current data indicates that spring s13 receives most of its flow during and from local spring snowmelt. Water is directed to the basin occupied by s13 through epikarst predominantly from lands to the east and possibly a minor contribution from the northeast (MTE, 2009 and Cowell, 2009). In previous studies (MTE, 2010), MTE defined a catchment area for spring s13 to be 11.7 ha and showed it extending towards the footprint of the proposed expansion, with 1.5 ha of the catchment area intersected by the quarry's footprint (Figure 1 of MTE, 2010). Based on the results of the dye tracer test (Cowell and Ford, 2011) and the results of the epikarst mapping (Cowell, 2011), the shape of the catchment area has been revised and is shown on Figure 1 of Appendix H. The size of the catchment area remains the same (11.7 ha).

Even though this new catchment area overlaps a small portion of the epikarst drainage area for the proposed expansion, the dye test showed no evidence to suggest that the epikarst/shallow bedrock aquifer in the area immediately southwest of the quarry footprint is connected to spring s13 and the dugout pond. Further investigations of the

epikarst by Cowell (July 29, 2011 and January 13, 2012) helped characterize the epikarst recharge zone which was found to be discontinuous over the entire site and likely topographically defined.

David Webster, in his letter dated Feb 2, 2012, pointed out that potential groundwater impacts to s13 are terminated wherever the epikarst is less well developed or truncated and he concluded that impacts to s13 and the Shouldice Wetland will be minimal to non-existent. That said, MTE agreed that these features should be monitored through the AMP. Given the current understanding, MTE believes that the work done to date is sufficient to ensure adequate protection.

The catchment area overlaps Zone 2 of the predicted cone of influence. This zone is only for the deep aquifer and does not affect the shallow bedrock or epikarst aquifer flow (MTE, 2010). The epikarst aquifer does not receive water from the deep bedrock (Cowell, 2011). Therefore, the potential for the drawdown zone to remove water from spring s13 due to the cone of influence for the deep bedrock is negligible.

Since spring s13 is under water, flow rates at spring s13 cannot be measured without the construction of a concrete structure around the spring, which would be intrusive to the wetland. As a result, flow characteristics at spring s13 will be detailed using qualitative observations such as 'flowing', 'no apparent flow', 'dry'. To ensure that spring s13 will be kept flowing at its natural state a minipiezometer will be installed into the discrete fracture where spring s13 is observed flowing from. A data logger will be installed in the minipiezometer and programmed to measure a water level every eight hours. Using a data logger in spring s13 to detect changes in head caused by flowing conditions will define its hydroperiod. Temperature and specific conductivity will also be measured at spring s13.

A data logger will be installed at the staff gauge in the dugout pond which will be useful for comparison to the water levels collect via the data logger at spring s13. This information will help determine when s13 contributes water to the dugout pond. Temperature and specific conductivity will also be measured at the staff gauge.

#### Key Indicator: Flow Conditions at the Shouldice Wetland Culverts

There are several culverts (culverts 4 through 7) that allow water to cross under a snowmobile trail constructed at the end of Gun Club road, which runs in a northwesterly direction through the Shouldice Wetland (Figure 2). Monitoring flows through these culverts will help to understand the hydroperiod of the Shouldice Wetland. Due to significant beaver activity at the culvert locations, only 'flowing', 'no apparent flow', 'dry' observations coupled with observations on the extent of beaver activity can be made at each culvert.

#### Key Indicator: Beaver Dam and Sinkhole

The Beaver Dam sinkhole is located approximately 850 m north of the New Keppel Quarry. It is a discrete karst feature that is connected to springs s1-s3 in The Glen Management Area. This feature serves to drain the northeast lobe of the Shouldice Wetland during peak recharge periods. The function of this sinkhole will not be impaired given its distance away from the New Keppel Quarry. However, due to its hydraulic connection to other features in the area, namely the springs in The Glen Management Area, monitoring flows at the Beaver Dam in association with the flows at the springs will be important to ensure there is no significant impact to the springs related to the quarry.

#### Key Indicators of the Glen Management Area

#### Key Indicator: Groundwater levels and Cone of Influence

Groundwater levels from observation wells along lines 1 and 2 will be used to monitor the groundwater divide that exists north of the existing Keppel Quarry. Monitoring shifts in the groundwater divide will indicate potential changes to the flows at springs s4 and s5 in advance of measurable impacts. Water levels from these wells will also be used to monitor the cone of influence.

The Sentry Wells that will be used to trigger response will be OW51, OW33s and OW33d because they represent the boundary where water level impacts due to the cone of influence are not predicted to occur (Figure 3). Data loggers will be programmed to measure a water level every 8 hours at these locations. The data loggers will be downloaded and reviewed monthly. A greater frequency of water level measurements will provide data to show that the cone of influence is not migrating further than predicted.

#### Key Indicators: Flow Conditions at Glen Management Area Springs s1-s3, Mud Creek and the Beaver Dam Sinkhole

Springs s1-s3 emanate from the base of the Amabel Formation of the Niagara Escarpment (Figure 2). Spring s3 is the largest spring of this set and has the longest hydroperiod. Mud Creek originates from springs s1-s3 and there are two channels; Channel A, the main channel, and Channel B, a secondary channel that tends to have intermittent flows.

Since springs s1 and s2 emanate through talus they cannot be measured without the construction of a concrete structure around the springs, which would be intrusive to the Glen Management Area. As a result, flow characteristics at springs will be described using 'flowing', 'no apparent flow', 'dry' observations in combination with flow rates measured downstream at channel A. Changes in flows at channel A will be used in combination with flows from the springs to indicate if the wetland system downstream is receiving flows comparable to historical conditions.

Flow rates from spring s3 can be measured using estimates derived from velocity – cross-section measurements. This method will provide quantitative estimates of the flows from the spring.

Temperature and specific conductivity will also be measured at springs s1-s3 to differentiate inputs from groundwater and surface water. Flow measurements from these springs will be compared to flow observations into the Beaver Dam Sinkhole so that comparisons can be made with respect to their hydroperiod and chemistry.





# **ECOLOGICAL MONITORING PROGRAM**



#### ECOLOGICAL MONITORING PROGRAM

The monitoring of select ecological features includes both terrestrial and wetland communities, to incorporate abiotic monitoring factors with biotic responses to the aggregate extraction and quarry operations. Ecological monitoring will be focused on features in the woodlands of the Area of Natural and Scientific Interest (ANSI), the Shouldice Wetland and the upper Glen Management Area.

<u>Terrestrial</u> ecological environmental monitoring will be focused on two primary ecological receptors:

- Woodland tree health, regeneration and flora biodiversity
- Woodland breeding bird activity

The forest tree health, regeneration and flora species diversity monitoring shall incorporate aspects from two standard protocols methodologies described in the following:

- a. Environment Canada: EMAN Monitoring Protocols and Standards, 2004 and 2006 Threshold Indicator.
- b. Ministry of Natural Resources: Vegetation Sampling Protocol, 2011

<u>Wetland</u> ecological environmental monitoring will be focused on two primary ecological receptors:

- Wetland flora biodiversity
- Wetland benthic macro-invertebrates

#### 1. Terrestrial

Two generalized terrestrial 'ecological monitoring areas' (EMA) are represented on Figure No. 5, Ecological Monitoring Network. The three primary woodland monitoring plot areas comprise the EMA-1 network located within the woodlands north of the north licence boundary, with each primary plot having subplots and sampling quadrates. One primary plot is located within each of the three hydrogeological 'predicted groundwater flow pattern' (Figure No. 4), that of Zone 1 being 4-10m predicted drawdown, Zone 2 being 0-4m predicted drawdown and Zone 3 being No Impact predicted. The woodland breeding bird monitoring comprises EMA-2 network situated within the ANSI designated woodlands north of the north licence boundary. Two parallel transect lines represent the centre line of the point count stations with the southern transect line 200m north of the north licence boundary and the second transect line 400m north of the north licence boundary:



#### I. EMA-1: Woodland Tree Health

Forest tree health data shall be collected within three permanent/fixed 20m x 20m vegetation monitoring plots, located north of the quarry licence north boundary. All sampling plots shall be within undisturbed woodland environments with one plot for each of the hydrogeological mapping of predicted groundwater flow patterns, of Zones 1, Zone 2 and Zone 3. Data Collection shall include:

- a. Diameter and species of all trees > 10cm diameter at breast height (dbh)
- b. PSLCentage cover of the dominate plant species in four vertical layers (0 to 0.5m, 0.5m to 2m, 2m to 10m and > 10m)
- c. Stand Basal Area (sq. meters/ha), taken from the plot center point
- d. The height of 3 average upper canopy trees
- e. Crown classification and rating
- f. Downed and standing woody debris, noting lengths, orientation, degree of decay.
- g. Photographic evidence taken from each Plot corner looking towards the plot center point.
- h. All four corner points for each main plot are to be fixed with permanent markers, with handheld GPS coordinates.
- i. Any additional observations on site conditions, SAR Species, invasive species and site disturbances shall be recorded.
- II. EMA-1: Woodland Regeneration

Regeneration surveys shall be conducted within five permanent/fixed, 2m x 2m subplots, with four subplots located 2m outside the main 20mx20m plot and the fifth within the main plot at its center point. Subplots shall be established where no trees >10cm dbh presently occur. Data Collection shall include:

- a. Sampling all tree seedlings and saplings species <10 cm dbh.
- b. Species and numbers within each of the five seedling height classes (16-35cm, 36-55cm, 56-75cm, 76-95cm, 96-200cm).
- c. Photographic evidence taken from a single/fixed vantage point in each subplot corner.
- d. The four corners of each subplot shall be fixed with permanent markers.



#### III. EMA-1: Woodland Flora Species Diversity

Data on flora species diversity for forest floor ground cover shall be collected within the five Woodland Regeneration plots as permanent/fixed 1mx 1m quadrates, located within the five subplots. Data collection shall include:

- a. Full vascular plant species listing and pSLCent composition of the four main species.
- b. Any additional observations, such as the presence of any Species at Risk (SAR).
- c. For each of the four 2m x 2m subplots, one corner shall be identified and marked as a fixed corner of the species diversity 1m x 1m quadrate.
- IV. EMA-2: Woodland Breeding Birds

A breeding bird survey within the forest interior (ANSI designated woodland feature) habitat shall be undertaken in accordance to Ontario Breeding Bird Atlas Protocols, with a minimum of 2 site visits, 15 days apart in the month of June.

- a. Eight permanent/fixed center points for the breeding bird point counts shall be established by following two parallel transect lines spaced 200m apart, north and parallel to the north licence boundary. Commencing on County Road 17 the first transect line shall be 200m north of the licence boundary, with the first point count center point 100m in from County Rd. 17 and the subsequent next 3 point count center points spaced 100m apart along transect line 1 (four point counts along line 1 in total). Transect line two shall be 200m north of transect line 1, with the first point count center point located 150m in from County Rd 17 and the subsequent next 3 point count center points spaced 100m apart along transect line 2.
- b. Each point count shall be monitored for 5 minutes with all bird species noted at the highest breeding code level.



#### 2. Wetland

The wetland community response to the quarry operations shall be monitored through several aspects and at several different locations. Four generalized ecological monitoring areas (EMA) locations are represented on Figure No. 5, Ecological Monitoring Network:

- > EMA-3 The Glen area s1 to s3 groundwater discharge feature.
- EMA-4 the Shouldice Wetland at the s8 and s9 groundwater discharge feature.
- EMA-5 the Woodland Ephemeral Pond amphibian breeding surface water feature.
- EMA-6 the Shouldice Wetland lobe at s13/Dugout Pond and the upper headwater channel for the East Branch of Park Head Creek.

#### I. EMA-3

a) Flora Species Diversity:

Within the wetland community immediately downstream of s1-s3 discharge areas, two permanent/fixed 1m x 1m plots shall be established to monitor vascular plant composition and wetness index through a full species listing, with photographic evidence of each plot at time of inspection.

- II. EMA-4
  - a) Groundwater discharge feature

Data collection shall be in accordance to surface water monitoring outlined in the Water Resources Monitoring Program, Table 2.

b) Flora Species Diversity

Within the wetland community fronting s8-s9 discharge areas, two permanent/fixed 1m x 1m plots shall be established to monitor vascular plant composition and wetness index through a full species listing, with photographic evidence of each plot at time of inspection.

b) Anuran Monitoring Survey

An Anuran Monitoring Survey shall be completed in accordance with Bird Studies Canada-Marsh Monitoring protocols at this location.



#### III. EMA-5

a) Surface water feature

Data collection shall be in accordance to surface water monitoring outlined in the Water Resources Monitoring Program, Table 4.

b) Amphibian Breeding Activity

An assessment of amphibian egg masses being 'present or absent' shall be noted during the active egg laying period of May, with photographic evidence of ephemeral pond conditions and typical egg mass observation, at time of inspection.

c) Anuran Monitoring Survey

An Anuran Monitoring Survey shall be completed in accordance with Bird Studies Canada-Marsh Monitoring protocols at this location.

- IV. EMA-6
  - a) Flora Species Diversity

Within the wetland lobe knows as 's13', four permanent/fixed 1m x 1m plots shall be established to monitor vascular plant composition and wetness index.

- i. Along the wetland/upland transition area to the dug-out pond environment, two permanent plots 1m x 1m shall be established, with a minimum 10m separation between the plots.
- ii. Within the downstream channel, two permanent plots being 1m square in area, encompassing both in-stream aquatic vegetation and immediate bank channel vegetation shall be established, with a minimum 10m separation between the plots, in an area of stable channel conditions.
- iii. Data collection shall include a full vascular plant species listing and pSLCent composition of the four main species within each plot.
- iv. For the two stream channel plots additional data collection shall include: water depth, hydraulic head, water temperature and general water clarity/turbidity.
- v. Photographic evidence taken from one single/fixed corner for each plot.
- vi. All four corner points for each plot are to be fixed with permanent markers.
- vii. Additional observations notes on alga, SAR species, and site disturbances.



b) Macro-Invertebrate Diversity

Within the wetland dug-pond area and within the downstream stream channel environment, a macro-invertebrate sampling shall be completed according to Provincial rapid assessment protocols. Macro-invertebrate sampling shall include:

- i. Sampling within the dug-pond environment with a long-handled dip net having 500 micron mesh using a full sweeping motion through the aquatic vegetation and upper sediment layer. A minimum target number of 50 invertebrates shall be sought or a minimum of 10 sampling sweeps if <50 invertebrates collected.
- ii. Sampling within the outlet stream channel with a 1m square 500 micron mesh net following a 'kick and sweep' method of the stream environment. A minimum target number of 50 invertebrates shall be sought or a minimum of 4 sampling station completed if <50 invertebrates collected.
- c) Anuran Monitoring Survey

An Anuran Monitoring Survey shall be completed in accordance with Bird Studies Canada-Marsh Monitoring protocols at this location.

#### 3. Frequency and Data Analysis of Ecological Monitoring

- EMA-1, woodland vegetation data collection (tree health, regeneration and flora diversity) shall be undertaken in Year 1, 2, 3 after licence issuance and then every 3 years thereafter throughout the active quarry operational life span. Data collection shall occur during the full leaf-out period between June 15 and August 31. Data analysis shall include a review of that years sampling and a comparative review to historical data for demonstration of trends and potential response to abiotic functions.
- II. EMA-2, woodland breeding bird data collection through point counts shall be undertaken in Year 1 and 3 after license issuance and then every 3 years thereafter throughout the quarry operational life span. Data collection shall occur between May 24 and July 10 with a minimum 15 day separation between site visits. Data analysis shall include a review of that years sampling and a comparative review to previous year's data for possible association to habitat condition trends.



- III. EMA-3, flora diversity monitoring shall be under taken every two years commencing in Year 1 after the license issuance, throughout the quarry operational life span. Data collection shall occur during the full leaf out period between June 15 and August 31. Data analysis shall include a review of that year's sampling results for flora species wetness index in accordance to the Ministry of Natural Resources 'Southern Ontario Floristic Quality Assessment System'. Comparison shall also be made to previous year's results for demonstration of trends and potential response to abiotic functions.
- IV. EMA-4, flora diversity monitoring shall be under taken every two years commencing in Year 1 after the license issuance, throughout the quarry operational life span. Data collection shall occur during the full leaf out period between June 15 and August 31. Data analysis shall include a review of that year's sampling results for flora species wetness index in accordance to the Ministry of Natural Resources 'Southern Ontario Floristic Quality Assessment System'. Comparison shall also be made to previous year's results for demonstration of trends and potential response to abiotic functions.
- V. EMA-5, ephemeral pond feature shall be monitored annually, during the active amphibian egg laying period of May. Surface water monitoring data shall be collected annually, during the months of April, May and June with maximum water depth recorded at a fixed location. The annual Anuran survey shall include 3 monitoring site visits; late April, late May and late June in accordance with Bird Studies Canada-Marsh Monitoring protocols.
- VI. EMA-6, wetland vegetation and macro-invertebrate data collection shall be undertaken in Year 1, 2 and 3 after license issuance and then a minimum of every 2 years thereafter throughout the quarry operational life span if the proposed infiltration pond is not used as a mitigative measure for the lobe of the Shouldice Wetland encompassing spring s13 and the Dug-out pond. However, if the infiltration pond is required to augment flows to spring s13/the dugout pond, then data collection shall occur annually while the infiltration pond is actively used. Data collection shall occur during the full leaf out period and typical mature macro-invertebrate life stage period between June 15 and August 31. Data analysis shall include a review of that year's sampling results for flora species wetness index in accordance to the Ministry of Natural Resources 'Southern Ontario Floristic Quality Assessment System'. Comparison shall also be made to previous year's results for demonstration of trends and potential response to abiotic functions.



#### 4. Triggers

The Ecological Monitoring Program outlined above will be used to collect baseline data. This program is the minimum allowable frequency and scope of ecological monitoring. It will continue throughout the life of the quarry and rehabilitation phase. No additional ecological actions will be required if ecological receptors do not display any adverse impacts, the ecological features/functions remain within anticipated normal parameters and the Water Resources Monitoring Program and/or Ecological Monitoring Program reveals <u>no trigger exceedences</u>.

As per the Memorandum of Agreement between SON and HSCL signed on July 31, 2014, baseline data shall be collected during year one of the Ecological Monitoring Program and reported on in the first annual report. Year one reporting shall be considered "normal" for flora community diversity and be used to establish trigger threshold levels for comparison to future monitoring results. Baseline data collection shall be undertaken during late spring and late summer period.

#### **Green Action**

In the event the Water Resources and/or Ecological Monitoring Program reveal a <u>green</u> <u>trigger exceedence</u>, the Ecologist/Biologist will be informed, but no changes will be made to the Ecological Monitoring Program. No additional actions are required because the ecological health of the natural features has not been negatively impacted and water levels are still above historical seasonal lows.

#### Yellow Action

A "Yellow Action" precautionary mitigation response is triggered if:

- 1. The Water Resources and/or Ecological Monitoring Program has revealed a <u>yellow trigger value exceedence</u> that can be attributed to the quarry operations; and/or
- 2. Early indicators of ecological impacts are observed that can be attributed to the quarry operations and can be corroborated with changes in the hydrogeologic regime.

A Yellow Action will include an internal interdisciplinary review of all monitoring programs, which could recommend changes to the Ecological Monitoring Program (i.e. more frequent site visits to collect more information), additional investigative works, further analysis of abiotic factors, possible creation of a new ephemeral pond to mitigate negative impacts to EMA-5 ephemeral pond monitoring site, and/or mitigative measures to the New Keppel Quarry ARA Site Plan.



#### **Red Action**

A "Red Action" immediate response is triggered if:

- 1. The Water Resources and/or Ecological Monitoring Program has revealed a <u>red</u> <u>trigger value exceedence</u> that can be attributed to the quarry operations;
- 2. Evidence of negative ecological impacts are observed that can be attributed to the quarry operations and can be corroborated with changes in the hydrogeologic regime; and/or
- 3. The mitigative measures initiated during the Yellow Action failed to correct or reverse the impact.

Quarry operations will cease until signoff is obtained from the MNR indicating the quarry may restart. An internal interdisciplinary review of all monitoring programs and Yellow Action activities to date shall be undertaken. The review might recommend significant changes to the Ecological Monitoring Program (i.e. expanded number of monitoring sites), the ARA Site Plan and/or the augmentation of flows to natural features to ensure all ecological impacts are addressed.

#### 5. Forest Restoration and Woodlot Expansion

Forest restoration works are planned post extraction, as part of the Quarry Rehabilitation (see Drawing 6 of the ARA Site Plans entitled "Progressive Rehabilitation and Final Rehabilitation Plans" and Drawing 7 entitled "Cross-Sections & Details" for the rehabilitated shoreline design) along the north extraction boundary, adjacent to the ANSI setback. The objective for this area of rehabilitation is to establish a natural landscape feature linkage or a diverse 'woodland edge' between the native woodlands and the open water quarry environment. This area shall function as a 'transitional zone' providing wildlife habitat and supporting woodland ecological functions such as flora forage species, cover habitat, reptile basking habitat and a shallow water marsh community.

The shallow water aquatic vegetation will seed-in and establish itself naturally, post the topsoil placement and final water level establishment. Within this immediate shoreline zone, boulders, logs and stumps shall be strewn above and below the final water level line to function as basking features and cover habitat. Tree and shrub planting shall occur throughout the northerly disturbed uplands, commencing 2m beyond the water line edge to the north license boundary. Tree and shrub species, sizes and planting density are noted on the Drawing 7 of the ARA Site Plans entitled "Cross-Sections and Details", with planting density lower than typical reforestation targets, to maintain a semi-open canopy cover promoting natural establishment of dense groundcover (herbs and forbs) growth and diversity.



The Woodland Expansion or reforestation plan shall commence a minimum of 2 years prior to land clearing activity occurring within Extraction Area 1B. The woodland expansion lands are shown on Drawing 5 of the ARA Site Plans entitled "Progressive Rehabilitation and Final Rehabilitation Plans", with two areas delineated for tree planting. The objective for the two tree planting areas is to rehabilitate the former old field environments to natural woodlands and creating/expanding woodland linkages to other features or off-site woodlands. Tree planting sizes, species and planting density are noted on Drawing 7 of the ARA Site Plans entitled "Cross-Sections & Details", with planting targets set at Provincial standards for natural woodlands to promote native forest cover and associated woodland-wildlife ecological functions.

- I. Forest Restoration Monitoring
  - a. Survival rates of tree and shrub planting shall be assessed annually for five consecutive years post planting, through numeric counts within two 10m square plots. As noted on Drawing 4 of the ARA Site Plans entitled "Consultant Recommendations" (point 1.10), a survival target rate of 80 percent shall be maintained, with any annual assessment falling below this threshold level, then tree/shrub mortalities are to be replaced in that year.
- II. Woodlot Expansion Monitoring
  - a. Survival rates of tree planting shall be assessed annually for three consecutive years post planting, then every three years until the planting stand has reached an age of 12 years through numeric counts within 10m square plots at 2 plots/ha. As noted on Drawing 4 of the ARA Site Plans entitled "Consultant Recommendations" (point 1.10), a survival target rate of 80 percent shall be maintained, with any assessment falling below this threshold level, then tree mortalities are to be replaced in that year. After 12 years, monitoring frequency shall be every 5 years throughout the Quarry operational period. Monitoring activity within the four tree planting areas post 12 years of age, shall follow provincial standard forest sampling methodology for basal area calculations (prism sweeps), tree canopy height and presence (qualitative observation) of tolerant hardwood understory regeneration. Target levels for woodlot expansion are a basal area of 15 m. square/ha, a canopy height of 10m and tolerant hardwood regeneration of 25%.

All of which is respectively submitted,

n p/2

John Morton, Pres. AWS Environmental





# TREE PRESERVATION PLAN



#### TREE PRESERVATION PLAN (TPP)

Along County Road 17 and Concession Road 10, there are three zones of existing trees that will be maintained as part of the Tree Preservation Plan (TPP) for the New Keppel Quarry. These zones, hereby referred to as the TPP Corridor, are to be preserved so that the New Keppel Quarry has sufficient visual screening and buffering along County Road 17 Concession Road 10. Figure 6 of the AMP shows the location of the TPP Corridor. ARA Site Plan Drawing 2 entitled "Sequence of Operations" and ARA Site Plan Drawing 8 entitled "Landscaping Details" identifies the TPP Corridor as the "Existing Forest Setback".

- Zone 1 of the TPP Corridor is the front line of existing trees in Area 1A as per the drip line survey by Hewett and Milne Limited⁶. This front line of trees is approximately 5 m wide and serves to protect successive trees, which visual screen Area 1A along County Road 17;
- **Zone 2** of the TPP Corridor is a stand of existing trees that shall remain at least 20 m wide to visually screen Areas 1B, Area 2 and Area 3 along County Road 17;
- **Zone 3** of the TPP Corridor is a stand of existing trees that shall remain at least 30 m wide to visually screen Areas 2 and Area 3 along Concession Road 10.

HSCL understands that, in addition to the New Keppel Quarry, there are natural threats that must be considered when implementing the TPP (i.e. the Emerald Ash Borer [EAB]). HSCL further understands that a large percentage of the TPP Corridor is currently populated by Ash. As such, two protocols - the Tree Monitoring Protocol and the Tree Replacement Protocol - were designed to ensure that neither the New Keppel Quarry nor natural threats (i.e. the EAB) will compromise the health of the TPP Corridor. These two protocols are described in detail below.

#### Tree Monitoring Protocol

The health of the TPP Corridor will be monitored on an annual basis by a qualified professional. The qualified professional will identify "Preservation Trees" in the TPP Corridor.

• A Preservation Tree is a tree found in the TPP Corridor that has a minimum Diameter at Breast Height (DBH) of 15 cm or a minimum crown height 5 m.

The qualified professional shall monitor Preservation Trees for the following:

• Individual tree numbering for long-term identification;

⁶ The Hewett and Milne Limited survey was completed April 27, 2012 in order to define the drip line of the existing trees in Area 1A. This was done to determine the placement of the protective fencing to protect the trees from the extraction. The protective fence is 5 m from the drip line and the excavation is to be 5 m from the fence. Surveying was accomplished using GPS and Total Station equipment.



- Tree species and DBH;
- Number of stems and total tree height;
- Crown class: 1(Dominant), 2(Co-dominate), 3(Intermediate) or 4(Suppressed);
- Percentage live crown;
- Evidence of twig dieback, branch dieback, defoliation, discoloration;
- Evidence of wounds, signs/symptoms of insect infestation, and any other health stressors; and
- Overall growing conditions and general tree health.

Monitoring data shall be collected during the growing season (June 1 to September 15) of each year. Annual reporting shall be used to track and document the health of the TPP Corridor as the New Keppel Quarry develops. The results of the TPP shall be incorporated into the annual ARA Compliance Report and/or the annual report for the AMP. Reporting shall be provided to the CLC for distribution to stakeholders.

Pre-quarry (baseline) conditions of the TPP Corridor shall be established. Zone 1 and Zone 2 have been partially characterized by Larry T Porter Landscape Architect in a report entitled 'Vegetation Inventory-Impact Assessment and Preservation Method Report' dated July 2014. The vegetation inventory focused on mature trees (>15cm DBH) commenting on the health of the trees, anticipated impacts, and proposed preservation methods. This information will be used to supplement the baseline monitoring data required before extraction proceeds.

Baseline monitoring data in Zone 1 shall be collected prior to any site alterations commencing in Extraction Area 1A. Baseline monitoring data in Zone 2 and Zone 3 shall be collected prior to site alterations in Extraction Areas 1B, Area 2 and Area 3.

#### Tree Replacement Protocol

If monitoring data collected over time shows that the health of Preservation Trees is deteriorating, then they may need to be replaced. The qualified professional shall determine if and when a Preservation Tree(s) needs a "Replacement Tree".

A Replacement Tree is a tree(s) found in the TPP Corridor (planted or natural) counted as a replacement for a lost Preservation Tree. The Replacement Tree(s) shall have a minimum DBH of 15 cm or a minimum cumulative caliper DBH of 15 cm.

The following Tree Replacement Protocol will be used to maintain the health of Preservation Trees.

#### Fair-Health Trees – Replacement Protocol

Preservation Trees are considered "Fair-Health" if they have a Live Crown Percentage between 51% to 75% or show advancing symptoms/signs of health degradation of the



main stem or upper canopy. If monitoring in the TPP Corridor identifies a Preservation Tree in Fair-Health then:

- Implement an action plan within one year to:
  - Encourage the growth of a Replacement Tree(s) by promoting the growth of surrounding immature trees and/or promoting the expansion of the crown of adjacent trees; or
  - 2. If there is no suitable Replacement Tree(s) within 6 m, then plant two native stock saplings (one Deciduous tree [not Ash] and one Coniferous tree) that are at least 1.5 m in height; on each side and in close proximity to the identified Fair-Health tree(s).

#### Poor-Health Trees – Replacement Protocol

Preservation Trees are considered "Poor-Health" if they have a Live Crown Percentage between 36% and 50% or show symptoms/signs of health degradation of the main stem or upper canopy. If monitoring in the TPP Corridor identifies a Preservation Tree(s) in Poor-Health then:

- Implement an action plan within one year to :
  - 1. Determine the effectiveness of any previous efforts implemented to encourage the growth of Replacement Trees (natural or planted); and
  - 2. If Replacement Tree efforts are deemed ineffective, then plant two additional native stock saplings (not Ash), that are at least 1.5 m in height, in close proximity to the identified Poor-Health tree(s).

#### Dying/Dead Trees – Replacement Protocol

Preservation Trees are considered dying/dead if they have a Live Crown Percentage at or below 35%. If monitoring in the TPP Corridor identifies a Preservation Tree(s) as dying/dead:

- Implement an action plan within one year to:
  - 1. Remove the dying/dead tree(s) without harming adjacent Replacement Tree(s), otherwise leave the dying/dead tree standing and remove the upper branches and the tree top for safety reasons;
  - 2. Look for a Replacement Tree(s) (planted or natural) that is at least 15 cm DBH and number them as the new Replacement Tree;



- If Replacement Tree(s) cannot be found, then plant enough saplings in proximity to the dying/dead tree to achieve the cumulative caliper (at least 15 cm DBH) of a Replacement Tree so that the future tree(s) will provide similar buffering and visual screening; and
- 4. Include the Replacement Tree(s) in future monitoring.

Respectively submitted,

R

John Morton, Pres. AWS Environmental





# **BLAST IMPACT ANALYSIS**

### **REPORT ON**

### **BLAST IMPACT ANALYSIS**

#### PROPOSED NEW KEPPEL QUARRY TOWNSHIP OF GEORGIAN BLUFFS (Formerly Keppel Twp) COUNTY OF GREY

Prepared for:

Harold Sutherland Construction (HSC) Aggregate Ltd. 323545 East Linton Road, R. R. #2 Kemble, Ontario N0H 1S0



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#### **Distribution:**

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#### EXECUTIVE SUMMARY

DST Consulting Engineers Inc. was retained by Harold Sutherland Construction Aggregates Limited (HSC) to conduct a blast impact analysis for the proposed New Keppel Quarry (the quarry). The quarry will be operated by HSC Limited of Kemble, Ontario. The quarry is in Parts of Lots 26, 27 and 28, Concession 10, of the Township of Georgian Buffs, in the County of Grey, in the Province of Ontario.

The Blast Impact Analysis report which includes recommended site specific "Blast Design" for the quarry is based on the following:

- Observations made during our site visit carried out on February 12-13, 2012,
- Reviews of drawings :
  - Drawing titled "FIG. 2 PRIVATE WELLS AND SURFACE WATER FEATURES", prepared by MTE Consultants Inc., Environmental Division, March, 2011,
  - o Drawing 1, titled "EXISTING FEATURES", June 8, 2012,
  - o Drawing 2, titled "OPERATIONAL PLAN", June 14, 2012,
  - Drawing 3, titled "SEQUENCE of OPERATIONS", June 13, 2012,
  - Drawing 4, titled "CONSULTANTS RECOMMENDATIONS", June 14, 2012
  - Drawing 5, titled "ADAPTIVE MANAGEMENT PLAN", June 8, 2012,
  - Drawing 6, titled "PROGRESSIVE REHABILITATION AND FINAL REHABILITATION PLANS", June 8, 2012,
  - o Drawing 7, titled "CROSS-SECTIONS AND DETAILS", June 8, 2012, and
  - Drawing 8, titled "LANDSCAPING DETAILS".
- The Ontario Ministry of the Environment (MOE) Guidelines for Blasting in Mines and Quarries,
- Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters, Department of Fisheries and Oceans Canada (DFO), 1998, and

• The worst case scenario for potential blast damage to surrounding structures from blasting operations.

Based on observations made on February 12-13, 2012, the proposed quarry is located across the existing quarry operating under Licence ID 4882. Elevation of the lay-down area will be maintained at +/-230 m. All drilling and blasting operations will be carefully controlled during site production phases to ensure that no damage occurs to nearby third-party buildings, water wells or structures and protection of existing natural environment is maintained.

Vibration prediction calculations for various standoff distances are conducted based on the worst-case scenario and the recommended blast design parameters. The resulting calculations indicate that the <u>initial blasting</u> operations in all proposed licensed areas can be carried out safely at an approximate standoff distance of +/-500 m from the closest receptor or third-party building/structure. Initial blasting in area 1A will commence at a standoff distance of 520 m from the dwelling located at 178717 on Grey County Road # 17 (Receptor #1) to the south. As the blasting progresses to the north in area 1A, the excavation will approach a second receptor located to the north of the area 1A, namely the dwelling located at 178841 on Grey County Road # 17 (Receptor #2) with the closest standoff distance of 620 m from the blasting operations. When extraction commences on the west side of Grey County Road # 17 in proposed areas 1B, 2, and 3 and the extraction progresses to the south and reaches its midpoint, Receptor # 1 becomes the closest third party property and will remain so for the duration of the extraction operations.

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#### 1.0 INTRODUCTION

The proposed New Keppel Quarry (the quarry) is located within Parts of Lots 26, 27 and 28, Concession 10, of the Township of Georgian Buffs, in the County of Grey, in the Province of Ontario. The quarry site can be accessed via Grey County Road # 17 off Grey Road 1. The proposed licensed area consists of approximately 27.1 hectares and the proponent is seeking an Aggregate License Application for a Class "A" Category 2 (Quarry below Water) with a maximum of 600,000 tonnes of annual extraction. The location of the initial blasting (extraction) site is displayed in the Aerial photo in Appendix "A". The proposed extraction will occur in four areas. The initial extraction will commence from the southwest section of the existing Keppel Quarry in the area denoted as "Area 1A" in drawing 2 titled "OPERATIONAL PLAN" where an existing rock-face is present from the previous operations in the Old Keppel Quarry. The extraction in area 1A will primarily proceed in the north and northwesterly directions. The proposed operation will extract Limestone and massive Dolomite rock with relative bulk density of 2.6 and to 2.8-2.9 g/cc, respectively. All site drawings including drawing 2 titled "Operational Plan" showing licensed area 1A, and proposed licensed areas 1B, 2 and 3 are also shown in drawing 2 titled "OPERATIONAL PLAN". Location of existing water-wells and other pertinent information is also shown in the drawing titled "Figure 2 Private Wells and Surface Water Features" attached in Appendix "A". Since surface water features such as Shouldice Wetland are not prone to vibration and noise induced by the blasting, for the purpose of this report they are not considered as receptors.

There are three (3) dwellings (receptors) located in the close proximity of the proposed blasting site. Receptor #1 is located at 178717 Grey County Road #17 (approximate coordinates 44° 37' 52.53" N, 80° 59' 27.56" W) and at an approximate distance of 520 m from the proposed <u>initial blasting</u> site in area 1A and is considered a third-party property. Receptor #2 is located at 178841 Grey County Road #17 (approximate coordinates 44° 38' 26.27" N, 80° 59' 52.68" W) and at an approximate distance of 640 m from the proposed <u>initial blasting</u> site in area 1A and is also considered as a third-party property. Both Receptor #1 and #2 are inhabited. Receptor #3 is located to the south of the proposed quarry and is owned by the applicant, HSC and presently not inhabited, and therefore is not considered a third-party property for the purpose of this report. Blasting parameters in the recommended blast design will consider the closest distance of 520 m standoff distance as the basis for the initial blasting operations. However, as the blasting in area 1A progresses to the north, the standoff distance between Receptor #1 will increase, and the standoff distance between the blast site and Receptor #2 will decrease. The initial extraction phase will be oriented and sequenced so that the

blasting (direction of throw) will predominantly be to the southeast or to the east (Area 1A, drawing #2). When blasting approaches areas 1B, 2 and 3 (drawing #2), the quarry face will be designed and oriented so that the direction of throw will always be to the northwest and west. Blasts will be designed so that the seismic activity (vibrations) and noise induced by the blasting operations will remain well within the Ontario Ministry of the Environment's (MOE) guidelines for blasting in mines and quarries in the province of Ontario.

The Blast Impact Analysis incorporating a suggested blast design recommended later in this report is based on the MOE Model Municipal Noise Bylaw (NPC 119) with regards to Guidelines for Blasting in Mines and Quarries in the province of Ontario. We have also assessed the area surrounding the proposed license application with regards to potential damage to third party properties from blasting operations.

Recommendations are included in this report to ensure that the blasting operations are carried out in a safe and productive manner and to ensure that no possibility of damage exists to any buildings, structures or residences surrounding the proposed quarry site.

Aggregate extraction from the proposed licensed area will be achieved in six phases. Extraction in each phase is described in detail in Section 7 of this report and summarized in Drawing 3 in Appendix A, titled "SEQUENCE of OPERATIONS".

#### 2.0 MOE'S BLAST VIBRATION AND OVERPRESSURE LIMITS PUBLICATION NPC 119

The MOE guidelines for blasting in quarries and mines are amongst the most stringent in North America. Recent studies by the U.S. Bureau of Mines have shown that normal temperature and humidity changes as well as other environmental factors can cause more damage to buildings and structures than blast vibrations and overpressure in the range permitted by the MOE. The limits suggested by the MOE are as follows:

Vibration	12.5	mm/sec	Peak Particle Velocity (PPV)
Overpressure	128	dB	Peak Sound Pressure Level (PSPL)

Cautionary limit for vibrations is 10.0 mm/s for quarries and mines which are not routinely monitored for blast induced vibrations.

For the proposed quarry, it is recommended that each and every blast be monitored for vibration and overpressure.

#### 2.1 Definitions

#### Blast Induced Peak Particle Velocity

The rate of change of the velocity amplitude usually measured in mm/sec or in/sec. This is the excitation of the particles in the ground resulting from vibratory motion induced by the blasting operations.

#### Blast Induced Overpressure

A compression wave in air caused by,

- a) The direct action of the unconfined explosive, or
- b) The direct action of the confining material subjected to explosive loading.

#### 3.0 BLAST VIBRATION AND OVERPRESSURE DATA

Blast vibration and overpressure data used in this report was collected from:

- Blasting in quarries and mines in Ontario.
- The International Society of Explosives Engineers (ISEE) recommended attenuation graph and formula.

Instantel self-triggering digital blasting seismographs were used to collect the data.

#### 3.1 Vibrations

All data was plotted using square-root scaling law for blast vibrations. This composite data, which proven to be quite conservative, has been used as start-up guideline for many quarries in the province of Ontario and until such time when site-specific data is acquired. It is also important to note that, in our professional opinion, it is more important to design the initial blasts for a new quarry based on a conservative formula than unauthenticated and undocumented historical data. The plots showing ISEE recommended graphs and our compiled blast induced vibration data from blasting operations in various quarries and mine sites are shown in Appendix B.

#### 3.2 Overpressure

It is our experience that blast overpressure creates the greatest concern for nearby residents. However, blast induced overpressure is highly variable and influenced by many factors including:

- Orientation of the blast face with respect to the monitoring observation points (Receptors),
- Wind speed and direction,
- Cloud Cover,
- Temperature and/or pressure inversions, and
- Length of blast-hole collar and the material used for stemming.

Due to high dependence of noise and overpressure induced by the blasting on the variables indicated above, it is very difficult to predict peak sound pressure levels induced by the blasting. However, we have outlined the best possible remedial measures to keep the noise and overpressure within MOE's recommended level.

#### 4.0 ALLOWABLE EXPLOSIVE LOAD PER DELAY PERIOD TO CONFORM TO MOE GUIDELINES FOR BLASTING IN MINES AND QUARRIES USING ISEE RECOMMENDED REGRESSION EQUATION

Distance to Receptor	Max. Allowable Explosives/Delay Period
(m)	(kg)
100	19
200	74
300	165
400	291
500	452
600	649
700	879
800	1144
900	1444
1000	1779

#### Blast Vibration Limit – 12.5 mm/s

The closest structure to the quarry during the <u>initial phase</u> of blasting will be approximately 520 m (at Receptor #2). The natural site geometry is so that the distance from the closest receptor to the blast site will increase with the progress of blasting in Area 1A.

#### 5.0 CALCULATION OF PREDICTED VIBRATION LEVELS

The most commonly used formula for predicting PPV is known as the Bureau of Mines (BOM) prediction formula or Propagation Law. This formula is used as a standard rule to predict vibration levels induced by the blasting at a given distance from a source of explosion (blast) and is also adopted by the MOE. Since the attenuation curve recommended by the ISEE is more conservative than the attenuation curve established by MOE and using our own data base, we have used the site constants in the (ISEE) curve to predict the PPV with <u>95% confidence level</u>, at the closest third-party structure for a given explosives load per delay period.

# $PPV_{max} = K [d X w^{-1/2}]^{e}$

Where, PPV = the predicted maximum peak particle velocity (mm/s)

- K, e = site factors
- d = distance from receptor (m)
- w = maximum explosive charge per delay (kg)

The value of site factor K is highly variable and is influenced by many factors (i.e. rock type, geology, thickness of overburden, etc.). Based on the ISEE recommended value the initial estimates for "e" will be set at -1.58 and "K" will be set at 1725 (see Appendix B). In the absence of site-specific vibration data from the quarry, these site factors are used for initial prediction purposes. Based on our experience, in almost all cases, the monitored vibrations are lower than those predicted.

An example of this calculation is as follows:

For a standoff distance of 520 m (i.e. the minimum standoff distance to the nearest receptor, in this case the house located at 178717 Grey County Road #17, denoted by Receptor #1), a maximum explosives weight of 141.9 kg per delay period (for a max. 102 mm diameter hole, max. 15.24 meter deep and a min. 1.2 meter collar), and a one hole per delay period detonation, loaded with bulk emulsion explosives of average loading density 1.25 g/cc, we can predict the maximum PPV at the receptor.

### $PPV_{max} = 1725 [500 X 141.9^{-1/2}]^{-1.58} = 4.42 \text{ mm/s} = 0.17 \text{ in/s}$

As discussed in previous sections, the MOE guideline for blast-induced vibration is 12.5 mm/s (0.5 in/s) peak particle velocity. The calculated predicted PPV of 4.42 mm/s (based on worst- case scenario) at the closest receptor (Receptor #1) is well within the MOE's guideline. Our past experience indicates that site-specific measured vibration levels are generally lower than the calculated predicted levels.

It must be noted that for the initial blasting the amount of explosives per delay period must be kept at or below 141.9 kg. As site-specific vibration data becomes available, the blasting parameters, including the maximum amount of explosives per delay period may be adjusted to suit the site conditions.

It is also important to note that, as the height of the bench increases, decking of explosives columns within the same blast-hole may be required to keep the vibration levels below the MOE guideline level of 12.5 mm/s.

For the purpose of this report, the process of determining the predicted PPV has been repeated for the case when the blasting and excavation approaches the most northerly boundary of Area 1A, where the distance from Receptor #2 will be approximately 308 m. This is the closest blasting operations will ever reach to Receptor #2. In this case, the blast-hole diameter maybe reduced to 89 mm (3.5") from 102 mm (4") in order to reduce the amount of explosives per delay period, or explosives column in each hole can be divided into two decks primed with a delay periods of 25 millisecond (ms) apart. This will subsequently, maintain vibration level to levels below MOE's guidelines. Therefore, a standoff distance of 308 m (i.e. the minimum standoff distance to Receptor #2 on the drawing 2), a maximum explosives weight of 108.7 kg per delay period (for a max. 89 mm diameter hole, max. 15.24 meter deep and a min. 1.2 meter collar), and a one hole per delay period detonation, loaded with bulk emulsion explosives of average loading density 1.25 g/cc, we can predict the maximum PPV at the receptor.

## $PPV_{max} = 1725 [308 X 108.7^{-1/2}]^{-1.58} = 8.20 \text{ mm/s} = 0.32 \text{ in/s}$

Vibrations obtained during the initial phase of blasting which occurs at distances well over 500 m to the nearest third party building will assist the blast designer to adjust the drilling and blasting parameters in order to adhere to the MOE vibration and overpressure guideline levels.

There are many known and well proven techniques available to blasters and blasting planners for reducing the vibration levels induced by the blasting operations even when standoff distances approach 100 m to sensitive receptors. These include but not limited to, reducing the number of rows of holes per blast, reducing the blast-hole diameter, implementing multiple and independent explosive charge placement within the same blast-hole and building barriers (berms) between the blasting site and receptors.

#### 6.0 PREDICTED OVERPRESSURE LEVELS

As discussed in previous sections, the MOE guideline for blast-induced overpressure is 128 dB (L) when monitored on a routine basis. Since factors such as climatic conditions affecting the overpressure levels induced by the blasting are highly variable and are not
the same on a given day, predicting noise and overpressure based on explosives load is extremely difficult. There are, however, factors that can be controlled and observed, such as length of blast-hole collar, avoidance of blasting on an overcast day and during temperature inversion that can minimize the impact of noise and overpressure induced by blasting operations. In our experience, attention to these details will result in compliance with the MOE guidelines for noise and overpressure.

## 7.0 SEQUENCE OF OPERATIONS

Aggregate extraction from the licensed area is proposed to occur in six (6) phases from start to completion. In this section, impact of blasting in each area (Areas 1A, 1B, 2 and 3) during each phase is summarised.

In order to demonstrate how the impact of blasting on neighboring receptors is mitigated, it is necessary to explain the process of blasting in more detail.

Generally, there are two sets of parameters to be considered when blasting operations are in the planning stage. The first set of parameters are those that cannot be controlled and are, the geology of the rock mass, the location of the third party properties (i.e. residences), climatic conditions, and to a lesser degree the location of the blasting operations (location of blasting site can be moved within the licensed area). The second set of parameters, are those that can be controlled by the blasting planners and executers and are drilling pattern (burden and spacing between drill-holes), drill-hole diameter, explosives type which includes physical and chemical composition of explosives, explosive charge weight per delay period (amount of explosives that is detonated at a given time/instant), sequence and timing of each explosive charge, number of explosive charges per drill-hole (multiple decking), direction of blasting, length of collar (uncharged portion of the drill-hole), width and depth, and height of the block to be blasted, and number of holes per blasted to name a few.

As noted above, there are number of parameters available to a blaster that can be controlled by making a combination of changes in a blast to reduce the impact of the blasting operation on neighboring properties and their occupants. Most if not all competent blasting planners and blasters take great measures in order to reduce and minimize the impact of the blasting operations they undertake on neighboring receptors. It is common practice then to start the initial blasting in an area of a licensed quarry that would have the minimum impact on third-party properties and receptors. During the initial blasting, the blaster will become familiar with the local geology and other site conditions. In addition, the seismic and noise data collected during this period will allow the blasting planners and blasters to adjust the above noted parameters in subsequent blast in order to reduce the impact of blasting on neighboring receptors. In most cases the blasting operations start at the maximum distance from receptors and as the blasting progresses towards these receptors, the controllable parameters are adjusted to maintain the undesired by-products of the blasting (mainly vibration and overpressure) within the governing guidelines.

Presently, there are many licensed quarries similar to the New Keppel Quarry throughout Ontario that are located well within urban areas and are operating within the Ontario Ministry of Environment (MOE) governing guidelines and regulations.

Now that the process of mitigating the impact of blasting is explained, it is prudent to consider the impact of blasting on receptors when extraction occurs in each area as outlined in drawing 2, titled "OPERATIONAL PLAN".

## 7.1 Extraction in Area 1A

Drilling and blasting operations in Area 1A will begin at the south section of the area. The blasting will be orientated so that the direction of throw (direction of movement of the fragmented rock when subjected to explosive charges) will be to the east and south east with the extraction progress to the northwest. At the most northerly boundary of Area 1A, the distance between the blasting and Receptor #2 will be approximately 308 m. This is the closest point of blasting to Receptor #2. Based on calculations outlined in previous sections, the maximum allowable explosives per delay period at given distances are presented in the table below. The calculation is made using the International Society of Explosives Engineers (ISEE) prediction regression formula and based on a 95% confidence level as required by the MOE.

## W_{max} = {(K x d^e)/PPV} ^{-1.25}

Where:

 $W_{max}$  = maximum amount of explosive per delay period (kg) K = site factor = 1725 E = site factor = -1.58 PPV = peak particle velocity (mm/s) d = distance between the receptor and the blast (m)

К	d	е	PPV	W
	(m)		(mm/s)	(kg)
1725	50	-1.58	12.50	5
1725	100	-1.58	12.50	19
1725	150	-1.58	12.50	42
1725	200	-1.58	12.50	74
1725	250	-1.58	12.50	115
1725	300	-1.58	12.50	165
1725	350	-1.58	12.50	224
1725	400	-1.58	12.50	291
1725	450	-1.58	12.50	367
1725	500	-1.58	12.50	452

Maximum allowable explosives charge per delay period for a given standoff distance to conform to MOE guideline of 12.5 mm/s with 95% confidence level.

It must be noted that blasting starts at the furthest possible distance from the Receptor #2 in Area 1A. The vibration and overpressure data collected during the initial stages of blasting will be used to calibrate the above formula (site constants will change). The blasting parameters and techniques will be revised accordingly to maintain the vibration levels below the guidelines.

Since the blasting parameters are constantly adjusted to conform to the guidelines and regulations at the closest receptor (Receptor #2), vibration and noise levels at the other two receptors located further to the south, namely Receptors #1, and #3, will automatically be significantly lower.

As evident by the parameters in the table above, as the distance increases, the allowable explosives per delay period also increases.

## 7.2 Extraction in Area 1B

It is recommended that drilling and blasting in area 1B be started at the northeast corner of the area with a sinking-cut. The initial sinking-cut will be drilled at the northwest corner of the shaded area as shown in the Operational Plan Drawing (Drawing 2) to an approximate depth of 10 m (ground elevation to elevation 242 m). It must be noted that the shaded area will be blasted in two lifts to an approximate depth of 22 m. Once the sinking-cut area for the first lift is extracted, the remaining rock in the shaded area will be blasted to the same elevation (elevation 242 m). The extraction operation will be sequenced so that direction of throw will be to the west and northwest. Once the extraction of the first lift in the shaded area is completed, the second sinking cut will be drilled from elevation 242 m to 230 m (for an approximate depth of 12 m). The progress of the second lift to elevation 230 m in the shaded area will follow the same footprint of extraction in the first lift. The remaining rock in Area 1B will then be blasted to a full depth to elevation 230 m. The direction of throw during the blasting for the remaining rock in Area 1B will be to the west and northwest (away from all receptors), and excavation will progress to the south and southeast. At one point it may be necessary to conduct a few full depth blasts with the direction of throw to the east in order to establish a desirable bench. However this will occur when the shaded area is excavated to elevation 230 m, and the guarry walls will attenuate the noise significantly. Vibrations experienced by Receptors #1 and #2 will also be reduced since there will be a void (the established quarry) between the blast and the receptors. There should be no difficulties maintaining vibration and noise levels well within the MOE guidelines when blasting in this area provided the appropriate blasting techniques are employed.

## 7.3 Extraction in Area 2

By the time extraction reaches Area 2, HSC must have accumulated a great number of vibration and noise data collected during blasting operations carried out in previous Areas (1A and 1B), and the quarry face is well established. At this point, an accurate attenuation curve can be developed using the site specific vibration and noise data. The attenuation curve will enable the blasting planner and executor to accurately determine the maximum allowable explosives charge per delay period when blasting planner can adjust other controllable parameters, such as drill-hole diameter, burden and spacing between drill-holes, number of holes to be charged and blasted, and number of deck per hole, if decking becomes necessary. At this point, the closest third party receptor will be Receptor #1. It is our understanding that the building at Receptor #3 is owned by the HSC and will not be inhabited.

In any event, the direction of throw will always be to the northwest which will be ideal, and always away from the receptors. In addition, the proposed 6 m high noise

attenuation berm erected on the east boundary of the quarry along the Grey County Road # 17 will also minimize the noise impact on both receptors.

## 7.4 Extraction in Area 3

It is understood that Area 3 will be on-hold for no blasting activities for at least 12 years. Extraction of Area 3 will most likely begin when the quarry face along the dividing line between Area 2 and Area 3 is well established. The wide face will allow the blasting planner to design the blast so that a maximum of two rows of holes is blasted at a time. This will assist in providing the required relief in front of the blast, and thus, reduce the vibration levels significantly. Minimizing the number of rows to be blasted each time will be coupled with proven blasting techniques, such as multiple decking and reduction in the size of the holes.

Proven blasting methods and techniques applied in mining industry can be employed to ensure adherence to the MOE guidelines and regulations. These methods allow mining companies to blast within very close proximity of shafts and structures which are vital in the safety of their employees and operation of the mines.

With the proper planning based on the reassessment of the site conditions at the time, and taking into consideration the historical vibration and noise data collected during the life of the quarry, extraction of the aggregate material in Area 3 is possible.

Periodic survey of the existing condition of the Receptor #1 is also necessary since this receptor will be located at a distance of 100 m from the closest point of blasting in Area 3.

It is recommended that two seismographs be installed at Receptors #1 and #2 during the entire blasting operations in the New Keppel Quarry.

We recommend the following procedure for the blasting operations in the proposed quarry location:

- Sequential blasting techniques will be used to ensure minimum explosives per delay period initiated. These include:
  - Non-electric blasting systems such as the EZ-Det / Handi-Det / Snap-Det systems or,

- Electronic initiation system with remote detonation.
- Drilling pattern for initial quarry blasting will be maximum 3.05 m (10') Burden by 3.66 m (12'). The pattern may be adjusted for subsequent blasts in order to achieve the required fragmentation.
- Maximum drill-hole diameter for initial quarry blasting will be 102 mm (4"). Vibration and overpressure data acquired during initial blasting may allow for an increase in drill-hole diameter. The pattern will be adjusted to accommodate for the increase in drill-hole diameter.
- Minimum collar will be 1.2 m (4 ft.) for 102 mm (4") diameter drill-holes.
- Bench height will not exceed 15.24 m (50') for initial quarry blasting. The subsequent increase in bench height is subject to acceptable vibration and noise levels. Bench height may also be increased provided multiple deck charging is applied.
- Clear crushed stone will be used for stemming.
- Primary and secondary dust collectors will be employed on the rock drills to keep the level of dust to a minimum.
- Blasting should be avoided during heavy overcast and temperature inversions when possible.
- Blast-hole detonation will be limited to a single hole per delay period.
- The amount of explosives per delay period for initial quarry blasting shall not exceed 141.9 kg.

A typical blast lay out (design) is shown in Appendix D.

## 8.0 IMPACT OF BLASTING ON WATER-WELLS

The effects of blast-induced vibrations on water wells have been studied by a number of mine operators and blasting consultants. In a study by Froedge (1983), blast vibration levels of up to 32.3 mm/s were recorded at the bottom of a shallow well located at a distance of 60 meters (200 feet) from an open pit blast. There was no report of visible damage to the well, nor was there any change in the water pumping flow rate. This study concluded that the commonly accepted limit of 50 mm/s PPV level is adequate to protect wells from any appreciable damage.

Rose et al. (1991), studied the effect of blasting in close proximity to water wells near an open pit mine in Nevada, USA. Blasts of up to 70 kilograms of explosives per delay period were detonated at a distance of up to 75 meters (245 feet) from deep water well. There was no reported visible damage to the well. Fluctuations in water level and flow rate were evident immediately after the blast. However, the well water level and flow rate stabilized after a few days.

Matheson et al. (1997) brought together available information on the most common complaints, the possible causes of the complaints and the relation between blasting and the complaint causes. This publication stated:

"Probably the most frequent blast related complaint is that a well has 'gone dry'. Related complaints about reductions in ground water quantity are also common. Blasting does not cause wells to go dry or reduce the water quantity available to a well. Research has shown that blasting near open borehole wells in bedrock may actually increase the water production capacity due to opening rock fractures.

The major complaints for changes in well water production capacity include: loss of quantity production, air in water and/or water lines, damage to pump, and damage to well screen or borehole.

The review of research and common causes of these problems indicates that most of these complaints are not related to blasting and can be shown to be related to either environmental factors, poor well construction, or wells whose elements required repair or replacement prior to blasting."

Based on observations and research, it is our professional opinion that the blast-induced vibrations at the proposed quarry will not affect the water wells in the area since the vibration levels must be maintained below 12.5 mm/s in accordance with the MOE guidelines. However, as a precautionary measure and due diligence, we recommend that water wells be tested periodically for drinking quality in accordance with the MOE guidelines and regulations.

## 9.0 BLAST MONITORING AND RESPONSE PROGRAM

In compliance with the MOE requirements and as a due diligence, a routine monitoring program of the blasting operations should be implemented. HSC's staff will be trained by

a blasting consultant to properly install, monitor, record and report the blast induced vibrations and overpressure. In addition, the following triggering system will be implemented after each blast:

## <u>Green</u>

Seismograph readings are within the MOE guidelines for vibration and overpressure, there is no flyrock generated beyond the blast area, there are no complaints from the public, and there is no negative report in the water tested from the quarry.

Remedial Action - No remedial action is necessary.

## <u>Yellow</u>

Seismograph readings exceeded the MOE guidelines for vibration and/or overpressure, there is no flyrock generated beyond the blast area, there are no reported damage complaints, there may be complaints from noise or vibration, and slight elevated nitrates and/or other chemicals associated with explosives in the water tested from the quarry. *Remedial Action* – Review the environmental conditions and blast design parameters. Make reasonable adjustments for subsequent blasts. Report the findings and remedial measures to be taken for subsequent blasts to complainants and affected residents.

## <u>Red</u>

Seismograph readings exceeded the MOE guidelines for vibration and/or overpressure and/or there is flyrock generated beyond the blast area, there are reported damage complaints, there are complaints from noise or vibration, and there is elevated level of nitrates and/or other chemicals associated with explosives used for blasting.

Remedial Action – Stop any further blasting until a full investigation has taken place into the reasons for the unexpected results. Make appropriate changes and report these changes before commencement of the blasting operation.

## 10.0 RECOMMENDATIONS

The following general recommendations will apply to all production blasting in the proposed excavation areas.

• Sequential blasting techniques will be used to ensure minimum explosives per delay period initiated. These include:

- Non-electric blasting systems such as the EZ-Det / Handi-Det / Snap-Det systems or,
- Electronic initiation system with remote detonation.
- Drilling pattern for initial quarry blasting will be maximum 3.05 m (10') Burden by 3.66 m (12'). The pattern may be adjusted for subsequent blasts in order to achieve the required fragmentation.
- Maximum drill-hole diameter for initial quarry blasting will be 102 mm (4"). Vibration and overpressure data acquired during initial blasting may allow for an increase in drill-hole diameter. The pattern will be adjusted to accommodate for the increase in drill-hole diameter.
- Minimum collar will be 1.2 m (4 ft.) for 102 mm (4") diameter drill-holes.
- Bench height will not exceed 15.24 m (50') for initial quarry blasting.
- Clear crushed stone will be used for stemming.
- Primary and secondary dust collectors will be employed on the rock drills to keep the level of dust to a minimum.
- Blasting should be avoided during heavy overcast and temperature inversions when possible.
- Blast-hole detonation will be limited to a single hole per delay period.
- The amount of explosives per delay period for initial quarry blasting shall not exceed 141.9 kg.

A typical production blast layout (design) is shown in Appendix D.

All blasts should be monitored for both vibration and overpressure (noise) at two of the closest third-party properties adjacent the site (Receptors #1 and #2) with digital seismographs. Compilation of the initial data should be used to establish a site specific vibration and noise attenuation graphs. The values of the Scaled Distance obtained from the graphs will assist in planning subsequent blasting operations. This will also allow blasts to be designed specifically for this location which should ideally induce vibration and noise levels within the MOE guidelines. All subsequent blasts should also be monitored by the quarry operator at the closest third party building or facility to the blast site. The blasting operations should be audited periodically by an independent blasting consultant.

The seismographs must be self-triggering units and calibrated on an annual basis, or as recommended by the manufacturer. Seismogram copies as well as blast reports for each blast should be filed for future reference.

Detailed blast records should be maintained for every blast. The MOE (1985) recommended that the body of blast reports should include the following information:

- a) Location, date and time of the blast.
- b) Dimensional sketch including photographs, if necessary, of the location of the blasting operation, and the nearest point of reception (vibration receptor).
- c) Physical and topographical description of the ground between the source and the receptor location.
- d) Type of material being blasted.
- e) Sub-soil conditions, if known.
- f) Prevailing meteorological conditions including wind speed in m/s, wind direction, air temperature in °C, relative humidity, degree of cloud cover and ground moisture content.
- g) Number of drill holes.
- h) Pattern and pitch of drill holes.
- i) Size of holes.
- j) Depth of drilling.
- k) Depth of collar.
- I) Depth of toe-load.
- m) Weight of charge per delay period.
- n) Number and time of delays.
- o) The result and calculated value of Peak Sound Pressure Level in dB (L) and Peak Particle Velocity in mm/s.
- p) Applicable limits.
- q) The excess, if any, over the prescribed limits.

The blast parameters described within this report will provide a good basis for the initial blasting operations at this quarry. However, it may be necessary to refine these parameters once site-specific vibration and overpressure data from the blasting operations become available.

Blasting procedures such as drilling and loading should be monitored or audited on occasional basis by an independent blasting consultant to ensure full compliance with governing guidelines and regulations.

## 11.0 CLOSURE

The proposed quarry can be operated safely and productively within the proposed licence boundary, while staying within the Ontario Ministry of the Environment guidelines and regulations for blasting in mines and quarries, provided the quarry operator follows all recommendations in this report and adheres to the governing laws and regulations.

## 12.0 REFERENCES

Froedge, D. T., "Blasting Effects on Water Wells", Proceedings of the Ninth Conference on Explosives and Blasting Technique", Dallas, Texas, 1983.

International Society of Explosives Engineers (ISEE), 17th Edition of the Blaster's Handbook" Chapter 38, 1998.

Matheson, G. M., Miller, D. K., "Blasting Vibration Damage to Water Supply, Well Water Quality and Quantity", Proceedings of the Twenty-Third Conference on Explosives and Blasting Technique", Las Vegas, Nevada, 1997.

Ontario Ministry of the Environment, "Publication NPC-119, Blasting", Noise Pollution Control Section, 1982.

Rose, R., Bowles, B., Bender, W. L., "Results of Blasting in Close Proximity to Water Wells at the Sleeper Mine", Proceedings of the Seventeenth Conference on Explosives and Blasting Technique", Las Vegas, Nevada, 1991.

A copy of the writer's curriculum vitae is attached in Appendix E for your records.

Sincerely,

For DST CONSULTING ENGINEERS INC.,

Prepared by:

Ray Jambakhsh, M.Sc., P. Eng. **Principal, Sector Manager** 

Append.





Appendix "A"

- Aerial view of licensed area and reviewed drawings











NOTES:

1. THESE SITE PLANS ARE PREPARED FOR SUBMISSION TO THE MINISTRY OF NATURAL RESOURCES TO COMPLY WITH THE STANDARDS FOR A CATEGORY 2, CLASS A (QUARRY BELOW WATER) LICENCE UNDER THE AGGREGATE RESOURCES ACT AND REGULATIONS.

2. ALL DIMENSIONS ARE IN METRIC UNITS. ELEVATIONS ARE GEODETIC, ASL. REFERENCE WAS MADE TO ONTARIO BASE MAP 10 17 4950 49400 & 10 17 5000 49400, REGISTERED PLAN 16R-3903, A DRAFT PLAN OF SURVEY BY HEWETT AND MILNE LIMITED, ONTARIO LAND SURVEYORS AND THE FOLLOWING REPORTS: - HYDROGEOLOGICAL REPORTS, ADDENDUMS, RESPONSES BY WATERLOO GEOSCIENCE LIMITED, NOVATERRA

ENVIRONMENTAL LIMITED, MTE CONSULTANTS INC.

- ADAPTIVE MANAGEMENT PLAN BY MTE CONSULTANTS INC.

- NATURAL ENVIRONMENT STUDIES, ADDENDUMS AND RESPONSES BY AQUATIC WILDLIFE SERVICES - NOISE AND BLASTING STUDIES BY AERCOUSTICS ENGINEERING LTD. AND DST CONSULTING ENGINEERS INC.

- ARCHAEOLOGICAL STUDIES BY SCARLETT JANUSAS

- VIEWSHED ANALYSIS AND REPORT BY L. PORTER, LANDSCAPE ARCHITECTS. - VEGETATION INVENTORY - IMPACT ASSESSMENT AND PRESERVATION METHODS REPORT 3. SITE SURVEYS AND INSPECTION BY WM. BRADSHAW, P.ENG. (OCTOBER, 2003) & ACI SURVEYS LTD.

(KITCHENER), OCTOBER, 2006.

4. THE PROPOSED LICENSED AREA IS LOCATED IN THE NIAGARA ESCARPMENT AREA. 5. THE WATER TABLE ELEVATION VARIES FROM APPROXIMATELY 240m TO 247m AND WAS DETERMINED FROM FIGURE 60 OF THE HYDROGEOLOGICAL INVESTIGATION BY MTE CONSULTANTS (OCT. 14, 2009). 6. FOR CROSS-SECTION INFORMATION, SEE DRAWING 7 OF 8, CROSS-SECTIONS & DETAILS. 7. THE PROPOSED LICENSED AREA IS 35.0 HECTARES.



Wm. Bradshaw, P.Eng. Kitchener, Ontario

SUBJECT LANDS V/K

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-			DRAINAGE DIRECTION	
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SITE PLAN OVERRIDES OF THE OPERATIONAL STANDARDS

## 1. STANDARD 5.1 -

licensee.

a.) The licensed boundaries shall not be fenced on the west or north side of the pond access corridor in the SW corner. Marker posts, minimum height 1.2m, shall be placed at the corners and at intervisible distances not to exceed 60m on any unfenced boundaries.

b.) The part of Area 1A that abuts the adjacent, existing Keppel quarry shall not be fenced. Marker posts shall be placed at the most northerly and most southerly corners of the unfenced boundary.

3. STANDARD 5.13.1 - Stockpiling within 30m of the north and west boundaries adjacent to lands owned by the

2. STANDARD 5.10.1 - Regulatory setbacks have been reduced to zero metres adjacent to lands owned by the

## SPILLS CONTINGENCY PLAN

- In case of accidental spill of petroleum based products the following contingency plan will be activated:

- 3. The quantity of absorbent material stored on site will be sufficient to meet the supplier's recommendations for absorbing petroleum products. If using sand, the owner will maintain a reasonable volume (3cu. m to 5 cu. m.) on site.
- 5. All contaminated material will be removed from the site and placed in an approved landfill site.

notified when cleanup is complete.

1. All spills of petroleum based products regardless of the quantity will be cleaned up as soon as possible following the spill.

2. A supply of absorbent material suitable for use on spilled petroleum products (e.g., sand, "Stay—Dry") will be maintained on site. The absorbent material will be stored in a easily accessible location in bags or containers that can be moved by hand. The absorbent material will be kept dry by protective coverings or containers.

4. The owner will first contain the spill using the absorbent material and block any crack or route by which a spilled product could enter the rock or soil on and around

the site. After containment, the owner will proceed to clean up the spill using additional absorbent materials as necessary.

6. The adjacent property owners will be notified of any spill that occurs on site as per the Environmental Protection Act.

7. For spills in excess of 20 L that are cleaned up immediately, the owner will also notify the local offices of the Ministry of the Environment and of the Ministry of Natural Resources of the occurrence and of the procedures followed including the disposal location.

8. For any spill regardless of quantity which can not be immediately cleaned up, the owner will notify the local offices of the Ministry of the Environment and of the Ministry of Natural Resources and the adjacent land owners of the problem. Action to clean up the spill will be undertaken as soon as possible and all parties will be

## OPERATIONAL NOTES

1. SETBACKS: Extraction setbacks shall be 40m along the County Road 17 road allowance boundary, 30m adjacent to the south boundary of Area 2 & Area 3 and as shown along the northwesterly side of Area 1B. There shall be no disturbance, i.e. no tree removal, no stripping, no stockpiling within the buffer zone shown between the licence boundary and the ANSI.

2. VEGETATED BUFFER: A "20m Existing Forest Setback" shall be maintained and enhanced in accordance with the "Viewshed Analysis and Report" by L. PORTER adjacent to the County Road 17 boundary. Similarily, a "30m Existing Forest Setback" shall be maintained and enhanced within the southern 30m setback area. Refer to drawing 8 of 8 by L. PORTER for details.

3. MAXIMUM DEPTH OF EXTRACTION: The maximum depth of extraction shall be to the bottom of the Amabel Formation at the approximate elevations shown (228m to 230m in Area 1B, 2 & 3, 234 in Area 1A). The perimeter area adjacent to the extraction limit along the northerly boundary of Area 1B shall only be extracted to 242m where shown in order to allow backfilling and the creation of 3:1 slopes adjacent to the 100m ANSI setback line. The slope will be constructed from the limit of extraction to +/-1 metre below the final water level of the future pond of +/-244m.

4. SIDE SLOPES: Perimeter side slopes to elevation 244m adjacent to the 100m ANSI setback shall be created by backfilling with onsite overburden and topsoil and clean inert fill. Final perimeter slopes adjacent to the 100m ANSI setback shall be constructed no steeper than 3(horizontal) to 1(vertical). All other boundaries shall have vertical faces at the limit of extraction. Final slopes adjacent to the 100m ANSI setback shall be spread with a minimum of 0.15 metres (6 inches) of topsoil and shall be seeded and planted as outlined on Drawing 6 of 8, Progressive Rehabilitation & Final Rehabilitation Plans and Drawing 7 of 8, Cross—Sections and Details. Where the slopes adjacent to the 100m Ansi setback boundary reach the 243 metre level the "slopes" will be vertical to the bottom of the guarry.

5. ENTRANCE/EXIT/GATE: The entrance to the quarry shall be on the eastern boundary of Area 1B as shown to Grey County Road #17. Any required turning lanes, deceleration lanes or tapers shall be constructed to Grey County Standards and according to Grey County procedures. The entrance area treatment including grading, planting, gates, signage and lighting shall be constructed as outlined in the "Viewshed Analysis and Report". Area 1A shall be accessed through the existing Keppel quarry entrance. A gate (minimum height 1.2m) with a lock shall be installed and maintained at the entrances. The entrance shall be closed & locked when the quarry is not operating.

6. FENCING: Post & wire fencing (minimum height 1.2 metres) shall be repaired or installed on the proposed licence boundary, where shown. Marker posts at intervisible intervals not to exceed 60m shall replace fences on the west and north side of the 50m infiltration pond access corridor. Warning signs shall be posted on the marker posts and along the fence at 20 metre intervals. Fences, marker posts and signs shall be maintained for the life of the quarry.

7. TOPSOIL/OVERBURDEN STORAGE: Stripped topsoil and overburden, and imported inert fill shall be used to construct the proposed berms where shown. These berms shall be constructed to the recommended heights as indicated in the Sequence of Operations notes. Also see note #27. After the required berms have been constructed, any further stripped materials not used immediately for rehabilitation, may be stored separately in berms in the perimeter areas and eventually used for perimeter backfilling. Stripped topsoil & overburden shall be graded to stable side slopes. Berms shall be seeded with perennial grasses. Vegetation on the berms and stockpiles shall prevent erosion.

8. VEGETATION: Vegetation on all berms, stockpiles, vegetated buffers and rehabilitated areas that dies or is otherwise damaged shall be reseeded or replanted.

9. STOCKPILES: No stockpiles of aggregate or stripped materials shall be located within 30 metres of the licence boundary, north and west boundaries excepted. See overrides. Stockpiles shall not exceed a height that is greater than 2m below the top height of the accoustical berms.

10. PROCESSING EQUIPMENT: Processing equipment to be utilised on this site shall include scrapers, buildozers, loaders, excavators, drill rigs, crushers, screeners, conveyors, a wash plant and dump trucks. A wash plant may be operated once a valid Permit To Take Water has been obtained. Washing would entail the construction of three ponds on the quarry floor. The ponds will be approximately 50m by 20m and 2m deep. The ponds shall be constructed from low permeable clay. The first pond is a sedimentation pond, the second a clearing pond and the third a clear water pond. Water from the clear water pond is recirculated through the wash plant. The sedimentation pond shall be cleaned out as required to maintain the depth. The material removed from the pond shall be dried and sold for uses such as agri-lime on farm fields or other clay products. Ponds may be laid out in various configurations and may be relocated from time to time as dictated by operations.

11. DUST CONTROL: Dust control shall be maintained through the application of water when necessary.

12. NOISE, DUST OR GROUNDWATER INTERFERENCE PROBLEMS: Should noise, dust or groundwater interference complaints be received, the licensee shall take appropriate measures as deemed necessary by the Ministry of the Environment to rectify the problem(s).

13. DEWATERING: Sumps and dewatering facilities shall be located on the quarry floor and may be relocated from time to time as extraction progresses. Ground water and precipitation shall be pumped as outlined in the sequence of operations. See Drawing 7 of 8 for the Sedimentation pond and Infiltration pond details and the Adaptive Management Plan summary on Drawing 5 of 8, "Adaptive Management Plan". The final water elevation in the pond is anticipated to be +/-244m.

14. SCRAP STORAGE: There shall be no scrap permanently stored on this site.

except in emergency situations. Processing: from 7am to 6pm Monday to Friday.

15. PETROLEUM STORAGE: Petroleum storage facilities shall be relocated to the vicinity of the shop in the new quarry from the old quarry when pumping to the old quarry commences. All petroleum storage shall be in above ground containers that meet the requirements of the Technical Standards and Safety Act 2000 and the Liquid Fuel Handling Code 2001 as may be amended. Any spills shall be removed and disposed of at a facility approved by the Ministry of the Environment. See the Spills Contingency Plan on this page. Mobile fuel tanks shall be the new generation engineered double-tanked variety with vacuum sealed

16. BUILDINGS: Operational buildings shall be located within the areas shown in Phase 1B.

17. DRAINAGE: Surface drainage and ground water shall be captured in temporary sumps and removed as indicated in Note 13 above. 18. HOURS OF OPERATION: The hours of operation for this site shall be: Shipping: from 7am to 6pm Monday to Friday. No shipping on Saturday or Sunday,

19. EXTRACTION AREA: The area to be extracted is 27.1 hectares.

20. TONNAGE CONDITION: The maximum number of tonnes to be removed from this site in any calendar year is 600,000. Note that while old Keppel quarry is still operating, the combined tonnage of this site and old Keppel quarry shall not exceed 600,000 tonnes.

21. TREE REMOVAL: Trees cut during stripping operations shall be marketed for lumber where possible or shall be cut up for fire wood. Stumps shall be stored for future use on the edges of the future quarry pond.

22. RECYCLING: Asphalt and concrete may be imported into this site for recycling and stored in the area shown.

23. TUNNEL: A tunnel shall be constructed between Area 1A and Area 1B for the transport of material between Areas. The tunnel shall consist of a precast and pre-engineered concrete culvert and shall be constructed and installed to meet the requirements of the Grey County Engineering Department.

24. ARCHAEOLOGICAL RECOMMENDATIONS (by Scarlett Janasus, Archaeological & Heritage Consulting, Tobermory, Ontario): Should deeply buried archaeological material be found on the property during excavation activities, the Ministry of Citizenship, Culture and Recreation (MCCR) shall be notified immediately (519-675-7742). In the event that human remains are encountered during excavation, the proponent shall immediately contact both the MCCR and the Registrar or Deputy Registrar of the Cemeteries Regulation Unit of the Ministry of Consumer & Commercial Relations (416–326–8392)

25. NATURAL ENVIRONMENT RECOMMENDATIONS (by Aquatic and Wildlife Services, Shallow Lake, Ontario): See Drawing 4 of 8: "Consultant Recommendations" Drawing 5 of 8 "Adaptive Management Plan" and Drawing 7 of 8, "Cross-sections and Details". 26. HYDROGEOLOGICAL RECOMMENDATIONS: (by MTE Consultants Inc., Kitchener, Ontario): See Drawing 4 of 8: "Consultant Recommendations", Drawing 5 of 8,

"Adaptive Mangement Plan". 27. NOISE CONTROL RECOMMENDATIONS: (by Aercoustics Engineering Limited, Toronto, Ontario) See Drawing 4 of 8: "Consultant Recommendations".

28. BLASTING CONTROL RECOMMENDATIONS: (by Aercoustics Engineering Limited, Toronto, Ontario and DST Consulting Engineers Inc., Sudbury, Ontario) See Drawing 4 of 8: "Consultant Recommendations"

29. SECTIONS AND DETAILS: See Drawing 7 of 8: "Cross-sections and Details".

30. IMPORTATION OF FILL: Only topsoil, subsoil and overburden meeting the definition of inert fill under Regulation 347 of the Environmental Protection Act shall be imported into this site for the purposes of conducting rehabilitation. Incoming loads of fill shall be monitored by staff.

 NOISE ATTENUATION BERM
 APPROXIMATE BENCH ELEVATIONS
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 ENTRANCE/EXIT
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 LOT LINE
 20m EXISTING FOREST SETBACK
 ANSI AREA
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## IN GENERAL:

1. Prior to the commencement of operations all required fencing & signs shall be constructed where shown. Unfenced boundaries shall be marked at intervisible distances not to exce fencing, signs and markers shall be maintained for the life of the licence.

2. Prior to the commencement of excavation the operator shall survey and clearly mark and flag the limits of extraction shown on the license.

3. Prior to the commencement of extraction and processing in any areas or any parts of areas acoustical attenuation berms shall be constructed as shown on drawing 4 of 8. "Consi 4. Once the acoustical attenuation berms are completed the planting of the tree/shrub screening plantings will be installed within the first year of operations

5. The calculation to determine the phasing timeline is based on using 500,000 tonnes per year for extraction and a conversion of 1 cubic meter of rock to 2.5 tonnes. The timelines longer or shorter depending on yearly sales volumes. The MNR tonnage limit is 600,000 tonnes per calendar year.

6. Drainage sumps will be created within the licensed area to support the dewatering operation in various areas. Pumps and associated piping will routinely be relocated within the lice The creation of any new sumps or the movement of the associated pumps and piping will not require any additional permitting.

7. Area 3 shall not be excavated for a period of 12 years from the issuance of a license under the Aggregate Resources Act. The excavation of Area 3 may only proceed if it is dete MOE through the results of the Adaptive Management Plan (AMP) developed for this site.

8. The maximum depth of extraction shall be to the elevation of the bottom of the Amabel Formation and in the general direction of the arrows shown.

9. If it is determined from the Natural Environment monitoring and the Adaptive Management Plan shown on drawing 5 of 8 that the existing ephemeral pond has had unacceptable i be constructed and maintained as directed by the Natural Environment consultant or by MNR.

Phase 1 (The period when excavation focus is in Area 1A-Year 1 to 3)

## AREA 1A

1. Area 1A shall be operated as an extension of the existing Keppel quarry with processing of aggregates taking place in the adjacent Keppel quarry. The depth of extraction shall be on the west side of the quarry will be set at 5m from the existing tree line. A fence is to be installed 5m from the trees to denote the limit of extraction. 2. Tunnel construction under County Road 17 can commence when Area 1A reaches the 242m level.

3. Extraction to the 234m level shall then be completed in Area 1A.

4. The asphalt plant is to be removed from the existing Keppel quarry by December 31, 2014.

AREA 1B

1. Construct access to Area 1B in accordance with landscape drawings.

2. Commence clearing and stripping operations in the north and north easterly portions of Area 1B and construct the required berms in the berm area along County Road 17 and in boundary

3. Execute the planting program for the 20m wide buffer strip between Area 1B and County Road 17.

4. Commence removal of aggregate in the proposed tunnel area to the 242m level and truck to the existing Keppel quarry for processing.

5. Complete tunnel construction from Area 1A.

6. Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped to the "Sump Pond" located in the southeast corner of the 3515-8M4PWM) when necessary. Associated pumps and piping shall also be moved within the licence area accordingly.

## AREA 2

1. Commence stripping in the proposed berm area between Area 2 and County Road 17 and construct the proposed berm.

2. Execute the planting program for the 20m wide buffer strip between Area 2 and County Road 17.

## Area 3

1. Commence stripping in the proposed berm area between Area 3 and County Road 17 and construct the proposed berm.

2. Execute the planting program for the 20m wide buffer strip between Area 2 and County Road 17.

3. Execute the planting program for the 30m wide buffer strip between Area 3 and Concession 10.

4. Area 3 shall be surveyed and the line between Area 2 and Area 3 shall be marked with highly visible marker posts at a minimum height of 2m.

## Phase 2 (The period when excavation focus is in Area 1B-Year 3 to 7)

## AREA 1A

1. Processing equipment shall be located in Area 1A until sufficient working area is established in Area 1B.

2. Commence moving aggregate from Area 1B to Area 1A through the tunnel for processing in Area 1A.

3. All processing equipment must be removed from Area 1A and rehabilitation commenced a maximum of seven (7) years after the issuance of the ARA licence.

4. Remove pumping equipment from Area 1A to Area 2.

5. Move existing stockpiles in Area 1A and from the old quarry floor to Area 1B as required.

## AREA 1B

1. Establish the quarry floor working area at the 242m level in the north eastern part of Area 1B and relocate the primary crusher to Area 1B. Continue at elevation 242m until work accommodate operational equipment. Once the 242m working area has been created, commence extraction to the lower bench levels.

2. Once the primary crusher has been established in Area 1B, crushed rock shall be transported through the tunnel for further processing in Area 1A.

3. Continue to clear and grub in the directions of the arrows shown.

4. Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped to the "Sump Pond" located in the southeast corner of the 3515—8M4PWM). Associated pumps and piping within the licensed area shall be moved/relocated within the licensed area when necessary.

5. Re-locate all processing equipment in the eastern part of Area 1B to the 230m level and commence all processing operations in Area 1B.

## AREA 2

1. Clear the minimum required area and construct Sedimentation pond #1 (0.4 ha in size) on the north east side of Area 2.

### AREA 3

1. Construct the riprap outlet in the area shown adjacent to the karst openings.

Infiltration Pond

1. Subject to the results of the AMP the infiltration pond may be constructed and clear water pumped to it during this phase.

## Phase 3 (The period when excavation focus is in area 1B-Year 8 to 14)

## AREA 1A

1. Commence perimeter and entrance rehabilitation in Area 1A.

2. Rehabilitation starts in year 8 as the old quarry starts to fill with water.

**3.** Decommission the tunnel under County Road 17.

### AREA 1B

1. Continue excavation to a depth of approximately 228m to 230m (to the bottom of the Amabel Formation).

2. Complete clearing and stripping operations in the southerly portion of Area 1B to Area 2.

3. Temporary sumps shall be created where necessary to catch precipitation and ground water which will then be pumped or trenched to the Sedimentation Pond #1 in Area 2. Associ relocated where necessary.

4. Extraction in Area 1B continues south easterly.

## AREA 2

1. Commence clearing and stripping in the rest of Area 2.

2. Pump clear water from sedimentation pond 1 to the riprap area in Area 3 adjacent to the karst openings.

AREA 3

1. Ensure riprop area remains functional.

Infiltration Pond

1. Subject to the results of the AMP the infiltration pond may be constructed and clear water pumped to it during this phase.

ed 60m with marker posts and signs. All	<u>Phase 4 (The period when excavation focus is in Area 1B—Year (15 to 18)</u> AREA 1A						
sultant Recommendations".	1. Perimeter slope and entrance rehabilitation has been completed. The old quarry is filling with water. AREA 1B						
s associated with the phases could be	1. Continue all processing operations in Area 1B.						
ansed area as the sumps are created	<ol> <li>2. Extraction in the southern part of Area 1B shall continue south easterly to a depth of approximately 228m to 230m (the bottom of</li> <li>3. Temporary sumps shall be created where necessary to catch precipitation and aroundwater which will then be pumped to Sedimentation</li> </ol>	the Amabel Formation). on Pond #1 located in Area 2. The water shall then be pumped to th					
sised died as the sumps are created.	rip rap in Area 3 adjacent to the observed karst openings. Associated pumps and piping within the licensed area shall be moved/relocat	ted when "necessary.					
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mpacts, then an ephemeral pond shall	<ol> <li>Extraction shall commence in Area 2 in the direction of the arrows shown (south easterly) to a depth of approximately 229m to 230</li> <li>Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped or trenched to pumped to the riprap in Area 3 adjacent to the observed karst openings.</li> <li>AREA 3</li> </ol>	Om (the bottom of the Amabel Formation). Sedimentation Pond #1 located in Area 2. Clear water shall then be					
	1. Ensure riprap area remains functional.						
to +/-234m. The limit of extraction	Infiltration Pond						
	1. Subject to the results of the AMP the infiltration pond may be constructed and clear water pumped to it during this phase.						
	Phase 5 (The period when excavation focus is in Area 2-Year 19 to 26)						
	AKEA TA						
	AREA 1B						
the berm area adjacent to the north	1. Area 1B will accommodate stockpiles.						
	<ol> <li>Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped or trenched to pumped to the rip rap in Area 3 adjacent to the observed karst openings. Associated pumps and piping within the licensed area shall b AREA 2</li> </ol>	Sedimentation Pond #1 located in Area 2. Clear water shall then be e moved/relocated when necessary.					
Eviating Kappel Ougray (op per 504 pe	1. Extraction and production shall continue in Area 2 in the direction of the arrows shown to a depth of approximately 229m to 230m (the bottom of the Amabel Formation).						
Existing Repper Quarry (as per ECA no.	2. Temporary sumps shall be created where necessary to catch precipitation and groundwater which will then be pumped to Sedimentation in Area 3 adjacent to the observed karst openings.	on Pond #1 in Area 2 and clear water shall be pumped to the rip ra					
	1. The excavation of Area 3 may only proceed if it is determined acceptable by the MNR and MOE through the results of the Adaptive M	Management Plan (AMP).					
	2. Upon authorization to excavate Area 3 being granted by MNR and MOE,— commence clearing and grubbing the area in preparation for	r extraction. Extraction from Area 2 can proceed through into Area 3					
	3. Construct Sedimentation Pond #2 in the location shown on the plans in the south east corner of Area 3 along Concession 10 and co	onnect to the previously constructed riprap area.					
	4. Temporary sumps shall be created where necessary to catch precipitation and groundwater which shall then be pumped to Sedimentat and be released into the adjacent observed karst openings. Associated pumps and piping shall be moved/relocated when necessary. Infiltration Pond	tion Pond #2 in Area 3. The water will make its way into the riprap					
	1. Depending on the results of the AMP the infiltration pond may be constructed and clear water pumped to it during this phase.						
	<u>Phase 6 (The period when excavation focus is in Area 3—Year (27 to 29)</u> AREA 1A						
	1. Perimeter rehabilitation has been completed. The old quarry is filling with water.						
	1. Area 1B may accomodate stockpiles.						
	2. Temporary sumps shall be created where necessary to catch precipitation and groundwater which shall then be pumped to Sedimentation Pond #2 in Area 3. The water will make its way into the riprap and be released into the adjacent observed karst openings. Associated pumps and piping shall be moved/relocated when necessary.						
	3. Upon completion of extraction in Area 2 and Area 3, all operational buildings and structures shall be removed from the 242 level in Area 1B and that area shall be excavated to 230m (the bottom of						
area is made large enough to	4. As part of the rehabilitation works the berm along the ANSI boundary shall be removed in sections of 50 metres. The bedrock will be as shown in "Rehabilitation Shoreline Detail to 100m ANSI Setback" on Page 7 of 8. The blasted rock is to be cast to the quarry floor material shall be graded to a 3:1 slope. The process shall be repeated in 50m increments moving northeasterly to the eastern extraction	e stripped to the extraction limit, drilled and blasted to the 243m lev and the berm material placed into the excavated notch. The backfill n limit.					
	5. Step number 4 shall be repeated until all of the quarry rock is mined out from the northern perimeter area to elevation 243m.						
Existing Keppel Quarry (as per ECA no.	b. The remaining perimeter berm on the roadside boundary shall also be excavated and used to finish the renabilitation along the northe shown on Drawing 7 of 8, "Cross-Sections and Details."	ern perimeter. The final perimeter renabilitation shall be completed as					
	7. Once all final rehabilitation has been completed the quarry shall be allowed to fill with water from groundwater and precipitation.						
	AREA 2						
	<ol> <li>Area 2 may accomodate stockpiles.</li> </ol>						
	3. Temporary sumps shall be created where necessary to catch precipitation and groundwater which shall then be pumped to Sedimentat and be released into the adjacent observed karst openings. Associated pumps and piping shall be moved/relocated when necessary. AREA 3	tion Pond #2 in Area 3. The water will make its way into the riprap					
	1. Move all processing operations into Area 3 when sufficient space becomes available. Processing equipment shall be located on the quo	arry floor at elevation 230m.					
	2. Continue excavtion south easterly to 230m (the bottom of the Amabel Formation).						
	<ol> <li>Temporary sumps shall be created where necessary to catch precipitation and groundwater which shall then be pumped to Sedimentat and be released into the adjacent observed karst openings. Associated pumps and piping shall be moved/relocated when necessary.</li> </ol>	tion Pond #2 in Area 3. The water will make its way into the riprap					
	<ol> <li>The sedimentation pond shall be extracted to the 230m level. Temporary sumps, previously created to catch precipitation and groundy been created. Associated pumps and piping shall be moved/relocated when necessary.</li> </ol>	water, shall pump to the old quarry or to the Infiltration pond if it h					
	Infiltration Pond						
	1. If, based on the results of the AMP, the infiltration pond has been previously constructed and clear water pumped to it during operat and the infiltration pond is no longer needed, the pond shall be regraded to form a shallow depressed area that shall naturally form a small marsh area.	ions, then once operations are completed					
	Final						
iated pumps and piping shall be	1. Once all operations are completed the quarry shall be alowed to fill with water.	R.R. #2, KEMBLE, ONTARIO, NOH1SO <b>NEW KEPPEL QUARRY</b> PARTS LOTS 26, 27 & 28, CONCESSION 10					

**ROLD SUTHERLAND CONSTRUCTION LTD.** R.R. #2, KEMBLE, ONTARIO, NOH1SO **NEW KEPPEL QUARRY** ARTS LOTS 26, 27 & 28, CONCESSION 10 TOWNSHIP OF GEORGIAN BLUFFS (formerly Keppel Twp) COUNTY OF GREY SEQUENCE of OPERATIONS DRAWING 3 of 8 DATE No. AMENDMENT

JUNE 13, 2012

## NATURAL ENVIRONMENT RECOMMENDATIONS (BY Aquatic Wildlife Services, Shallow lake, Ontario)

1 Mitigation Measures

These measures are recommended to maintain the ecological functioning role and natural heritage features that have been identified within this study area and are in keeping with provincial and municipal policies and auidelines.

1.1 The proposed licensed boundary is to maintain a minimum setback distance of 120 m from the Significant Shouldice Wetland boundary and a minimum setback of 100m from The Glen ANSI boundary.

1.2 The setback lands from the identified significant features are to be considered 'buffer lands' to these features; as such no site development or site alterations are to occur including noise attenuation berms, aggregate stockpiling or buildings. Buffer lands are to remain in a natural vegetation condition though minor site alteration through reforestation; adjacent boundary fencing, and property internal road/trail upkeep is acceptable.

1.3 In conjunction with the approved 'Adaptive Management Plan' if a yellow threshold level mitigative action requires construction of a new seasonal ephemeral pond, said pond shall be constructed with a low permeable bottom/lining, in suitable terrain conditions prior and location approved by reviewing agencies. Said ephemeral pond design & construction shall reflect the following design guidelines:

- Continuous forest cover around the pond perimeter to be maintained with direct linkage to the forested ANSI lands. No fencing or berm placement around the pond perimeter.

- Pond to maintain a minimum of 10:1 slope, with 20cm of native topsoil deposited over the pond bottom for the establishment of natural hydrophilic plants. Pond to be constructed with varying widths and depths but should not exceed 10m in width or exceed 0.7m in depth and a minimum length of 50m

- The ephemeral pond construction site should maximize natural terrain snowmelt runoff to the site. Pond design parameters should try to maintain surface waters within the pond between the sprina snowmelt periods to late June, during the remaining life of the quarry operations and rehabilitative period.

1.4 Rare plant mitigation relocation measures, within the new (2012) licence area that is proposed to be disturbed, shall be undertaken in the first spring season after the aggregate license approval and prior to any further site clearing within the proposed licensed quarry expansion area.

1.5 Any and all equipment storage, stock piled material, out buildings etc. in relation to this aggregate extraction proposal shall be contained within the 'limit of extraction' area.

1.6 No vegetation clearing or overburden stripping should occur during the spring season months of April, May or June in any given year per phase compartment. Thus providing for the maintenance and protection of active forest bird nests, in accordance to the federal Migratory Birds Act.

1.7 Required advanced tree and vegetation removal should be undertaken only 1-2 years prior to required extraction for that 'phase area' during the previous year's summer, fall or winter seasons. Land clearing should not occur beyond what can be utilized within the quarry for a 2-year period, other than those lands identified as the settling/infiltration pond.

1.8 The final rehabilitation plan is to include a 'Naturalized Shoreline' fronting the ANSI boundary incorporating the following design recommendations, but not limited to:

- Shoreline to be stabilized to a 3:1 slope out to a minimum water depth point of 1.0 m

- Removal of berm and any fence fronting the ANSI boundary with material utilized to slope shoreline and provide suitable growing substrate (above and below water).

- Reforestation phase shown on operational plan, with native tree/shrub species, sizes and density planting auideline.

- Final 'water's edge' of quarry environment fronting the ANSI boundary to be restored to a natural environment, with an irregular shoreline providing habitat cover creation (rock piles, logs, stumps, boulders), varying water depths through deposition of topsoil (berm material from overburden clearing) out to the quarry vertical face (approx. 1.5 m water depth zone).

1.9 A 'Stewardship Management Plan' focused on wildlife habitat and woodland ecology shall be completed for Lot 25, 26 and 27, Concession 10 of the former Keppel Township, for the lands which occur beyond the extraction limits. This Stewardship Plan shall follow the format of the Ontario 'Guide to Stewardship Planning for Natural Areas' and shall be submitted for review and approval by appropriate staff from the Ontario Ministry of Natural Resources and the Niagara Escarpment Commission prior to aggregate extraction operations commencing.

1.10 Reforestation mitigation zones that occur outside the licensed boundary area have been shown on the "REFORESTATION AREAS" figure on the operational plan. Said reforestation measures shall follow provincial standards for tree density and native species with reforestation efforts to be completed prior to extraction Phase 1B start up.

1.11 The Natural Environment Ecological Monitoring Plan requirements have been incorporated into the Keppel Quarry Adaptive Management Plan which shall be considered a mitigative measure for both short-term and long-term environmental monitoring activity with adaptive management strategies, threshold levels, remedial action works and contingency plans if deemed necessary. Said monitoring activities shall be reported to all reviewing agencies in a timely manner as per the AMP monitoring program outline

### NETR NOTES:

1) The 2007 Natural Environment Technical Reporting figures are based upon the draft extraction lands at that time, which have been significantly reduced to-date through the agency review/commenting process. The current licence lands and extraction area is still contained within the original 2007 Natural Environment Technical Reporting 'study lands' and as such environmental data analysis, impact assessment and conclusions are valid and consistent with the current licence/extraction lands and operational design.

2) The 2007 Natural Environment Technical Reporting for 'Mitigation Measures' and 'Ecological Monitoring Program' have been modified and revised above, to address the current 2012 licence boundary, extraction lands, Adaptive Management Plan and supplementary technical reporting on hydrology and hydrogeological assessment.

3) The 2007 Natural Environment Technical Reporting for the 'Recommendations' section associated with Mr. Sutherlands land holding of Lot 30, Concession 10 of the former Keppel Township are no longer deemed applicable to this current and significantly reduced extraction land area.



## NOISE CONTROL RECOMMENDATIONS (By Aercoustics Engineering Ltd.)

1) The noise emission of the rock drill shall satisfy a reference sound power level of 111 dB(A).

**1.1 GENERAL CONTROLS** 

Construction Equipment"

1.1.2 Quarry equipment shall satisfy the reference power levels listed in Table 1.

1.1.3 The drilling, extraction and processing (crushing, washing and/or screening) operations shall be limited to the daytime hours of 07:00 - 19:00. Table 1: Reference Sound Power Levels of Quarry Equipment

Equipment	Reference Sound Power Level (dB(A))
Rock Drill (In-the-hole type)	111
Primary Crusher	121
Secondary Processing Plant	129
Extraction Loader or Shovel	114
Pit Trucks (40 passes/hr, 100m section, 25 km/hr)	104
Loader - for shipment, loading trucks	109

**<u>1.2 AREA 1A</u>** (see Figure 1) - The following noise controls in addition to the general controls are recommended.

1.2.1 Extraction should proceed in a westerly direction. See Figure 1 below.

1.3.2 Acoustic barriers in the form of an earth berm, acoustic fence, or combination of these shall be constructed on the north and east perimeter of the quarry area as shown in Figure 2. This perimeter acoustic barrier shall remain for the life of the guarry.

1.3.4 When operating in Area 1B the secondary processing plant shall be located on the quarry floor at EL242m or less and shielded from the R1 and R2 receptors by an acoustic barrier. The barrier shall have minimum height of 8m and be positioned at a maximum distance of 50m from the processing plant crushers and screens. The acoustic barrier must be solid without gaps or openings and satisfy an area density of 20 kg/m2.

1.3.5 When operating in Areas 2 or 3, the secondary processing plant shall be positioned on the guarry floor +/-EL230m and be shielded from the R2 receptor with an acoustic barrier. The barrier shall have a minimum height of 8m and be positioned at a maximum distance of 50m from the processing plant crushers and screens. The acoustic barrier must be solid without gaps or openings and satisfy an area density of 20 kg/m2. An acoustic barrier can take the form of a stockpile, an un-extracted rock face, stacked ISO containers, or anything else satisfying the requirements of an acoustic barrier.

**<u>1.4 AREA 2 and AREA 3</u>** (See Figure 3) — The following noise controls in addition to the general controls are recommended.

1.4.1 Extraction shall proceed in a southeasterly direction with the working face moving towards the R1 receptor.

1.4.3 The secondary processing plant shall be positioned on the quarry floor +/-EL230m and be shielded from the R2 receptor with an acoustic barrier. The barrier shall have a minimum height of 8m and be positioned at a maximum distance of 50m from the processing plant crushers and screens. The acoustic barrier must be solid without gaps or openings and satisfy an area density of 20 kg/m2. An acoustic barrier can take the form of a stockpile, an un-extracted rock face, stacked ISO containers, or anything else satisfying the requirements of an acoustic barrier.

1.4.4 In Area 2 and Area 3, the secondary processing plant crushers and screens shall be positioned at a maximum distance of 60m from the quarry face in the direction towards the R1 receptor.

(PERIMETER BERMING, PLANT LOCATION)



2) The Area 2 and Area 3 extraction shall have the working face moving towards the R1 receptor.

3) In Area 2 and Area 3, the secondary processing plant crushers and screens shall be positioned at a maximum distance of 60m from the quarry face in the direction towards the R1 receptor.

1.1.1 Equipment used in site preparation and other construction activities shall satisfy the noise emission levels of MOE NPC-115 "Noise due to

1.3 AREA 1B - (See Figure 2) The following noise controls in addition to the general controls are recommended.

1.3.1 Extraction shall proceed in a south or south-easterly direction.

1.3.3 The primary plant shall travel with the working face positioned such that the working face provides shielding towards receptor R1.

1.4.2 The primary plant shall travel with the working face positioned such that the working face provides shielding towards receptor R1.

FIGURE 1: RECOMMENDED NOISE CONTROLS-AREA 1A

DETAILS OF RECOMMENDED BLASTING PROCEDURES (by DST Consulting Engineers Inc., Sudbury, On) - Sequential blasting techniques will be used to ensure minimum explosives per delay period initiated. These include: - Non-electric blasting systems such as the EZ-Det / Handi-Det / Snap-Det systems or, - Electronic initiation system with remote detonation. - Drilling pattern for initial quarry blasting will be maximum 3.05 m (10') Burden by 3.66 m (12'). The pattern may be adjusted for subsequent blasts in order to achieve the required fragmentation. - Maximum drill—hole diameter for initial quarry blasting will be 102 mm (4"). Vibration and overpressure data acquired during initial blasting may allow for an increase in drill-hole diameter. The pattern will be adjusted to accommodate for the increase in drill-hole diameter. - Minimum collar will be 1.2 m (4 ft.) for 102 mm (4") diameter drill-holes. - Bench height will not exceed 15.24 m (50') for initial quarry blasting. - Clear crushed stone will be used for stemming. - Primary and secondary dust collectors will be employed on the rock drills to keep the level of dust to a minimum - Blasting should be avoided during heavy overcast and temperature inversions when possible.

BLAST IMPACT ANALYSIS RECOMMENDATIONS (by DST Consulting Engineers Inc., Sudbury, Ontario) All blasts should be monitored for both vibration and overpressure (noise) at two of the closest third-party properties adjacent the site (Receptors 1 and 2) with digital seismographs. Compilation of the initial data should be used to establish a site specific vibration and noise attenuation graphs. The values of the Scaled Distance obtained from the graphs will assist in planning subsequent blasting operations. This will also allow blasts to be designed specifically for this location which should ideally induce vibration and noise levels within the MOE Guidelines. All subsequent blasts should also be monitored by the quarry operator at the closest third party building or facility to the blast site. The blasting operations should be audited periodically by an independent blasting consultant.

The seismographs must be self-triggering units and calibrated on an annual basis, or as recommended by the manufacturer. Seismogram copies as well as blast reports for each blast should be filed for future reference. Detailed blast records should be maintained. The MOE (1985) recommended that the body of blast reports

should include the following information:

a) Location, date and time of the blast.

b) Dimensional sketch including photographs, if necessary, of the location of the blasting operation, and the nearest point of reception (vibration receptor). c) Physical and topographical description of the ground between the source and the receptor location.

d) Type of material being blasted.

e) Sub-soil conditions, if known.

f) Prevailing meteorological conditions including wind speed in m/s, wind direction, air temperature in degrees Celcius, relative humidity, degree of cloud cover and ground moisture content.

a) Number of drill holes.

h) Pattern and pitch of drill holes.

i) Size of holes.

j) Depth of drilling.

k) Depth of collar.

I) Depth of toe-load.

m) Weight of charge per delay period.

n) Number and time of delays.

o) The result and calculated value of Peak Sound Pressure Level in dB (L) and Peak Particle Velocity in mm/s.

**p)** Applicable limits.

**q)** The excess, if any, over the prescribed limits.

The blast parameters described within this report will provide a good basis for the initial blasting operations at this quarry. However, it may be necessary to refine these parameters once site-specific vibration and overpressure data from the blasting operations become available. Blasting procedures such as drilling and loading should be monitored or audited on an occasional basis by an independent blasting consultant to ensure full compliance with governing guidelines and regulations.

HYDROGEOLOGICAL RECOMMENDATIONS (by MTE Consultants Inc., Kitchener, Ontario) The hydrogeological recommendations have been implemented within the Adaptive Management Plan on Drawing 5 of 8, "Adaptive Management Plan".

HAR	ROLD SUTHERLAND CONSTRUCTION L R.R. #2, KEMBLE, ONTARIO, NOH1SO	TD.
	NEW KEPPEL QUARRY	
PA	RTS LOTS 26, 27 & 28, CONCESSION	10
TOWNS	SHIP OF GEORGIAN BLUFFS (formerly Keppel COUNTY OF GREY	Twp)
COI	NSULTANT RECOMMENDATIO DRAWING 4 of 8	NS
No.	AMENDMENT	DATE

- Blast-hole detonation will be limited to a single hole per delay period.

- The amount of explosives per delay period for initial quarry blasting shall not exceed 141.9 kg.

JUNE 14, 2012

#### Adaptive Management Plan - New Keppel Quarry WATER RESOURCES MONITORING PROGRA

#### Purpose: To track the performance of the New Keppel Quarry and the potential impacts on water resources 1) Establish a weather station so that site-specific climate data can be obtained

2) Retain a person qualified to:

- Conduct monthly measurements of water levels at the observation wells, minipiezometers, test pits, and private wells listed below

- Conduct monthly measurements of flows at springs, the Beaver Dam sinkhole, culverts, mud creek channel A, the Ephemeral Pond and the dugout pond listed below - Conduct monthly measurements of specific conductivity and temperature at springs, the Beaver Dam sinkhole, culverts, mud creek channel A and the dugout pond listed

- Install and maintain data loggers in 'Sentry Wells' listed below and download the data loggers monthly

- Install and maintain data loggers in minipiezometers to be installed in spring s8, spring s13, and the dugout pond and download the data loggers monthly

- Download precipitation data and pumping records monthly or as needed

- Compile monitoring data and compare it to precipitation data and pumping records monthly

- Inspect for water bearing fractures along active quarry faces immediately after a blast - Check infiltration pond installed near s13 for proper function on a weekly basis

3) Retain an independent Hydrogeologist to:

- Assess and interpret water levels and flows measured against historical patterns, seasonal lows, trigger values, pumping records and precipitation records on a monthly basis - Compare monitoring data against trigger on a monthly basis and make recommendations for monitoring program alterations if required

- Map cone of influence on a monthly basis and assess its pattern using groundwater contours and/or distance-water elevation plots - Provide an annual monitoring report and make recommendations for future monitoring

Trigger Values

Water Resources Moni	toring Loca	tions														
Observation Wells																
Line 1	: OW36	OW37	OW49	OW50	OW51	OW52										
Line 2	: OW14s	OW14d	OW28s	OW28d	OW32s	OW32d	3345	OW33s	OW33d							
Line 3	: OW34	OW35	OW36	OW14s	OW14d	OW41s	OW41d	OW67s	OW67d	OW68s	OW68d	OW58k	OW58s	OW58d		
Line 4	: OW39	OW65s	OW65d	OW66s	OW66d	OW12s	OW12d	OW25s	OW25d	OW59s	OW59d					
Line 5	: OW39	OW40	OW42s	OW42d	OW63s	OW63d	OW64s	OW64d	OW8s	OW8d	OW69s	OW69d	OW24			
Line 6	: OW39	OW40	OW61s	OW61d	OW62k	OW62s	OW62d	OW9s	OW9d	OW70s	OW70d	OW27s	OW27d			
Line 7	: OW39	OW7s	OW7d	OW43s	OW43d	OW11s	OW11d	OW46s	OW46d	OW47s	OW47d	OW48s	OW48d			
Line 8	: OW30s	OW30d	OW39	OW10s	OW10d	OW44s	OW44d	OW45								
Line 9	: OW40	OW7s	OW7d	OW29s	OW29d											
Zone 1	: OW3	OW4	OW7s	OW7d	OW10s	OW10d	OW11s	OW11d	OW14s	OW14d	OW29s	OW29d	OW30s	OW30d	OW34	OW35
	OW36	OW37	OW38	OW39	OW40	OW42s	OW42d	OW43s	OW43d	OW61s	OW61d	OW63s	OW63d	OW65s	OW65d	
Zone 2	: OW15s	OW15d	OW28s	OW28d	OW31s	OW31d	OW32s	OW32d	OW41s	OW41d	OW44s	OW44d	OW46s	OW46d	OW49	OW50
	OW62k	OW62s	OW62d	OW64s	OW64d	OW66s	OW66d									
Zone 3	: OW8s	OW8d	OW9s	OW9d	OW12s	OW12d	OW13s	OW13d	OW24	OW25s	OW25d	OW26	OW27s	OW27d	OW33s	OW33d
	OW45	OW47s	OW47d	OW48	OW51	OW52	OW53	OW58k	OW58s	OW58d	OW59s	OW59d	OW60s	OW60d	OW67s	OW67d
	OW68s	OW68d	OW69s	OW69d	OW/0s	OW/Ud	OW/1K	OW/1s	OW/1d							
Sentry Wells	s OW8s	OW8d	OW9s	OW9d	OW12s	OW12d	OW13s	OW13d	OW33s	OW33d	OW45	OW47s	OW47d	OW51	OW67s	OW67d
	OW71k	OW71s	OW71d													
Minipiezometers	MP54	MP55	MP56	MP57												
Test Pits	TP16	TP17	TP18	TP19												
Springs	s1	s2	s3	s8	s13											
Beaver Dam	flow into s	inkhole								-						
Culverts	1	2	3	4	5	5a	6	6a	7							
Mud Creek	Channel A															
Ephemeral Pond	water leve	ls														

### Water Resources Triggers

water levels outflows

Dugout Pond

ocasonal values					ingger r											
		summer	autumn		green	green	green	green	yellow	yellow	yellow	yellow	red	red	red	red
Monitoring Station	spring low	low	low	winter low	(spring)	(summer)	(autumn)	(winter)	(spring)	(summer)	(autumn)	(winter)	(spring)	(summer)	(autumn)	(winter)
	March 21 -	June 21 -	Sept 21 -	Dec 21 -	March 21	- June 21 -	Sept 21 -	Dec 21 -	March 21	- June 21 -	Sept 21 -	Dec 21 -	March 21	- June 21 -	Sept 21 -	Dec 21 -
	June 21	Sept 21	Dec 21	March 21	June 21	Sept 21	Dec 21	March 21	June 21	Sept 21	Dec 21	March 21	June 21	Sept 21	Dec 21	March 21
Sentry Observation Well	s															
OW8s	243.77	243.23	243.07	243.89	243.92	243.38	243.22	244.04	243.77	243.23	243.07	243.89	243.62	243.08	242.92	243.74
OW8d	243.19	242.45	242.31	243.46	243.34	242.60	242.46	243.61	243.19	242.45	242.31	243.46	243.04	242.30	242.16	243.31
OW9s	242.83	242.20	242.25	242.93	242.98	242.35	242.40	243.08	242.83	242.20	242.25	242.93	242.68	242.05	242.10	242.78
OW9d	243.01	241.99	242.23	243.23	243.16	242.14	242.38	243.38	243.01	241.99	242.23	243.23	242.86	241.84	242.08	243.08
OW12s	243.65	243.36	243.30	243.72	243.80	243.51	243.45	243.87	243.65	243.36	243.30	243.72	243.50	243.21	243.15	243.57
OW12d	243.47	242.89	242.76	243.68	243.62	243.04	242.91	243.83	243.47	242.89	242.76	243.68	243.32	242.74	242.61	243.53
OW13s	244.58	243.67	243.40	244.80	244.73	243.82	243.55	244.95	244.58	243.67	243.40	244.80	244.43	243.52	243.25	244.65
OW13d	241.99	241.42	241.32	242.48	242.14	241.57	241.47	242.63	241.99	241.42	241.32	242.48	241.84	241.27	241.17	242.33
OW33s	243.47	243.10	243.09	243.62	243.62	243.25	243.24	243.77	243.47	243.10	243.09	243.62	243.32	242.95	242.94	243.47
OW33d	239.25	238.59	238.73	239.92	239.40	238.74	238.88	240.07	239.25	238.59	238.73	239.92	239.10	238.44	238.58	239.77
OW45	243.93	243.22	243.83	244.13	244.08	243.37	243.98	244.28	243.93	243.22	243.83	244.13	243.78	243.07	243.68	243.98
OW47s	243.45	243.00	243.14	243.47	243.60	243.15	243.29	243.62	243.45	243.00	243.14	243.47	243.30	242.85	242.99	243.32
OW47d	243.36	242.71	243.27	243.42	243.51	242.86	243.42	243.57	243.36	242.71	243.27	243.42	243.21	242.56	243.12	243.27
OW51	239.75	239.00	238.97	240.08	239.90	239.15	239.12	240.23	239.75	239.00	238.97	240.08	239.60	238.85	238.82	239.93
OW53	241.65	242.39	243.45	244.38	241.80	242.54	243.60	244.53	241.65	242.39	243.45	244.38	241.50	242.24	243.30	244.23
OW67s*	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
OW67d*	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
OW71s*	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
OW71d*	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
OW71k*	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Springs																
Spring s8 Water Levels	239.82	239.51	239.63	239.89	239.97	NA	239.78	240.04	239.82	NA	239.63	239.89	239.67	NA	239.48	239.74
Spring s13 Water Levels	242.86	242.33	242.35	242.93	243.01	NA	242.50	243.08	242.86	NA	242.35	242.93	242.71	NA	242.20	242.78
Dugout Pond																
SG1	243.09	243.01	243.07	243.06	243.24	243.16	243.22	243.21	243.09	243.01	243.07	243.06	242.94	242.86	242.92	242.91
Ephemeral Pond	*****	<u></u>					******		*****							
Staff Gauge	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

TBD = To Be Determined NA = Not Applicable * = Seasonal values and subsequent trigger values shall be based on at least three years of monitoring data collected while extracting in Area 1B

ECOLOGICAL MONITORING PROGRAM Purpose: To evaluate the ecological health of selected natural features throughout the life cycle of the quarry and ensure that their ecological function is maintained The Ecological Monitoring Program relies upon an understanding of changes observed through the Water Resources Monitoring Program because ecological receptors tend to respond more slowly to impacts compared to the hydrogeologic regime. Therefore the Water Resources Monitoring Program will be a critical early warning system for detecting potential impacts to ecological health. The program will be carried

out by a qualified person. It should be noted that there are no numerical trigger values for the Ecological Monitoring Program. Ecological Monitoring Areas (EMA)

Staff Gauge

The Ecological Monitoring Program will be focused on features in the woodlands of the Area of Natural and Scientific Interest (ANSI), the Shouldice Wetland and the upper Glen Management Area and include

both terrestrial ecological features (EMA-1 and EMA-2) and wetland ecological features (EMA-2 through EMA-6). EMA-1: Woodland Tree Health, Woodland Regeneration and Woodland Flora Species Diversity;

EMA-2: Woodland Breeding Birds; EMA-3: The Glen area s1 to s3 groundwater discharge feature:

EMA-4: The Shouldice Wetland at the s8 and s9 groundwater discharge feature;

EMA-5: The Woodland Ephemeral Pond amphibian breeding surface water feature; and

EMA-6: The lobe of the Shouldice Wetland encompassing spring s13 and the Dugout Pond and the upper headwater channel for the East Branch of Park Head Creek.

### Water Resources/Ecological Green Actions Purpose: Identify changes prior to impacting groundwater and surface water features and implement investigative actions

In the event the Water Resources Monitoring Program reveals a green trigger exceedence: a) Report the excedance to the quarry owner/operator within 24 hrs and increase monitoring frequency to weekly at:

> - Observation wells along Lines 1 and 2, at Spring s1, s2, s3, and at the Beaver Dam Sinkhole IF a green trigger value is exceeded at OW33s, OW33d, or OW51 - confirm that water is entering Beaver Dam sinkhole and that spring s3 is flowing

- confirm that groundwater seepage along the north quarry face has not increased Observation wells along Lines 3, 4, 5, at Spring s8, at Test Pits TP15, TP16, TP17, TP18, and at Minipiezometers MP55, MP56, and MP57, IF a green trigger value is exceeded at OW67s, OW67d, OW12s, OW12d, OW8s, OW8g

- Observation wells along Lines 6, 7, 8, Spring s13, the Dugout Pond (water levels and flow) IF a green trigger value is exceeded at OW9s, OW9d, OW71k, OW71s, OW71d, OW47s,

OW47d, OW45 b) Make recommendations for changes to the monitoring program as required. Changes may include but not limited to:

#### - Installation of observation wells

- Increase monitoring frequency at other monitoring stations

Water Resources/Ecological Yellow Actions Purpose: Implement mitigation measures that will prevent impacts to the groundwater system, the Shouldice Wetland, or the springs s1-s3 in the Glen Management Area thus preventing the need for Red Actions. If changes to natural features are related to climatological influences or non-quarry related activities then Yellow Actions may not be required.

## A "Yellow Action" precautionary mitigation response is triggered if:

1. The Water Resources Monitoring Program has revealed a yellow trigger value exceedence that can be attributed to the quarry operations; and/or

### 2. Early indicators of ecological impacts are observed that can be attributed to the quarry operations.

A Yellow Action will include an interdisciplinary review of all monitoring programs, which could recommend the following:

#### 1) Report to MNR and NEC within 72 hours the exceeded trigger values and Mitigative Actions that will be

implemente 2) Prepare to augment flows¹ to the impacted area(s) and review the operational plan for possible alterations, which may include but not limited to

- Changing the quarry direction and/or,

- Revising the quarry floor elevation and/or,

#### - Grouting a significant water bearing fracture if encountered. ¹ Augmentation of flows to springs may be in the form of a pipe that directs water or an infiltration

pond that allows water to recharge the groundwater system - If the impact was observed at OW71k, OW71s or OW71d, then recommendations to the design of the infiltration pond should be considered in order to provide adequate protection for

s13 such as:

- Altering the size of the infiltration pond to encourage more infiltration of water to the bedrock groundwater syster

- Altering the location of the infiltration pond so that it is closer to s13 so that its

hydraulic connection to s13 may be enhanced

3) Continue monitoring weekly until the system recovers as determined by a Hydrogeologist 4) If mitigation measures as per Yellow Action 2 prove to be working whereby water levels in affected area

## have recovered¹ and there is no observed impact to spring(s) in question then: - Quarry activities in the direction of the affected area can resume

- Extraction in the direction of s8 and or s13 can continue only when their flows are observed to occur by a Ministry Inspector. naturally as determined by the Hydrogeologist and the Qualified Person for the Ecological Monitoring

#### ¹ recovered water levels means that water levels in the affected observation well(s) has returned above green trigger values for at least 3 monitoring events spaced one week apart 5) Summarize the results of 1 through 4 in a report to the MNR and NEC and make recommendations for

the operation of the quarry

#### Water Resources/Ecological Red Actions

Purpose: To implement mitigation measures that will minimize the impact on the groundwater system due to the quarry. If changes to natural features are related to climatological influences or non-guarry related activities then Red Actions may not be required.

#### A "Red Action" immediate response is triggered if:

1. The Water Resources Monitoring Program has revealed a red trigger value exceedence that can be

ed to the quarry operation 2. Evidence of negative ecological impacts are observed that can be attributed to the quarry operations;

A Red Action will include an interdisciplinary review of all monitoring programs and Yellow Action

activities to date, which could recommend the following: 1) Report to MNR and NEC within 24 hours the exceeded trigger value(s) and Mitigative Actions that will be

## implemented

2) Stop guarry activities

3) Augment¹ flows to the bedrock system in the area of the observed impact

Augmentation of flows may involve direct discharges to the affected spring(s) or the construction of an infiltration basin that allows water to recharge the groundwater system

## 4) Monitor to determine the effectiveness of flow augmentation

5) If it is deemed that flow augmentation is effective¹, then quarry activities may resume in a direction that will not exacerbate the impact, provided that a sign-off acceptance from the MNR, NEC and other relevant reviewing agencies has been obtained

¹ Groundwater levels in the impacted observation well(s) in Zone 3 have returned above green trigger values as determined by at least three monitoring events spaced one week apart 6) If it is deemed by the Hydrogeologist, the Qualified Person for the Ecological Monitoring Program, the owner/operator and reviewing agencies that the quarry cannot operate without negatively impacting water levels in the Shouldice Wetland and/or the springs in the Glen Management Area then the need to close the quarry should be assessed in consultation with all relevant reviewing agencies.

7) Hydrogeologist and the Qualified Person for the Ecological Monitoring Program to summarize the results of Mitigation Actions 1 through 6 in a report to the MNR and NEC along with the recommendations for the operation of the quarry

T INVATE VIELE MODINIA	ZAMAG I NOCIVEM		
Private Well Locations	Catogory A Wells: 3345, 3447, 51	97, New Cramp Well	Category B Wells: IBD
Private Well Trigger Val	ues		
Monitoring Station	Green	Yellow	Red
Well No. 3345	None	227.5 mAMSL	Complaint Received
Well No. 3447	None	TBD	Complaint Received
Well No. 5197	None	TBD	Complaint Received
New Cramp Well	None	TBD	Complaint Received
Category B Wells	None	TBD	Complaint Received
TRD - To Ro Determined			

TBD = To Be Determined

* = Seasonal values and subsequent trigger values shall be based on at least three years of monitoring data collected while extracting in Area 1B Private Well Yellow Actions Purpose: To implement mitigation measures that will prevent impacts to private water supply wells thus preventing the need for Red Actions. If impacts to private wells are not related to quarry activities then Yellow Actions may not be required.

If a yellow trigger value is exceeded for any of the Category A or Category B private wells, then the following mitigation measures will be initiated:

a) The quarry operator shall report to the local MOE District Office within 72 hours the exceeded trigger values and Mitigative Actions that will be implemented.

b) Inform the resident and enquire about well yield. c) If well yield is affected, then the quarry operator shall retain an MOE licensed plumber to inspect the well and mechanical components thereof and confirm if mechanical issues (i.e. the pump and/or plumbing system) are the cause and to validate the decrease in well yield.

d) If the cause is not mechanically related, then:

- The guarry operator will provide a temporary supply of water within 24 hours (if required)

- The quarry operator will make arrangements to provide a suitable alternative water supply. - Provisions for the affected resident could include all or part of the costs associated with water delivered to fill a temporary water system and associated costs, lowering the pump, drilling a new well, well-deepening, abandonment of the old well.

Private Well Red Actions Purpose: To implement mitigation measures that will minimize the impact to private water supply wells due to the quarry. If changes to private wells are not related to quarry activities then Red Actions may not be required.

Well Interference Complaint Response Procedure Upon receipt of a well interference complaint the receiver shall immediately notify Harold Sutherland Construction Ltd. by calling Harold Sutherland (Owner/Operator), at the following number(s):

After Hours Contact:

Mobile: 226-668-4495

Working Hours Contact Phone: 519-376-5698 Fax: 519-371-6121

Mobile: 226-668-4495 Email: jennifer@hsc-ltd.com

> A well interference complaint from a private well owner will constitute a red trigger breech, and the response procedure will be initiated: 1) Report to MOE within 24 hours the Mitigative Actions to be implemented

2) The quarry operator will call a MOE licensed plumber immediately upon receipt of the complaint to inspect the well and mechanical systems to confirm that the problem is not mechanical (i.e. pump malfunction) and to validate the complaint. 3) If the complaint is determined not to be mechanically related (i.e. plumbing), the quarry operator will provide a temporary water supply within 24

hours for the affected resident and make arrangements to investigate (hydrogeological consultant) the cause of the interference 4) Where the results of the investigation indicate that the interference is legitimately from dewatering the New Keppel Quarry, the quarry operator will make arrangements to provide compensation. Compensation must be acceptable to the home owner and the quarry operator, and could include all or part of the costs associated with drilling of a new well, well deepening, abandonment of the old well.

5) Where the results of the investigation do not indicate interference from dewatering of the New Keppel Quarry, the quarry operator will provide a letter report summarizing the results of the investigation to the property owner. In this case, the quarry operator shall maintain the temporary water supply (provided under item 3) for at least an additional 24 hours to allow the resident to make alternate water supply arrangements.

6) The quarry operator shall document the interference complaint and its resolution and keep the results on file in the event that they be requested

BLASTING MONITORING PROGRAM Purpose: To ensure that the blasting operations are carried out in a safe and productive manner and to ensure that no possibility damage exists to any buildings, structures or residences surrounding the New Keppel Quarry. Blasts should be designed so that the seismic activity (vibrations) and noise induced by the blasting operations will remain well within the MOE guidelines. HSCL staff will be trained by a blasting consultant to properly install, monitor, record and report the blast induced vibrations and overpressure. All blasts will be monitored for vibration and overpressure at the Ritchie Property (R1) and Cramp Property (R2) with digital

seismographs. Green Blast Trigger

Seismograph readings are within the MOE guidelines for vibration and overpressure, there is no flyrock generated beyond the blast area, there are no complaints from the public, and there is no negative report in the water tested from the quarry.

Remedial Action - No remedial action is necessary

Yellow Blast Trigger

Seismograph readings exceeded the MOE guidelines for vibration and/or overpressure, there is no flyrock generated beyond the blast area, there are no reported damage complaints, there may be complaints from noise or vibration, and slight elevated nitrates and/or other chemicals associat with explosives in the discharge water tested from the quarry as part of the ECA requirements.

Remedial Action - Review the environmental conditions and blast design parameters. Make reasonable adjustments for subsequent blasts. Report the findings and remedial measures to be taken for subsequent blasts to complainants and affected residents. Red Blast Trigger

Seismograph readings exceeded the MOE guidelines for vibration and/or overpressure and/or there is flyrock generated beyond the blast area, there are reported damage complaints, there are complaints from noise or vibration, and there is an elevated level of nitrates and/or other chemicals associated with explosives used for blasting in the discharge water tested from the quarry as part of the ECA requirements

Remedial Action - Stop any further blasting until a full investigation has taken place into the reasons for the unexpected results. Make appropriate changes and report these changes before commencement of the blasting operation

REPORTING REQUIREM	ENTS
Report Type	Reporting Requirements
First Annual Report	Annual reports detailing the results of the monitoring program will be provided to the MNR, MOE and NEC. Annual reporting will involve data compilation, presentation and evaluation of the performance monitoring data, including the trend analysis. The reports will determine if the AMP is effectively monitoring the site conditions. The first annual report will be completed at the initiation of operations to summarize the baseline data collected pre-quarry.
Subsequent Annual Reports	<ul> <li>All subsequent annual reports will include a discussion on: <ul> <li>The quarry's influence on the bedrock groundwater system, specifically describing the progression of the cone of influence and any changes to the 'epikarst aquifer';</li> <li>The effect on the Shouldice Wetland including an assessment of the hydroperiod, ecology, and flows at spring s8, s9, s13 and the dugout pond;</li> <li>The effect on the Glen Management Area and its associated springs (s1-s3) including an assessment of the hydroperiod and ecology; and</li> <li>The effect on local private wells that have agreed to participate in the Private Well Monitoring Program.</li> </ul> </li> </ul>
Interim Reports	Interim reports will be submitted if trigger values are triggered as listed under the "Green", "Yellow" and "Red" actions in the AMP.

TO

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R.R. #2, KEMBLE, ONTARIO, NOH1	SO
ARTS LOTS 26 27 & 28 CONCE	
NSHIP OF GEORGIAN BLUFFS (formerly	y Keppel Twp)
COUNTY OF GREY	
DAPTIVE MANAGEMEN	T PLAN
DRAWING 5 of 8	
AMENDMENT	DATE
	UNE 8 2012



# REHABILITATION NOTES

1. The area to be rehabilitated is 27.1 hectares.

2. This site is to be rehabilitated to a natural environment after use.

**3.** Perimeter 3:1 side slopes along the 100m ANSI setback line to elevation 243m shall be created by backfilling with onsite overburden & topsoil or clean imported fill. Final slopes shall be spread with a minimum of 0.15 metres (6 inches) of topsoil and shall be seeded and planted as outlined on the "Perimeter Extraction Detail (ANSI Side) on Drawing 7 of 8, "Cross-sections and Details".

4. Rehabilitated areas shall drain in the direction of the arrows as shown. Surface water from precipitation to the north of the site will continue to drain towards the pond area. Other areas will drain in the same direction as they had prior to development and during extraction operations.

5. Rehabilitated slopes are to be regraded and replanted in the event of die out or washouts.

6. There shall be no buildings or roads on site upon completion of rehabilitation.

7. Only topsoil, subsoil and overburden meeting the definition of inert fill under Regulation 347 of the Environmental Protection Act shall be imported into this site for the purposes of conducting rehabilitation. Incoming loads of fill shall be monitored by staff.

8. Shoreline zones will be created in a jagged fashion where possible. Stumps and boulders shall be randomly strewn along the waters edge .

9. For cross section A-A' refer to Drawing 7 of 8, "Cross Sections and Details".

10. Any vegetation that dies or is otherwise damaged shall be reseeded or replanted.

11. Refer to Drawing 3 of 8, "Sequence of Operations", for progressive rehabilitation timing and to drawing 8 of 8, "Landscaping Details", by L. Porter, Landscape Architect.



HA	ROLD	<b>SUTHE</b> R.R. #2,	RLAND CO	NSTRUCTION RIO, NOH1SO	I LTD.
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TOWN	ISHIP (	OF GEOR	GIAN BLUFFS UNTY OF	(formerly Kep GREY	pel Twp)
Ρ	ROGI FIN	RESSIV Al Re	<b>/E REHABI HABILITA</b> DRAWING 6 of	LITATION A	AND S
			SCALE: 1:4000		
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AMENDMENT

JUNE 8, 2012

DATE

20m EXISTING FOREST SETBACK(IE ^ FOR PROPOSED PLANTING THE VISUAL ANALYSIS A PROPOSED LICENCE BOUNDARY LINE BETWEEN LOTS 26 & 27 TING GRADE	VEGETA GS REF ND REP /IRE FEI Dm SET 7 & 28 IER LEV
POND APPROXIMATE FINAL WA         VERTICAL FACE-         PROPOSED REHABILITATE         VRIZONTAL 1:4000         SRTICAL 1:400         SRTICAL 1:400         Image: Structure of the structure of	ID GRA
VERTICAL FACE- PROPOSED REHABILITATE PROPOSED REHABILITATE QUARRY FLOOR SRTICAL 1:400 100m FROM ANSI) 100 BERM	D GRA
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AE STREWN ABOVE & BELOW WATER WITH BOULDERS, ROCK PILES AND STUMPS EXISTING GRADE IL DEPOSITION WITH NATURAL AQUATIC VEGETATION GROWTH AL REHABILITATED 3:1 SLOPE ON NORTHERLY BOUNDARIES 243 METRE LEVEL (+/-244m) 243 METRE LEVEL BOTTOM OF AMABEL FORMATION C ADJACENT TO 100m ANSI SETBACK	3 
1.2m HIGH PAGE WRE FENCE 100m ANSI SETBACK	
POSSIBLE 5.18m ROAD WIDENING COUNTY ROAD 17 20m EXISTING FOREST SETBACK	
	LEVENING GRADE



HAR	HAROLD SUTHERLAND CONSTRUCTION LTD. R.R. #2, KEMBLE, ONTARIO, NOH1SO						
	NEW KEPPEL QUARRY						
PAF	RTS LOTS 26, 27 & 28, CONCESSION	10					
TOWNS	TOWNSHIP OF GEORGIAN BLUFFS (formerly Keppel Twp) COUNTY OF GREY						
CR	CROSS-SECTIONS & DETAILS DRAWING 7 of 8						
No.	AMENDMENT	DATE					

	Number
cal	1
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1	1
	4

This proposed re-vegetation plan would result in 4,040 (10.1 hectares) trees and shrubs

Scientific Name Pinus strobus Thuja occidentalis Populus balsamifera Populus grandidentata Betula papyrifera Acer saccharum Fraxinus americana

Prunus pennsylvanica Prunus virginiana Cornus racemosa Sambucus canadensis

Viburnum lentago





# Appendix "B"

- Attenuation curves



S.D. (m/kg^1/2)	Predicted PPV (mm/s)	Actual PPV (mm/s)
1.1	858.56	
310	0.10	
15.5	12.46	0.53





S.D. (m/kg^1/3)	OP (dB)
10	147.00
9000	88.00









## Appendix "C"

- Calculation of maximum allowable explosives per delay period based on MOE guidelines



#### Proposed New Keppel Quarry

#### CALCULATION OF MAXIMUM ALLOWABLE EXPLOSIVES/DELAY PERIOD

Wmax = ((K * (d^e))/PPV)^-1.8

PPV = predicted peak particle velocity (mm/s) K,e = site factors (pre-determined) d = distance from receptor (m) W_{max} = max. explosive charge per delay (kg)

DST's In-house Database

ĸ	d (m)	e	PPV mm/s	w (kg)
350	420	-1.11	12.50	432.88
350	399	-1.11	12.50	390.71
350	378	-1.11	12.50	350.71
350	312	-1.11	12.50	239.02

350	100	-1.11	12.50	24.61
350	200	-1.11	12.50	98.30
350	300	-1.11	12.50	221.01
350	400	-1.11	12.50	392.67
350	500	-1.11	12.50	613.28
350	600	-1.11	12.50	882.80
350	700	-1.11	12.50	1201.22
350	800	-1.11	12.50	1568.52
350	900	-1.11	12.50	1984.69
350	1000	-1.11	12.50	2449.71

#### Wmax = ((K * (d^e))/PPV)^-1.25

ISEE's D50

K	d (m)	e	PPV mm/s	w (ka)
1140	420	-1.58	12.50	538.18
1140	399	-1.58	12.50	486.33
1140	378	-1.58	12.50	437.07
1140	312	-1.58	12.50	299.20

1140	100	-1.58	12.50	31.62
1140	200	-1.58	12.50	124.32
1140	300	-1.58	12.50	276.90
1140	400	-1.58	12.50	488.74
1140	500	-1.58	12.50	759.40
1140	600	-1.58	12.50	1088.57
1140	700	-1.58	12.50	1475.96
1140	800	-1.58	12.50	1921.36
1140	900	-1.58	12.50	2424.57
1140	1000	-1.58	12.50	2985.43

ISEE's D95

к	d (m)	e	PPV mm/s	w (kg)		
1725	420	-1.58	12.50	320.68		
1725	399	-1.58	12.50	289.78		
1725	378	-1.58	12.50	260.43		
1725	312	-1.58	12.50	178.28		

1725	100	-1.58	12.50	18.84
1725	200	-1.58	12.50	74.08
1725	300	-1.58	12.50	164.99
1725	400	-1.58	12.50	291,22
1725	500	-1.58	12.50	452.50
1725	600	-1.58	12.50	648.63
1725	700	-1.58	12.50	879.47
1725	800	-1.58	12.50	1144.86
1725	900	-1.58	12.50	1444.71
1725	1000	-1.58	12.50	1778.90



# Appendix "D"

- Typical blast layout (Area 1A)







# Appendix "E"

- Writer's Curriculum Vitae



## Ray M. Jambakhsh, M. Sc., P. Eng.

## EDUCATION

- B. Sc. Mining Engineering, Laurentian University, Sudbury, Ontario, Canada
- M. Sc., Applied Physics, Laurentian University, Sudbury, Ontario, Canada

## PROFESSIONAL AFFILIATIONS

- Registered member of the Association of Professional Engineers of Ontario (PEO)
- Designated Consultant by the Association of Professional Engineers of Ontario
- Member of the International Society of Explosives Engineers (ISEE)
- Chair Person ISEE Ontario Trillium Chapter, Sudbury Chair
- Member of the Canadian Institute of Mining, Metallurgical and Petroleum Engineers (CIMM)

## SUMMARY OF EXPERIENCE

Ray Jambakhsh has underground and surface mining experience and has been involved in numerical modeling as a rock mechanics engineer for a major Canadian mining firm. He has also been instrumental in design, introduction, and implementation of electric and non-electric sequential blasting techniques for underground (VCR/VRM), open pit and quarry applications, building demolition by blasting, pipeline blasting, marine blasting, and highway blasting projects. He has handled blast vibration monitoring, vibration risk analysis, vibration and noise impact analysis, blasting audits, and blast damage complaints for insurance companies, law firms, government agencies, and contractors. Ray specializes in explosives, explosives demolition, explosion impact analysis, blasting and vibrations.



# **PROFESSIONAL RECORD**

- 06/2004 Present Principal & Sector Manager DST Consulting Engineers
- 07/2003 06/02004 Owner, President, Ray-Tech Engineering Limited
- 03/2003 07/2003 Senior Blasting Engineer, Golder Associates Limited
- 1989 2003 General Manager, Explotech Engineering Limited
- 1988 1989 Project Engineer, Explotech Engineering Limited
  - 1987 Field Engineer, M.H.M. Consultants Limited
  - 1987 Engineer-In-Training, Kidd Creek Mines Limited
  - 1986 Researcher, Centre in Mining and Mineral Exploration
  - 1986 1990 Graduate Studies and Research, Laurentian University

# KEY PROJECT EXPERIENCE

# **KEY DEMOLITION PROJECTS**

- Client Rakowski Cartage & Wrecking Limited Demolition of South Main Head Frame, Hudson Bay Mining & Smelting Company, Flin Flon, Manitoba. Site blasting engineer responsible for design, implementation and supervision of the demolition by blasting, July 27, 2009.
- Client Delsan AIM Demolition and Environmental Services Xstrata Gaspe Mine Site, Murdochville, Quebec. Responsible for design, sequencing, charge placement and blasting of steel ore bin building, December 9, 2008.
- Client City of Ottawa Frank Clair Stadium Demolition by Blasting Responsible for specification writing, site supervision and blasting safety, July 16, 2008.
- Client Delsan AIM Demolition and Environmental Services Abitibi Stephenville Paper Mill Site, Newfoundland. Responsible for design, sequencing, charge placement and blasting of multiple structures on site, June 3, 2008.



- Client B. Curry & Sons Limited Phalen Mine Rotary Crusher Building demolition by blasting, Sydney, Nova Scotia. Responsible for design, sequencing, charge placement and blasting, June 18, 2007.
- Client Rakowski Cartage & Wrecking Limited Winnipeg Arena demolition by blasting, Winnipeg, Manitoba. Responsible for design review, sequencing, charge placement and blasting, March 26, 2006.
- Client Lac des Iles Mines Limited Old Mill Transfer House Building demolition by blasting, Thunder Bay, Ontario. Responsible for design, sequencing, charge placement and blasting, June 16, 2005.
- Client Rakowski Cartage & Wrecking Limited APRO Grain Storage Building demolition by blasting, Winnipeg, Manitoba, June 12, 2005.
- Client Noranda Inc. Noranda Inc. Gaspe Site, Murdochville, Quebec. A 550-foot Smoke Stack demolition by blasting. Responsible for design, sequencing, charge placement and blasting, October 13, 2003.
- Client Aim Waste Management Group London Health Science Centre Incinerator Stack demolition by blasting, London, Ontario. Responsible for design, sequencing, charge placement and blasting, May 10, 2003.
- Client Denison Environmental Services –Inco's Shebandowan # 2 Shaft Headframe demolition by blasting, Shebandowan, Ontario. Responsible for design, sequencing, charge placement and blasting, August 18, 2001.
- Client Cambrian Blasting Limited Lafarge Twin-Stack demolition by blasting, Winnipeg, Manitoba. Responsible for design, sequencing, charge placement and blasting, June 10, 2001.
- Client Rakowski Cartage & Wrecking Limited Canada Packers Building demolition by blasting, Winnipeg Manitoba. Responsible for design, sequencing, charge placement and blasting, March 4, 2001.
- Client Rakowski Cartage & Wrecking Limited Centragas Steel Propane Storage Tank demolition by blasting, Winnipeg Manitoba. Responsible for design review, sequencing, charge placement and blasting, October 22, 2000.
- Client Maceron Limited Inco's Little Stobie Mine, Reinforced Concrete Head Frame demolition by blasting, Sudbury, Ontario. Responsible for design, loading, sequencing and blasting, December 1999.
- Client Techplode Limited Robie Street Water Reservoir Dome demolition by blasting, Halifax, Nova Scotia. Responsible for design review, approval, loading, sequencing and blasting, October 1999.
- Client A & E Enterprises Demolition of the Proctor & Gamble Building by means of blasting, Hamilton, Ontario. Designated site blasting engineer and consultant, responsible for the blast design review, approvals, and site supervision, October 1999.



- Client LebRun Northern Contracting Limited Ontario Hydro's 110 m Smoke Stack demolition by blasting, Mission Island, Thunder Bay, Ontario. Responsible for blast design review, pre-blast survey, seismic monitoring, impact attenuation design and vibration impact prediction, September 1998.
- Client Stanley Buildings and Alberta Public Works Commission Bow Valley Centre (Calgary General Hospital) demolition by blasting, Calgary Alberta. Responsible for blast design review, blast impact analysis, safety review and seismic monitoring, October 1998.
- Client Abitibi Consolidated, Fort William Division Triple Tower Acid Silo demolition by blasting, Thunder Bay, Ontario. Responsible for blast design, explosives loading, blasting sequence, seismic monitoring and blasting safety, December 1998.
- Client Corona Inc. Denison Mine Pebble Bin and Ore Silo demolition by blasting, Elliot Lake, Ontario. Responsible for blast design, explosives loading, blasting sequence, seismic monitoring and blasting safety, September 1995.
- Client Matthews Group Portage Dam demolition by blasting, Dokis, Ontario. Responsible for blast design, explosives loading, blasting sequence, seismic monitoring and blasting safety, November 1992.
- Client Various Contractors St. Lawrence Seaway (Welland Canal) demolition by blasting, St. Catharines, Ontario. Site blasting engineer in charge of blast design implementation, explosives loading, blasting sequence, seismic monitoring and blasting safety, January 1990, 1991, 1992.

# **KEY CIVIL PROJECTS**

- Client Kiewit-Alarie, A Partnership (KAP) Blast Consulting Services at the Hound Chute and Sandy Falls Hydro Electric Project September 2008.
- Client Consbec Inc., Leo Alarie and Sons Limited, SNC Lavalin Blast Consulting Services at the Ear Falls OPG new hydro dam construction, 2004 to present.
- Client Consbec Inc. Blast Consulting Services at the Wuskwatim GS, Manitoba Hydro, Thompson, Manitoba, June November, 2008.
- Client Union Gas Installation of Lateral and Distribution Gas Lines, various locations in Ontario. Blasting consultant responsible for blast design review, approvals, pre-blast surveys, vibration monitoring and blasting safety, 1997 – present.
- Client Laurentian University and Dennis Consultants Site preparation blasting for Laurentian Health Science Centre. Responsible for preparing blasting specifications, blast vibration monitoring audit and site risk assessment on several contracts. 2003 -2005
- Client Castonguay Blasting Limited Proposed Highway 400 Four Lane Project, various MTO contracts. Blast consulting engineer responsible for risk analysis, blast



design approvals, vibration monitoring, and pre-blast survey requirements. 2003-Present

- Client Belanger Construction Limited Laurentian Hospital Expansion Project. Blast consulting engineer responsible for blast design, vibration monitoring and site supervision during rock excavation phase of the project. 1999 – 2007.
- Client Interpaving Limited Dynamic Earth Project in Sudbury Ontario. Responsible for blast design, vibration control and wall control. Summer 2001.
- Client Home Depot Responsible for the drilling and blasting operations for site preparation of the Home Depot building in Sudbury, Ontario, August – November, 2000.
- Client Castonguay Blasting Limited Proposed Highway 400 Four Lane Project, Parry Sound, Ontario. Blast consulting engineer responsible for risk analysis of drilling and blasting operations, November 2000 – 2002.
- Client Dyna-Con Explosive Technologies Proposed Highway 400 Four Lane Project, Parry Sound, Ontario. Blast consulting engineer responsible for all aspects of drilling and blasting operations, November 1999 – 2003.
- Client TransCanada PipeLines Limited (TCPL) High Pressure Gas Line Installation, along TCPL's right-of-way, in Ontario and Manitoba. Associate consulting engineer responsible for blast design review, approvals, blasting safety, vibration monitoring and public relations, 1990 – 1999.
- Client Lindsey Morden Limited and representing MTO Traffic Vibration Impact Analysis, Northern Ontario. Analysis of vibrations induced by vehicular traffic on residential buildings, 1997.
- Client Peter Kiewit Sons Company Limited Ontario Hydro's Matabitchuan Power Station Rehabilitation Project, North Cobalt, Ontario. Consulting engineer responsible for, blast design review, approvals, pre-blast survey, vibration monitoring and blast supervision, September 1995.
- Client John Bianchi Limited South Falls Power Generating Station, Heron Bay, Ontario. Consulting engineer responsible for, blast design review, approvals, preblast survey, vibration monitoring and blast supervision, October 1995.
- Client Arcam Engineering E.B.Eddy Power Plant Installation, Espanola, Ontario. Consulting engineer responsible for, blast design review, approvals, pre-blast survey, vibration monitoring and blast supervision, 1993.
- Client Bruce Evans Limited Ontario Hydro's Big Chute Hydroelectric Generating Station, Port Severn, Ontario. Consulting engineer responsible for, blast design review, approvals, pre-blast survey, vibration monitoring, and blast supervision, May – December 1992.
- Client International Pipeline Engineering Limited (IPEL) Bell Canada Fiber Optics Transmission Project, along Trans-Canada Highway, Ontario. Site blasting engineer


responsible for implementation of blast design, blasting safety, vibration monitoring and explosives loading, 1987 – 1989.

 Client - Matthews Group – Sturgeon Falls Water Treatment Plant, Sturgeon Falls, Ontario. Site blasting engineer responsible for blast design, excavation sequence, supervision of explosives loading, pre-blast survey, vibration monitoring and blasting safety, May 1985.

## **KEY MARINE PROJECTS**

- Client TransCanada PipeLines Limited Lake and River Crossings, various locations in Ontario and Manitoba. Associate consulting engineer responsible for blast design review, approvals, blasting safety, underwater blast overpressure and vibration monitoring and public relations, 1990 – 1999.
- Client Ontario Hydro Dear Lake Powerhouse Project, Dear Lake, Ontario. Blast consulting engineer responsible for determination of explosive quantities used in marine blasting operation, March 1998.
- Client Ontario Trap Rock Limited Shipping Dock Construction, Bruce Mines, Ontario. Blast consulting engineer responsible for blast design, ice blasting, explosives loading, underwater blast over-pressure and seismic monitoring, blasting safety and blast data logging, 1995.
- Client Peter Kiewit and Sons Company Limited Little Chute Channel Expansion Project, Port Severn, Ontario. Blast consulting engineer responsible for blast design, blast design implementation, application of sequential blasting techniques, underwater blast over-pressure and seismic monitoring, blasting safety and blast data logging, 1993.
- Client Hugh Cole Limited Port Colborne Bridge Pier Blasting, Port Colborne, Ontario. Site engineer responsible for blast design, explosive selection and loading, blast supervision, underwater blast over-pressure and seismic monitoring, blasting safety and blast data logging, September 1992.
- Client Peter Kiewit and Sons Company Limited Lemieux Island Development Project, Ottawa, Ontario. Site blasting engineer responsible for implementation of blast design, explosives loading, sequential sequencing, vibration monitoring, blast tie-up, and execution, October 1990.



## **KEY MINING PROJECTS**

- Client BH Martin Consultants Limited Blast impact analysis and risk Assessment for proposed reopening of gold mines in the Timmins area mining properties, 2007 to present.
- Client Superior Aggregate Company Blast Impact Analysis and Risk Assessment, 2003 to present
- Client Inco Limited Underground VRM Blasting Audits and Special Projects, 2003 – 2007.
- Client Goldcorp Incorporated Red Lake Mining Division, Balmertown, Ontario. Blast consulting specialist responsible for drilling and blasting operations for crown pillar remediation projects, September 2003.
- Client Inco Limited Blast Vibration Monitoring Program, Ontario Division, Sudbury, Ontario. Blast consulting engineer responsible for implementation of third-party blast induced vibration-monitoring program, 1990 - 2003.
- Client Goldcorp Incorporated Red Lake Grinding Complex construction, Balmertown, Ontario. Blast consulting engineer responsible for drilling and blasting operations for expansion and installation of new grinding complex, 1999.
- Client Rainbow Concrete Industries Limited Hick's Quarry, Sudbury Division, Sudbury, Ontario. Blast consulting engineer responsible for all aspects of drilling and blasting operations, 1996 – 2003.
- Client Rainbow Concrete Industries Limited Sudbury, Ontario. Blast consulting engineer responsible for all aspects of drilling and blasting operations in their quarries, 1990 - present.
- Client Placer Dome Limited Timmins Super Pit Development, South Porcupine, Ontario. Consulting engineers responsible for establishing vibration attenuation curves, recommending blast parameters affecting mining operations, seismic monitoring and blast impact analysis, January 1994.
- Client Monenco Sudbury Neutrino Observatory (SNO) Project, Creighton Mine, Sudbury, Ontario. Consulting engineer responsible for blasting operations required for the SNO cavity development, 1993 – 1994.
- Client Inco Limited Pillar Recovery at Sudbury Area Mines, Sudbury, Ontario. Instrumental in design, introduction and implementation of combined electric/nonelectric sequential blasting techniques in underground Vertical Retreat Mining (VRM) stopes, 1989 – 1995
- Client Inco Limited Long Hole Blind Slot Raise Development, Sudbury Area Mines, Sudbury, Ontario. Responsible for design and introduction of blind inverted raises. Development of raises 18 meters long with production holes in the same blast was achieved. This technique is now being widely implemented as a mining method, 1989 - 1990



 Client - Inco Limited – Inco Garson Ore/waste Segregation Project, Garson, Ontario. Responsible for introduction of sequential blasting techniques at the open pit mine. Segregation of ore from waste was achieved within the blasting operations, 1988 – 1989.

## TRAINING AND TEACHING

- Lecturing and training of drillers and blasters for Sudbury area blasting companies, 2003 to present.
- Lecturing and field training for the Surface Blaster Apprenticeship and Licensing Program, Sir Sandford Fleming Collage, Lindsey, Ontario. Training blasters and new candidates on specialized blasting techniques, 1997 1999.
- Lecturing and training the TransCanada PipeLine Blasting Inspectors in all aspects of pipeline drilling and blasting operations, 1999.
- Annual lecturing and training the Union Gas Blasting Inspectors in all aspects of drilling and blasting operations, 1999 2006.
- Lecturing and training engineers at the Inco Thompson Mine for all aspects of advanced drilling, blasting, vibration monitoring, vibration waveform analysis, and blast diagnostics procedures, 1997.
- Lecturer, post diploma program in ground control, sponsored by the Mining Research Directorate (MRD) at the Ontario Centre for Ground Control Training, Sudbury, Ontario. Provided hands on training in the application of new technology in explosives, rock fragmentation by blasting and controlled blasting techniques to engineers and planner from Northern Ontario mines, 1997.
- Lecturing and field training of candidates for drilling and blasting course sponsored by the Corporation of the Town of Nickel Centre in Sudbury, Ontario, 1994.

## RESEARCH AND DEVELOPMENT

- Evaluation of methods to control flyrock in quarry and open pit mining operations.
- Evaluation of prototype electronic detonators in underground mining applications. Analyses of time domain and frequency domain vibrations induced by blasting using electronic detonators. Research conducted at Inco's Sudbury area mines.
- Timing evaluation of prototype non-electric detonators for Ensign-Bickford Limited at several underground mine sites.
- Velocity of Detonation (VOD) measurements of explosive products for quality control purposes in production and controlled test blasting sites, 1999.



- Research in modification of new high-frequency geophones for near-field blast monitoring applications. 1997
- Research in development of high-pressure sensors for determining in-situ rock properties in mining applications, 1996.
- Research on rock fragmentation fatigue using ultra-sonic cyclic loading techniques, 1986 –1987.

## PUBLICATIONS

- Bourget, G., Jambakhsh, R.M., "Ontario Hydro T.G.S. Chimney Demolition, Thunder Bay, Ontario, Canada", Proceedings of the Twenty Sixth Annual Conference on Explosives and Blasting Technique, International Society of Explosive Engineers, Anaheim, California, 2000.
- Jambakhsh, R.M., Copping, C., "Improved Methods of Blasting Concrete for Welland Canal Rehabilitation", Proceedings of the Twentieth Annual Conference on Explosives and Blasting Technique, International Society of Explosive Engineers, Austin, Texas, 1994.
- Jambakhsh, R.M., Okell, J., "Blast Vibrations and Overpressure Control Using Sequential Blasting Techniques at Inco's McCreedy West Mine", Proceedings of the Nineteenth Annual Conference on Explosives and Blasting Technique, International Society of Explosive Engineers, San Diego, California, 1993.
- Jambakhsh, R.M., Cameron, E.A., Richardson, S., "Development of Upper Blind Raises By Long hole Carbide Drilling (LCD) Methods", Proceedings of the Eighteenth Annual Conference on Explosives and Blasting Technique, International Society of Explosive Engineers, Orlando, Florida, 1992.
- Jambakhsh, R.M., Stephen, G., Muzzeral, B., Hamill, D., "Blast Design and Vibration Analysis in Trench Blasting for Bell Canada's Fibre Optics Line Project across Ontario", An Internal Publication, May 1989.





# WATER BALANCE CALCULATION



TO:	Bruce Flowers, HSCL	MTE FILE NO.:	33862-100
	Michael Zeidenberg, HSCL	DATE:	<u>April 13, 2012</u>
		FROM:	Jay Flanagan, MTE
			Peter Gray, MTE
C.C.:		PROJECT NAME:	Keppel Quarry

### Re: Water Balance Calculation – Groundwater Inputs, Keppel Quarry

The purpose of this memo is to present the results of water balance calculations completed to quantify groundwater contributions made to the existing Keppel Quarry and the New Keppel Quarry. This information will then be used to assess the potential impact of the New Keppel Quarry on natural features such as the lobe of the Shouldice Wetland encompassing spring s13 and the dugout pond.

The memo is an addendum to the original memo dated June 27, 2011, which was included in a response package to comments received from Dr. Ken Howard on behalf of the Niagara Escarpment Commission. The comments were presented in a report dated March 14, 2011 entitled *Peer Review of the Proposed Keppel Quarry Expansion Niagara Escarpment Plan Amendment Application PG 16707.* The results of the original memo have been revised using updated information. The updated information included:

- Corrected 2010 pumping records⁷;
- 2011 pumping records;
- Revised evaporative values that more accurately represent evaporative losses from the existing Keppel Quarry; and
- A more detailed understanding of the source of water for the lobe of the Shouldice Wetland encompassing spring s13 and the dugout pond as provided in reports by Daryl W. Cowell & Associates Inc. dated May 16, 2011, July 1, 2011 and January 13, 2012.

With this new information, the memo presents:

- Revised groundwater inputs into the existing Keppel Quarry;
- A revised epikarst drainage area for the New Keppel Quarry;
- Revised calculations for the number of years estimated for the New Keppel Quarry to fill with water; and
- A revised location for the proposed infiltration pond.

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⁷ The pumping records used in the June 27, 2011 memo had erroneous pumping records reported for the months of August, November and December. Table 1 has been updated with the correct numbers and the MOE has received the updated pumping records via the WTRS website.



### 1.0 **PUMPING RECORDS**

To quantify the flow of groundwater into the existing Keppel Quarry, the pumping records were used in combination with water balance calculations. The amount of water pumped from the existing Keppel Quarry was measured in 2010 using a digital flow meter. Table 1 shows the amount pumped in 2010 on a monthly basis. The total amount of water pumped was 242,826 m³ which included inputs from precipitation and groundwater.

Month	Amount Pumped (m ³ )	*precipitation (mm)
Jan	27,096.39	67.00
Feb	8,199.46	37.20
March	29,788.97	8.40
April	11,130.76	41.80
May	14,265.89	74.00
June	22,706.61	164.00
July	11,920.93	53.20
Aug	22,293.32	78.20
Sept	26,645.41	173.70
Oct	23,428.87	44.00
Nov	19,027.51	78.40
December	26,321.74	92.40
Total	242,826	912.30

### Table 1: 2010 Pumping Records and Precipitation

* Environment Canada Weather Station - Wiarton Airport

### 2.0 GROUNDWATER INPUTS INTO THE EXISTING KEPPEL QUARRY

A water balance approach is used to estimate the amount of groundwater that contributed to the existing Keppel Quarry in 2010. Once known, this contribution can be used to derive a bulk hydraulic conductivity value for the epikarst unit so that the amount of groundwater expected to flow into the New Keppel Quarry can be estimated. The following equation was used to derive the groundwater contribution into the existing Keppel Quarry:

(1) Q pumping = Q groundwater + P - E, where

 $Q_{pumping}$  = the amount of water pumped from the existing Keppel Quarry in 2010 = 242,826 m³

Q groundwater = the amount of groundwater intercepted by the existing Keppel Quarry

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P = Precipitation = 0.912 m (Environment Canada, Canadian Climate Data for 2010 - Wiarton Airport). The surface area of the Keppel Quarry is 21.929 ha. The volume of precipitation can be calculated by multiplying it by the surface area:

• 0.912 m x 219,290 m² = 199,992 m³

E = Evaporation from the Quarry =  $E_{quarry ponds +} E_{quarry floor}$ , where

E _{quarry ponds} = Mean Annual Evaporation from Surface Water = 0.7 m/yr (MNR, 1984, pg. 23). Using satellite imagery, there were seven ponds present on the floor of the existing Keppel Quarry as of July 2010. The ponds had a cumulative surface area of 7,231 m². The surface area of the ponds multiplied by the amount of evaporation (0.7 m/yr) can be used to calculate the volume of evaporative losses in 2010 from the ponds:

• 0.7 m x 7,231 m² = 5,062 m³

E _{quarry floor} = Evaporation from the quarry floor. Even though the quarry floor is a hard surface, there will be evaporative losses due to the accumulation of water in surface depressions after a rain event. MTE accounted for these evaporative losses by assuming the evaporation rate would be similar to a paved urban surface. Modeling completed for urban surfaces using the Guelph All-Weather Storm Event Response (GAWSER) Model produced a value of 0.154 m/yr. The surface area of the quarry floor (minus the surface area of the ponds already accounted for above) multiplied by the evaporation rate (0.154 m/yr) can be used to calculate the volume of evaporative losses from the remaining quarry floor:

Total evaporative losses for the quarry can be calculated by adding the evaporative losses from the ponds on the quarry floor to the evaporative loses for the remaining quarry floor:

 $E = E_{quarry ponds +} E_{quarry floor} = 5,062 \text{ m}^3 + 32,657 \text{ m}^3 = 37,719 \text{ m}^3$ 

To quantify the amount of groundwater inputs, Equation (1) can be rearranged to:

(2) Q groundwater = Q pumping - (P - E)

Using equation (2), the amount of groundwater that was pumped from the existing Keppel Quarry in 2010 was:

Q groundwater = 242,826 m³ - (199,992 m³ - 37,719 m³) Q groundwater = 80,552 m³

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Using this equation, approximately 80,553 m³ of groundwater was pumped from the existing Keppel Quarry in 2010. Table 2 summarizes the results of the above water balance calculations. This water balance calculation showed that approximately 33% of the water inputs into the existing Keppel Quarry in 2010 were groundwater derived.

### Table 2: Water Balance Summary

Year	Amount Pumped (m ³ )	Precipitation (m ³ )	Evaporative Loses (m³)	Groundwater Inputs (m ³ )	Total Groundwater Pumped (% of amount pumped)
2010	242,826	199,992	37,719	80,552	33%

Under the guidance of Andy Hims from Genivar, MTE used a second method for estimating groundwater inputs into the existing Keppel Quarry to verify that 80,552 m3/year (2.6 L/s) is a representative number for groundwater inputs. MTE was advised to search the 2010 and 2011 pumping records in January and February for extended periods of pumping when temperatures were below zero degrees Celsius. Assuming all precipitation that fell during these periods was bound in snowpack, it was assumed that any pumping would have been related to groundwater inputs. MTE found three extended periods during the months of January and February when pumping occurred and temperatures were below zero. Table 3 provides a summary of the results for these three periods. A complete set of pumping records and climate data, with the above noted periods highlighted is found in Attachment 1. Climate data was obtained from Environment Canada's Weather Station at Wiarton Airport.

Start date	End date	Total no. of days	Total volume pumped (L)	Average Maximum Temperature	Groundwater Inputs (L/s)
1-Jan-10	8-Jan-10	8	2,001,608	-6.2	2.9
3-Feb-10	16-Feb-10	14	1,915,683	-3.4	1.6
20-Jan-11	11-Feb-11	23	8,354,621	-5.6	2.3
				AVERAGE	2.3

### Table 3: Groundwater Inputs - 2010 and 2011

This method calculated groundwater inputs to be 2.3 L/s, on average. As previously mentioned, this method assumes that all pumping that occurred was groundwater. It also assumes that the pumping volumes directly reflect the water that is entering the quarry (i.e. no mechanical limitations, no water going into "storage" on the quarry floor etc.). This method shows good agreement with the previous estimate of 80,552 m3/year (2.6 L/s).

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Gamsby and Mannerow Limited also estimated expected groundwater inputs into the then proposed (now existing) Keppel Quarry in their report dated October 1986 entitled *Impact Assessment of Proposed Sutherland Quarry on Surface and Groundwater*. The results of their groundwater seepage calculations estimated groundwater inputs to be 143 L/min (2.4 L/s), which also shows good agreement with the calculations above. As a result, MTE is confident that a groundwater estimate of 80,552 m3/year (2.6 L/s) is a reasonable estimate for the annual groundwater input into the existing Keppel Quarry in 2010.

## 3.0 EPIKARST GROUNDWATER - EXISTING KEPPEL QUARRY

Using the amount of groundwater that flowed into the existing Keppel Quarry in 2010 (80,552 m³) as a calibration tool along with the Darcy flux for estimating flows through the shallow and deep bedrock units (based on previously documented field-derived hydraulic conductivity values), a bulk hydraulic conductivity value can be derived for the epikarst aquifer. This value can be used to quantify the amount of groundwater that flowed through the epikarst aquifer in 2010. Table 4 summarizes the results of the Darcy flux calculations and a complete data set is found in Attachment 2. The calculation was completed to quantify the flow of groundwater through the east and south quarry faces of the existing Keppel Quarry only. Field observations showed that groundwater contributions were negligible along the north and west faces of the existing quarry (MTE, 2010).

### Table 4: Summary of Groundwater Flow in the Existing Keppel Quarry

	East Face (m3/yr)	South Face (m3/yr)	Total (m3/yr)
Epikarst Groundwater Flow (Qk)	47,941	31,609	79,550
Shallow Bedrock Groundwater Flow (Qs)	53	35	88
Deep Bedrock Groundwater Flow (Qd)	535	353	888
Total (Qt = Qk+Qs+Qd)	48,529	31,997	80,526

Total Groundwater Inputs in 2010 calculated using pumping records (calibration	80,552	m³/yr
tool)		
Total groundwater using Darcy Flux calculation	80,526	m³/yr
PSLCent Error	0.0003	%

	PSLCent Flow -	PSLCent Flow -	PSLCent Flow –
	Epikarst	Shallow Bedrock	Deep Bedrock
Flow into Quarry	98.8%	0.1%	1.1%



Using the aforementioned calibration tool, a bulk hydraulic conductivity value of  $2.71 \times 10^{-4}$  m/s was derived for the epikarst aquifer⁸. For the sake of comparison, a hydraulic conductivity value of  $1.44 \times 10^{-5}$  m/s was measured in the field at OW62k sing a single well response hydraulic tests (MTE, 2011). Using a hydraulic conductivity value of  $2.71 \times 10^{-4}$  m/s, the results showed that approximately 79,550 m³ (approx. 99%) of the groundwater flowing into the existing Keppel Quarry flowed through the epikarst aquifer.

# 4.0 EPIKARST DRAINAGE AREA AROUND THE NEW KEPPEL QUARRY (AREA 1B PLUS AREA 2)

Using a bulk hydraulic conductivity of  $2.71 \times 10^{-4}$  m/s for the epikarst aquifer the amount of groundwater expected to contribute to the Area 1b plus Area 2 of the New Keppel Quarry can be calculated using the Darcy flux (see Table 2d in Attachment 2). Using the resultant flow through the epikarst (1.41 x 10⁻² m³/s), the areal extent of the epikarst drainage can be calculated using a water balance equation:

(1) Q Epikarst Drainage = P - ET, where:

- Q _{Epikarst Drainage} = 1.41 x 10⁻² m³/s = 220,000 m³/year (assuming significant drainage from the epikarst occurs for 180 days of every year during the months of March, April, May, June, October, November);
- P = Precipitation = 1.04 m/yr (Environment Canada, Canadian Climate Normals or averages for 1971-2000 Wiarton Airport);
- ET = Mean Annual Evapotranspiration = 0.5 m/yr (MNR, 1984, pg. 23).

If X represents the size of the drainage area, then equation (1) can be changed to:

(2) Q Epikarst Drainage = (P - ET) X

220,000 m³/yr = 1.04X m/yr - 0.5X m/yr 220,000 m³/yr = 0.54X m/yr 407,407 m² = X 40.7 ha = X

Using this method, the epikarst drainage area for Area 1b plus Area 2 is approximately 41 ha, assuming drainage on all four sides. This drainage area also includes drainage from the glacial deposits that are shown to occur around the New Keppel Quarry. The drainage area is depicted on Figure 1 and represents the areal extent to which drainage from the epikarst aquifer plus drainage from the shallow glacial deposits is expected to flow into the New Keppel Quarry. In this illustration, drainage from the epikarst/glacial deposits is assumed to be uniform around the expansion.

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⁸ The hydraulic conductivity of the epikarst aquifer across the New Keppel Quarry area could range from 1x10⁻³ to 1x10⁻⁷ m/s based on well tests done in the upper Amabel Formation at other locations around Ontario.



As noted by Daryl Cowell (pers comm.) the actual drainage area is expected to be more irregular in shape. Further, the epikarst west of the New Keppel Quarry does not form a continuous aquifer connecting the New Keppel Quarry with the lobe of the Shouldice wetland encompassing spring s13 and the dugout pond. In fact, any potential epikarst connection is intercepted by glacially-filled bedrock scours. One may expect a different response from thicker glacial deposits than from exposed epikarst and as such the epikarst drainage area shown on Figure 1 is considered a conservative scenario.

### 5.0 NUMBER OF YEARS TO FILL THE NEW KEPPEL QUARRY

The number of years required to fill the proposed expansion was previously calculated by MTE to be 36 years (MTE, 2010). However, this calculation did not include inputs via the epikarst aquifer. As a result, it has been revised (Attachment 3). Using a bulk hydraulic conductivity of  $2.71 \times 10^{-4}$  m/s for the epikarst aquifer, the number of years for the proposed expansion to fill with water was found to range from 17 years to 26 years. The lower bound (17 years) assumes that the New Keppel Quarry will receive inputs of groundwater from all four sides. The upper bound (26 years) assumes that inputs will be received from only two sides. If the New Keppel Quarry receives input from only two sides, primarily the east and south sides. If the New Keppel Quarry receives inputs in the same manner, then it would require closer to 26 years to fill with water.

The revised water balance is presented in Attachment 2 and the results of the water balance are summarized in Tables 5a and 5b.

	Area 1a (The 'Wedge') (m³/yr)	Area 1b + Area 2 (m³/yr)	Total (m³/yr)
Inputs			
Precipitation (P)	40,611	310,307	350,918
Groundwater (G)	21,225	125,855	147,080
Losses			
Evaporation (E)	27,300	208,600	235,900
Inputs minus Losses (P + G – E)	34,535	227,563	262,098

#### Table 5a: Water Balance Summary (based on 1 side for the wedge and 2 sides for Area 2)

#### Table 5b: Water Balance Summary (based on 2 sides for the wedge and 4 sides for Area 2)

	Area 1a (The 'Wedge') (m ³ /yr)	Area 1b + Area 2 (m³/yr)	Total (m³/yr)
Inputs			
Precipitation (P)	40,611	310,307	350,918
Groundwater (G)	63,248	222,700	285,948
Losses			
Evaporation (E)	27,300	208,600	235,900
Inputs minus Losses (P + G – E)	76,558	324,408	400,966

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There have been concerns raised that water flowing to natural features (i.e. spring s13) may be intercepted by the quarry and that this water will not be available during the rehabilitation phase of the proposed expansion as it will be needed to fill the quarry. Total Inputs (precipitation plus groundwater) into the proposed expansion were estimated to range from 262,098 m³/year (8.3 L/s) to 400,966 m³/year (12.7 L/s) (Table 5a and 5b). Spring s13 requires 2 L/s during its peak flow period (WGC, 2009) which occurs during the spring snowmelt period for a maximum of 120 days (from March to June). Therefore, to accommodate flow augmentation to spring s13, should it be required, the amount of water available to fill the quarry may be reduced to 241,362 m³/year – 20,736 m³/year) for the lower range value and to 380,230 m³/yr (400,966 m³/year – 20,736 m³/year) on the higher range value. In the unlikely event that spring s13 requires water then the fill-time range will increase from 17 - 26 years to 18 - 28 years (Attachment 3). As a result, flows can be mitigated by directing some of the quarry discharge to the spring with only a small change to the number of range in years to fill the new quarry with water.

## 6.0 CATCHMENT AREA FOR SPRING s13

In previous studies (MTE, 2010), MTE defined a catchment area for spring s13 to be 11.7 ha and showed it extending towards the footprint of the proposed expansion, with 1.5 ha of the catchment area intersected by the quarry's footprint (Figure 1 of MTE, 2010). Based on the results of the dye tracer test (Cowell and Ford, 2011) and the results of the epikarst mapping (Cowell, 2011), the shape of the catchment area has been revised and is shown on Figure 1. The size of the catchment area remains the same (11.7 ha).

This new catchment area overlaps a small portion of the epikarst drainage area for the proposed expansion. Therefore, there is limited potential for water flowing to the spring via epikarst/glacial deposits to drain back into the proposed expansion. Although the catchment area overlaps Zone 2 of the predicted cone of influence, this zone is only for the deep aquifer and does not affect the shallow bedrock or epikarst aquifer flow (MTE, 2010). The epikarst aquifer does not receive water from the deep bedrock (Cowell, 2011). Therefore, the potential for the drawdown zone to remove water from spring s13 due to the cone of influence for the deep bedrock is negligible.

### 7.0 PROPOSED INFILTRATION POND LOCATION

The original purpose of the infiltration pond was to allow water pumped from the new quarry expansion to infiltrate back into the bedrock groundwater system and contribute water to spring s13. However, given the results of the dye tracer test (Cowell and Ford, 2011) and epikarst mapping (Cowell, 2011) it is concluded that the proposed expansion will not impact flows to spring s13 due to the discontinuous nature of the epikarst and the interpreted low potential for a any significant hydraulic connection between the footprint of the New Keppel Quarry and the catchment area for spring s13. Therefore, flow augmentation should not be required. However, as a precaution, an infiltration pond has been proposed and will be included the Adaptive Management Plan as a mitigation measure if needed.

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On December 14, 2011, MTE and Daryl Cowell visited the Site to field-verify the location of the proposed infiltration pond as shown on Figure 1 of the June 27, 2011 memo written by MTE. The objective was to ensure that the pond was in the optimal location for returning water to the lobe of the Shouldice Wetland encompassing spring s13 and the dugout pond, should the monitoring program indicate that it is needed. In the June 27, 2011 memo, the proposed infiltration pond was shown west of OW9 outside the New Keppel Quarry's potential cone of influence for the deep bedrock. After the site visit, it became apparent that based on topography, the proposed location needed to be adjusted to take full advantage of local topographic conditions. As a result, MTE recommends that the proposed infiltration pond be located east of OW9 as described in Daryl Cowell's letter to the Ministry of the Environment dated January 13, 2012.

The revised location is shown on Figure 1. As stated by Cowell, this location will *"ensure that the infiltration water will flow through the basin and will not be lost to other locations outside the tributary"* (Cowell, 2012, page 2). The proposed location is within the New Keppel Quarry's predicted cone of influence for the deep bedrock but given the interpreted low potential for any significant hydraulic connection between the epikarst aquifer and the deep bedrock, it is expected that the infiltration pond's ability to return groundwater to the lobe of the Shouldice Wetland will not be affected by quarry operations.

### 8.0 SUMMARY

Based on the information presented above, we conclude that:

- Approximately 80,552 m³ of groundwater was pumped from the existing Keppel Quarry in 2010, which equates to approximately 33% of the total water pumped.
- Approximately 99% (79,550 m³) of the groundwater that flowed into the existing Keppel Quarry came through the epikarst aquifer in 2010.
- Using a bulk hydraulic conductivity value of 2.71x10⁻⁴ m/s, the flow through the epikarst aquifer into the New Keppel Quarry is estimated to be 220,000 m³/year, that is assuming that flow into the quarry occurs around the entire perimeter of the quarry.
- The areal extent of the drainage from the epikarst aquifer/shallow glacial deposits into the proposed expansion was calculated to be approximately 41 ha.
- Given the estimated groundwater inputs via the epikarst aquifer/shallow glacial deposits, the proposed expansion will require 17 26 years to fill with water. In the unlikely event that spring s13 requires water during the rehabilitation phase; the New Keppel Quarry will require 18 28 years to fill with water.
- Due to the areal extent of the drainage area for the epikarst/shallow glacial deposits (41 ha) and the fact that the catchment area for spring s13 overlaps only a small portion of this drainage area, flow augmentation to spring s13 should not be required.
- Although the new catchment area for spring s13 overlaps the predicted cone of influence for the deep bedrock unit, the epikarst aquifer does not receive water from the deep bedrock unit.

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Therefore, there is no potential for the drawdown zone to remove water from spring s13 due to the cone of influence.

• The infiltration pond should be relocated to an area east of OW9 in order to take full advantage of local topographic conditions with respect to getting water to spring s13, should the need arise.



## **ATTACHMENT 1**

## 2010 AND 2011 PUMPING RECORDS AND CLIMATE DATA

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
1-Jan-10			0	4.0	-1.2	-12.2	-6.7	24.7	0	0	4	4
2-Jan-10			0	4.8	-12	-15.1	-13.6	31.6	0	0	8	4.8
3-Jan-10			0	9.8	-8.4	-13.8	-11.1	29.1	0	0	24	9.8
4-Jan-10			0	4.2	-7.3	-11	-9.2	27.2	0	0	4.2	4.2
5-Jan-10			0	2.6	-5.2	-9	-7.1	25.1	0	0	2.6	2.6
6-Jan-10			0	0.8	-4.3	-7.8	-6.1	24.1	0	0	1.2	0.8
7-Jan-10	2,006,500	4 090	0	1.0	-4.2	-7.5	-5.9	23.9	0	0	1	1
0-Jan-10	2,006,590	4,902	2,001,000	2.0	-0.0 -0.3	-10.1	-0.5	20.0	0	0	3.4	2.0
10-Jan-10			0	0.4	-1.9	-15.6	-8.8	26.8	0	0	0	0.4
11-Jan-10	1,830,460	528,989	1,301,471	0.8	-3.8	-7.9	-5.9	23.9	0	0	1.4	0.8
12-Jan-10	2,030,260	136,236	1,894,024	0.6	-4.3	-9.9	-7.1	25.1	0	0	0.6	0.6
13-Jan-10	1,672,830	41,512	1,631,319	0.0	-0.4	-4.6	-2.5	20.5	0	0	0	0
14-Jan-10	1,612,750	13,173	1,599,577	0.0	3.9	-4.6	-0.4	18.4	0	0	0	0
15-Jan-10	1,695,210	13,267	1,681,943	0.6	1.8	0.1	1	17	0	0.2	0.4	0.6
16-Jan-10	0	0	0	0.0	1.2	-2.7	-0.8	18.8	0	0	0	0
17-Jan-10	1 688 130	14 077	1 674 053	0.0	-2.4	-8.6	-5.5	23.5	0	0	02	02
19-Jan-10	2 076 320	6 593	2 069 727	6.6	-0.7	-5.2	-1.5	21	0	0	7.6	0.2
20-Jan-10	1,716,260	82,829	1,633,431	0.0	-3.8	-8.1	-6	24	0	0	0.8	0.0
21-Jan-10	1,583,050	142,794	1,440,256	0.0	-2.2	-14.4	-8.3	26.3	0	0	0.0	0
22-Jan-10	1,665,380	242,151	1,423,229	0.0	0.9	-10.2	-4.7	22.7	0	0	0	0
23-Jan-10			0	0.0	1.6	-10.6	-4.5	22.5	0	0	0	0
24-Jan-10			0	1.8	5.6	-1.5	2.1	15.9	0	1.8	0	1.8
25-Jan-10	1,746,490	14,896	1,731,594	5.6	5.3	0.4	2.9	15.1	0	5.6	0	5.6
26-Jan-10	1,928,100.00	6,062.50	1,922,038	4.4	0.9	-3.8	-1.5	19.5	0	0	4.4	4.4
27-Jan-10	1,718,260.00	20,760.90	1,697,499	6.8	-3.3	-6.4	-4.9	22.9	0	0	6.8 2.2	6.8 2.2
28-Jan-10	1,738,550.00	79 645 30	1,729,490	0.0	-12.9	-17.1	-10.0	20.0	0	0	3.2	3.2
30-Jan-10	1,7 11,7 7 0.00	70,010.00	0	1.0	-9.4	-18.4	-13.9	31.9	0	0	1	1
31-Jan-10			0	4.4	-4.2	-10.9	-7.6	25.6	0	0	4.4	4.4
1-Feb-10	1,682,780	420,988	1,261,792	0.2	-3.8	-14.4	-9.1	27.1	0	0	0.2	0.2
2-Feb-10	1,883,440	60,044	1,823,396	0.2	-1.3	-12.1	-6.7	24.7	0	0	0.2	0.2
3-Feb-10			0	0.8	-1.9	-10.3	-6.1	24.1	0	0	0.8	0.8
4-Feb-10			0	0.0	-1.1	-10.1	-5.6	23.6	0	0	0	0
5-Feb-10			0	0.0	-0.5	-8.3	-4.4	22.4	0	0	0	16
7-Feb-10			0	1.0	-0.4	-11.0	-9	27	0	0	4	1.0
8-Feb-10			0	0.0	-4.4	-13.1	-8.8	26.8	0	0	0	0
9-Feb-10			0	0.4	-4.7	-8.7	-6.7	24.7	0	0	0.4	0.4
10-Feb-10			0	3.8	-4.7	-6.8	-5.8	23.8	0	0	3.8	3.8
11-Feb-10			0	0.0	-3.7	-13.5	-8.6	26.6	0	0	0	0
12-Feb-10			0	0.0	-4.3	-18.2	-11.3	29.3	0	0	0	0
13-Feb-10			0	0.2	-3.8	-16.5	-10.2	28.2	0	0	0.8	0.2
14-Feb-10	0	0	0	1.2	-2.2	-5.8	-4	22	0	0	1.2	1.2
15-Feb-10	1 927 /90	11 807	1 915 683	0.6	-3	-6.9	-5	23	0	0	0.6	0.6
17-Feb-10	1,927,490	11,007	0	0.4	0.2	-0.3	-2.8	20.8	0	0	0.4	0.4
18-Feb-10	0	0	0	0.6	0.6	-3.4	-1.4	19.4	0	0	0.6	0.6
19-Feb-10	1,409,960	5,985	1,403,975	0.0	0	-3.3	-1.7	19.7	0	0	0	0
20-Feb-10			0	0.0	2.1	-9.3	-3.6	21.6	0	0	0	0
21-Feb-10			0	0.0	1.1	-13.5	-6.2	24.2	0	0	0	0
22-Feb-10			0	3.8	-2.1	-11.3	-6.7	24.7	0	0	4.2	3.8
23-Feb-10	1,799,330	4,716	1,794,614	1.2	-1	-3	-2	20	0	0	1.2	1.2
24-FED-10		<u> </u>	0	3.8	0	-0.5	-3.3	21.3	0	0	3.8	3.8
26-Feb-10			0	0.2 Q R	-0.4	-0.9	-7.7	20.7	0	0	10.2	0.2
27-Feb-10			0	2.4	1.7	-1.8	-0.1	18.1	0	0	.0.4	2.4
28-Feb-10			0	0.0	1.7	-0.5	0.6	17.4	0	0	0	0
1-Mar-10	1,866,890	6,769	1,860,121	0.0	-0.1	-6.8	-3.5	21.5	0	0	0	0
2-Mar-10	1,485,220	387,633	1,097,587	0.0	-0.6	-3.6	-2.1	20.1	0	0	0	0
3-Mar-10			0	0.0	1.9	-2.9	-0.5	18.5	0	0	0	0
4-Mar-10	1 474 050	0.404	0	0.0	0.3	-4.8	-2.3	20.3	0	0	0	0
5-1viar-10 6-Mar-10	1,471,850	8,494	1,463,356	0.0	0.7	-11.1	-5.2	23.2	0	0	0	0
5 10101 - 10			0	0.0	0.7	-13	-+./	<u> </u>	0			

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
7-Mar-10			0	0.0	4.1	-1.9	1.1	16.9	0	0	0	0
8-Mar-10	1,602,150	18,956	1,583,194	0.0	5.8	-0.3	2.8	15.2	0	0	0	0
9-Mar-10			0	0.0	7.1	-3.1	2	16	0	0	0	0
10-Mar-10	1,528,230	694,715	833,515	0.2	9.3	-5	2.2	15.8	0	0.2	0	0.2
11-Mar-10	1,712,170	140,601	1,571,569	0.0	10.1	1.6	5.9	12.1	0	0	0	0
12-Mar-10	4,702,380	276,017	4,426,363	1.0	8.2	3.6	5.9	12.1	0	1	0	1
13-Mar-10			0	0.0	9.1	3.9	6.5	11.5	0	0	0	0
14-Mar-10	0	0	0	2.2	6.4	2.5	4.5	13.5	0	2.2	0	2.2
15-Mar-10	1,761,940	119,811	1,642,129	0.0	12.3	2.4	7.4	10.6	0	0	0	0
16-Mar-10	2,763,490	5,962	2,757,529	0.0	13.3	-2.9	5.2	12.8	0	0	0	0
17-Mar-10	1,794,780	138972	1,655,808	0.0	10.9	-2.8	4.1	13.9	0	0	0	0
18-Mar-10	1,814,950	914,277	900,673	0.0	13.5	1.3	7.4	10.6	0	0	0	0
19-Mar-10	1,747,110	88,128	1,658,982	0.0	12.5	-0.5	00	17.0	0	0	0	0
20-Mar-10			0	0.0	2	-1.6	0.2	17.8	0	0	0	0
21-Mar-10	1 717 620	107 721	1 600 990	0.0	5.5	-4.9	0.3	16.5	0	0	0	0
22-1viai-10	1,717,020	107,731	1,009,009	0.0	7.9	-0	1.5	10.5	0	0	0	0
23-Iviai-10			0	0.0	4.0	-3.0	0.5	17.5	0	0	0	0
24-1viai-10	1 208 420	15 027	1 103 303	0.0	0	-0.1	03	17 7	0	0	0	0
25-Iviai-10	1,200,420	504 410 00	1,193,393	0.0	4.9	-4.3	0.3	17.7	0	0	0	0
20-Iviai-10	1,757,420.00	504,410.00	1,255,010	0.0	-3.4	-0.2	-5.8	23.0	0	0	0	0
27-1viai-10 28-Mar-10			0	0.0	84	-7.5	-0.0	10.0	0	5	0	5
20-Mar-10	1 175 400 00	67 446 00	1 107 054	5.0	5.5	-1.2	0.4	17.4	0	0	0	0
29-Mar-10	1,175,400.00	53 783 00	1 6/2 /27	0.0	10	-4.7	2.1	17.0	0	0	0	0
31-Mar-10	1,000,210.00	183 133 00	1 531 /67	0.0	19.5	-2.9	83	9.7	0	0	0	0
1-Apr-10	1,714,000.00	146 172	1 626 688	0.0	20.1	10.5	15.3	27	0	0	0	0
2-Apr-10	1,772,000	140,172	1,020,000	0.0	26.6	14.9	20.8	0	28	0	0	0
3-Apr-10	0	0	0	0.0	27.2	6.6	16.9	11	2.0	04	0	04
4-Apr-10	0	0	0	0.4	19.4	6.6	13	5	0	0.4	0	0.4
5-Apr-10	2 881 830	71 098	2 810 732	2.6	17.8	8	12.9	51	0	2.6	0	2.6
6-Apr-10	1 607 390	2 484	1 604 906	11.4	11.0	53	8.5	9.5	0	11.4	0	11.0
7-Apr-10	1,007,000	2,101	1,001,000	7.2	10.4	5.8	8.1	9.9	0	7.2	0	7.2
8-Apr-10	1.676.190	16.321	1.659.869	15.6	11.9	0.8	6.4	11.6	0	15.6	0	15.6
9-Apr-10	0	0	0	1.4	2.3	-1.4	0.5	17.5	0	0	1.4	1.4
10-Apr-10	0	0	0	0.0	12.7	-1.4	5.7	12.3	0	0	0	0
11-Apr-10	0	0	0	0.0	10.8	1.8	6.3	11.7	0	0	0	0
12-Apr-10	0	0	0	0.0	10.5	-1.5	4.5	13.5	0	0	0	0
13-Apr-10	1,679,750	16,958	1,662,792	0.0	12.9	0.5	6.7	11.3	0	0	0	0
14-Apr-10	0	0	0	0.0	15.3	-1.6	6.9	11.1	0	0	0	0
15-Apr-10	0	0	0	0.0	23	5.7	14.4	3.6	0	0	0	0
16-Apr-10	1,801,640	35,870	1,765,771	0.4	20.4	2.9	11.7	6.3	0	0.4	0	0.4
17-Apr-10	0	0	0	2.4	4.8	0.6	2.7	15.3	0	2.4	0	2.4
18-Apr-10	0	0	0	0.0	12.1	3.2	7.7	10.3	0	0	0	0
19-Apr-10	0	0	0	0.0	13.3	2.5	7.9	10.1	0	0	0	0
20-Apr-10	0	0	0	0.0	14.3	-0.5	6.9	11.1	0	0	0	0
21-Apr-10	0	0	0	0.0	12.7	0.6	6.7	11.3	0	0	0	0
22-Apr-10	0	0	0	0.0	7.2	-2.2	2.5	15.5	0	0	0	0
23-Apr-10	0	0	0	0.0	12.8	-3.8	4.5	13.5	0	0	0	0
24-Apr-10	0	0	0	0.0	19.1	1.4	10.3	7.7	0	0	0	0
25-Apr-10	0	0	0	0.0	14.6	6.7	10.7	7.3	0	0	0	0
26-Apr-10	0	0	0	0.0	13.5	3.4	8.5	9.5	0	0	0	0
27-Apr-10	0	0	0	0.0	7.2	2.1	4.7	13.3	0	0	0	0
28-Apr-10	0	0	0	0.0	10	2.5	6.3	11.7	0	0	0	0
29-Apr-10	0	0	0	0.0	14.9	2.5	8.7	9.3	0	0	0	0
30-Apr-10	0	0	0	0.0	22.4	7.8	15.1	2.9	0	0	0	0
1-May-10	0	0	0	12.2	24.2	16.4	20.3	0	2.3	12.2	0	12.2
2-May-10	0	0	0	9.8	20.9	8.2	14.6	3.4	0	9.8	0	9.8
3-May-10	0	0	0	1.0	20.2	8.9	14.6	3.4	0	1	0	1
4-May-10	0	0	0	0.0	16.2	5.1	10.7	7.3	0	0	0	0
5-May-10	2,756,400	255,591	2,500,809	5.6	20.2	7.4	13.8	4.2	0	5.6	0	5.6
6-May-10	0	0	0	0.2	10.4	2.4	6.4	11.6	0	0.2	0	0.2
7-May-10	1,686,180	21,065	1,665,115	7.2	8.4	1.9	5.2	12.8	0	7.2	0	7.2
8-May-10	0	0	0	14.6	7.7	0.3	4	14	0	11.4	3.2	14.6
9-May-10	0	0	0	0.0	6.7	-0.2	3.3	14.7	0	0	0	0
10-May-10	0	0	0	0.0	11.2	-0.8	5.2	12.8	0	0	0	0
111-May-10	0	0	0	0.0	10.6	-0.7	5	13	0	0	0	0

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
12-May-10	1,600,910	11,217	1,589,693	0.0	15.1	2.7	8.9	9.1	0	0	0	0
13-May-10	1,781,470	92,304	1,689,166	13.2	12.5	2.3	7.4	10.6	0	13.2	0	13.2
14-May-10	1,747,560	112,610	1,634,950	0.2	16	6	11	7	0	0.2	0	0.2
15-May-10	0	0	0	0.0	12.5	4.7	8.6	9.4	0	0	0	0
16-May-10	0	0	0	0.0	18.7	2.7	10.7	7.3	0	0	0	0
17-May-10	1,693,600	84,596	1,609,004	0.0	21.1	4.2	12.7	5.3	0	0	0	0
18-May-10	1,900,980	5,073	1,895,907	0.0	22.5	7.5	15	3	0	0	0	0
19-May-10	1,692,200	10,957	1,681,243	0.0	19.2	6.1	12.7	5.3	0	0	0	0
20-May-10	0	0	0	0.0	21.4	8.4	14.9	3.1	0	0	0	0
21-May-10	0	0	0	0.0	22.7	8.2	15.5	2.5	0	0	0	0
22-May-10	0	0	0	2.2	21.6	12.5	17.1	0.9	0	2.2	0	2.2
23-May-10	0	0	0	0.0	23.2	14.6	18.9	0	0.9	0	0	0
24-May-10	0	0	0	0.0	26.5	14.5	20.5	0	2.5	0	0	0
25-May-10	0	0	0	0.0	20.7	12.2	20.4	0	2.4	0	0	0
20-101ay-10	0	0	0	0.0	22.3	12.0	10.7	0	2.7	0	0	0
27-Way-10	0	0	0	0.0	20.0	12.3	18.0	0	0.1	0	0	0
20-May-10	0	0	0	0.0	24.0	11.2	16.6	14	0.0	0	0	0
30-May-10	0	0	0	6.0	26.8	10.7	18.8	1.4	0.8	6	0	6
31-May-10	0		0	1.8	28.1	15.2	21.7	0	3.7	18	0	18
1-Jun-10	0	0	0	0.0	19.1	11.4	15.3	2.7	0.1	0	0	0
2-Jun-10	0	0	0	8.4	21.2	13.2	17.2	0.8	0	8.4	0	8.4
3-Jun-10	0	0	0	3.6	18.5	8.3	13.4	4.6	0	3.6	0	3.6
4-Jun-10	0	0	0	8.6	21.4	6.9	14.2	3.8	0	8.6	0	8.6
5-Jun-10	0	0	0	7.2	18.2	13.4	15.8	2.2	0	7.2	0	7.2
6-Jun-10	0	0	0	14.4	16.4	9.9	13.2	4.8	0	14.4	0	14.4
7-Jun-10	0	0	0	0.0	14.7	5.1	9.9	8.1	0	0	0	0
8-Jun-10	0	0	0	0.0	18.5	4.7	11.6	6.4	0	0	0	0
9-Jun-10	0	0	0	11.6	17.8	10.4	14.1	3.9	0	11.6	0	11.6
10-Jun-10	0	0	0	0.0	17.4	10	13.7	4.3	0	0	0	0
11-Jun-10	1,890,090	17,467	1,872,624	3.4	21	9.4	15.2	2.8	0	3.4	0	3.4
12-Jun-10	0	0	0	28.4	18.8	14.9	16.9	1.1	0	28.4	0	28.4
13-Jun-10	0	0	0	0.6	22.6	14.2	18.4	0	0.4	0.6	0	0.6
14-Jun-10	1,906,290	7,840	1,898,450	0.0	22.5	11.7	17.1	0.9	0	0	0	0
15-Jun-10	1,503,160	129,596	1,373,564	0.0	22.6	9.9	16.3	1.7	0	0	0	0
16-Jun-10	1,862,010	58,226	1,803,784	22.2	19.1	12.1	15.6	2.4	0	22.2	0	22.2
17-Jun-10	1,737,670	10,619	1,727,052	0.0	21.6	10.2	15.9	2.1	0	0	0	0
18-Jun-10	1,620,900	62,692	1,558,208	0.0	26.3	10.7	18.5	0	0.5	0	0	0
19-Jun-10	0	0	0	0.0	25.7	16.6	21.2	0	3.2	0	0	0
20-Jun-10	0 002 960	0	0 070 560	0.0	21.9	13.1	17.5	0.5	0	0	0	0
21-Jun-10	2,093,000	21,297	2,072,003	0.0	22.9	12.0	17.9	0.1	0	15.9	0	15.9
22-Jun-10	2,002,190	6 056	1 795 254	10.0	20.0	14.0	10.0	0.4	10	10.0	0	15.0
23-301-10 24- Jun-10	1,731,410	3 500	1,705,554	2.0	21.6	13.0	17.8	02	1.9	76	0	76
25-Jun-10	876 959	248 911	628 048	7.0	21.0	11.2	16.2	1.8	0	,.0	0	7.0
26-Jun-10	0/0,000	0	020,040	20.6	19.3	13.1	16.2	1.0	0	20.6	0	20.6
27-Jun-10	0	0	0	5.0	22.5	11.7	17.1	0.9	0	5	0	5
28-Jun-10	1.591.270	83.618	1.507.652	4.6	24.8	13.2	19	0.0	1	4.6	0	4.6
29-Jun-10	1,837,850	18,642	1,819,209	0.0	14.9	11.8	13.4	4.6	0	0	0	0
30-Jun-10	1,016,440	37,879	978,562	0.0	16.3	11.1	13.7	4.3	0	0	0	0
1-Jul-10	1,073,910	11,024	1,062,886	0.0	19.8	7.3	13.6	4.4	0	0	0	0
2-Jul-10	0	0	0	0.0	23.7	7.7	15.7	2.3	0	0	0	0
3-Jul-10	0	0	0	0.0	26.7	14.2	20.5	0	2.5	0	0	0
4-Jul-10	0	0	0	0.0	29.7	17.6	23.7	0	5.7	0	0	0
5-Jul-10	610,052	13,463	596,589	0.0	30	20	25	0	7	0	0	0
6-Jul-10	0	0	0	0.0	30.9	20.4	25.7	0	7.7	0	0	0
7-Jul-10	0	0	0	0.0	28.9	19.3	24.1	0	6.1	0	0	0
8-Jul-10	0	0	0	0.4	30.4	19.2	24.8	0	6.8	0.4	0	0.4
9-Jul-10	0	0	0	3.0	25.2	16.3	20.8	0	2.8	3	0	3
10-Jul-10	0	0	0	0.0	24.8	12.2	18.5	0	0.5	0	0	0
11-Jul-10	0	0	0	0.0	27.2	12	19.6	0	1.6	0	0	0
12-JUI-10	0	0	0	3.6	23.3	18.7	21	0	3	3.6	0	3.6
13-JUI-10	0	0	0	0.0	24.9	14.0	20.5	0	2.5	0	0	0
14-Jul-10	0	0	0	0.0	28	14.3	21.2	0	3.2	10.0	0	10.0
16-Jul-10	0	0	0	0.0	26.0	19.5	22.0	0	4.0 5.2	10.2	0	10.2

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
17-Jul-10	0	0	0	0.0	24.6	17.6	21.1	0	3.1	0	0	0
18-Jul-10	0	0	0	23.2	22.7	15.2	19	0	1	23.2	0	23.2
19-Jul-10	0	0	0	0.2	21.8	16.2	19	0	1	0.2	0	0.2
20-Jul-10	0	0	0	0.0	25.1	14.7	19.9	0	1.9	0	0	0
21-Jul-10	569,628	37,676	531,952	0.0	23.8	16.7	20.3	0	2.3	0	0	0
22-Jul-10	0	0	0	3.0	23.3	15.7	19.5	0	1.5	3	0	3
23-Jul-10	1,457,490	126,650	1,330,840	8.2	24.9	18.5	21.7	0	3.7	8.2	0	8.2
24-Jul-10	0	0	0	0.0	23.8	19.8	21.8	0	3.8	0	0	0
25-Jul-10	0	0	0	0.0	23.2	16.6	19.9	0	1.9	0	0	0
26-Jul-10	1,492,070	52,510	1,439,561	0.0	24.3	15.4	19.9	0	1.9	0	0	0
27-Jul-10	1,823,540	5,766	1,817,774	0.0	27.2	13.6	20.4	0	2.4	0	0	0
28-Jul-10	1,600,590	5,025	1,595,565	1.0	25.4	17.3	21.4	0	3.4	1	0	1
29-Jul-10	2,125,530	19,369	2,106,161	0.0	22.1	14.4	18.3	0	0.3	0	0	0
30-Jul-10	1,598,140	158,537	1,439,603	0.0	20.8	8.9	14.9	3.1	0	0	0	0
31-Jul-10			0	0.4	20.5	8.6	14.6	3.4	0	0.4	0	0.4
1-Aug-10	0	0	0	4.4	23.1	15	19.1	0	1.1	4.4	0	4.4
2-Aug-10	0	0	0	1.0	25.3	16	20.7	0	2.7	1	0	1
3-Aug-10	1,731,910	77,982	1,653,928	0.0	27.9	20.8	24.4	0	6.4	0	0	0
4-Aug-10	1,631,770	10,744	1,621,026	0.0	26.6	19.1	22.9	0	4.9	0	0	0
5-Aug-10	0	0	0	0.0	25	17.4	21.2	0	3.2	0	0	0
6-Aug-10	1,461,960	12,200	1,449,760	0.0	20.2	10	15.1	2.9	0	0	0	0
7-Aug-10	0	0	0	0.4	23.3	6.7	15	3	0	0.4	0	0.4
8-Aug-10	0	0	0	49.2	24.3	18.1	21.2	0	3.2	49.2	0	49.2
9-Aug-10	1,760,650	7,181	1,753,469	3.4	24.9	17.9	21.4	0	3.4	3.4	0	3.4
10-Aug-10	1,651,710	5,441	1,646,269	0.0	26.7	20	23.4	0	5.4	0	0	0
11-Aug-10	1,531,510	639,269	892,241	0.0	26.1	18.8	22.5	0	4.5	0	0	0
12-Aug-10	3,197,360	220,419	2,976,941	0.0	28.1	20.3	24.2	0	6.2	0	0	0
13-Aug-10	1,552,050	14,495	1,537,555	0.0	28	16.3	22.2	0	4.2	0	0	0
14-Aug-10	0	0	0	0.0	28.2	19	23.6	0	5.6	0	0	0
15-Aug-10	0	0	0	0.0	28.8	20.2	24.5	0	6.5	0	0	0
16-Aug-10	1,548,560	10,416	1,538,144	0.0	22.9	14.9	18.9	0	0.9	0	0	0
17-Aug-10	1,645,640	5,881	1,639,759	0.0	22.5	11.1	16.8	1.2	0	0	0	0
18-Aug-10	1,333,020	51,451	1,281,569	0.0	23.8	10.6	17.2	0.8	0	0	0	14.4
19-Aug-10	831,708	23,391	808,117	14.4	21.7	9.3	15.5	2.0	0	14.4	0	14.4
20-Aug-10	005,037	0,243	077,394	0.0	22.7	17.0	21.1	2.2	21	20	0	20
21-Aug-10	0	0	0	3.2	24.2	10.9	10.2	0	1.0	3.2	0	3.2
22-Aug-10	1 190 260	93 267	1 096 993	1.2	20.2	15.1	18.7	0	0.7	1.2	0	1.2
24-Aug-10	1,100,200	00,207	1,000,000	0.0	24.3	13.6	10.7	0	0.7	0	0	0
25-Aug-10	1 263 850	23 913	1 239 938	1.0	22	15.6	18.8	0	0.8	1	0	1
26-Aug-10	702,918	222,699	480,219	0.0	18.7	8.7	13.7	4.3	0.0	0	0	0
27-Aug-10	00	0	0	0.0	22.2	8.2	15.2	2.8	0	0	0	0
28-Aug-10	0	0	0	0.0	27.4	15.1	21.3	0	3.3	0	0	0
29-Aug-10	0	0	0	0.0	28.9	15.4	22.2	0	4.2	0	0	0
30-Aug-10	0	0	0	0.0	29.6	19.4	24.5	0	6.5	0	0	0
31-Aug-10			0	0.0	30.5	18.9	24.7	0	6.7	0	0	0
1-Sep-10	0	0	0	11.2	31.1	17.7	24.4	0	6.4	11.2	0	11.2
2-Sep-10	1,268,940	76,887	1,192,053	1.8	24.4	16.8	20.6	0	2.6	1.8	0	1.8
3-Sep-10	1,749,290	79,735	1,669,555	15.9	22.3	14.4	18.4	0	0.4	15.9	0	15.9
4-Sep-10	0	0	0	10.0	15.2	10.3	12.8	5.2	0	10	0	10
5-Sep-10	0	0	0	2.6	17.4	10.5	14	4	0	2.6	0	2.6
6-Sep-10	0	0	0	1.2	20.9	8.6	14.8	3.2	0	1.2	0	1.2
7-Sep-10	1,726,290	483,188	1,243,102	3.4	26.4	13.6	20	0	2	3.4	0	3.4
8-Sep-10	1,533,310	238,897	1,294,413	3.2	15.3	12.8	14.1	3.9	0	3.2	0	3.2
9-Sep-10	1,022,730	55,641	967,089	0.0	14.8	13	13.9	4.1	0	0	0	0
10-Sep-10	0	0	0	0.0	17.5	6.6	12.1	5.9	0	0	0	0
11-Sep-10	0	0	0	4.8	20.9	5.6	13.3	4.7	0	4.8	0	4.8
12-Sep-10	0	0	0	10.8	19.5	13.1	16.3	1.7	0	10.8	0	10.8
13-Sep-10	1,400,540	150,698	1,249,842	3.2	19.2	11.7	15.5	2.5	0	3.2	0	3.2
14-Sep-10	1,679,340	78,108	1,601,232	0.0	16.3	10.4	13.4	4.6	0	0	0	0
15-Sep-10	1,678,200	16,176	1,662,024	0.0	15.9	9.2	12.6	5.4	0	0	0	0
16-Sep-10	0	0	0	23.0	12.9	11.1	12	6	0	23	0	23
17-Sep-10	1,680,960	318,196	1,362,764	0.0	16.7	6	11.4	6.6	0	0	0	0
18-Sep-10	0	0	0	2.0	18.6	/.8	13.2	4.8	0	2	0	2
19-Sep-10	0	100 575	0	0.0	15	2.4	8.7	9.3	0	0	0	0
∠u-Sep-10	1,670,630	138,575	1,532,055	0.0	16.4	2	9.2	8.8	0	0	0	0

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
21-Sep-10	1,730,050	46,698	1,683,352	32.4	27.5	10	18.8	0	0.8	32.4	0	32.4
22-Sep-10	1,792,860	10,942	1,781,918	3.0	18	8.4	13.2	4.8	0	3	0	3
23-Sep-10	1,692,910	10,273	1,682,637	15.2	22.9	7.9	15.4	2.6	0	15.2	0	15.2
24-Sep-10	1,694,690	204,357	1,490,333	0.4	27	13.8	20.4	0	2.4	0.4	0	0.4
25-Sep-10	0	0	0	1.0	14.2	8.4	11.3	6.7	0	1	0	1
26-Sep-10	0	0	0	0.8	12.4	8.1	10.3	7.7	0	0.8	0	0.8
27-Sep-10	1,686,350	38,643	1,647,707	3.0	16.4	10.5	13.5	4.5	0	3	0	3
28-Sep-10	1,693,160	226,182	1,466,978	24.8	13.2	10.9	12.1	5.9	0	24.8	0	24.8
29-Sep-10	1,684,460	157,045	1,527,415	0.0	18	6.6	12.3	5.7	0	0	0	0
30-Sep-10	1,692,330	101,391	1,590,939	0.0	17.9	11.3	14.6	3.4	0	0	0	0
1-Oct-10	1,706,310	322,221	1,384,089	0.0	14.2	4.5	9.4	8.6	0	0	0	0
2-Oct-10	0	0	0	0.0	10	4.9	7.5	11.5	0	0	0	0
3-Oct-10	1 670 670	177 940	1 402 920	0.0	9.9	3.5	6.7	11.0	0	0	0	0
4-0ct-10	1,070,070	16 120	1,492,030	0.0	16.5	1.7	0.9	0.0	0	0	0	0
6-Oct-10	1,003,000	267 296	1 / 13 27/	0.0	18.8	6.8	9.2	0.0 5.2	0	0	0	0
7-Oct-10	1 8/18 700	105 983	1 7/2 717	0.0	15.6	10.7	13.2	1.8	0	0	0	0
8-Oct-10	1 722 9/0	15 773	1 707 167	0.0	19.0	9.7	14.5	4.0	0	0	0	0
9-Oct-10	1,722,540	10,770	1,707,107	0.0	14.3	1.3	7.8	10.2	0	0	0	0
10-Oct-10	0	0	0	0.0	17	1.0	9.1	8.9	0	0	0	0
11-Oct-10	0	0	0	0.0	13.6	6.2	9.9	8.1	0	0	0	0
12-Oct-10	1.681.820	10.906	1.670.914	0.0	12.1	0.9	6.5	11.5	0	0	0	0
13-Oct-10	1,790,120	5.673	1.784.447	3.0	12.5	1.3	6.9	11.1	0	3	0	3
14-Oct-10	1.801.660	9,669	1.791.991	2.0	13.1	3.1	8.1	9.9	0	2	0	2
15-Oct-10	1.697.560	76.957	1.620.604	0.3	13.9	1.3	7.6	10.4	0	0.3	0	0.3
16-Oct-10	0	0	0	0.0	14	2.3	8.2	9.8	0	0	0	0
17-Oct-10	0	0	0	0.0	14.1	6.7	10.4	7.6	0	0	0	0
18-Oct-10	1,637,540	93,566	1,543,974	1.8	10.9	3	7	11	0	1.8	0	1.8
19-Oct-10	849,438	84,894	764,544	1.4	12.5	2.5	7.5	10.5	0	1.4	0	1.4
20-Oct-10	0	0	0	2.4	15.2	1.8	8.5	9.5	0	2.4	0	2.4
21-Oct-10	1,223,370	29,642	1,193,728	0.3	7.5	2.3	4.9	13.1	0	0.3	0	0.3
22-Oct-10	0	0	0	1.0	11.2	1.4	6.3	11.7	0	1	0	1
23-Oct-10	0	0	0	5.2	15.1	3.1	9.1	8.9	0	5.2	0	5.2
24-Oct-10	0	0	0	5.2	16.3	10.7	13.5	4.5	0	5.2	0	5.2
25-Oct-10	1,801,700	6,615	1,795,085	5.6	17.7	13.1	15.4	2.6	0	5.6	0	5.6
26-Oct-10	1,025,690	59,886	965,804	4.2	19.7	13	16.4	1.6	0	4.2	0	4.2
27-Oct-10	890,164	_	890,164	1.6	18	10.7	14.4	3.6	0	1.6	0	1.6
28-Oct-10	0	0	0	3.0	12.5	3.9	8.2	9.8	0	3	0	3
29-Oct-10	0	0	0	5.6	8.9	1.7	5.3	12.7	0	5.6	0	5.6
30-Oct-10	0	0	0	0.2	10.1	2.3	6.2	11.8	0	0.2	0	0.2
31-Oct-10	0	0	0	1.2	4.3	0.7	2.5	15.5	0	0	1.2	1.2
1-INOV-10	1,677,060	12,941	1,664,119	0.0	0.2	-3.3	1.5	10.0	0	0	0	0
2-INOV-10	1,090,910	133,773	957,137	0.0	7.8	-3.8	24	15.6	0	14	0	1.4
4-Nov-10	0	0	0	5.4	7.5	-2.0	2.4	10.0	0	5.4	0	1.4 5.4
4-Nov-10	1 527 120	3 201	1 523 919	6.8	2.8	0.9	19	16.1	0	2.4	46	6.8
6-Nov-10	1,527,120	0,201	1,020,010	0.0	<u> </u>	-0.5	1.5	16.2	0	0.2	0 2	0.0
7-Nov-10	0	0	0	0.4	9.9	0.0	5.1	12.9	0	0.2	0.2	0.4
8-Nov-10	0	0	0	0.0	10	-2.1	4	14	0	0	0	0
9-Nov-10	0	0	0	0.0	9.6	-1.2	4.2	13.8	0	0	0	0
10-Nov-10	2.016.260	5.293	2.010.967	0.0	12.9	-1.5	5.7	12.3	0	0	0	0
11-Nov-10	0	0	0	0.0	12.8	-2.9	5	13	0	0	0	0
12-Nov-10	0	0	0	0.0	13.8	2	7.9	10.1	0	0	0	0
13-Nov-10	0	0	0	0.0	12.2	4.8	8.5	9.5	0	0	0	0
14-Nov-10	0	0	0	0.8	11	4.2	7.6	10.4	0	0.8	0	0.8
15-Nov-10	2,395,583	17,358	2,378,225	0.4	8.2	-0.8	3.7	14.3	0	0.4	0	0.4
16-Nov-10	0	0	0	13.0	11.8	-0.1	5.9	12.1	0	13	0	13
17-Nov-10	1,719,758	47,887	1,671,871	16.8	8.3	4	6.2	11.8	0	16.8	0	16.8
18-Nov-10	1,672,913	37,249	1,635,664	2.6	4.4	-0.1	2.2	15.8	0	0	2.6	2.6
19-Nov-10	1,650,354	468,044	1,182,310	0.0	6.9	-1.5	2.7	15.3	0	0	0	0
20-Nov-10	0	0	0	0.0	6.5	-1.2	2.7	15.3	0	0	0	0
21-Nov-10	0	0	0	0.2	10	-2.4	3.8	14.2	0	0.2	0	0.2
22-Nov-10	1,651,449	223,379	1,428,070	2.8	16.5	9.7	13.1	4.9	0	2.8	0	2.8
23-Nov-10	1,844,596	23,105	1,821,491	1.8	14.6	-0.2	7.2	10.8	0	0.6	1.2	1.8
24-INOV-10	1,705,540	9,680	1,695,860	0.0	0.4	-3.8	-1.7	19.7	0	0	0	0
∠ว-IN0V-10	1,354,700	296.821	1,05/,8/9	9.4	1 5./	J -U.8	2.5	15.5	0	9.4	0	9.4

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
26-Nov-10	0	0	0	3.4	0.4	-3.2	-1.4	19.4	0	0	3.4	3.4
27-Nov-10	0	0	0	2.0	2.5	-0.8	0.9	17.1	0	0	2	2
28-Nov-10	0	0	0	0.0	2.7	-2.3	0.2	17.8	0	0	0	0
29-Nov-10	0	0	0	0.0	6	-2.5	1.8	16.2	0	0	0	0
30-INOV-10	1 250 720	140.651	1 101 060	11.2	12.2	3.8	8	10	0	11.2	7 0	11.2
1-Dec-10	1,230,720	149,001	1,101,009	7.0	3.9	-0.1	-0.3	18.3	0	0	12.8	7.0
2-Dec-10	1 625 240	42,044	1,529,270	0.0	0.9	-2	-0.3	19.5	0	0	12.0	0.0
4-Dec-10	1,020,240	0,040	1,010,002	2.6	-2.1	-6	-4.1	22.1	0	0	2.6	2.6
5-Dec-10	0	0	0	2.0	-2.1	-7.1	-4.6	22.6	0	0	2	2
6-Dec-10	1,743,910	10,424	1,733,486	3.8	-5.2	-7	-6.1	24.1	0	0	4	3.8
7-Dec-10	1,688,010	5,586	1,682,424	1.0	-5.2	-8	-6.6	24.6	0	0	1	1
8-Dec-10	1,670,970	44,199	1,626,771	0.0	-7.6	-9.9	-8.8	26.8	0	0	0	0
9-Dec-10	1,664,170	19,979	1,644,191	0.0	-5	-11.4	-8.2	26.2	0	0	0	0
10-Dec-10	1,778,680	5,636	1,773,044	2.8	2.3	-5.2	-1.5	19.5	0	0.6	2.2	2.8
11-Dec-10	1,697,920	187,350	1,510,570	0.0	2.3	0.3	1.3	16.7	0	0	0	0
12-Dec-10	1,654,070	192,251	1,461,819	21.0	2	-10.8	-4.4	22.4	0	0	12.6	12.6
13-Dec-10	0	0	0	13.0	-9	-12.4	-10.7	28.7	0	0	13.6	13.0
14-Dec-10	1 656 540	271 520	1 385 020	0.4	-3.6	-11	-7.3	25.3	0	0	0.4	0.4
16-Dec-10	1 654 890	271,320	1,383,176	0.4	-3.5	-6.9	-5.2	23.2	0	0	0.4	0.4
17-Dec-10	1.656.070	205.787	1.450.283	3.6	0.3	-6	-2.9	20.9	0	0	4.4	3.6
18-Dec-10	0	0	0	3.6	-1.9	-6.6	-4.3	22.3	0	0	3.6	3.6
19-Dec-10	0	0	0	4.6	-3.8	-6.4	-5.1	23.1	0	0	4.6	4.6
20-Dec-10	1,339,740	680,857	658,883	1.4	-1.1	-6.1	-3.6	21.6	0	0	1.4	1.4
21-Dec-10	1,656,950	93,858	1,563,092	0.4	-2.2	-4.1	-3.2	21.2	0	0	0.4	0.4
22-Dec-10	1,933,430	5,380	1,928,050	0.6	-2.6	-4.3	-3.5	21.5	0	0	0.6	0.6
23-Dec-10	2,276,600	5,604	2,270,996	0.4	-2.9	-4.7	-3.8	21.8	0	0.2	0.2	0.4
24-Dec-10	0	0	0	0.0	-2.6	-4.9	-3.8	21.8	0	0	0	0
25-Dec-10	0	0	0	1.0	-3.3	-6.2	-4.8	22.8	0	0	1	1
26-Dec-10	0	0	0	2.6	-5.4	-7.8	-0.0	24.0	0	0	3	2.6
27-Dec-10	0	0	0	0.0	01	-7.7	-3.9	21.9	0	0	0.0	0.0
20-Dec-10	0	0	0	0.0	1.4	-1.3	-0.3	20.1	0	0	0	0
30-Dec-10	0	0	0	0.0	3.9	-4.9	-0.5	18.5	0	0.4	0	0.4
31-Dec-10	0	0	0	0.6	7.9	3.6	5.8	12.2	0	0.6	0	0.6
1-Jan-11	0	0	0	6.0	9.8	-3.8	3	15	0	6	0	6
2-Jan-11	0	0	0	1.8	-3.4	-5.7	-4.6	22.6	0	0	1.8	1.8
3-Jan-11	174,310	9,334	164,976	6.8	-1.8	-3.8	-2.8	20.8	0	0	7.6	6.8
4-Jan-11	1,007,640	529,429	478,211	4.1	-0.5	-4.9	-2.7	20.7	0	0	5.6	4.1
5-Jan-11	1,679,280	43,791	1,635,489	5.8	-4.5	-10.7	-7.6	25.6	0	0	11.2	5.8
6-Jan-11	1,985,770	12,340	1,973,430	2.4	-4.3	-11.5	-7.9	25.9	0	0	3	2.4
7-Jan-11	1,826,050	12,695	1,813,355	8.6	-5.7	-14.5	-10.1	28.1	0	0	16	8.6
8-Jan-11	0	0	0	5.2	-5.4	-16.2	-10.8	28.8	0	0	8.8	5.2
9-Jan-11	1 679 600	1/ 379	1 665 221	0.0	-0.4	-11	-0.7	20.7	0	0	2	0.0
11-Jan-11	1,820,390	5.831	1,814,559	0.0	-3.3	-12.7	-12.5	26	0	0	0	0
12-Jan-11	1.682.410	18.154	1.664.256	1.8	-6.4	-8.5	-7.5	25.5	0	0	2.2	1.8
13-Jan-11	1,681,770	15,909	1,665,861	3.0	-5.9	-10.6	-8.3	26.3	0	0	7.2	3
14-Jan-11	1,974,610	43,615	1,930,995	1.2	-2.7	-11	-6.9	24.9	0	0	1.6	1.2
15-Jan-11	0	0	0	8.0	-2.5	-8.9	-5.7	23.7	0	0	8.4	8
16-Jan-11	0	0	0	0.0	-8.8	-25	-16.9	34.9	0	0	0	0
17-Jan-11	2,127,410	5,818	2,121,592	0.4	-3.3	-14.5	-8.9	26.9	0	0	0.4	0.4
18-Jan-11	1,885,600	205,712	1,679,888	7.8	0.9	-9.7	-4.4	22.4	0	0	8.4	7.8
19-Jan-11	1,689,560	98,680	1,590,880	3.4	-9.6	-13.4	-11.5	29.5	0	0	12.8	3.4
20-Jan-11	0	0	0	1.6	-6.9	-23.8	-10.7	33.4	0	0	1.6	1.6
21-Jan-11	0	0	0	0.0	-10.7	-21.3	-13.7	31.7	0	0	5.6	0.0
23-Jan-11	0	0	0	0.0	-15.3	-26.8	-21.1	39.1	0	0	0.0	0.0
24-Jan-11	0	0	0	2.0	-7.6	-19.7	-13.7	31.7	0	0	2	2
25-Jan-11	0	0	0	1.2	-1.6	-7.7	-4.7	22.7	0	0	1.2	1.2
26-Jan-11	0	0	0	0.4	-1.7	-5.6	-3.7	21.7	0	0	0.4	0.4
27-Jan-11	0	0	0	2.0	-2.2	-6.1	-4.2	22.2	0	0	4	2
28-Jan-11	0	0	0	4.6	-1.8	-13.3	-7.6	25.6	0	0	7.6	4.6
29-Jan-11	0	0	0	0.6	-7.6	-22.3	-15	33	0	0	0.6	0.6
30-Jan-11	0	0	0	0.2	-9.5	-19.5	-14.5	32.5	0	0	0.2	0.2

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
31-Jan-11	0	0	0	0.6	-9	-20.8	-14.9	32.9	0	0	0.6	0.6
1-Feb-11	0	0	0	1.6	-3.4	-10.9	-7.2	25.2	0	0	1.6	1.6
2-Feb-11	0	0	0	22.0	-6.8	-19.9	-13.4	31.4	0	0	23	22
3-Feb-11	0	0	0	0.0	-3.4	-22	-12.7	30.7	0	0	0	0
4-FeD-11	0	0	0	0.4	-4.2	-8.9	-6.6	24.6	0	0	0.4	0.4
5-Feb-11	0	0	0	0.0	-1.5	-0.4	-4	10.7	0	0	0	0
7-Feb-11	1 676 990	93 498	1 583 492	24	-0.4	-13.6	-7.9	25.9	0	0	24	24
8-Feb-11	1,857,110	26.381	1,830,729	1.4	-7.2	-16.9	-12.1	30.1	0	0	1.4	1.4
9-Feb-11	1,956,760	5,903	1,950,857	1.6	-6	-11.7	-8.9	26.9	0	0	1.8	1.6
10-Feb-11	1,753,710	9,371	1,744,339	1.2	-7.6	-14.3	-11	29	0	0	1.2	1.2
11-Feb-11	1,717,660	472,456	1,245,204	2.8	-5.8	-13.7	-9.8	27.8	0	0	4.2	2.8
12-Feb-11	0	0	0	2.4	-3.1	-8.1	-5.6	23.6	0	0	2.6	2.4
13-Feb-11	0	0	0	0.4	4.8	-5.9	-0.6	18.6	0	0	0.4	0.4
14-Feb-11	2,070,790	57,851	2,012,939	2.6	4.8	-10.9	-3.1	21.1	0	1.6	1	2.6
15-Feb-11	1,838,550	5,537	1,833,013	0.0	-3.8	-19	-11.4	29.4	0	0	0	0
16-Feb-11	1,734,140	19,631	1,714,509	0.2	2.8	-4.9	-1.1	19.1	0	0	0.2	0.2
17-Feb-11 18-Eob-11	1,677,580	38,000	1,639,030	2.8	0.6	-5.4	4.0	13.4	0	2.8	1	2.8
10-Feb-11	1,777,780	101,712	1,590,008	1.0	-12	-5.4	-6.8	24.8	0	0	0.8	1
20-Feb-11	0	0	0	0.0	-4.2	-10.2	-0.0	24.0	0	0	0.0	0.0
21-Feb-11	0	0	0	0.0	-9.6	-14.4	-12	30	0	0	0.4	0.4
22-Feb-11	1,970,460	4,524	1,965,936	0.0	-6.8	-14.6	-10.7	28.7	0	0	0	0
23-Feb-11	1,713,390	13,628	1,699,762	0.0	0.5	-16.2	-7.9	25.9	0	0	0	0
24-Feb-11	1,691,230	242,998	1,448,232	0.0	0.3	-5.9	-2.8	20.8	0	0	0	0
25-Feb-11	0	0	0	0.0	-1.6	-8.5	-5.1	23.1	0	0	0	0
26-Feb-11	0	0	0	1.8	-5	-9.9	-7.5	25.5	0	0	2.2	1.8
27-Feb-11	0	0	0	1.8	1.7	-6.1	-2.2	20.2	0	0	1.8	1.8
28-Feb-11	0	0	0	3.4	0.4	-9.4	-4.5	22.5	0	0	3.4	3.4
1-Mar-11	0	0	0	0.0	1.1	-11./	-5.3	23.3	0	0	0	0
2-1VIar-11	0	0	0	0.0	1.3	-11.4	-5.1	23.1	0	0	0	0
3-101ar-11	0	0	0	0.0	-4.1	-11.8	8- 8 0-	20 18.8	0	38	0	0 3.8
5-Mar-11	0	0	0	19.8	2.5	-71	-2.3	20.3	0	15	48	19.8
6-Mar-11	0	0	0	0.0	-6.4	-10.6	-8.5	26.5	0	0	0	0
7-Mar-11	0	0	0	0.0	-5.8	-11.7	-8.8	26.8	0	0	0	0
8-Mar-11	0	0	0	0.0	1.9	-10.3	-4.2	22.2	0	0	0	0
9-Mar-11	0	0	0	8.0	6.2	-2.3	2	16	0	1	7	8
10-Mar-11	0	0	0	11.0	4.8	0.8	2.8	15.2	0	11	0	11
11-Mar-11	0	0	0	17.1	0.9	-1.9	-0.5	18.5	0	1.2	19.2	17.1
12-Mar-11	0	0	0	6.6	2.2	-2.9	-0.4	18.4	0	0.4	6.2	6.6
13-Mar-11	0	0	0	0.2	-0.5	-5.5	-3	21	0	0	0.2	0.2
14-Mar-11	0	0	0	0.0	0.1	-9.8	-4.9	22.9	0	0	0	0
15-Mar-11	0	0	0	0.0	3.9	-10.8	-3.5	21.5	0	26	0	26
17-Mar-11	0	0	0	3.0	12 /	-0.0	2.4	10.0	0	3.0	0	3.0
17-Mar-11	0	0	0	0.8	10.9	-0.7	51	12.9	0	0.8	0	0.8
19-Mar-11	0	0	0	0.0	-0.5	-6.5	-3.5	21.5	0	0.0	0	0.0
20-Mar-11	0	0	0	1.0	3.6	-7.2	-1.8	19.8	0	1	0	1
21-Mar-11	0	0	0	5.6	2.9	0.6	1.8	16.2	0	5.6	0	5.6
22-Mar-11	0	0	0	0.0	1.3	-3.6	-1.2	19.2	0	0	0	0
23-Mar-11	0	0	0	0.0	-1.1	-5.6	-3.4	21.4	0	0	0	0
24-Mar-11	0	0	0	0.0	-3.8	-8.7	-6.3	24.3	0	0	0	0
25-Mar-11	0	0	0	0.0	-4.3	-11.7	-8	26	0	0	0	0
26-Mar-11	0	0	0	0.0	-3.7	-10	-6.9	24.9	0	0	0	0
2/-Mar-11	0	0	0	0.0	-3	-9.3	-6.2	24.2	0	0	0	0
28-Mar-11	0	0	0	0.0	-0.5	-9.9	-5.2	23.2	0	0	0	0
23-1vid1-11 30-Mar-11	0	0	0	0.0	50	-5.2	-1.1	19.1	0	0	0	0
31-Mar-11	0	0	0	0.0	5.9	-0.0	-0.5	10.0	0	0	0	0
1-Apr-11	0	0	0	0.0	6.5	-3.1	1.7	16.3	0	0	0	0
2-Apr-11	0	0	0	0.0	6.2	-1.9	2.2	15.8	0	0	0	0
3-Apr-11	0	0	0	1.4	9.2	-1.3	4	14	0	1	0.4	1.4
4-Apr-11	0	0	0	4.4	12.9	1.5	7.2	10.8	0	4.4	0	4.4
5-Apr-11	1,457,860	769	1,457,091	0.2	3.1	-1.3	0.9	17.1	0	0	0.2	0.2
6-Apr-11	1,737,130	207,746	1,529,384	0.0	5	-4.1	0.5	17.5	0	0	0	0

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
7-Apr-11	. 0	0	0	0.0	8.6	-5	1.8	16.2	0	0	0	0
8-Apr-11	0	0	0	0.0	10.1	-2.9	3.6	14.4	0	0	0	0
9-Apr-11	0	0	0	0.0	13.2	-2.5	5.4	12.6	0	0	0	0
10-Apr-11	2,230,780	217,505	2,013,275	48.2	21.2	2.5	11.9	6.1	0	48.2	0	48.2
11-Apr-11	1,634,860	78,278	1,556,582	0.0	21.3	3.7	12.5	5.5	0	0	0	0
12-Apr-11	1,879,480	6,053	1,873,427	0.0	9	0.7	4.9	13.1	0	0	0	0
13-Apr-11	1,708,120	14,104	1,694,016	0.0	13.9	-1.9	6	12	0	0	0	0
14-Apr-11	1,879,400	5,186	1,874,214	0.0	6.4	-1.2	2.6	15.4	0	0	0	0
15-Apr-11	1,711,000	9,528	1,701,472	0.0	6	-2.5	1.8	16.2	0	0	0	0
16-Apr-11	1,632,090	10,189	1,621,901	11.6	10.3	2.7	6.5	11.5	0	11.6	0	11.6
17-Apr-11	1,371,440	627	1,370,813	1.6	2.9	-1.5	0.7	17.3	0	0.4	1.2	1.6
18-Apr-11	1,619,750	11,286	1,608,465	0.0	2.5	-2.5	0	18	0	0	0	0
19-Apr-11	2,278,390	14,910	2,263,481	14.7	5.6	-2.7	1.5	16.5	0	12.4	2.3	14.7
20-Apr-11	2,332,070	11,767	2,320,303	24.0	1.3	0.2	0.8	17.2	0	22.4	1.6	24
21-Apr-11	1,612,290	83,367	1,528,923	1.0	5.7	-1.9	1.9	16.1	0	0	1	1
22-Apr-11	1,799,250	40,156	1,759,095	0.6	10.1	-2.3	3.9	14.1	0	0.6	0	0.6
23-Apr-11	972,910	10,567	962,343	3.2	11.7	2.5	7.1	10.9	0	3.2	0	3.2
24-Apr-11	2,484,970	37,443	2,447,527	0.0	/./	-0.5	3.6	14.4	0	0	0	0
25-Apr-11	1,569,620	694,327	875,293	0.0	11.8	0.2	6	12	0	0	0	0
26-Apr-11	1,380,170	146,633	1,233,537	5.2	19.5	3.9	11./	6.3	0	5.2	0	5.2
27-Apr-11	0	0	0	13.0	20.4	8.4	14.4	3.6	0	13	0	13
28-Apr-11	0	0	0	36.2	10	2.4	6.2	11.8	0	36.2	0	36.2
29-Apr-11	1,680,740	300,993	1,3/9,/4/	0.6	10.1	1.3	5.7	12.3	0	0.6	0	0.6
30-Apr-11	1 740 510	0	1 700 500	0.0	10	-0.5	10.0	10.2	0	0	0	0
1-May-11	1,746,510	23,990	1,722,520	0.0	18.9	0.0	12.8	5.2	0	0	0	0
2-May-11	1,730,930	240,892	1,490,038	1.0	9.6	3.7	6.7	11.3	0	1	0	1
3-101ay-11	1,524,000	75,201	1,448,799	0.4	0.9 10.5	3	C 0 4	13	0	0.4	0	0.4
4-101ay-11	0	0	0	0.0	13.5	3.2	0.4	9.6	0	0	0	0
5-May-11	0	0	0	0.0	14.0	20	/.8	10.2	0	10	0	1 2
7 May 11	1 700 610	14 044	1 604 666	1.2	125	3.9	0.5	9.5	0	1.2	0	1.2
7-1Vlay-11	1,709,010	9 052	1,094,000	0.0	12.0	2.4	7.5	10.5	0	0	0	0
0-101ay-11	1,762,050	0,000	1,773,997	0.0	17.2	3.1	9.2	0.0	0	0	0	0
9-101ay-11	1,743,010	72,003	1,070,207	0.0	17.3	2.4	9.9	6.8	0	0	0	0
10-10/10y-11	1,000,430	37,038	1,001,072	0.0	22.6	4.5	15.1	2.0	0	0	0	0
12-May-11	0	0	0	0.0	10.1	6.7	12.0	2.3	0	0	0	0
12-May-11	1 713 610	14 552	1 699 058	0.0	19.1	0.7	1/ 9	3.1	0	21	0	21
14-May-11	3 964 780	52 902	3 911 878	22.8	14.1	3.3	14.5	6.9	0	22.1	0	22.1
15-May-11	0,004,700	02,002	0,011,070	0.8	10.7	4.8	7.8	10.2	0	0.8	0	0.8
16-May-11	0	0	0	0.0	11.2	3.8	7.0	10.2	0	0.0	0	0.0
17-May-11	1,932,350	8,659	1,923,691	1.0	15.7	4.7	10.2	7.8	0	1	0	1
18-May-11	1,975,870	5,860	1,970,010	0.0	17.4	10.2	13.8	4.2	0	0	0	0
19-May-11	1,937,580	4,944	1,932,636	6.2	18.5	10.5	14.5	3.5	0	6.2	0	6.2
20-May-11	1,769,840	124,586	1.645.254	0.2	21	10	15.5	2.5	0	0.2	0	0.2
21-May-11	0	0	0	0.0	21.2	7.9	14.6	3.4	0	0	0	0
22-May-11	0	0	0	12.5	26	10.3	18.2	0	0.2	12.5	0	12.5
23-May-11	0	0	0	5.4	24.1	12.5	18.3	0	0.3	5.4	0	5.4
24-May-11	0	0	0	0.6	13.1	4.8	9	9	0	0.6	0	0.6
25-May-11	0	0	0	2.6	14.5	3.9	9.2	8.8	0	2.6	0	2.6
26-May-11	4,560,270	226,043	4,334,227	25.2	10.8	4.3	7.6	10.4	0	25.2	0	25.2
27-May-11	2,395,890	464,047	1,931,843	0.0	15.5	6.3	10.9	7.1	0	0	0	0
28-May-11	508,587	163,868	344,719	0.0	17	9	13	5	0	0	0	0
29-May-11	0	0	0	0.0	21.9	10.2	16.1	1.9	0	0	0	0
30-May-11	0	0	0	0.0	23.3	10.6	17	1	0	0	0	0
31-May-11	0	0	0	0.0	31.3	11.6	21.5	0	3.5	0	0	0
1-Jun-11	0	0	0	0.0	20.3	9	14.7	3.3	0	0	0	0
2-Jun-11	<u>2</u> ,101,780	23,490	2,078,290	0.0	13.6	5.8	9.7	8.3	0	0	0	0
3-Jun-11	4,765,420	614,975	4,150,445	0.0	20.5	3.8	12.2	5.8	0	0	0	0
4-Jun-11	2,378,080	62,801	2,315,279	45.0	21.5	10.2	15.9	2.1	0	45	0	45
5-Jun-11	0	0	0	0.0	21.3	8.9	15.1	2.9	0	0	0	0
6-Jun-11	0	0	0	0.0	24.2	8	16.1	1.9	0	0	0	0
7-Jun-11	0	0	0	2.2	27.3	15.3	21.3	0	3.3	2.2	0	2.2
8-Jun-11	0	0	0	12.4	27.9	17	22.5	0	4.5	12.4	0	12.4
9-Jun-11	2,707,100	16,735	2,690,365	1.0	24.3	6.9	15.6	2.4	0	1	0	1
10-Jun-11	3,510,590	270,307	3,240,283	0.8	14.5	6.8	10.7	7.3	0	0.8	0	0.8
11-Jun-11	684,841	119,948	564,893	0.4	16.2	9.6	12.9	5.1	0	0.4	0	0.4

Table 1a: Pumping Records and Climate Data

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
12-Jun-11	0	0	0	0.2	16	8.8	12.4	5.6	0	0.2	0	0.2
13-Jun-11	0	0	0	0.0	16	7.2	11.6	6.4	0	0	0	0
14-Jun-11	0	0	0	0.0	21.3	8.9	15.1	2.9	0	0	0	0
15-Jun-11	0	0	0	0.0	23.8	/./	15.8	2.2	0	0	0	0
16-Jun-11	0	0	0	0.0	27.8	10	18.9	22	0.9	0	0	0
17-Jun-11	0	0	0	0.0	21.0	10	15.0	2.2	0	0	0	0
19-Jun-11	0	0	0	0.0	21.2	10	15.8	2.0	0	0	0	0
20-Jun-11	0	0	0	0.0	24.4	8.8	16.6	1.4	0	0	0	0
21-Jun-11	0	0	0	0.0	23.9	13.5	18.7	0	0.7	0	0	0
22-Jun-11	0	0	0	47.2	25.2	13.6	19.4	0	1.4	47.2	0	47.2
23-Jun-11	0	0	0	9.8	21.5	14.8	18.2	0	0.2	9.8	0	9.8
24-Jun-11	0	0	0	7.2	18.2	13.2	15.7	2.3	0	7.2	0	7.2
25-Jun-11	0	0	0	12.0	18.2	11.4	14.8	3.2	0	12	0	12
26-JUN-11	0	0	0	0.0	21.2	10.6	15.9	2.1	0	20	0	20
28-Jun-11	0	0	0	2.3	20.4	10.5	15.5	2.5	0	2.5	0	2.3
29-Jun-11	0	0	0	0.0	16.9	10.4	13.7	4.3	0	0.2	0	0.2
30-Jun-11	0	0	0	0.0	21	8.2	14.6	3.4	0	0	0	0
1-Jul-11			0	0	25.7	6.9	16.3	1.7	0	0	0	0
2-Jul-11			0	0	25.8	17	21.4	0	3.4	0	0	0
3-Jul-11			0	0	23.6	13.6	18.6	0	0.6	0	0	0
4-Jul-11			0	0	21.7	12.1	16.9	1.1	0	0	0	0
5-Jul-11			0	0	26	11.4	18.7	0	0.7	0	0	0
6-JUI-11			0	10.2	22.1	14.5	18.3	02	0.3	10.2	0	10.2
7-Jul-11 8-Jul-11			0	0	23.4	14.3	17.7	0.3	15	0	0	0
9-Jul-11			0	0	23.4	13.2	18.3	0	0.3	0	0	0
10-Jul-11			0	0.4	28.7	15.3	22	0	4	0.4	0	0.4
11-Jul-11			0	0	29.3	19.1	24.2	0	6.2	0	0	0
12-Jul-11			0	0	23.4	16.6	20	0	2	0	0	0
13-Jul-11			0	0	21.9	11.2	16.6	1.4	0	0	0	0
14-Jul-11			0	0	24.3	9.5	16.9	1.1	0	0	0	0
15-Jul-11			0	0	26.2	9.9	18.1	0	0.1	0	0	0
16-JUI-11			0	0	28.7	12.3	20.5	0	2.5	0	0	0
17-Jul-11			0	56	27.2	18.6	24.4	0	0.4 4 9	56	0	56
19-Jul-11			0	0.0	28.3	17.9	23.1	0	5.1	0.0	0	0.0
20-Jul-11			0	0	30.5	16.7	23.6	0	5.6	0	0	0
21-Jul-11			0	0	29.5	19.9	24.7	0	6.7	0	0	0
22-Jul-11			0	0	27.2	19.1	23.2	0	5.2	0	0	0
23-Jul-11			0	0	30	19.9	25	0	7	0	0	0
24-Jul-11			0	3.4	24.6	18.1	21.4	0	3.4	3.4	0	3.4
25-Jul-11			0	4	22	18.6	20.3	0	2.3	1.0		4
20-Jul-11			0	1.0	25.2	11.0	10.2	0	0.2	1.0	0	1.0
28-Jul-11			0	0.2	25.2	19.1	22.6	0	4.6	0.2	0	0.2
29-Jul-11			0	47.4	26.7	19.1	22.9	0	4.9	47.4	0	47.4
30-Jul-11			0	0	26.1	14.7	20.4	0	2.4	0	0	0
31-Jul-11			0	12	27.8	15	21.4	0	3.4	12	0	12
1-Aug-11			0	0	25.9	18.2	22.1	0	4.1	0	0	0
2-Aug-11			0	3.2	27.2	15.1	21.2	0	3.2	3.2	0	3.2
3-Aug-11			0	7	24	14	19	0	1	7	0	7
4-Aug-11			0	0	25.2	12.5	18.9	0	0.9	0	0	0
5-Aug-11			0	0	27.5	14.9	21.2	0	3.2	0	0	0
7-Aug-11			0	0.6	25	19.2	22.1	0	4.1	0.6	0	0.6
8-Aug-11			0	0.0	24.2	14.3	19.3	0	1.3	0	0	0
9-Aug-11			0	0.4	25.3	15	20.2	0	2.2	0.4	0	0.4
10-Aug-11			0	1.5	19.7	14	16.9	1.1	0	1.5	0	1.5
11-Aug-11			0	0	21.7	11.6	16.7	1.3	0	0	0	0
12-Aug-11			0	0	25.2	11	18.1	0	0.1	0	0	0
13-Aug-11			0	4	25	16.5	20.8	0	2.8	4	0	4
14-Aug-11			0	0	22.6	15.8	19.2	0	1.2	0	0	0
16-Aug-11			0	0	26.6	10.9	18.8	0	0.8	0	0	0

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
17-Aug-11			0	0	26.8	12.6	19.7	0	1.7	0	0	0
18-Aug-11			0	0	24.7	13.7	19.2	0	1.2	0	0	0
19-Aug-11			0	0	26.5	12.1	19.3	0	1.3	0	0	0
20-Aug-11			0	16	22.9	15.2	19.1	0	1.1	16	0	16
21-Aug-11			0	10.2	19.7	14	16.9	1.1	0	10.2	0	10.2
22-Aug-11			0	0	19.9	10.6	15.3	2.7	0	0	0	0
23-Aug-11			0	0	24.5	10	17.3	0.7	0	0	0	0
24-Aug-11			0	6.4	27.2	16.9	22.1	0	4.1	6.4	0	6.4
25-Aug-11			0	0.6	21.2	16.9	19.1	0	1.1	0.6	0	0.6
26-Aug-11			0	0	22.3	10.8	16.6	1.4	0	0	0	0
27-Aug-11			0	0	24.7	14.2	19.5	0	1.5	0	0	0
28-Aug-11			0	0	20.4	10.6	15.5	2.5	0	0	0	0
29-Aug-11			0	0	22.0	9.8	10.2	1.8	0	0	0	0
30-Aug-11			0	0	23.3	14.5	18.9	0	0.9	0	0	0
1 Son 11			0	0.0	24.4	10.0	20	0	2	25.4	0	25.4
2 Sop 11			0	20.4	20.0	10.9	20.1	0	2.1	20.4	0	20.4
2-Sep-11			0	0	32.7	17.7	20.0	0	7.0	06	0	06
4-Sep-11			0	0.0	24.4	14.6	18.3	0	0.1	8.8	0	8.8
5-Sep-11			0	0.0	14.7	10.7	10.0	53	0.0	0.0	0	0.0
6-Sep-11			0	0.2	14.7	83	11.7	6.5	0	0.2	0	0.2
7-Sep-11			0	0	18.9	7.8	13.4	4.6	0	0	0	0
7 0cp 11 8-Sen-11			0	0	20.8	10.6	15.7	2.3	0	0	0	0
9-Sep-11			0	0	23.8	8.7	16.3	1.7	0	0	0	0
10-Sep-11			0	0	21.8	9.9	15.9	2.1	0	0	0	0
11-Sep-11			0	7.2	24.2	10.4	17.3	0.7	0	7.2	0	7.2
12-Sep-11			0	0	25.6	15.9	20.8	0	2.8	0	0	0
13-Sep-11			0	3.8	22.1	10.8	16.5	1.5	0	3.8	0	3.8
14-Sep-11			0	0	17.5	5.2	11.4	6.6	0	0	0	0
15-Sep-11			0	0	12.4	6.8	9.6	8.4	0	0	0	0
16-Sep-11			0	0	12.7	2	7.4	10.6	0	0	0	0
17-Sep-11			0	0	15.6	1.8	8.7	9.3	0	0	0	0
18-Sep-11			0	0	20.9	3.5	12.2	5.8	0	0	0	0
19-Sep-11			0	10.4	17	10.4	13.7	4.3	0	10.4	0	10.4
20-Sep-11			0	0	18.8	6.6	12.7	5.3	0	0	0	0
21-Sep-11			0	12.8	24.9	10.2	17.6	0.4	0	12.8	0	12.8
22-Sep-11			0	0	18.8	10	14.4	3.6	0	0	0	0
23-Sep-11			0	34.2	15	12.2	13.6	4.4	0	34.2	0	34.2
24-Sep-11			0	0	19.1	7.9	13.5	4.5	0	0	0	0
25-Sep-11			0	0	21.4	7.5	14.5	3.5	0	0	0	0
26-Sep-11			0	2.8	24.7	15.6	20.2	0	2.2	2.8	0	2.8
27-Sep-11			0	14.2	20.1	11.6	15.9	2.1	0	14.2	0	14.2
28-Sep-11			0	0	21.3	10.8	16.1	1.9	0	0	0	0
29-Sep-11			0	3.8	18.5	11.5	15	3	0	3.8	0	3.8
30-Sep-11			0	41.2	13.5	6.4	10	8	0	41.2	0	41.2
1-Oct-11			0	0	12.0	5.3	1.1	10.3	0	0	0	0
2-001-11			0	0.8	10.9	0.0	9.0	0.4	0	0.0	0	0.0
4-Oct-11			0	0.0	17.6	9.4	11.4	0.0	0	0.0	0	0.0
5-Oct-11			0	0	17.0	2.9	9.4	8.6	0	0	0	0
6-Oct-11			0	0	10.7	2.9	10.0	7 1	0	0	0	0
7-Oct-11			0	0	22.6	65	14.6	3.4	0	0	0	0
8-Oct-11			0	0	24.0	12.1	18.3	0.4	0.3	0	0	0
9-Oct-11			0	0	23	10.5	16.0	12	0.0	0	0	0
10-Oct-11			0	0	24.1	8.5	16.3	1.7	0	0	0	0
11-Oct-11			0	0	23	9.5	16.3	1.7	0	0	0	n n
12-Oct-11			0	8.6	19.6	10.4	15		0	8.6	0	8.6
13-Oct-11			0	5.2	17.4	12.9	15.2	2.8	0	5.2	0	5.2
14-Oct-11			0	22.4	15.3	9.9	12.6	5.4	0	22.4	0	22.4
15-Oct-11			0	33.6	10.6	7.6	9.1	8.9	0	33.6	0	33.6
16-Oct-11			0	2.8	12.6	4.8	8.7	9.3	0	2.8	0	2.8
17-Oct-11			0	1.2	10.6	7.9	9.3	8.7	0	1.2	0	1.2
18-Oct-11			0	0	10.3	4.2	7.3	10.7	0	0	0	0
19-Oct-11			0	24.6	9	5.9	7.5	10.5	0	24.6	0	24.6
20-Oct-11			0	40.4	10.7	6.5	8.6	9.4	0	40.4	0	40.4
21-Oct-11		1	0	1.2	8	4.6	6.3	11.7	0	1.2	0	1.2

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
22-Oct-11			0	0	9.7	1.6	5.7	12.3	0	0	0	0
23-Oct-11			0	0	16	1.3	8.7	9.3	0	0	0	0
24-Oct-11			0	10.2	12.1	6.8	9.5	8.5	0	10.2	0	10.2
25-Oct-11			0	11.4	8.8	5.6	7.2	10.8	0	11.4	0	11.4
26-Oct-11			2,049,054	3.2	/ 51	4.7	5.9	12.1	0	3.2	0	3.2
27-Oct-11			1,087,813	0.2	5.1	-0.5	2.3	10./	0	02	0	0 0 0
20-0ct-11			1 986 355	0.2	10.6	-0.0	6.3	11.0	0	0.2	0	0.2
30-Oct-11			670,021	0.4	10.8	1	5.9	12.1	0	0.4	0	0.4
31-Oct-11			1.800.039	0.8	12.2	3.6	7.9	10.1	0	0.8	0	0.8
1-Nov-11			2,126,319	0	12.4	3.9	8.2	9.8	0	0	0	0
2-Nov-11			2,000,884	0.6	17.1	7.5	12.3	5.7	0	0.6	0	0.6
3-Nov-11			2,015,035	4.2	9.9	1.6	5.8	12.2	0	4.2	0	4.2
4-Nov-11			2,086,254	0	6.4	-3.7	1.4	16.6	0	0	0	0
5-Nov-11			2,132,591	0	10.3	-3.7	3.3	14.7	0	0	0	0
6-Nov-11			1,787,223	0	16.5	3.9	10.2	7.8	0	0	0	0
7-Nov-11			2,156,859	0	14.2	2.7	8.5	9.5	0	0	0	0
8-Nov-11			2,158,973	9	9.1	1.4	5.3	12.7	0	9	0	9
9-Nov-11			2,139,816	9	14.6	5.9	10.3	/./	0	9	0	9
10-Nov-11			2,143,907	10.8	7.3	0.3	3.8	14.2	0	4.7	5.5	10.8
11-NOV-11			2,151,627	1	4.9	0.2	2.6	15.4	0	0.2	0.8	1
12-Nov-11			2,129,307	56	10.3	2.4	0.4 11 Q	6.2	0	56	0	56
13-Nov-11			2,140,369	5.0	14 14 5	0.2	9.6	8.4	0	0.0	0	5.0
15-Nov-11			2 136 951	0	11.3	<del>-</del>	8.3	9.7	0	0	0	0
16-Nov-11			2,128,399	0	11.2	2	6.6	11.4	0	0	0	0
17-Nov-11			2,141,544	7.8	3.3	-1.3	1	17	0	0	7.8	7.8
18-Nov-11			2.137.211	0	5.9	-0.1	2.9	15.1	0	0	0	0
19-Nov-11			2,147,549	2.4	10.8	4.3	7.6	10.4	0	2.4	0	2.4
20-Nov-11			2,149,659	1	11.3	-0.9	5.2	12.8	0	1	0	1
21-Nov-11			1,761,960	0	2.4	-4.5	-1.1	19.1	0	0	0	0
22-Nov-11			2,139,611	0	2.1	-4.7	-1.3	19.3	0	0	0	0
23-Nov-11			2,130,588	0	6.8	0.3	3.6	14.4	0	0	0	0
24-Nov-11			704,784	0	7	1.6	4.3	13.7	0	0	0	0
25-Nov-11			2,128,699	0	12.5	5.3	8.9	9.1	0	0	0	0
26-Nov-11			2,131,480	0	14.6	9.6	12.1	5.9	0	0	0	0
27-Nov-11			2,135,627	23.4	14.2	2.7	8.5	9.5	0	23.4	0	23.4
28-INOV-11			659,531	10	3	0.1	1.6	16.4	0		10.4	1
29-IN0V-11			2,141,719	40	3.3	0.7	2	16.6	0	20.0	10.4	40
1-Dec-11			2,147,090	18	4	-1.3	1.4	16.6	0	14	0.4	12
2-Dec-11			2 154 359	0.6	0	-3.7	-1.4	19.4	0	1.4	0.4	0.6
3-Dec-11			2,155,419	0.0	8.1	-3	2.6	15.4	0	0.4	0.0	0.0
4-Dec-11			2,143,635	11.8	9.4	4.9	7.2	10.8	0	11.8	0	11.8
5-Dec-11			2,151,364	0	5.1	-0.1	2.5	15.5	0	0	0	0
6-Dec-11			2,152,183	0.6	-0.1	-2.9	-1.5	19.5	0	0	0.6	0.6
7-Dec-11			2,149,589	0.4	1.7	-1.9	-0.1	18.1	0	0	0.4	0.4
8-Dec-11			2,157,670	4.6	1.5	-2.2	-0.4	18.4	0	0	6	4.6
9-Dec-11			1,033,193	1.8	0.6	-3.9	-1.7	19.7	0	0	2	1.8
10-Dec-11			949,443	0.9	-1.2	-5.1	-3.2	21.2	0	0	0.9	0.9
11-Dec-11			863,130	0	3.3	-3.5	-0.1	18.1	0	0	0	0
12-Dec-11			986,573	0	3.5	-2.6	0.5	1/.5	0	0	0	0
13-Dec-11			992,343	0.2	01	1.4	3.7	14.3	0	0.2	0	0.2
14-Dec-11			2 148 371	5.4	12.9	-1.1	6.9	14.5	0	5.4	0	0.0 5.4
16-Dec-11			2 150 391	1.4	2.5	-5.9	-1 7	19.7	0	0.4	12	1.4
17-Dec-11			2,152,299	0	-4	-8.3	-6.2	24.2	0	0.2	0	0
18-Dec-11			2,151.969	1	1.8	-5.6	-1.9	19.9	0	0	1	1
19-Dec-11			2,153.607	0.2	5.5	-2.9	1.3	16.7	0	0.2	0	0.2
20-Dec-11			2,155,727	0	0.3	-4.4	-2.1	20.1	0	0	0	0
21-Dec-11			2,154,327	3.8	3.9	0.2	2.1	15.9	0	3.8	0	3.8
22-Dec-11			2,156,273	1.4	3.7	-2.2	0.8	17.2	0	1	0.4	1.4
23-Dec-11			2,158,515	0.8	-2.2	-9.3	-5.8	23.8	0	0	1.4	0.8
24-Dec-11			2,157,451	0	0.3	-7.9	-3.8	21.8	0	0	0	0
25-Dec-11			0	0.4	3.4	0.1	1.8	16.2	0	0.4	0	0.4
26-Dec-11			0	0	4.4	-0.5	2	16	0	0	0	1 0

Table 1a.		Decerde	ام مر م	Climante	Data
Table Ta:	Pumbina	Records	and	Ciimaie	Dala

Date	Liters Pumped	Liters Back Flow	Total Liters	Precipitation (mm)	Max Temp	Min Temp	Mean Temp	Heat Deg Days	Cool Deg Days	Total Rain	Total Snow	Total Precip
27-Dec-11			967,813	11.6	3.7	-6.5	-1.4	19.4	0	0	11.6	11.6
28-Dec-11			992,781	2.8	-6.5	-18.4	-12.5	30.5	0	0	7	2.8
29-Dec-11			973,624	4.3	-3.3	-13.1	-8.2	26.2	0	0	5.1	4.3
30-Dec-11			989,531	6.8	2.3	-3.4	-0.6	18.6	0	6.4	0.4	6.8
31-Dec-11			0	0.4	1.8	-0.5	0.7	17.3	0	0.4	0	0.4

# **ATTACHMENT 2**

# DARCY FLUX CALCULATIONS

Epikasrt Groundw	ater Flow (Qk)				
q _k =K _k i _k	1.36E-06	m/s	$Q_k = q_k x A_k$	3.08E-03	m³/s
K _k	2.71E-04	m/s	A _k =Lxb _k	2275	m²
i _k	5.00E-03	m/m	L	455	m
			b _k	5	m
Shallow Bedrock	Groundwater F	low (Qs)			
q _s =K _s i _s	1.50E-09	m/s	Q _s =q _s xA _s	3.41E-06	m³/s
Ks	3.00E-07	m/s	A _s =Lxb _s	2275	m²
is	5.00E-03	m/m	L	455	m
			b _s	5	m
Deep Bedrock Gro	oundwater Flow	w (Qd)			
q _d =K _d i _d	6.30E-09	m/s	$Q_d = q_d x A_d$	3.44E-05	m³/s
K _d	2.10E-07	m/s	A _d =Lxb _d	5460	m²
i _d	3.00E-02	m/m	L	455	m
			b _d	12	m
Total (Qt = Qk+Qs	+Qd)				
Total	3.E-03	m³/s			
Groundwater					
Volume	48,529.01	m³/yr			

Table 2a: Groundwater Flow through East Face of Existing Keppel Quarry

Epikasrt Groundwa	ter Flow (Qk)						
q _k =K _k i _k	1.36E-06	m/s	$Q_k = q_k x A_k$	4.02E-03	m³/s		
K _k	2.71E-04	m/s	A _k =Lxb _k	2,965	m²		
i _k	5.00E-03	m/m	L	593	m		
			b _k	5	m		
Shallow Bedrock Groundwater Flow (Qs)							
q _s =K _s i _s	1.44E-09	m/s	Q _s =q _s xA _s	4.27E-06	m³/s		
K _s	3.00E-07	m/s	A _s =Lxb _s	2,965	m²		
i _s	4.80E-03	m/m	L	593	m		
			b _s	5	m		
Deep Bedrock Grou	undwater Flow	w (Qd)					
q _d =K _d i _d	6.30E-09	m/s	Q _d =q _d xA _d	4.48E-05	m³/s		
K _d	2.10E-07	m/s	A _d =Lxb _d	7,116	m²		
i _d	3.00E-02	m/m	L	593	m		
			b _d	12	m		
Total (Qt = Qk+Qs+Qd)							
Total	4.07E-03	m³/s					
Groundwater Volume	63,244.94	m ³ /yr					

Epikasrt Groundwa	ater Flow (Qk)				
$q_k = K_k i_k$	1.36E-06	m/s	$Q_k = q_k x A_k$	2.03E-03	m³/s
K _k	2.71E-04	m/s	A _k =Lxb _k	1500	m²
i _k	5.00E-03	m/m	L	300	m
			b _k	5	m
Shallow Bedrock	Groundwater Flow	(Qs)			•
q _s =K _s i _s	1.50E-09	m/s	Q _s =q _s xA _s	2.25E-06	m³/s
Ks	3.00E-07	m/s	A _s =Lxb _s	1500	m²
i _s	5.00E-03	m/m	L	300	m
			b _s	5	m
Deep Bedrock Gro	undwater Flow (C	)d)			
$q_d = K_d i_d$	6.30E-09	m/s	Q _d =q _d xA _d	2.27E-05	m³/s
K _d	2.10E-07	m/s	A _d =Lxb _d	3600	m²
i _d	3.00E-02	m/m	L	300	m
			b _d	12	m
Total (Qt = Qk+Qs-	+Qd)				•
Total	2.E-03	m³/s			
Groundwater					
Volume	31,997.15	m³/yr			

Table 2b: Groundwater Flow though South Face of Existing Keppel Quarry

Table 2d: Groundwater into Area 1b and Area 2 of New Keppel Quarry

Epikasrt Groundwater Flow (Qk)								
q _k =K _k i _k	1.36E-06	m/s	Q _k =q _k xA _k	1.41E-02	m³/s			
K _k	2.71E-04	m/s	A _k =Lxb _k	10,440	m²			
i _k	5.00E-03	m/m	L	2,088	m			
			b _k	5	m			
Shallow Bedrock	Groundwater Flow	(Qs)						
q _s =K _s i _s	1.50E-09	m/s	Q _s =q _s xA _s	1.57E-05	m³/s			
Ks	3.00E-07	m/s	A _s =Lxb _s	10,440	m²			
i _s	5.00E-03	m/m	L	2,088	m			
			b _s	5	m			
Deep Bedrock Gro	oundwater Flow (G	(d)						
q _d =K _d i _d	6.30E-09	m/s	$Q_d = q_d x A_d$	1.58E-04	m³/s			
K _d	2.10E-07	m/s	A _d =Lxb _d	25,056	m²			
i _d	3.00E-02	m/m	L	2,088	m			
			b _d	12	m			
Total (Qt = Qk+Qs	+Qd)							
Total	1.43E-02	m³/s						
Groundwater Volume	222,700.17	m³/yr						

## **ATTACHMENT 3**

## REVISED CALCULATION - NUMBER OF YEARS TO FILL THE PROPOSED KEPPEL QUARRY EXPANSION WITH WATER

#### Number of Years to Fill the Quarry - Based on One Side for the Wedge and Two Sides for Area 2

Table 3a: Area 1a (the 'wedge')

Table 3b: Area 1b + Area 2

Area						
	3.90	Ha				
	39,000	m²				
Precipitation (P)						
	1,041.30	mm/yr	En	vironment C	anada - Wia	rton
	1.04	m/yr	Air	port		
Volume	40,610.70	m³/yr				
Evapotranspiration	<u>1 (ET)</u>		N 4 N	D 1001	. 00	
Mahama	0.70	m/yr	IVIIN	IR, 1984, pg	. 23	
volume	27,300.00	m /yr				
Groundwater (C)					I	
Enikaert Groundw	ater Flow (Ok)	<u> </u>				
		m/s		$\bigcap_{i=\alpha_i} \times \Delta_i$	1 35E-03	m³/s
	2 71 E 04	m/s		$\Delta = l \times b$	1.550-005	m²
	2.712-04	111/5			990	
I _k	5.00E-03	m/m		L	199	m
				b _k	5	m
Shallow Bedrock C	aroundwater I	-low (G	(S)		4 405 00	$m^{3}/2$
q _s =K _s I _s	1.50E-09	m/s		Q _s =q _s xA _s	1.49E-06	m /s
Ks	3.00E-07	m/s		A _s =Lxb _s	995	m⁻
i _s	5.00E-03	m/m		L	199	m
				b _s	5	m
Deep Bedrock Gro	undwater Flov	w (Qd)	-	1		- <del>.</del>
q _d =K _d i _d	6.30E-09	m/s		Q _d =q _d xA _d	1.50E-05	m°/s
K _d	2.10E-07	m/s		A _d =Lxb _d	2,388	m⁴
i _d	3.00E-02	m/m		L	199	m
				b _d	12	m
Total (G = Qk+Qs+	Qd)	-				
G = Oe + Os + Od	1.36E-03	m³/s				
	21,224.78	m³/yr				
I otal Inputs Minus	Losses (P - E	: <b>+ G)</b>	1			
Volume	34,535.48	m˘/yr				

Area			-			
	29.80	На				
	298,000	m²				
Precipitation (P)						
	1,041.30	mm/yr	En	vironment C	anada - Wia	irton
	1.04	m/yr	Air	port		
Volume	310,307.40	m³/yr				
Evapotranspiration	n (ET)	1				-
	0.70	m/yr	MN	IR, 1984, pç	g. 23	
Volume	208,600.00	m³/yr				
Groundwater (G)						
Epikasrt Groundw	ater Flow (Qk	)				7.
q _k =K _k i _k	1.36E-06	m/s		$Q_k = q_k x A_k$	7.99E-03	m°/s
K _k	2.71E-04	m/s		A _k =Lxb _k	5,900	m²
i _k	5.00E-03	m/m		L	1,180	m
				b _k	5	m
Shallow Bedrock	Groundwater	Flow (Qs	5)			
q _s =K _s i _s	1.50E-09	m/s		Q _s =q _s xA _s	8.85E-06	m³/s
K _s	3.00E-07	m/s		A _s =Lxb _s	5,900	m²
i _s	5.00E-03	m/m		L	1,180	m
				b _s	5	m
Deep Bedrock Gro	oundwater Flo	w (Qd)				
q _d =K _d i _d	6.30E-09	m/s		$Q_d = q_d x A_d$	8.92E-05	m³/s
K _d	2.10E-07	m/s		A _d =Lxb _d	14,160	m²
i _d	3.00E-02	m/m		L	1,180	m
				b _d	12	m
Total (G = Qk+Qs+	-Qd)					
G = Oe + Os + Od	8.09E-03	m³/s				
	125,855.46	m³/yr				
Total Incorde AT	(F)					
I otal Inputs Minus	S LOSSES (P - E	<b>= + G)</b>	-			_
Volume	227,562.86	m˘/yr				

#### Table 3c: Summary

1 4 5 1 5 5 1 5 5 1		
Total Inputs		
34,535.48	m³/yr	Area 1a
227,562.86	m³/yr	Area 1b + Area 2
262,098.34	m³/yr	Area 1a + Area 1b + Area 2
33.7	Ha	Area 1a + Area 1b + Area 2
337,000	m²	Area 1a + Area 1b + Area 3
20	m	Total depth of quarry
6,740,000	m ³	Volume of quarry
26	yr	No. of years to fill the new quarry
2	L/s	amount of water needed to sustain s13
20,736	m³/yr	
241,362	m³/yr	input to quarry minus water needed to sustain s13
28	yr	No. of years to fill the new quarry if water needed for s13

#### Table 3d: Definition of Symbols

Symbol	Definiftion	Unit
q	Specific Discharge	m/time
Q	Total Discharge	m ³ /time
K	Hydraulic Conductivity	m/time
i	Horizontal Gradient	m/m
A	Cross Sectional Area	m ²
L	Length (as illustrated on Figure 2)	m
b	Saturated Aquifer Thickness	m
S	shallow bedrock aquifer	-
d	deep bedrock aquifer	-

#### Number of Years to Fill the Quarry - Based on Two Sides for the Wedge and Four Sides for Area 2

Table 3a: Area 1a (the 'wedge')

Table 3b: Area 1b + Area 2

Area	•					
	3.90	Ha				
	39,000	m²				
Precipitation (P)				•	•	
	1,041.30	mm/yr	Env	vironment C	anada - Wia	rton
	1.04	m/yr	Air	port		
Volume	40,610.70	m³/yr				
Evapotranspiration	ו (ET)		1			
	0.70	m/yr	ΜN	IR, 1984, pg	. 23	
Volume	27,300.00	m³/yr				
Crevedurator (C)						
Groundwater (G)	ator Flow (Ok)	\				
Epikasit Giouliuwa		m/a	1	O _α ×Λ	4 025 02	m ³ /s
q _k =r\ _k i _k	1.36E-06	III/S			4.02E-03	$m^2$
	2.7 IE-04	m/s		A _k =LXD _k	2,965	
I _k	5.00E-03	m/m		L	593	m
				b _k	5	m
Shallow Bedrock C	Groundwater I	-low (C	ls)		1	37
q _s =K _s i _s	1.50E-09	m/s		Q _s =q _s xA _s	4.45E-06	m°/s
K _s	3.00E-07	m/s		A _s =Lxb _s	2,965	m²
i _s	5.00E-03	m/m		L	593	m
				b _s	5	m
Deep Bedrock Gro	undwater Flor	w (Qd)	-		-	
q _d =K _d i _d	6.30E-09	m/s		$Q_d = q_d x A_d$	4.48E-05	m³/s
K _d	2.10E-07	m/s		A _d =Lxb _d	7,116	m²
i _d	3.00E-02	m/m		L	593	m
			Ī	b _d	12	m
Total (G = Qk+Qs+	Qd)		•	•		
	4.07E-03	m³/s				
G = QR + QS + QU	63,247.70	m ³ /yr				
Total Inputs Minus	Losses (P - E	+ G)	1	1		
Volume	76,558.40	m³/yr				

Area			-			
	29.80	Ha				
	298,000	m²				
Precipitation (P)						
	1,041.30	mm/yr	En	vironment C	anada - Wia	irton
	1.04	m/yr	Air	port		
Volume	310,307.40	m³/yr				
Evapotranspiratio	n (ET)	-	-			
	0.70	m/yr	M٢	IR, 1984, pc	j. 23	
Volume	208,600.00	m³/yr				
Creve durator (C)						
Groundwater (G)	ator Flow (Ok	<b>`</b>				
		)			1 415 00	m ³ /s
q _k =κ _k ι _k	1.36E-06	111/S			1.412-02	$m^2$
n _k	2.71E-04	m/s		A _k =LXD _k	10,440	
I _k	5.00E-03	m/m		L	2,088	m
	_			b _k	5	m
Shallow Bedrock	Groundwater	Flow (Qs	)			37
q _s =K _s i _s	1.50E-09	m/s		Q _s =q _s xA _s	1.57E-05	m²/s
K _s	3.00E-07	m/s		A _s =Lxb _s	10,440	m²
i _s	5.00E-03	m/m		L	2,088	m
				b _s	5	m
Deep Bedrock Gro	oundwater Flo	w (Qd)				
q _d =K _d i _d	6.30E-09	m/s		Q _d =q _d xA _d	1.58E-04	m³/s
K _d	2.10E-07	m/s		A _d =Lxb _d	25,056	m²
i _d	3.00E-02	m/m		L	2,088	m
				b _d	12	m
Total (G = Qk+Qs-	-Qd)					
G = Ok + Os + Od	1.43E-02	m³/s				
G = QR + QS + QU	222,700.17	m ³ /yr				
Total Inputs Minus	s Losses (P - E	<b>- + G</b> )	1	1		
Volume	324,407.57	m˘/yr				

#### Table 3c: Summary

Total Inputs		
76,558.40	m³/yr	Area 1a
324,407.57	m³/yr	Area 1b + Area 2
400,965.98	m³/yr	Area 1a + Area 1b + Area 2
33.7	Ha	Area 1a + Area 1b + Area 2
337,000	m²	Area 1a + Area 1b + Area 3
20	m	Total depth of quarry
6,740,000	m ³	Volume of quarry
17	yr	No. of years to fill the new quarry
2	L/s	amount of water needed to sustain s13
20,736	m³/yr	
380,230	m³/yr	input to quarry minus water needed to sustain s13
18	yr	No. of years to fill the new quarry if water needed for s13

#### Table 3d: Definition of Symbols

Symbol	Definiftion	Unit
q	Specific Discharge	m/time
Q	Total Discharge	m ³ /time
K	Hydraulic Conductivity	m/time
i	Horizontal Gradient	m/m
Α	Cross Sectional Area	m²
L	Length (as illustrated on Figure 2)	m
b	Saturated Aquifer Thickness	m
S	shallow bedrock aquifer	-
d	deep bedrock aquifer	-




# **STAKEHOLDERS LIAISON COMMITTEE**





TO:	Jay Flanagan	MTE FILE NO.:	33862-100
		DATE:	October 21, 2014
		FROM:	Sean Anderson
		PROJECT	
		NAME:	Keppel Quarry

### RE: KEPPEL QUARRY – STAKEHOLDERS LIAISON COMMITTEE

This memo is an addendum to the original memo dated March 23, 2012, which was included in the Adaptive Management Plan dated July 11, 2012. The details and the language of the original memo have been revised as per comments received from the Ministry of the Environment (MOE) in a letter dated October 25, 2012. The changes include:

- Changing the name of the committee from Citizen Liaison Committee to Stakeholders Liaison Committee;
- The inclusion of a Terms of Reference for affirmation by the committee.
- Appointment of a co-chair alongside HSCL.
- Overlapping the appointment terms of committee members to ensure consistency year to year.

#### 1.0 INTRODUCTION

Harold Sutherland Construction Limited (HSCL) has applied for a Category 2, Class "A" Quarry License to be located on Part Lots 26, 27, and 28, Concession 10, in the Township of Georgian Bluffs, County of Grey, hereby referred to as the New Keppel Quarry. An Adaptive Management Plan (AMP) has been developed that will be used to ensure there are no adverse impacts to the natural environment while the New Keppel Quarry operates. As part of the AMP, public consultation and liaison will be incorporated to encourage open dialogue between HSCL and the community. To facilitate this process, a Stakeholders Liaison Committee (SLC) will be assembled that includes members of the stakeholders that have a vested interest in the New Keppel Quarry. The suggested participants and format of the SLC is outlined below.

### 1.1 Regulatory Agencies

A representative from each of the following regulatory agencies will be invited to serve on the SLC:

- The Ministry of Natural Resources (MNR)
- The Ministry of the Environment (MOE); and
- The Niagara Escarpment Commission (NEC).



### INTERNAL MEMORANDUM

The representatives of the three regulatory agencies will form the core on the SLC along with two representatives of HSCL familiar with the environmental planning process for the New Keppel Quarry.

### **1.2 Stakeholder Organizations**

In addition to the regulatory agencies, stakeholder organizations that will be considered as participants may include but not limited to:

- Coalition on the Niagara Escarpment (CONE);
- County of Grey;
- Grey Sauble Conservation Authority;
- Métis Nation of Ontario.
- Saugeen Ojibway Nation (SON);
  - Chippewas of Nawash First Nation; and
  - The Saugeen First Nation
- The Grey Association for Better Planning (GABP);
- Township of Georgian Bluffs;

Invitations will be sent to each of the stakeholder organizations to nominate a representative of their organization to serve on the SLC. In addition, two (2) community representatives will be selected to serve on the SLC. To attract candidates for the community representative roles, local residents will be notified of the SLC nomination process through an advertisement in the local paper and/or notices posted at local community centres, post offices, etc.

Candidates from the stakeholder organization and the community will be required to submit a resume outlining their qualifications and a letter expressing why they feel they will make a positive contribution to the SLC.

### **1.3 Committee Member Selection**

Following the deadline for nominations, HSCL will meet with the representatives of the NEC, MNR and MOE to discuss the candidates for the stakeholder and community representative positions. HSCL will then select the ideal candidates to fill each of the stakeholder and community representative positions. The selected candidates do not need to have a technical background, but should not be affiliated with HSCL and should have the following qualities:

- An interest in activities at the New Keppel Quarry;
- A willingness to attend and contribute positively to meetings;
- An ability and willingness to represent community interests and to provide feedback to members of the community;
- An ability to look beyond personal interests; and
- A willingness to work together on a common challenge.

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The names of the successful candidates will be published in the local paper to inform the public of the selection.

The stakeholder and community representatives will serve on the SLC for a term of two years. To ensure there is consistency year to year, the two year term of appointment will overlap so that there is no time at which all the members are new (saving, of course, for the initial appointment). Once the term lapses, the representatives must reapply to sit on the SLC. If a stakeholder or community representative is found to be obstructing the work of the SLC or not participating in a respectful manner, they may be asked to leave the SLC before their term expires. Removing a member from the SLC would require the approval of a majority of SLC members.

### 1.4 Roles and Responsibilities

The purpose of the SLC is to encourage information sharing so that input may be considered from the agencies, stakeholder organizations, and citizens when reviewing the monitoring programs and mitigation measures use by the AMP. The committee will be linked to HSCL by acting as a sounding board and adviser to the operator in regards to the implementation of the AMP.

A Terms of Reference shall be developed for affirmation by the committee itself. To expedite the process, HSCL will draft the initial Terms of Reference and present it to the committee during their first meeting. Based on discussions, it shall be modified and circulated for final comment prior to implementation. Once finalized, the Terms of Reference shall be ratified by the committee members. Any Terms of Reference developed for affirmation shall include a minimum of two meetings per year.

The Draft Terms of Reference shall include but not be limited to the following:

- 1. The SLC shall meet a minimum of two times per year.
- 2. The SLC has an important liaising role and will be required to comment on the effectiveness of the AMP (monitoring programs and mitigation measures). The SLC will also be encouraged to table other relevant issues related to the operation of the New Keppel Quarry.
- 3. Based on their review of the AMP, the SLC shall make recommendations to the operator. The recommendations shall not be viewed as a platform for dictating or directing how HSCL operates the quarry. Rather, the recommendations must be in accordance with relevant Acts and Regulations.
- 4. The committee will be established and administered by HSCL:
  - d. HSCL will provide the venue for the meetings and will provide administrative staff to record the minutes and action items.





- e. HSCL will provide specialists to interpret data and offer expert opinion on discussion points and monitoring reports.
- f. HSCL will provide a website to post information for the committee members to share by way of confidential pass words as well as to post information for the general public.

#### 1.5 Administrative Details

A representative of HSCL will act as chair and guide the meetings to ensure that they are focused and orderly. The committee will be required to appoint a co-chair alongside HSCL. In so doing, there will be a direct transfer of information from the SLC to HSCL. The role of the appointed cochair will be to offer guidance for the committee and presentation of issues to HSCL that they might not be aware of. The chair and co-chair will set the agenda and then conduct the meeting proceedings and taking minutes.

HSCL may invite experts to attend meetings to interpret technical data and summarize reports.

The first SLC meeting should include an agreement on the meeting times and places of future SLC meetings. As per the Memorandum of Agreement between SON and HSCL, the SLC will meet two times per year; however, the SLC may choose to meet more frequently if an urgent issue arises. Meetings will be held in a neutral and easily accessible location. The SLC meetings may include a site inspection. As a result, it may be beneficial to hold the meeting on or near the New Keppel Quarry site.

A discussion should be held about the roles and responsibilities of the SLC, and may include the adoption of a formal code of conduct or charter for the SLC. A draft Code of Conduct is included in Attachment 1 and a template for SLC agenda and meeting minutes is provided in Attachment 2. These documents may be amended as required by the SLC.

#### 1.6 Information Sharing and Public Outreach

In addition to the regular SLC meetings, public information sessions may also be held to allow members of the community to meet representatives of HSCL and ask questions about the operations and environmental monitoring of the New Keppel Quarry. The need for a public information session will be determined by HSCL.

A public website and/or blog will be established to allow members of the public at large to submit feedback, comments and questions related to the New Keppel Quarry. Information may also be posted to the public website, including SLC meeting minutes, updates on the New Keppel Quarry operations and environmental monitoring, and the times and locations of public information sessions (if required).

HSCL will also establish a protected file sharing webpage with a link to it on the public website. The purpose of this webpage will be to share information related to the New Keppel Quarry MTE Consultants Inc.



### INTERNAL MEMORANDUM

amongst members of the SLC. Each member of the SLC will be provided a user name and password to login to the webpage and will be required to sign a confidentiality agreement to ensure that information is not shared with the general public or organization outside of the SLC. In this way, information sharing will be controlled to avoid misinformation being transferred to the general public. This approach does not rule out committee involvement/discussion of process. Information will be shared with those outside of the committee after information has been submitted to relevant agencies as finalized annual reports. This information will be made available to members of the SLC through the website, which will be administered by HSCL. Members of the SLC will be allowed to share the information provided to them through the webpage with their respective stakeholder organizations. Information made available to members of the SLC may include the AMP, annual monitoring reports, proposed ARA Site Plans, site photographs, site maps and monitoring data.

The information provided to members of the SLC and their stakeholder organizations will be provided "as is". While representatives of HSCL will be available to answer any questions related to technical data or reports provided to members of the SLC, stakeholder organizations will be responsible for retaining their own technical experts to conduct an independent review of technical documents if they so choose.

### 2.0 REFERENCES

*"Environmental Review Committees"* published by the Australian Department of Primary Industries, June 2009.

Phone: 519-743-6500 Fax: 519-743-6513

## **ATTACHMENT 1**

### DRAFT CODE OF CONDUCT

### New Keppel Quarry Stakeholders Liaison Committee

The following is a Code of Conduct for the structure and operation of the Stakeholders Liaison Committee (SLC) for the New Keppel Quarry. The purpose of the Code of Conduct is to ensure that SLC meetings are conducted in an orderly and respectful manner. All SLC members are required to review the document and sign the attached acknowledgment form before participating in the SLC.

### 1.0 Purpose

The purpose of the SLC is to encourage information sharing so that Harold Sutherland Construction Limited (HSCL) may consider input from the community and stakeholder organizations when revising the AMP and the ARA Site Plans. The SLC will review the environmental monitoring of the New Keppel Quarry and compare it to regulatory requirements. The SLC meetings will consist of discussions on how to improve environmental monitoring of the New Keppel Quarry, if required.

The goals of the SLC will be to:

- Act as a sounding board and adviser to the operator in regards to the implementation of the AMP.
- Improve HSCL's knowledge and understanding of community interests and concerns;
- Improve community knowledge and understanding of the New Keppel Quarry policies and activities related to the environment and government legislation; and
- Encourage HSCL, the community and other stakeholders to work together

#### 2.0 Membership

A representative from each of the following regulatory agencies will be invited to serve on the SLC:

- The Ministry of Natural Resources (MNR)
- The Ministry of the Environment (MOE); and
- The Niagara Escarpment Commission (NEC).

The representatives of the three regulatory agencies will form the core on the SLC along with two representatives of HSCL familiar with the environmental planning process for the New Keppel Quarry.

In addition to the regulatory agencies, two community representatives will be selected to serve on the SLC along with will a representative from each of the following stakeholder organizations:

- Coalition on the Niagara Escarpment (CONE);
- County of Grey;
- Grey Sauble Conservation Authority;
- Métis Nation of Ontario;

- Saugeen Ojibway Nation (SON);
  - Chippewas of Nawash First Nation; and
  - The Saugeen First Nation
- The Grey Association for Better Planning (GABP); and
- The Township of Georgian Bluffs;

**Terms of appointment** – The stakeholder and community representatives will serve on the SLC for a term of two years. To ensured there is consistency year to year, the two year term of appointment will overlap so that there is no time at which all the members are new (saving, of course, for the initial appointment).Once this term lapses, the representatives must reapply to sit on the SLC. If a stakeholder or community representative is found to be obstructing the work of the SLC or not participating in a respectful manner, they may be asked to leave the SLC before their term expires. Removing a member from the SLC would require the approval of a majority of SLC members.

#### 3.0 Operation

**Participation in meetings** – Each member will make their best effort to attend all meetings to maintain continuity and understanding of the issues. If three consecutive meetings are missed without an acceptable explanation, the SLC member will be approached and may be asked to step down or to send another representative from the organization they represent.

**Meeting agenda and minutes** – the SLC will meet a minimum of two times per year. A representative of HSCL will act as chair and guide the meetings to ensure that they are focused and orderly. The committee will be required to appoint a co-chair alongside HSCL. In so doing, there will be a direct transfer of information from the SLC to HSCL. The role of the appointed co-chair will be to offer guidance for the committee and presentation of issues to HSCL that they might not be aware of. The chair and co-chair will set the agenda and then conduct the meeting proceedings and taking minutes.

HSCL may invite experts to attend meetings to interpret technical data and summarize reports. All members are able to make suggestions. Minutes and agendas will be distributed to all members within four weeks of the meeting.

**Communication with press and other organizations** – The HSCL's co-chairperson will act as the voice of the SLC when required to speak to the press and other organizations. His/her comments should accurately reflect the SLC's activities as documented in the meeting minutes.

#### 4.0 Ground Rules

- Listen respectfully to the views of others and keep an open mind;
- Allow everyone to speak by not dominating conversation;
- Critique issues, do not criticize people;

- Please come prepared for each meeting and be prepared to actively participate;Please be respectful of others at the meeting by ensuring your mobile phone is turned off while meetings are in session;Obtain debriefings from the chairperson in the event that a meeting is missed.

### CODE OF CONDUCT ACKNOWLEDGEMENT FORM

I verify that I have read the Code of Conduct for the New Keppel Quarry SLC in its entirety, and understand its contents. I will abide by all of its directions.

Print Name	Organization	Signature	Date

## **ATTACHMENT 2**

### TEMPLATE FOR AGENDA AND MEETING MINUTES

### NEW KEPPEL QUARRY - STAKEHOLDERS LIAISON COMMITTEE

Agenda & Minutes			Date:						
Attendees:									
Abse	ent:								
Chairperson:				Minute taker:					
ltem 1	Time	<b>Item description</b> Welcome	Issues raise	ed	Action	Person responsible	Date due		
		Acceptance of minutes of last meeting							
		Action items from previous meetings							
2		Operational activities							

3 Environmental Monitoring

- 4 Complaints or issues received by HSCL since last meeting
- 5 Progressive rehabilitation/ landscaping
- **6** Future activities

- **7** General business
- 8 Next meeting