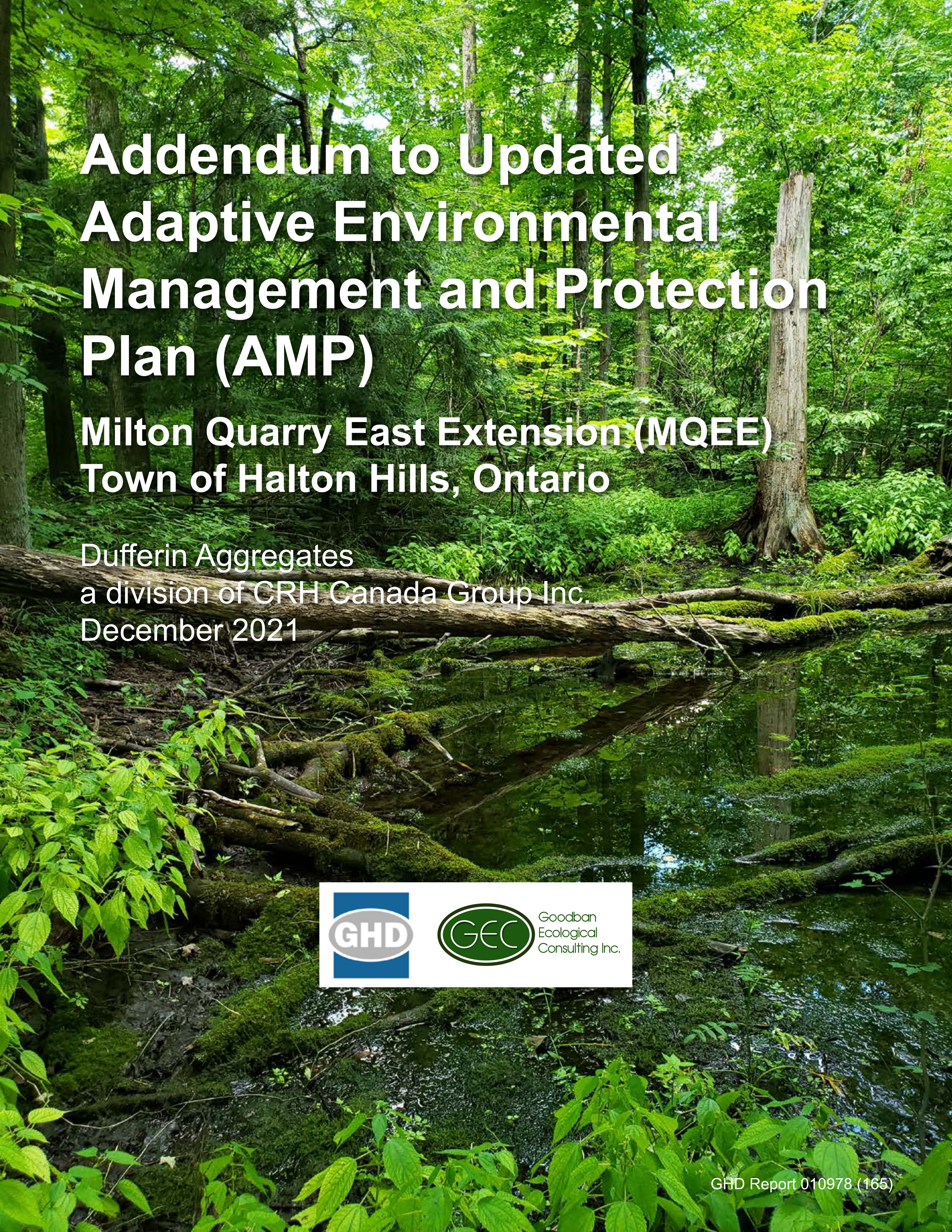


Addendum to Updated Adaptive Environmental Management and Protection Plan (AMP)

Milton Quarry East Extension (MQEE)
Town of Halton Hills, Ontario

Dufferin Aggregates
a division of CRH Canada Group Inc.
December 2021

GHD Report 010978 (165)

Part I

Adaptive Management Plan Requirements

Goodban Ecological Consulting Inc.

Part I: Adaptive Management Plan Requirements

Table of Contents

Figure Index

Table Index

Part II: AMP – Supplemental Information and Implementation Details

Part II Sections Index

Appendices

1. Introduction

This report is an addendum to the approved Adaptive Environmental Management and Protection Plan[1] (AMP) pertaining to the Milton Quarry East Extension (MQEE) of the Dufferin Aggregates Milton Quarry Extension in the Town of Halton Hills in the Region of Halton. The existing AMP is briefly described in Section 1.1 herein and included in Appendix A for reference.

The MQEE is a relatively small extension of the existing approved Milton Quarry as shown on Figure 1. The MQEE will be extracted by expanding the East Cell to the south following approval and removal of the common setback on the south side of the East Cell. Dewatering of the combined extraction cell will continue as needed to facilitate operations under typical dry quarry floor conditions.

The water resources and related ecological features in the area potentially influenced by the MQEE dewatering will be monitored, maintained, protected, and in some cases enhanced by the implementation of mitigation measures and AMP provisions consistent and compatible with those already in use at the Milton Quarry. The background and assessment of such measures are described in the Geology and Water Resources Assessment Report (GWRA) and the Natural Environment Technical Report and Environmental Impact Assessment (NETR & EIA) prepared by GHD and Goodban Ecological Consulting Inc. (GEC), respectively.

This addendum to the AMP (AMP Addendum) has been prepared by GHD in collaboration with GEC and is meant to be read in conjunction with the AMP (Appendix A). Curriculum Vitae for the authors of the AMP Addendum are included in Appendix B.

The AMP Addendum is organized as follows:

PART I — Presents the key requirements for the implementation of the AMP pertaining to the MQEE. These requirements are further detailed in Part II.

PART II — Provides detailed requirements for the implementation of the AMP Addendum. More specifically:

- Sections A through D provide details on the mitigation and monitoring requirements.
- Section E documents requirements with respect to reporting.

1.1 Existing AMP and AMP Addendum Context

The existing approved AMP describes the implementation, operation, monitoring, performance assessment, response actions, and reporting required for the protection of water resources and related ecological features associated with Phase 2 (West Cell) and Phase 3 (East Cell) of the Milton Quarry Extension. The AMP was approved in 2006. The current version of the AMP is the 2011 Updated AMP.

1 Updated Adaptive Environmental Management and Protection Plan (AMP) May 2003 – Modified December 2011, prepared by Conestoga-Rovers & Associates in Association with Ecoplans Limited and Goodban Ecological Consulting Inc.

The protection and enhancement of water resources and related ecological features for the Milton Quarry Extension relies upon a comprehensive water management system incorporating mitigation measures based on the conscientious management of water, groundwater recharge (injection wells) diffuse discharges to select wetlands, and rehabilitation lakes to help passively support groundwater levels in the long-term. This state-of-the-art mitigation system and AMP have been in place and operating successfully since 2007. This rigorous approval and operating quarry review process provides the highest standard of care for protection of water resources.

The MQEE incorporates mitigation measures to maintain and enhance water resources and related ecological features as identified in Section 1 above and described in Part II Section A of this AMP Addendum. The mitigation measures are a straightforward addition to the existing system using the same proven techniques. They include a readily manageable extension of the current recharge well system and diffuse discharges to support and enhance three wetland pools. Similarly, the rehabilitation plan for the MQEE is easily integrated into the existing quarry rehabilitation plan by the extension of one of the approved lakes and the creation of integrated terrestrial and wetland habitats.

The existing AMP requirements for the precautionary implementation, monitoring, and response measures are integrated into this AMP Addendum for the MQEE. Specifically including:

- Installation and verification of the effectiveness of mitigation measures prior to extraction below the water table in the MQEE
- Rigorous ongoing monitoring and assessment compared to pre-determined targets
- Pre-defined agency notifications, response actions, and timelines if targets are not continuously maintained
- Detailed and timely reporting of operating conditions and all collected data to agency technical representatives
- Confirmatory studies of rehabilitation conditions prior to and following completion of rehabilitation lake filling

The adjustments described in this AMP Addendum for the MQEE have been readily incorporated into the existing quarry mitigation measures and AMP requirements. They do not introduce any major operational changes to the systems before, during, or following extraction and rehabilitation lake filling. The overall integration of the MQEE into the existing quarry has been designed to benefit the watershed and the long-term plans for Conservation Halton which will be the landowner for the majority of the Milton Quarry lands and the water management system in the long term.

It is noted that this AMP Addendum, by intention, does not include additional provisions specific to the monitoring or protection of private water supply wells. The AMP provides comprehensive measures for all private wells in the area of the Milton Quarry and there are no private wells that are within the zone of influence of the MQEE. Therefore, no additional provisions specific to the MQEE are necessary or warranted. Refer to the GWRA Report and the AMP (Section 4.6) for further information regarding private wells.

2. Licensee Roles, Responsibilities, and Approvals

The protection of water resources associated with the MQEE, including surface water and related ecological features, depends on the successful implementation and operation of the mitigation and rehabilitation measures, as described in this AMP Addendum and illustrated on Figures 2 and 3. This AMP Addendum, in conjunction with the AMP, is the key implementing document for these matters.

The AMP Addendum is to be implemented as required by the Aggregate Resources Act (ARA) Licence. The Ministry of Northern Development, Mines, Natural Resources and Forestry (MNDMNRF) is the lead approval agency for any modifications or exceptions to the AMP Addendum. Other agencies (Niagara Escarpment Commission [NEC], Ministry of Environment, Conservation, and Parks [MECP], Regional Municipality of Halton, Town of Halton Hills, Town of Milton, and Conservation Halton [CH]) will be included in the circulation of information described herein (including, but not limited to, annual monitoring reports, 5-year review reports, on-line reporting, pre-extraction reports, mitigation verification reports, and notifications) such that MNDMNRF and Dufferin may consider any comments provided. *Refer to Part II Section E for further information on reporting. Refer to Section 6.0 herein for further information on modification of the AMP Addendum.* For activities required but not covered specifically under the AMP, or AMP Addendum, specific approvals from appropriate agencies will be obtained – for example: water management works will also be subject to MECP approval requirements under the Ontario Water Resources Act (OWRA).

3. AMP Requirements

The AMP requirements pertaining to specific stages of MQEE development are described in the following section. Ongoing requirements and response actions that apply throughout the quarry operation and lake filling period are described in Sections 4.0 and 5.0, respectively.

Figure 2 presents the interim water management and mitigation configuration, and Figure 3 presents the rehabilitation plan. Additional information and details of requirements are provided in the referenced sections of Part II of the AMP Addendum.

3.1 MQEE Pre-Extraction Requirements

The following steps must occur prior to the extraction below the bedrock groundwater level in the MQEE:

- Complete installation of target water level monitoring locations, including trigger wells and surface water monitors, and background monitoring locations. Preliminary proposed locations are shown on Figure 4. *Refer to Part II Sections B and D for further details on monitoring and target water levels*

- Collect minimum 3-year baseline water level monitoring at existing trigger well monitoring network (Figure 4) and background monitoring locations (Figure 7)[2]. *Refer to Part II Sections B and D for further details on monitoring and target levels*
- Complete installation of supplemental water level and ecological monitoring network similar to proposed network shown on Figure 5 Figure 6 and monitoring program summarized on Table 1. Initiate/conduct supplemental monitoring program for MQEE. *Refer to Part II Sections B and D for further details on monitoring network and monitoring program*
- Installation of Water Management System (WMS) for the MQEE, including all primary mitigation measures, to ensure they are available as required during extraction. *Refer to Part II Section A for further information on mitigation measures.* Initial water management system to include:
  - Watermain loop extending around west, south, and east sides of MQEE connecting to existing watermain at Townline Road and northeast corner of MQEE as shown on Figure 2
  - Diffuse surface water discharge/seepage locations for Wetland U1 and upper portion of Wetland W36 (2 pool areas represented by staff gauges SG57 and SG58) as shown on Figure 2
  - Groundwater recharge well system along the south and east side of MQEE with a minimum of 15 initial recharge wells at locations similar to those shown on Figure 2
- The necessary steps include:
  - Detailed engineering design
  - Installation of appropriate initial systems (in addition to the three diffuse surface water discharges this system will include the above minimum number of groundwater recharge wells along the south and east side of the MQEE and allow for future increases in the number of recharge wells and pumping capacity)
  - Commissioning
  - Verification study to confirm that implemented mitigation measures are operational and perform as intended. Submit mitigation verification report a minimum of 30 days in advance of extraction below the bedrock groundwater level in the MQEE. *Refer to Part II Section E.3.2 for further description*
- Following the installation and verification of diffuse discharges at Wetlands U1 and the upper portion of Wetland W36, commence operation of the diffuse discharges to enhance wetland hydrology (e.g., spring peak water levels, extend hydroperiod) at the onset of the next winter-spring transition period (or earlier as directed by Dufferin's ecological consultant). *Refer to Part II Section A.2.1.* The response action framework and target level requirements (Part II Sections B

[2] For existing proposed trigger well OW83.21, a minimum of 2 years of baseline water level monitoring will be required. If any new trigger or background monitoring wells are installed prior to extraction below the bedrock groundwater level, collect a minimum of 1-year of baseline water level monitoring (or lesser period if agreed to be acceptable by the agencies). Additional years of data may be developed using surrogate data from background correlation analysis as done for existing quarry.

and C) will be fully applicable following the commencement of extraction below the water table in the MQEE area

- Establish operating targets for MQEE trigger wells and Wetland U1 and Wetland W36 surface water levels. *Refer to Part II Section B for further details on target level determination*
- Confirm that the existing WMS is in good operating order with sufficient water volume and quality in storage to support the MQEE mitigation requirements
- Complete report on pre-extraction conditions and submit it to the agencies a minimum of 30 days in advance of extraction below the bedrock groundwater level in the MQEE. *Refer to Part II Section E for further information on reporting requirements*

3.2 MQEE Extraction and Lake Filling

The following activities are required during the MQEE extraction and lake filling period:

- Operate dewatering system as required to maintain dry working condition or control lake filling, as necessary. MQEE dewatering flow returns back to Main Quarry Reservoir, other quarry cell, or Main Quarry operations area for storage or other use
- Implement/operate primary interim mitigation measures as needed, including:
  - Diffuse discharge of water to Wetland U1 and upper portion of Wetland W36 as necessary to maintain associated target water levels (refer to Part II Section B)
  - Groundwater recharge wells to maintain groundwater levels at trigger wells to the east and south of the MQEE. *Refer to Part II Section B*
  - Operation/adjustment of the above measures to maintain water levels at target levels.
- Operate water management system for overall quarry water management, including mitigation, dewatering, storage, operations, lake filling, and discharge
- Conduct monitoring and reporting as identified in Section 4.0 and submit for agency review
- *Refer to Part II Section A for information on mitigation response and contingency measures*
- Prior to the completion of extraction in MQEE, conduct confirmatory water management study based on information collected during active quarry extraction conditions to confirm/refine the appropriate long-term water management system parameters (final lake levels, pumping and gravity flow for lake top-up and control) and proposed rehabilitation condition mitigation measures. Refer to the AMP and Site Plans for further information on rehabilitation implementation, including lake level/mitigation considerations. The Site Plans include further requirements regarding rehabilitation

3.3 MQEE Rehabilitation

The following activities are anticipated upon the completion of lake filling and transition to long-term rehabilitation conditions.

- Maintain target rehabilitation lake level in East Cell/MQEE (contiguous water body) through seasonal top-up flow from Reservoir using WMS and overflow to West Cell lake as necessary

- Continue seasonal use of diffuse discharge to Wetland U1 and the upper portion of Wetland W36 as required to maintain target water level regime (i.e., consistent with long term requirements for Wetlands V2, W7, and W8 as part of the existing quarry requirements and approvals)
- Potential seasonal recharge well use to top up spring groundwater levels to area east of MQEE in conjunction with similar operation approved for the East Cell area of the existing quarry
- Complete confirmatory analysis of rehabilitation condition and submit for agency review. If necessary, implement further response actions or contingency rehabilitation measures. *Refer to Part II Section A*
- Confirm ongoing monitoring and management requirements, including responsible party, financial arrangements, regulatory and other legal requirements

4. Ongoing Requirements

The following activities must be initiated prior to/during the extraction period and continue to the completion of lake filling and transition to long-term rehabilitation conditions

- Initiate and continue Performance monitoring programs and Supplemental monitoring programs, including background monitoring. Key quarry stage-specific requirements are listed in preceding Sections 3.1 through 3.3. *Refer to Part II Sections B and D, respectively, for details*
- Initiate and continue annual reporting to agencies and provision of data on-line for agency technical representatives in conjunction with existing reporting for Milton Quarry. The first report incorporating the MQEE will be for the calendar year following the year in which the licence, Site Plans, and all other necessary approvals are issued. *Refer to Part II Section E for further information on reporting*
- The MQEE will be incorporated into the AMP 5-year review report currently required by the AMP and submitted to the agencies for review. *Refer to Part II Section E for further information on reporting*
- Undertake response actions described below as appropriate in response to monitoring results

5. Response Actions

The following response actions are required (as necessary) throughout the extraction and lake-filling periods.

- If one or more water levels drop below applicable target level at trigger well locations or target locations in Wetland U1 or Wetland W36, take response actions in accordance with the Response Action Plan as required to restore water level and satisfy mitigation objectives. *Refer to Part II Section C for further information on Response Action Plan*
- If supplemental water or ecological monitoring data and related analyses indicate a negative effect has occurred, or is likely to occur in the future, an appropriate response action plan will be implemented. Such a plan may include modifications to mitigation measures, target levels,

monitoring programs, or other measures. *Refer to Part II Section D for further information on supplemental monitoring and ecological analysis, and Part II Section C for further information on response actions*

6. Modifications to the AMP Addendum

As described in Section 2.0, the MNDMNRF will be the approval agency for any proposed amendments or modifications to the AMP Addendum or components thereof (e.g., monitoring requirements, target water levels, mitigation measures, etc.) and will consider comments provided by the other agencies and Dufferin. Dufferin and the MNDMNRF will ensure that other agencies are circulated on related information in a timely manner. Recommendations for modifications may arise through the regular reporting (Annual Monitoring Report or 5-Year Review Report), Milestone reports (e.g., Pre-Extraction Report) or other circumstance-specific documentation. Refer to Part II, Section E for further information on reporting.

In the event that minor variations or modifications are necessary and must be implemented immediately (e.g., a monitoring location is destroyed or a substantive discrepancy is identified), Dufferin will immediately notify the MNDMNRF and other involved agencies in writing, implement the necessary variation or modification in keeping with the overall intent of the AMP and AMP Addendum, and promptly follow-up to satisfy any requirements identified by MNDMNRF (in consultation with the other agencies and Dufferin) to address the situation.

Any modifications (approved or pending) will be documented in the corresponding Annual Monitoring Report, as well as other documentation as appropriate.

All of Which is Respectfully Submitted,

GHD

LICENSED PROFESSIONAL ENGINEER
K. J. FRITZ
100205356
December 10, 2021
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J. R. MURPHY
December 10, 2021
PROVINCE OF ONTARIO

Kyle Fritz, P.Eng

J. Richard Murphy, P.Eng.

Goodban Ecological Consulting Inc. (GEC)

Anthony G. Goodban, B.Sc., M.E.S. (Pl.) MCIP, RPP
Consulting Ecologist & Natural Heritage Planner

List of Acronyms

AMP	Adaptive Management Plan
ARA	Aggregate Resources Act
CA	Conservation Authority
CH	Conservation Halton
ECA	Environmental Compliance Approval
EIA	Environmental Impact Assessment
GEC	Goodban Ecological Consulting Inc.
GWRA	Geology and Water Resources Assessment Report
HFRT	Hilton Falls Reservoir Tributary
JESA	Jefferson Salamander Complex
MECP	Ministry of the Environment, Conservation and Parks
MNDMNRF	Ministry of Northern Development, Mines, Natural Resources and Forestry
MQEE	Milton Quarry East Extension
NEC	Niagara Escarpment Commission
NETR	Natural Environment Technical Report
OWRA	Ontario Water Resources Act
PTTW	Permit To Take Water
QPM	Quantitative Photo-Monitoring
SCADA	Supervisory Control and Data Acquisition System
WMS	Water Management System

Figures

LEGEND

- 360 EXISTING GROUND CONTOUR
- ROAD
- RAILROAD
- MUNICIPAL BOUNDARY
- PROPERTY BOUNDARY
- DUFFERIN OWNED LICENSED
- DUFFERIN OWNED BUFFER
- DUFFERIN LEASED
- EXTENSION LICENCE LIMIT
- LICENSED EXTRACTION LIMIT
- EXTENSION EXTRACTION LIMIT
- BRUCE TRAIL (APPROXIMATE)
- LANEWAY/TRAIL
- WETLAND IDENTIFIED AS PROVINCIALLY SIGNIFICANT
- OTHER WETLAND
- SIGNIFICANT WOODLANDS
- MONITORING WELL LOCATION
- SURFACE WATER MEASUREMENT LOCATION
- STAFF GAUGE LOCATION
- TEST PIT LOCATION
- BOREHOLE LOCATION
- WATERMAIN (AS-BUILT/EXISTING)
- PROPOSED WATERMAIN
- CONTROL VALVE HUTS
- DIFFUSE DISCHARGE
- RECHARGE WELL
- PRELIMINARY TARGET MONITORING LOCATIONS

Map Orientation: Directions referenced in the report are identified as the general direction of the page from the Existing Quarry Licensed Area. Major roads, for example Sixth Line and Town Line, are referenced to the page, as the general north-south direction. This convention has been adopted from the Site Plans and Planning Summary Report to improve readability and ensure consistency in map illustration.

SOURCES:

- BASE MAPPING PRODUCED BY MACNAUGHTON HERMSEN BRITTON CLARKSON PLANNING LIMITED AND CONESTOGA-ROVERS & ASSOCIATES UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES © QUEEN'S PRINTER 1997
- TOPOGRAPHIC INFORMATION FOR AREAS OTHER THAN W8 AND V2 OBTAINED FROM NORTHWAY MAP TECHNOLOGY LIMITED. CONTOURS WERE DRAWN FROM SPRING 1997 AERIAL PHOTOGRAPHY UTILIZING EXISTING CONTROL. CONTOUR INTERVAL IS 1 METRE.
- TOPOGRAPHIC INFORMATION FOR W8 FROM MARCH 11, 2002 SURVEY USING 1 METRE CONTOUR INTERVAL.
- TOPOGRAPHIC INFORMATION FOR V2 FROM JUNE 24/25, 2002 SURVEY USING 1 METRE CONTOUR INTERVAL.
- MAIN QUARRY CONTOURS REVISED TO REFLECT 2001 EXISTING CONDITIONS (CRA DRAWING 10978-10(028)GN-WA002).
- BOUNDARY INFORMATION COMPILED FROM SURVEYS AND SKETCHES PREPARED BY FRED G, CUNNINGHAM, ONTARIO LANDS SURVEYORS, MILTON, ONTARIO, DECEMBER 2,1997.

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

Project No. **10978-200**
Date **December 2021**

LEGEND KEY

Filename: N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(165)\010978(RPT165)GN-WA009.dwg
Plot Date: 07 December 2021 12:42 PM

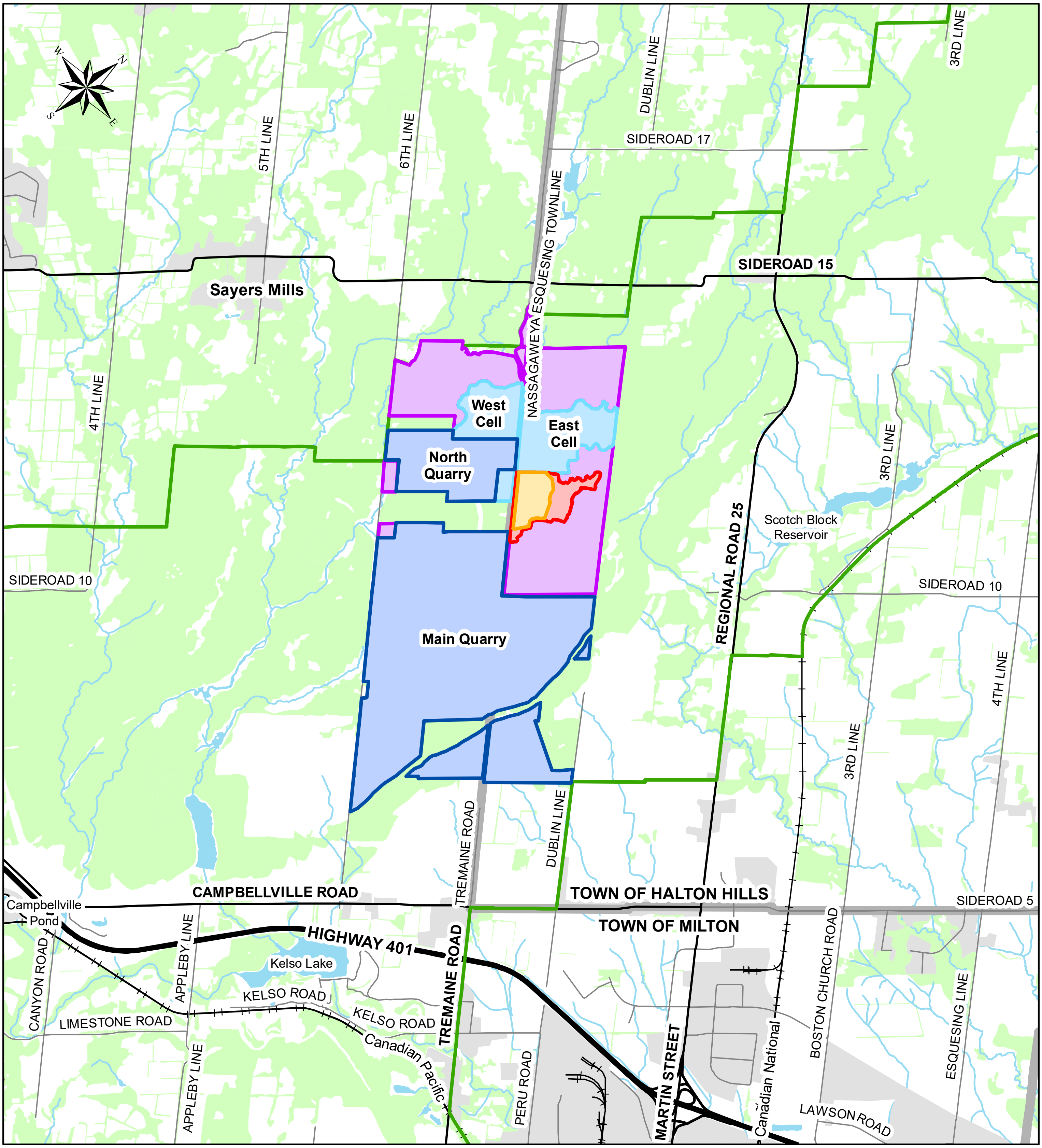


Figure 1

Location

Milton Quarry East Extension

Part of Lots 11 and 12, Concession 1
(Geographic Township of Esquesing)
Town of Halton Hills
Regional Municipality of Halton

Legend

- Proposed Milton Quarry East Extension - Licence Boundary
- Proposed Milton Quarry East Extension - Limit of Extraction
- Milton Quarry (1962)
- Milton Quarry Extension (2007)
- Other Lands Owned by Dufferin
- Niagara Escarpment Plan Boundary
- Built up Area

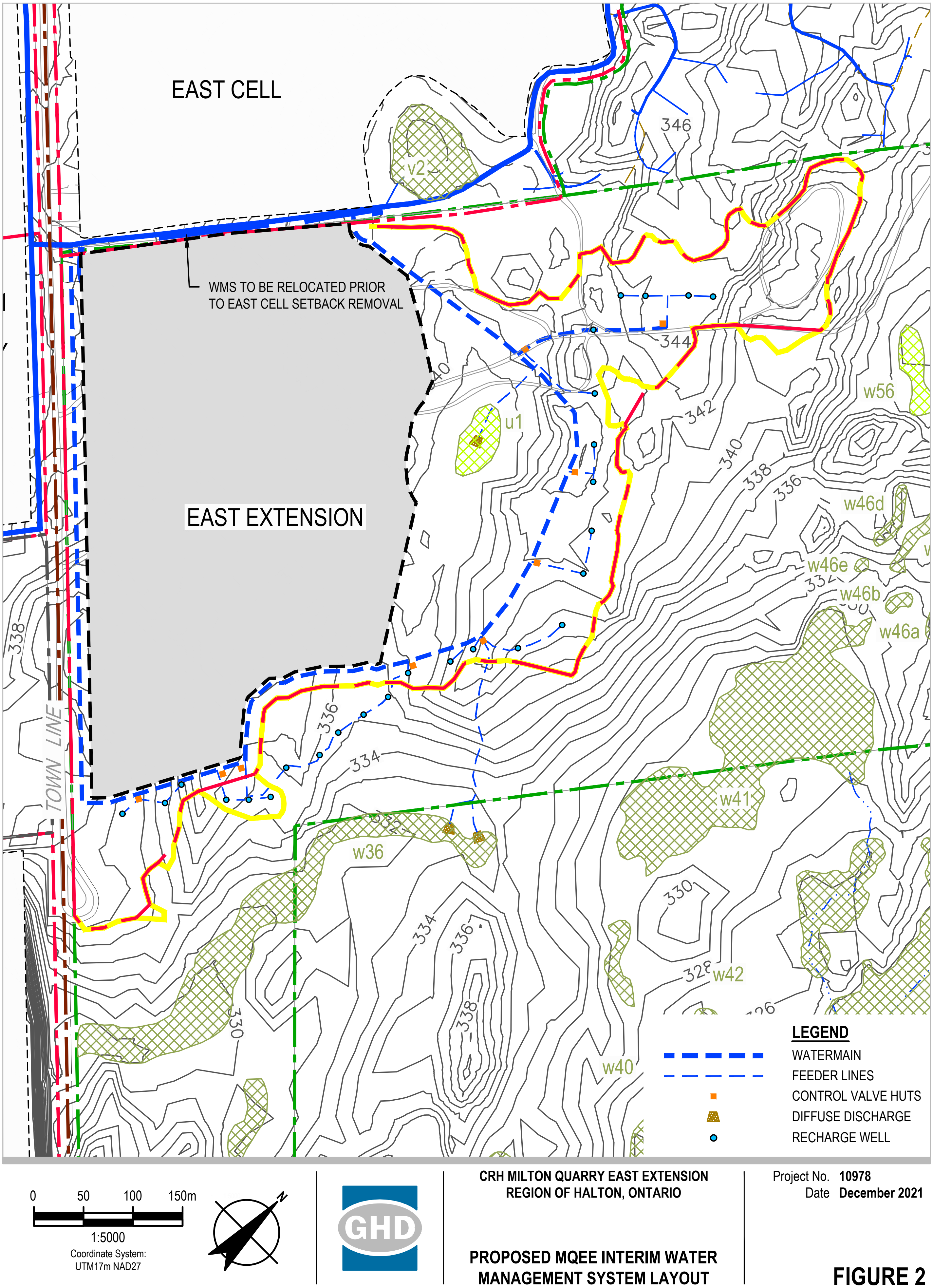
DATE: November 2021

SOURCES: Land Information Ontario
Contains information licensed under the Open Government Licence - Ontario

0 250 500 1,000 1,500 2,000
Meters (1:50,000)

N:\Brian\9061DJ Dufferin - Milton Quarry East Extension\Drawings - Must be in NAD 27\Figures for Other Consultants\Figures for GHD\GIS\9061DJ - Figure 1 - Location.mxd

MHBC PLANNING URBAN DESIGN & LANDSCAPE ARCHITECTURE



GHD

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

Project No. 10978
Date December 2021

PROPOSED MQEE INTERIM WATER MANAGEMENT SYSTEM LAYOUT

FIGURE 2

Filename: N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(165)\010978(RPT165)GN-WA004.dwg
Plot Date: 07 December 2021 12:43 PM

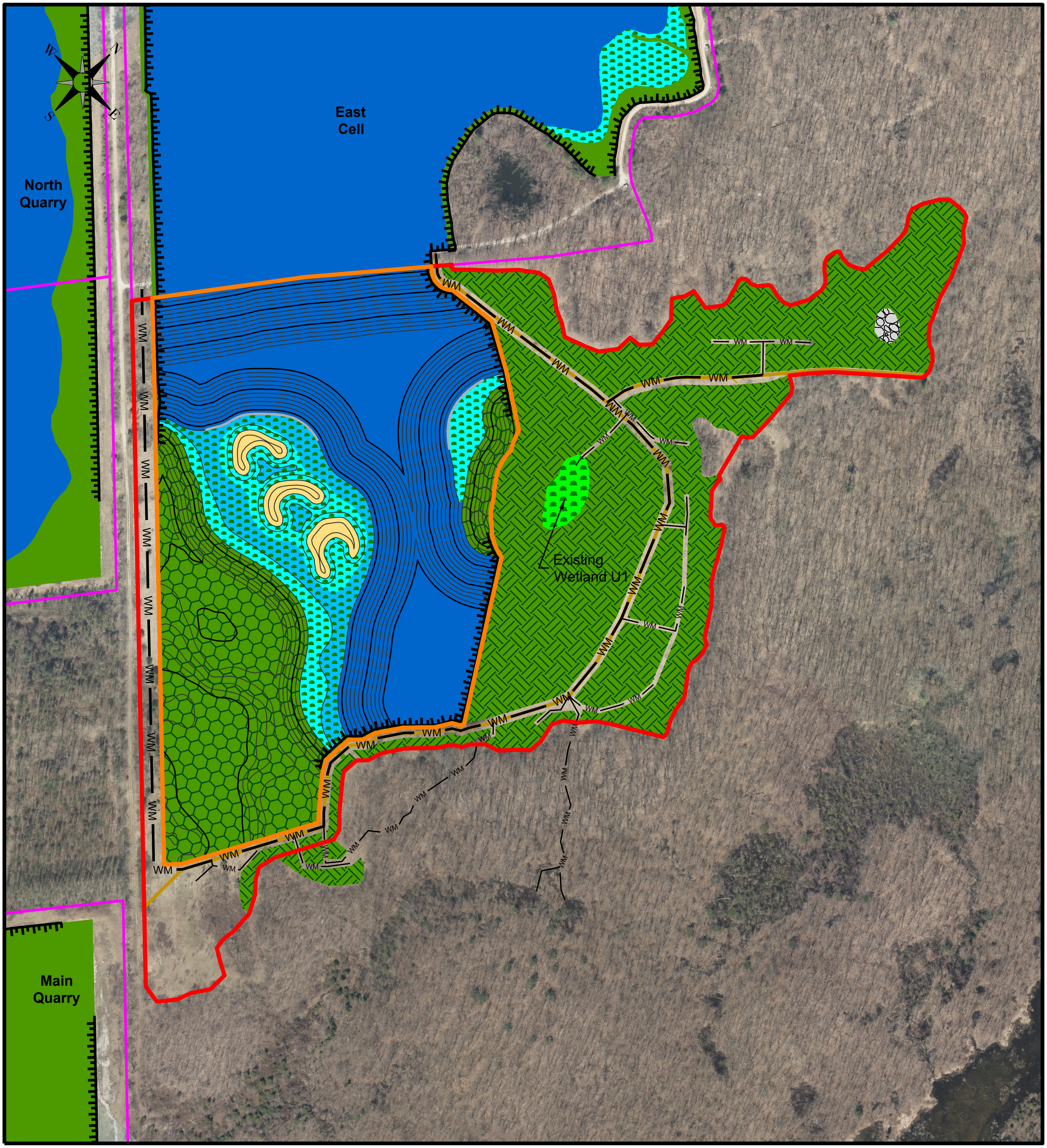


Figure 3

Rehabilitation and Ecological Enhancement Plan Schematic

Milton Quarry East Extension

Part of Lots 11 and 12, Concession 1
(Geographic Township of Esquesing)
Town of Halton Hills
Regional Municipality of Halton

Legend

- Proposed Milton Quarry East Extension - Licence Boundary
- Proposed Milton Quarry East Extension - Limit of Extraction
- Main Watermain / Service Access
- Feeder Line
- Rocky Shoal
- Shallow / Deep Wetland
- Deep Lake
- Islands
- Forested Area: Within Extraction Limit
- Forested Area: Outside Extraction Limit
- Snake Hibernaculum
- Cliff Face

Date: December 2021

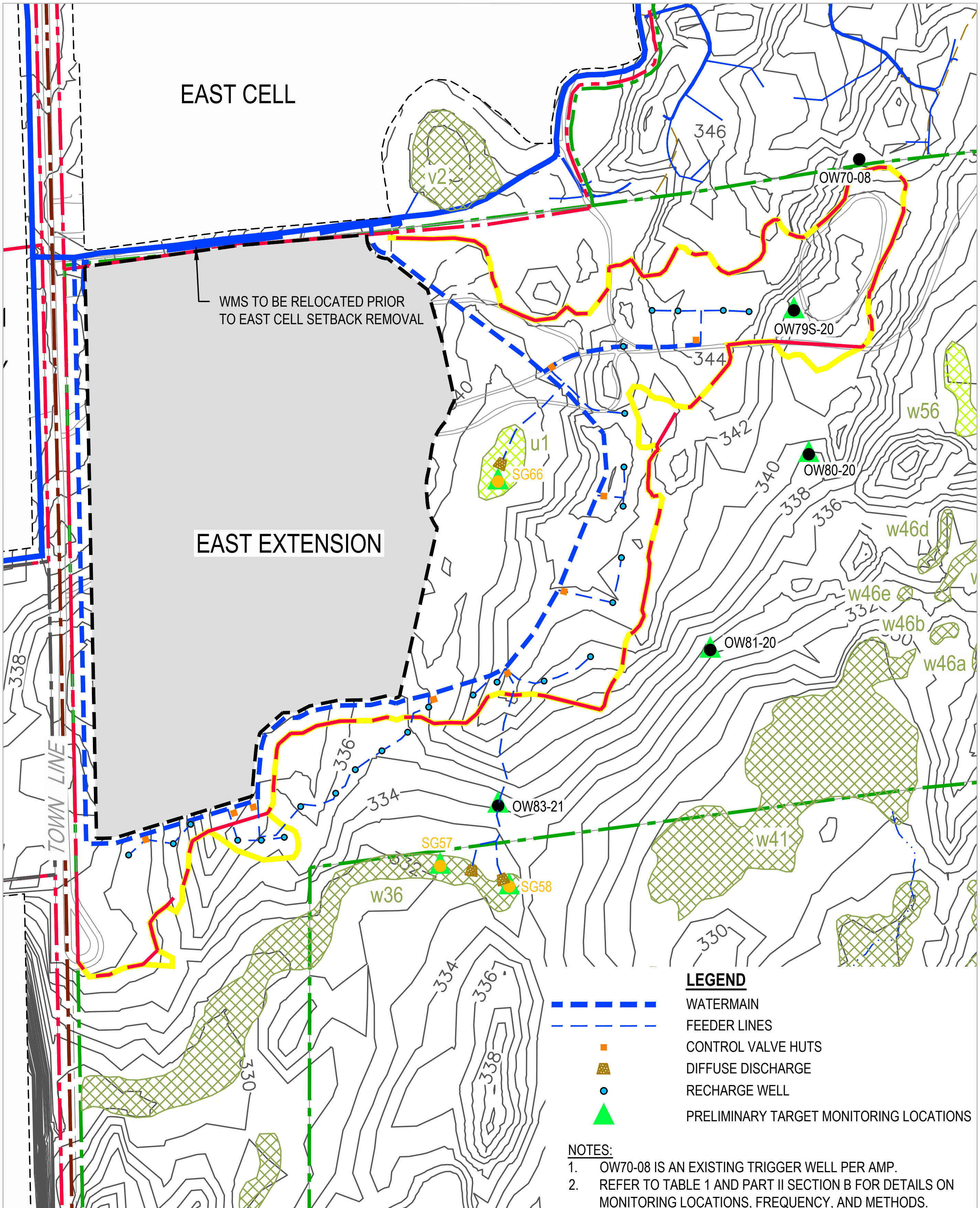
Sources: Milton Quarry East Extension Rehabilitation Plan prepared by MHBC dated December 2021

Scale - 1:5000

0 75 150 Meters

N:\Brian\9061DJ Dufferin - Milton Quarry East Extension\Drawings - Must be in NAD 27\Planning Report Figures and Schedules\AutoCAD - UTM NAD27\9061DJ - Figures 3 to 5 - Limit of Extraction and Schematics.dwg

MHBC PLANNING URBAN DESIGN & LANDSCAPE ARCHITECTURE



0 50 100 150m
1:5000
Coordinate System: UTM17m NAD27

GHD

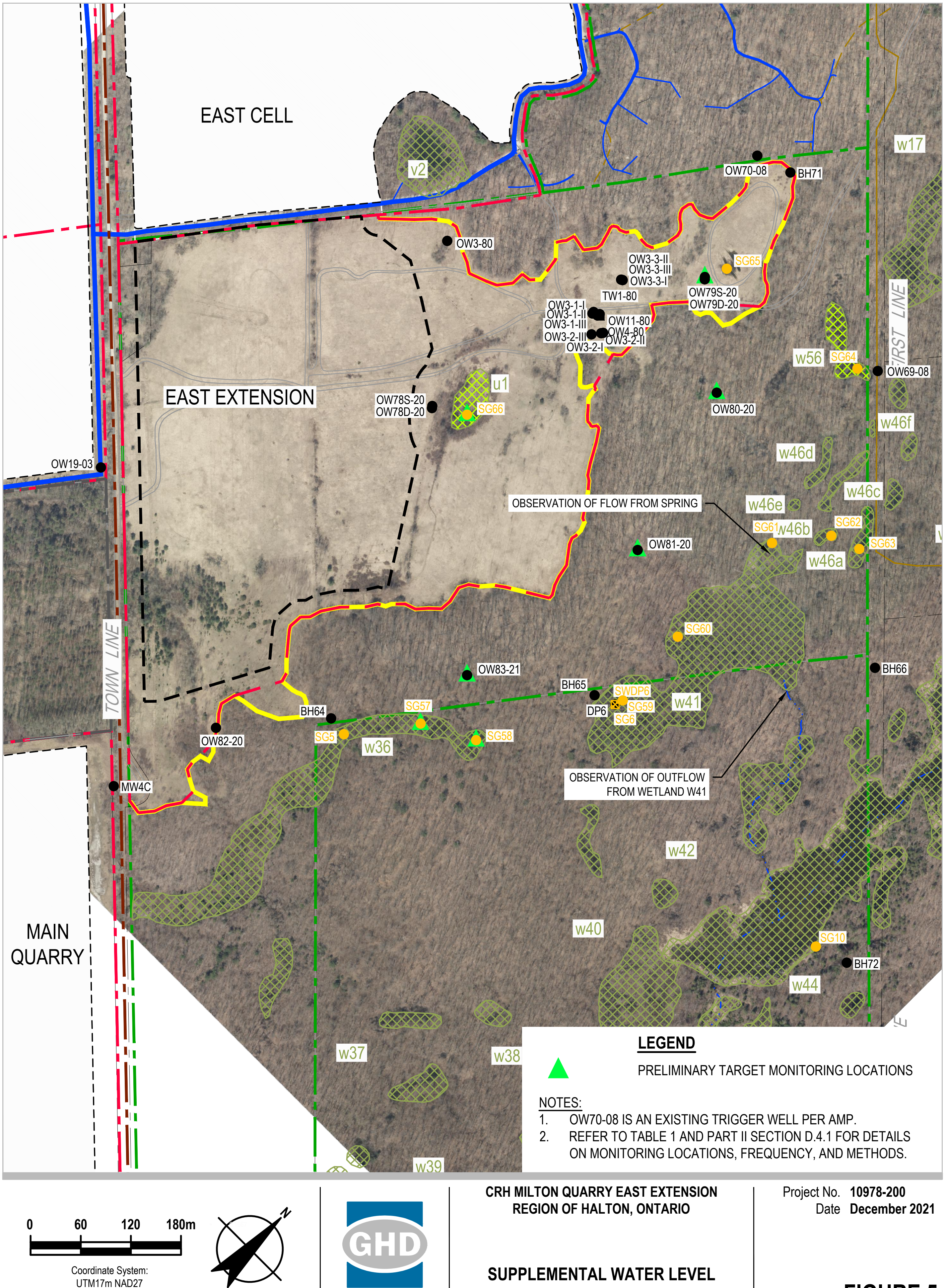
CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

PRELIMINARY PERFORMANCE TARGET MONITORING LOCATIONS

Project No. **10978**
Date **December 2021**

FIGURE 4

Filename: N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(165)\010978(RPT165)GN-WA005.dwg
Plot Date: 07 December 2021 12:43 PM



GHD

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

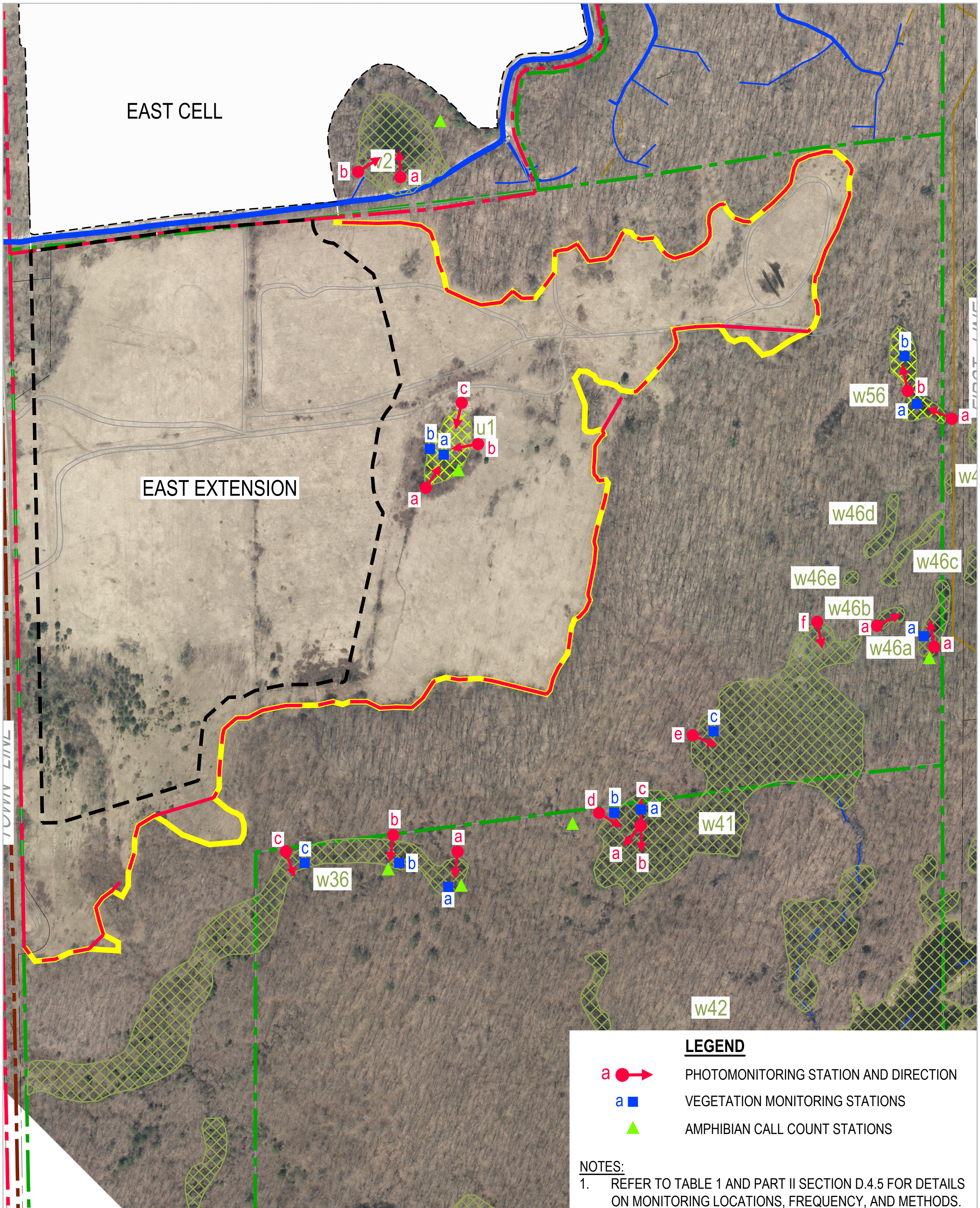
SUPPLEMENTAL WATER LEVEL MONITORING LOCATIONS

Project No. **10978-200**
Date **December 2021**

FIGURE 5

Filename: N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(165)\010978(RPT165)GN-WA006.dwg
Plot Date: 07 December 2021 2:32 PM

Image: 2019 Halton Region Orthoimagery from First Base Solutions.



0 50 100 150m

Coordinate System: UTM17m NAD27

GHD

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

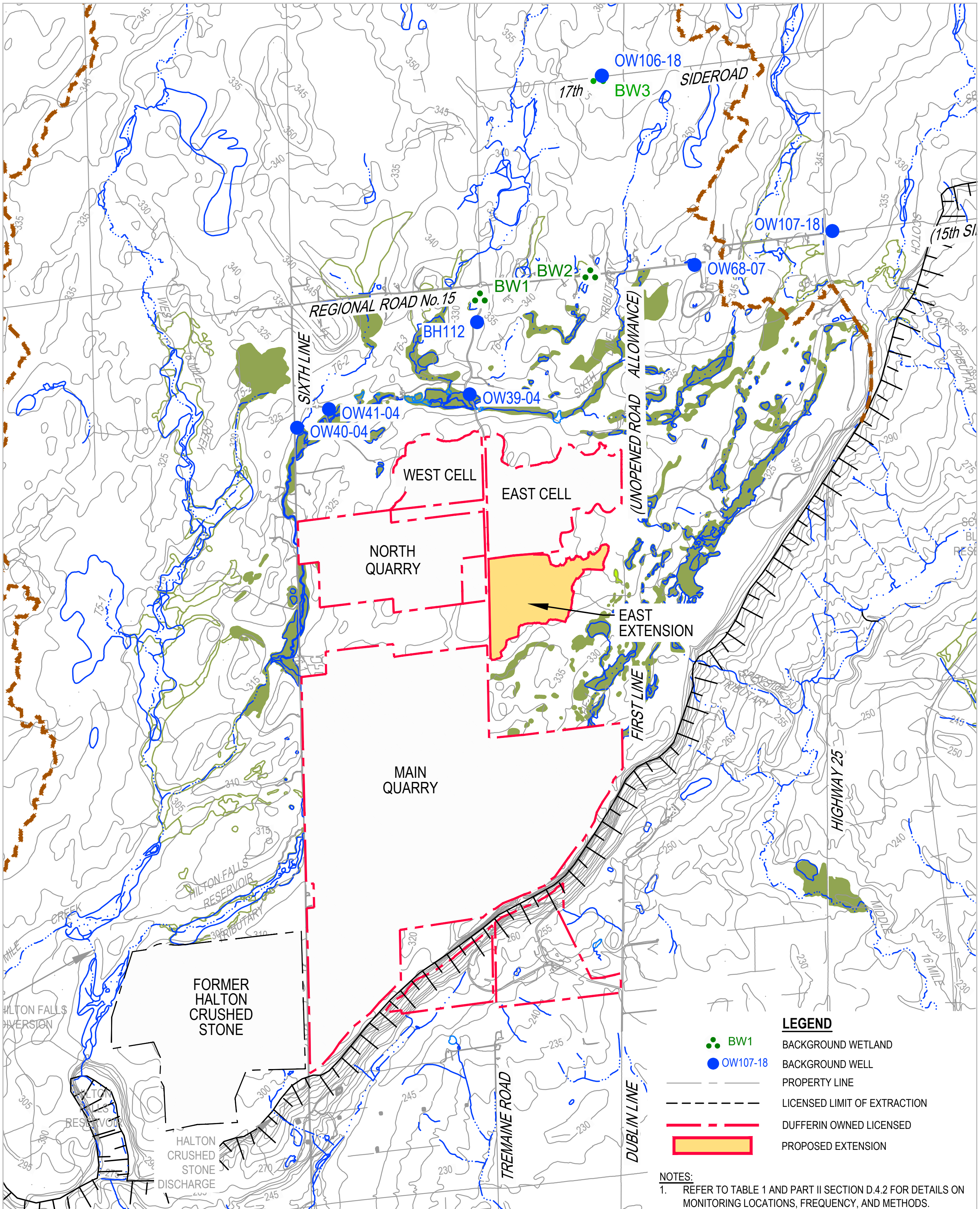
WETLAND ECOLOGY MONITORING NETWORK

Project No. **10978-200**
Date **December 2021**

FIGURE 6

Filename: N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(165)\010978(RPT165)GN-WA008.dwg
Plot Date: 07 December 2021 12:44 PM

Image: 2019 Halton Region Orthoimagery from First Base Solutions.



0 350 700 1050m

Coordinate System: UTM17m NAD27

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

Project No. **10978-200**
Date **December 2021**

BACKGROUND MONITORING LOCATIONS

FIGURE 7

Filename: N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(165)\010978(RPT165)GN-WA007.dwg
Plot Date: 07 December 2021 12:45 PM

Table

Table 1

Summary of AMP Addendum Monitoring
CRH Milton Quarry East Extension
Region of Halton, Ontario

Monitoring Section/Component	Locations	Minimum Frequency
<u>PERFORMANCE MONITORING/RESPONSE PROGRAM</u>[1]		
Water Levels at Trigger Wells and in Wetlands with Targets (Part B Section B.3.1)	Existing wetlands and existing or future wells installed approximately as presented on Figure 4. See preliminary proposed target monitoring locations denoted by a triangle.	**<u>Pre-Extraction</u>** (a) Monthly manual measurements (b) Daily with automated water level recorders at minimum 4 trigger wells and 3 surface water target locations in 2 wetlands **<u>Extraction Period</u>** (a) Transition to weekly when below-water extraction occurs in the MQEE (b) Daily measurements for trigger wells in a potentially affected area from extraction (blasting) within 100 metres of the recharge well alignment on the day after extraction and continuing for 3 business days thereafter (c) If the water level data are available through the WMS SCADA system then manual measurements are reduced to an as-needed basis for verification of instrument accuracy (d) Daily automated water level recorder readings at trigger wells and target surface water target locations **<u>Post-Extraction/Lake Filling Period</u>** (a) Decreasing frequency from weekly, to bi-weekly, to monthly, and ultimately to quarterly, as appropriate. Wetlands to remain at least monthly (b) Extraction Period Item C also applies during this period **<u>Post Lake Filling Period</u>** (a) Continue from the Post-Extraction/Lake Filling Period with an anticipated reduction to monthly or quarterly manual measurements for a minimum duration of 3 years post lake filling then cease if appropriate (b) Extraction Period Item C also applies during this period (c) Contingency for long-term monitoring program if ongoing seasonal recharge is required
Water Quality (AMP Section 3.2)	No additional monitoring needed for MQEE Refer to AMP	--

[1] Refer to corresponding sections of AMP Addendum for detailed information on Performance Monitoring Program

Table 1

Summary of AMP Addendum Monitoring
CRH Milton Quarry East Extension
Region of Halton, Ontario

Monitoring Section/Component	***Locations***	***Minimum Frequency***
SUPPLEMENTAL MONITORING PROGRAM[2]		
Groundwater and Surface Water Levels (Part II Section D.4.1)	i) Selected existing/new groundwater monitoring well locations and surface water locations approximately as presented on Figure 5 ii) Groundwater recharge monitoring wells or recharge wells (refer to Section 4.1) installed in the future	a) Monthly (minimum) b) Recharge monitoring wells should be measured at a minimum frequency similar to the trigger wells (refer to Section 4.1) c) Monitoring at wells may decrease from monthly to quarterly as appropriate in the Post Extraction/Lake-Filling Period d) If data collection is automated with telemetry, manual measurements should be collected on a periodic basis for verification of instrument accuracy, as may be recommended by the instrument manufacturer or based on operational experience e) Continue monitoring for a minimum duration of 3 years post lake filling then cease if appropriate
Background Locations Groundwater and Surface Water Levels (Part II Section D.4.2)	Groundwater: Milton Quarry background monitoring locations BH112, OW39-04, OW40-04, OW41-04, and OW68-07. In addition, existing Acton Quarry background monitoring wells OW106-18 and OW107-18 will be included in the program. Surface Water: Monitoring of Background Wetlands BW1, BW2, and BW3 will also be added to the program. All locations are presented on Figure 7	a) Monthly (minimum) manual measurements until cessation of the supplemental monitoring program b) Daily with automated water level recorders
Meteorological Data (Part II Section D; AMP Section 4.3)	No additional monitoring needed for MQEE Refer to AMP	--

2 Refer to corresponding sections of AMP and AMP Addendum for detailed information on Supplemental Monitoring Program

Table 1

Summary of AMP Addendum Monitoring
CRH Milton Quarry East Extension
Region of Halton, Ontario

Monitoring Section/Component	***Locations***	***Minimum Frequency***
SUPPLEMENTAL MONITORING PROGRAM (cont'd)		
Water Balance (Part II Section D.4.4; AMP Section 4.4)	Consistent with AMP: i) Water levels in the reservoir at the pumping station ii) Water levels in the lake/wetland area in the Main Quarry iii) Water levels in the North Quarry Cell, West Cell and East Cell when post extraction/lake filling has commenced iv) Water flow at the inflow/transfer/outflow points	Consistent AMP: i) "Continuous" with automated water level recorder ii) Weekly (minimum) iii) Weekly (minimum) iv) Totalizing flow meters with weekly readings (minimum)
4.5 Ecological (Part II Section D.4.5)	i) Surface water and groundwater levels at 6 wetlands (U1, W36, W41, W46a, W46b and W56) ii) Photos and general wetland reconnaissance at photographic stations in 6 wetlands (as above) iii) Jefferson Salamander egg mass surveys and amphibian call count surveys in Wetlands U1, V2, W36, W41 and W46a, and iv) Wetland vegetation monitoring in Wetlands U1, W36, W41, W46a and W56	i) Monthly (refer to Sections 3.1 and 4.1, above) ii) Seasonally (refer to Section 4.5) iii) Seasonally (refer to Section 4.5) iv) Annually (refer to Section 4.5)
Residential Well (AMP Section 4.6)	No additional monitoring needed for MQEE Refer to AMP	--

Part II
AMP Addendum
Supplemental Information and Implementation Details

Part II

Sections Index

- Section A – Interim Mitigation Measures and Rehabilitation
- Section B – Establishment and Monitoring of Target Levels
- Section C – Response Action Plan
- Section D – Supplemental Monitoring
- Section E – Reporting

Section A
Interim Mitigation Measures and Rehabilitation

Part II – Section A Interim Mitigation Measures and Rehabilitation

Table of Contents

Figure Index

List of figures

(following text)

Part II – Section A

Interim Mitigation Measures and Rehabilitation

1. Introduction

During the active life of the quarry and lake filling, target water levels in groundwater and 3 wetland pools in 2 wetland areas (Wetland U1 and the upper portion of Wetland W36) will be maintained by interim mitigation measures that will maintain or enhance the associated water resources and related ecological features. The mitigation measures are shown on Part I Figure 2 and are described herein. The target levels are described in Part II Section B. In the event targets are not satisfied, response actions will be implemented as described in Part II Section C. Supplemental monitoring in addition to the water level monitoring at water level target locations is described in Part II Section D.

Mitigation measures consist of the primary mitigation measures and supporting mitigation measures (including routine response actions and contingency measures) that will be taken if the primary mitigation measures are insufficient to consistently achieve the targets (refer to Section 2). The key primary mitigation measures are direct diffuse release or discharge of surface water to 3 wetland pools and recharge of groundwater using wells to the east and south of the MQEE. In general, routine response actions are measures that can be readily implemented if/when the primary measures (as then operating) are not sufficient to continuously maintain target levels. Examples include increasing the recharge flows or adding recharge wells.

Contingency measures are additional measures that are unlikely to be necessary but that can be undertaken if other more routine response actions are not sufficient. In order to take a precautionary approach, a wide range of mitigation measures will be available to support the primary mitigation measures in the event that the monitoring data, changing conditions or new information suggest that the primary mitigation measures are not completely adequate to protect the features. Dufferin will consult with the agencies as appropriate regarding the implementation of additional mitigation or contingency measures.

The AMP process will ensure that targets are achieved by enabling the application of additional interim mitigation measures or refining or adapting the application of the existing measures to ensure the protection of the water-dependent ecological features in each area.

The resulting interim mitigation and water management system will allow for quarry dewatering, mitigation of features, and discharge of excess water. Figure 2 (Part I) shows the planned layout (conceptual design) for the MQEE extension of the existing water management system (WMS), including watermain location, initial control hut and recharge well locations where they are planned for primary mitigation, and the diffuse discharges for Wetland U1 and the upper portion of Wetland W36. Figures A.1 and A.2 herein show the conceptual design layout for the Wetland U1 and Wetland W36 diffuse discharges in more detail. Recharge wells and other mitigation works may also be employed in other areas than shown, as appropriate. Such additional measures/locations would be sited in consultation with a qualified ecologist in a manner sensitive to existing ecological features and in respect of the implementation considerations identified in Section 2.1.

In addition to the discharge features, recharge wells, and connecting piping, the WMS will be operated using the existing long-term (permanent) recharge pumping station at the Main Quarry Reservoir. This pumping station and Reservoir provides a centralized source of water for mitigation. The pumping station also provides a control centre for monitoring and operation of the overall WMS. For reference, the associated components of the WMS located in the existing quarry areas are shown on AMP Figure 1.2).

WMS mitigation and rehabilitation infrastructure is implemented to suit full-time, year-round operations, as necessary, including aspects such as: an "indoor" pumping station, buried watermains (and/or local heat tracing as necessary), firm (redundant) pumping capacity, above grade control/valve huts, remote data access, and alarm capabilities. Temporary works (e.g., above ground piping or manual operation) will only be utilized on a limited duration basis as necessary during system implementation, testing, early operations, modification, seasonal supplementation, maintenance/repairs, etc. consistent with the existing system practices.

The MQEE area will be dewatered in conjunction with the East Cell dewatering using a main sump with local satellite sump/pumping and/or surface conveyance (e.g., ditch/culvert) as necessary. Water from dewatering will be pumped back to the Reservoir for storage and handling, or another excavated quarry cell for lake filling or temporary storage. Excess water will be discharged from the Reservoir to the HFRT as is currently done.

2. Interim Mitigation Measures

The interim mitigation measures required during the active quarry extraction and lake-filling period consist primarily of the diffuse surface water discharges to Wetland U1 and Wetland W36, and groundwater recharge mitigation. Extensive routine response measures and contingency response measures are also available. These measures and their implementation are described further herein.

The interim mitigation measures required during the active quarry extraction period involve the extension of the existing successful mitigation system operating at the Milton North Quarry and Extension Quarry as indicated above. This system expansion will protect and enhance the adjacent Wetland U1 and the upper portion of Wetland W36, and will protect or enhance other wetlands that are located to the east and south from the potential influence of quarry dewatering.

For context, the existing WMS for the Milton Quarry includes:

- A reservoir in the Main Quarry with a total capacity of 5.2 million m^3
- An outfall (gravity or pumped flow) from the Reservoir to the HFRT on the west side of the Main Quarry or to the Lake/Wetland area of the Main Quarry
- A recharge system pumping station on the north side of the Reservoir to feed the recharge well and wetland mitigation system that surrounds the North Quarry, West Cell, and East Cell

- A watermain that extends from the recharge pumping station around the mitigation loop
- Control huts spaced around the mitigation loop to control and monitor flow from the watermain to individual recharge wells and diffuse discharges to wetlands
- Recharge wells located between the extraction limit and the surrounding groundwater resources to maintain groundwater levels at the associated Trigger Well locations
- Diffuse discharges into 3 wetlands to directly maintain their pool water level and hydroperiod at target levels defined in accordance with the AMP
- Trigger Wells located beyond the extraction limits and recharge wells to monitor the groundwater levels. Target water levels are defined for each Trigger Well in accordance with the AMP
- Response and contingency mitigation measures (as needed)
- Quarry dewatering and operations facilities, including: dewatering from the North Quarry, West Cell, and East Cell to the Main Quarry Reservoir (or East Side operations area of Main Quarry)
- Central Sump pumping station to dewater the East Side of the Main Quarry into the Reservoir and to provide water from the Reservoir to the East Side operations area if needed

The mitigation system for the proposed MQEE is a simple extension of this existing WMS as shown on Figure 2 (Part I). The existing Reservoir and recharge pumping station have sufficient capacity to accommodate the extension of the WMS for the proposed MQEE. The specific WMS components that will be required for the MQEE include:

- Diffuse discharges into 3 wetland pools, including Wetland U1 and Wetland W36 (2 separate discharges into 2 pool areas in the upper portion of Wetland W36).
- Recharge wells located to the east and south of the proposed MQEE extraction limit.
- Extension and rerouting of the watermain that is currently in the setback on the south side of the East Cell along the contiguous boundary with the MQEE extraction limit.
- Control huts located along the watermain alignment to service the diffuse discharge and recharge wells with interconnecting water feeder lines.

2.1 Diffuse Discharges into Wetland U1 and Wetland W36

As described in Section 5 of the GWRA and the NETR/EIA, Wetland U1 and Wetland W36 contain seasonal pools with relatively short hydroperiods that are planned to be enhanced by the MQEE mitigation measures. The Wetland U1 pool area is located in an open field. Wetland W36 is in a wooded area and contains 2 pool areas in the vicinity of staff gauges SG57 and SG58 as shown on Figure A.1 and Figure A.2, respectively.

The water regime in the 3 identified pool areas of Wetland U1 and the upper portion of Wetland W36 will be maintained and enhanced through the implementation of the MQEE mitigation measures, specifically the seasonal addition of water with a diffuse discharge from the WMS, similar to that already implemented for Wetlands V2, W7 and W8 adjacent to the East Cell extraction area. This mitigation approach allows the water level to be raised to an optimum high spring water level and to be maintained for a suitably long hydroperiod to support existing and desired ecological functions as described in the NETR/EIA.

Downstream (west) of the SG57 pool area, Wetland W36 exhibits a more channelized character and an absence of surface water. Within the central segment of Wetland W36, there remains a low potential for groundwater interaction with the wetland (downstream of the SG57/SG58 pool areas to the vicinity of SG5). In the area of SG5, only occasional, short-duration water presence has been observed in the past and no water has been observed in 2020 or 2021. In this area the mitigation objective will be to prevent drying of the wetland (e.g., drying of substrate) relative to existing conditions. The adjacent groundwater recharge well system and upstream diffuse discharges will be operated with the goals of preventing MQEE-induced drying and potentially enhancing wetland conditions. During the spring target period, BH64 will be employed as a supplemental monitoring well similar to existing supplemental monitoring locations BH65, BH66, and OW69-08 and the ecological conditions will be evaluated. Refer to Part II Section D for further information on the supplemental monitoring program.

Further west (downstream) of SG5 in Wetland W36, the groundwater level is well below the base of the wetland and there is no potential for groundwater support or discharge to the wetland. Therefore, direct mitigation protection and associated monitoring is not necessary in this area.

The proposed diffuse discharges include a granular bed located in a deeper area of the wetland pool fed by a buried feeder pipe extending from a nearby watermain control hut as shown on Figure 2 (Part I). For Wetland U1, the feeder line from the control hut to the east will approach along the former laneway on the north side of the wetland and enter Wetland U1 from the north as shown on Figure A.1. For the upper portion of Wetland W36, two feeder lines will approach the wetland pools from the north along an old skidder trail as shown on Figure A.2. Further specific implementation details are provided in Section 2.4.

2.2 Recharge Wells

Recharge wells are used to maintain the groundwater levels beyond the extraction limit so as to protect or enhance the water resources and water-dependent natural features (e.g., wetlands). The recharge system is operated to maintain groundwater levels that are at, or above, target water levels at Trigger Wells. Maintaining the groundwater levels in this way ensures the natural or desired flow of groundwater occurs beyond the extraction area to suitably support the water-dependent natural features (wetlands) in the potential area of influence from quarry dewatering.

Recharge wells are planned along the east and south side of the proposed MQEE extraction limit in proximity to the watermain alignment. The watermain is located at a practical distance from the extraction limit on the east side to provide a separation distance between the recharge wells and the actual quarry extraction cell to help limit recirculation of recharge water back into the extraction cell. Recharge wells will be generally located relatively close to the watermain to limit the length of feeder lines but will deviate where it is considered advantageous with respect to recharge effectiveness and suitable subject to ecological considerations. Where possible, recharge wells will be located in open field areas, providing a buffer to the adjacent woodlands; however, in limited instances recharge wells may be advanced into treed areas such as in the area southeast of the proposed MQEE. Any such advance into, or in close proximity to, treed areas will be done under the supervision of Dufferin's ecologist as has been done successfully in the past for the existing WMS.

Figure 2 shows conceptual or preliminary recharge well locations based on predictive analysis, field siting considerations, and practical experience with the existing recharge wells system. The initial installation of the mitigation measures is anticipated to include fewer wells than shown. A sufficient array of initial recharge wells will be installed and verified to be effective prior to extraction below the water table in the MQEE and additional recharge wells will be added as necessary based on the recharge system performance as the extraction (and hence the dewatering influence) advances, increasing the recharge requirement. The ultimate number of wells installed will depend on the actual performance characteristics of the installed network of wells under operating conditions. The recharge system design readily facilitates these enhancements, and they are routinely done now for the existing recharge system.

The recharge wells are designed as open-hole wells that fully penetrate the Amabel Formation to provide broad groundwater support over the entire depth of the Amabel aquifer. Each well is fed from a nearby control hut through a buried feeder line. The recharge well flow will be controlled to maintain recharge that supports a groundwater level that is at, or above, the target level in the nearby trigger wells or associated recharge monitoring wells. The target levels will be established based on existing groundwater levels as well as natural environment considerations, with seasonal and annual variations consistent with the existing target levels at Milton Quarry as described in Part II Section B of this AMP Addendum.

2.3 Watermain Extension and Control Huts

The watermain and control huts facilitate the delivery, control, and monitoring of water pumped from the Recharge Pumping Station in the Main Quarry to the individual diffuse discharges and recharge wells. The existing watermain and control hut network will be extended to encompass the proposed MQEE extraction area as described herein and illustrated on Figure 2.

The existing watermain for the Milton Quarry WMS passes through the setback on the south side of the East Cell. This setback is proposed to be removed (following approval) to allow the MQEE to be extracted as a continuation of the East Cell. Therefore, this watermain must be removed and relocated. The proposed extension of the WMS includes rerouting this watermain from the southwest corner of the East Cell (at the east side of the TownLine road crossing), south along the TownLine setback and around the south and east side of the proposed MQEE extraction area as shown on Figure 2. The detailed design of the WMS extension may result in some variation of this alignment in accordance with the AMP.

On the south side of the proposed MQEE, the watermain is situated within a defined 10-metre wide zone outside the woodland limit and woodland buffer as defined in the Natural Environment Technical Report and EIA, and on the Site Plans. The watermain extends further to the east of the proposed MQEE extraction limit on the east side to increase the separation distance of the recharge wells from the extraction limit. The alignment shown on Figure 2 is based on practical consideration of this separation distance, vegetation, and topography.

The WMS alignment also includes a branch that extends to the east as shown on Figure 2. This branch provides flexibility to facilitate placement of recharge wells in this area to optimize the existing East Cell recharge well network and additional recharge wells required for the proposed MQEE.

The control huts are small building enclosures that allow multiple recharge connections to the watermain. These above ground control huts increase safety and operational efficiency for the recharge system by avoiding the need for below grade equipment that would require confined-space access. Each control hut will allow connection and supply of at least 4 recharge wells or diffuse discharges with associated control and metering of flow and pressure. Consistent with the existing WMS, each control hut will also incorporate a bag-filter system to provide for removal of possible fine particles from the recharge flow that can arise from precipitation and sedimentation processes in the watermain.

2.4 WMS Implementation

The proposed MQEE WMS layout is shown on Figure 2 and the exact routing will be finalized in the field with a qualified ecologist to minimize ecological effects. Following issuance of an ARA licence, Dufferin will finalize the planned alignments for the work zones and will clear and maintain the areas. In addition, existing access and drainage components such as culverts will be maintained consistent with normal land management practices.

This section outlines the various restrictions and design considerations that are recommended with respect to the establishment of the MQEE WMS, with the aim of minimizing negative effects on natural features and functions, and Species at Risk.

2.4.1 General Restrictions and Design Considerations

The following restrictions, best practices and design considerations are recommended for the WMS installation in those areas that are outside of Significant Woodlands, Significant Wetlands and their buffers:

- A qualified ecologist will provide direction to Dufferin staff and contractors, as necessary, with respect to natural heritage features, species at risk, and their protection. Instruction will be provided with respect to "no-go" areas, such as ecological buffers, ecological enhancement areas, etc.
- The limits of the disturbance zones necessary for WMS installation will be clearly demarcated and silt/exclusion fencing will be installed as necessary along the edges of these zones at the outset of installation activity.
- If Bobolink and/or Eastern Meadowlark are confirmed to be present, removal of ground vegetation will be conducted outside of the grassland bird breeding season, i.e., April 1 to August 26. In areas located between Wetland U1 and the adjacent forested areas to the northwest, northeast and southeast, removal of ground vegetation will also avoid the salamander migration period, i.e., March 10 to May 10.
- Watermains and control huts will be implemented outside the Wetland U1 buffer (50 m) and woodland buffer (10 m).

- The watermain will generally be installed within a 10 m wide disturbance zone which will not encroach into the buffers for Significant Woodlands or Significant Wetlands. The access road will generally have a maximum width of 4 m except as required for practical considerations such as corners, slopes, culverts, and areas for equipment access and turnaround. Some additional areas may be required for staging and logistics purposes during WMS installation. All disturbed areas outside of the extraction area will be restored and seeded with a suitable seed mix.
- Control huts will be designed and located to minimize the overall number and footprint of huts to the extent practical. Typically, each hut will facilitate connection of at least four recharge wells or diffuse discharges. Additional huts may be added if necessary, in a particular circumstance; however, the proposed network is considered generally adequate for anticipated conditions. Exterior lighting for huts will be minimized and use motion activation.
- Temporary disturbance for feeder line installation will generally be limited to a 5 m wide zone, although some exceptions may apply in order to increase efficiency of feeder line installation in open areas. The disturbed areas will be restored and allowed to regenerate such that, over time, it will be difficult to identify where feeder lines were buried. Restoration may involve placement of 15 cm of fresh wood chips or seeding with a suitable seed mix.
- Recharge wells will be established to have a minimal practical area, typically disturbing approximately 25 m^2 or less during installation. Silt fencing will be installed as necessary, to contain rock cuttings during drilling operations.
- Tree clearing, where required, will be conducted outside of the bird breeding season and bat active period, i.e., no tree-clearing from April 1 to October 31.
- Trees that are cut to clear the extraction area and the WMS footprint will be salvaged for ecological enhancement and rehabilitation purposes. Branches will either be cut up to make small brush piles or chipped for use in the restoration of WMS feeder lines. Logs will be cut up into 1.0 m to 1.5 m lengths and placed in various ecological enhancement areas.
- Weathered rocks will be salvaged from fence lines and stone piles within the area to be disturbed/extracted. The salvaged material will be used to create habitat features for small wildlife, as well as for the diffuse discharges.
- Areas disturbed during WMS installation will be seeded with a suitable native seed mix.

2.4.2 Significant Woodlands, Significant Wetlands and Buffers – Restrictions and Design Considerations

The following restrictions, best practices and design considerations are recommended for the WMS installation within Significant Woodlands, Significant Wetlands and their buffers:

- Temporary disturbance for feeder line installation will be limited to a 5 m wide zone. The disturbed areas will be restored and allowed to regenerate such that, over time, it will be difficult to identify where feeder lines were buried and where diffuse discharges and recharge wells are located.
- The limits of the 5 m disturbance zones will be clearly demarcated and silt/exclusion fencing will be installed along the edges of these zones prior to the installation of feeder lines, recharge wells and diffuse discharges.

- The existing grades within woodlands and wetlands will be preserved as much as possible.
- The duration of disturbance will be minimized within natural heritage features.
- Tree clearing, where required, will be conducted outside of the bird breeding season and bat active period, i.e., no tree-clearing from April 1 to October 31.
- Timing of the installation of diffuse discharges, recharge wells and their feeder lines will be scheduled to avoid critical ecological periods, i.e., breeding periods for amphibians and birds, between March 10 to August 26. Installation of diffuse discharges should occur when water levels are low or features are dry, i.e., between August 26 to February 28.
- Trees that are cut to clear the WMS footprint will be salvaged for ecological enhancement purposes. Branches will either be cut up to make small brush piles or chipped for use in the restoration of WMS feeder lines. Logs will be cut up into 1.0 m to 1.5 m lengths and placed on the forest floor.
- Weathered rocks within the 5 m disturbance zone for feeder lines will be carefully placed on the adjacent forest floor or used for the diffuse discharges.
- Diffuse discharges (perforated pipe in stone bedding) will be established to have a minimal practical area, typically covering approximately 5 to 10 m^2 or less. In each location the diffuse discharge will be field fit to suit the wetland topography and minimize the footprint to the greatest extent practical while providing the intended mitigation function.
- Recharge wells will be established to have a minimal practical area, typically disturbing approximately 25 m^2 or less during installation. Silt fencing will be installed as necessary, to contain rock cuttings during drilling operations.
- Prior to working in sensitive areas, equipment will be sufficiently cleaned following applicable protocols to ensure invasive plant species are not introduced to an area.
- Fresh wood chips (minimum 15 cm deep) will be placed along the backfilled feeder line routes to prevent the spread of invasive plant species and the areas will be allowed to regenerate. Wood chip placement may occur following removal of silt/exclusion fencing.
- Where appropriate, a suitable native seed mix will be used along the edges of the feeder line routes. Seeds collected from suitable native species in the local landscape may also be utilized.
- WMS components will be designed with consideration for aesthetics, including the incorporation of available weathered stone and woody debris at diffuse discharge locations.
- Areas within the wetlands, woodlands, or their buffer zones that are temporarily disturbed by mitigation will be rehabilitated in accordance with recommendations from a qualified ecologist.

2.5 Automation and Real-Time Data Collection

Mitigation water flows (e.g., diffuse surface water discharges and groundwater recharge wells) will be automated to the extent practical so that flows are controlled (and/or alarmed) based on real-time monitoring control data. The control data will be from target level monitoring locations (Wetland U1, upper portion of Wetland W36, and trigger wells) or suitable alternate operational monitoring locations (e.g., recharge monitoring wells).

All control monitoring locations that can practically connected will be designed to provide real-time data communication with the water management operation control SCADA system[1]. Automation will be implemented in stages consistent with the existing WMS approach as operating experience and technology develops.

2.6 Potential Response and Contingency Mitigation Measures

In the event that a need is determined for mitigation measures beyond those planned or currently in operation, various routine response actions and contingency response measures are available, including (but not limited to) the following. These measures are essentially the same as those identified in the AMP.

- Increasing or adjusting recharge flows to individual recharge wells or diffuse discharges
- Increasing flow to recharge system by increasing flow (pressure) from recharge pumping station
- Refurbish or replace existing recharge wells or diffuse discharges that are not performing adequately
- Adding recharge wells (including possible use of inclined recharge wells) or diffuse discharges to planned areas
- Additional monitoring (e.g., additional water level monitoring locations or ecological monitoring) to further characterize conditions and evaluate potential changes to target levels and/or mitigation operation (including further automation)
- Increasing capacity of recharge system (e.g., adding control huts, feeder lines, twinning of trunk watermain, pumping station upgrade)
- Modify blasting activities in close proximity to recharge wells to minimize local effects of blast-induced fracturing beyond the quarry face
- Consider other possible means of supplying water to affected features (e.g., alternate recharge system alignment, recharge ponds, diffuse discharge to other wetlands, or other means)
- Localized grouting of high permeability bedrock feature
- Hydraulic buttress implementation
- Temporary or longer term cessation of bedrock extraction below the water table in an affected area

The need to initiate supporting response actions or contingency mitigation measures will be determined based on monitoring of the target water levels, supported by the supplementary monitoring of the ecological features themselves. The list of potential measures above is presented in the general mitigation order of consideration (first to last). Other Site-specific applications or refinements of these mitigation measures may be developed, or alternative measures identified for implementation.

1 SCADA system refers to a computerized Supervisory Control and Data Acquisition system.

The identification and selection of appropriate measures will consider various factors such as:

- The characteristics of the water resource/ecological feature
- The associated hydroperiod sensitivity
- The feasibility of the measure in the particular circumstance
- The anticipated effectiveness in the particular circumstance
- The goal of avoiding or minimizing potential direct impacts or other negative effects to ecological features and functions

The decision to implement specific measures will be done in accordance with the Response Acton Plan (Part II Section C) and in consideration of these factors with the goal of providing effective mitigation and avoiding or minimizing potential direct impacts or other negative effects to ecological features and functions. The assessment of non-routine alternatives would include a “no further action” alternative to ensure a balanced consideration of potential risks. It is recognized that some measures may require further agency consultation (and/or approval) prior to implementation.

3. Rehabilitation Measures

As described in the GWRA, the proposed MQEE rehabilitation plan is an extension of the existing comprehensive Milton Quarry rehabilitation plan. This plan includes the passive support of the surrounding groundwater level with a lake, the support and enhancement of the adjacent wetland U1 and the upper portion of Wetland W36 through the seasonal use of the interim diffuse discharge mitigation, and the potential seasonal contingency use of a limited portion of the recharge well system in combination with the East Cell requirements. The planning and natural environment aspects of the plan are described in the Natural Environment Technical Report and EIA, and the Planning Summary report.

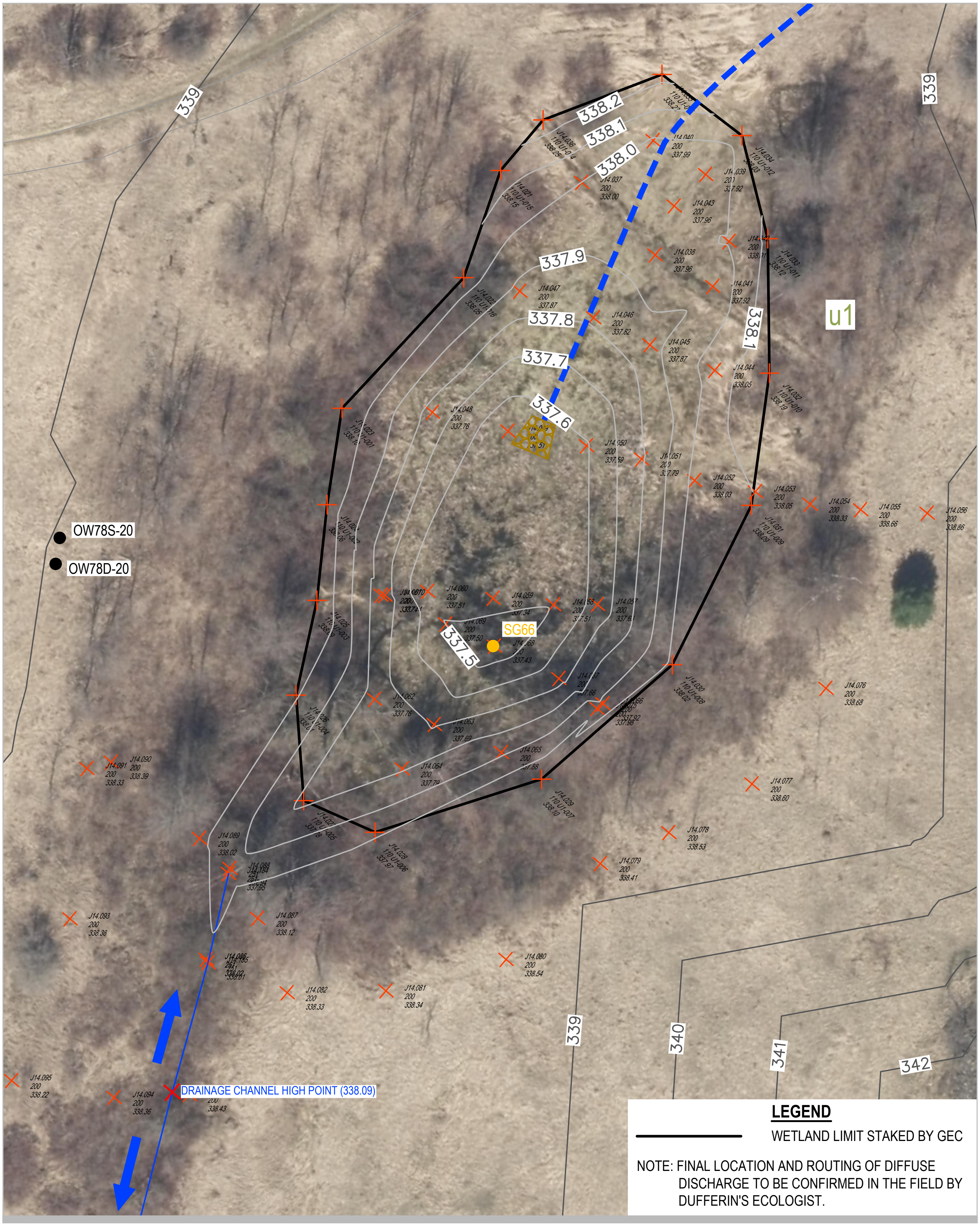
The created East Cell/MQEE lake will have an elevation of approximately 333 m AMSL. This is the approved lake level for the East Cell and is suitable for the proposed extension of the lake into the MQEE area. The AMP and AMP Addendum include provisions to review, and refine if warranted, the lake level prior to final rehabilitation.

The lake level will passively support the groundwater levels to the south and east of the proposed MQEE through the quarry walls exposed to the lake as well as any leakage through fill material placed in the lake area. The strategic placement of the fill as planned, the generally permeable nature of the quarry walls, and the Amabel aquifer allow the lake level to suitably support groundwater levels as described in the GWRA.

The proposed diffuse discharge system will continue to be used on a seasonal basis to maintain the optimum water regime in Wetland U1 in support of natural environment conditions. This operation would be similar to the long-term operations approved for Wetlands V2, W7, and W8 as part of the existing Milton Quarry requirements and approvals.

Also similar to the existing Milton Quarry, the passive groundwater level support provided by the lake may not result in the optimum high seasonal groundwater levels in the spring relative to the natural environment functions of the nearby wetlands. Furthermore, the location of the proposed MQEE recharge wells provides for advantages to some of the existing recharge well locations associated with the East Cell and may benefit the operational effectiveness of any contingency recharge wells operations that may be required for the existing quarry rehabilitation. Therefore, it is proposed to consider potential seasonal recharge well operation of some of the MQEE recharge wells. The need for any such operations would be very limited in terms of the seasonal duration, number of wells, and recharge flows relative to the requirements during the interim extraction and lake filling period.

Monitoring programs will be required during the quarry filling period and for the long-term following final rehabilitation to both ensure the protection of water resources and to assist in managing the lake filling and control. Following lake-filling activities, the WMS will be adapted, as needed, from interim conditions to long-term rehabilitation conditions, in accordance with the final rehabilitation plan.



0 5 10 15m

1:500

Coordinate System: UTM17m NAD27

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

Project No. **10978**
Date **November 2021**

WETLAND U1 DETAILS

FIGURE A.1

Filename: N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(165)\010978(RPT165)GN-WA002.dwg
Plot Date: 18 November 2021 3:45 PM

0 10 20 30m

Coordinate System:
UTM17m NAD27

N

GHD

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

WETLAND W36 DETAILS

Project No. 10978-200
Date November 2021

FIGURE A.2

Filename: N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(165)\010978(RPT165)GN-WA003.dwg
Plot Date: 18 November 2021 9:47 AM

Image: 2019 Halton Region Orthoimagery from First Base Solutions.

Section B
Establishment and Monitoring of Target Levels

Part II – Section B Establishment and Monitoring of Target Levels

Table of Contents

Figure Index

List of figures

(following text)

Part II – Section B

Establishment and Monitoring of Target Levels

1. Introduction

The establishment and monitoring of target water levels for the MQEE will follow the same approach used for the existing quarry as required by the AMP. The current AMP requirements for groundwater level targets at trigger wells are documented in Section 3.1 through Section 3.1.4 and Appendix A of the AMP. The current AMP requirements for surface water level targets are documented in Appendix C, Sections 3.1 through Section 3.3 of the AMP.

These applicable target level requirements are reproduced herein with minor modifications to suit the specific MQEE conditions. The principal modifications made in the following, include:

- Specification of proposed target water level monitoring locations (i.e., trigger wells and wetland staff gauges) for the MQEE
- Specification of minimum baseline monitoring requirements and procedures for historical water level data analysis
- Update of monitoring frequency to match current operating experience and instrumentation
- Use of only “wetland target levels” for trigger wells as there are no MQEE trigger well locations corresponding to the AMP “creek target level” designation

The groundwater level target requirements are presented in Section 2 and the surface water target requirements are presented in Section 3. Information on the response requirements associated with the target levels is provided in Part I Section 5 and Part II Section C.

2. Groundwater Target Levels at Trigger Wells

The MQEE uses the same approach of maintaining target water levels at trigger monitoring wells as is presently used for the existing quarry. As discussed in Section 1.2 of the AMP and in the GWRA for the MQEE (Section 9), the principal performance basis for the protection of water resources is to maintain suitable groundwater levels at trigger wells. Maintaining these operating target groundwater levels at the series of trigger wells will maintain the groundwater levels beyond the trigger well alignment, thereby protecting the water resources from potential dewatering influences. Refer to Section 3 regarding protection of Wetland U1 and Wetland W36, as well as Part II Section D regarding the supplemental monitoring program.

The trigger wells will be located between the limit of extraction and the limit of the water-dependent ecological features (wetlands) that are to be protected from quarry influences. Routine monitoring of trigger well water levels will be conducted at the frequency described in Section 2.2.

The groundwater recharge system will be operated to generally maintain the groundwater levels at or above the target operating levels (Section 2.3). Trigger well water levels which drop below the target levels will "trigger" the modification of groundwater recharge activities in the affected area. The target values will be set as long-term, operating target values, not as short-term "minimum threshold" values. That is, the target levels will reflect "average" conditions for various times of the year and will be above the "minimum" level recorded in each monitoring well over time. Therefore, minor water level variations below (or above) the target operating levels are not a short-term concern given the wide range of natural variation in water level above and below the target levels, as discussed in Section 2.3.

The principal response actions available to maintain the target levels are described in Part II Section A. Ongoing monitoring of the trigger wells will be used to provide confirmation that the target levels are being maintained (or identify that further response action is required).

In accordance with the response action framework presented in Part II Section C, the "minimum" water levels will be utilized to define when shortened response times are required (i.e., Red Zone). Minimum levels will be calculated as described in Section 2.6.

Target water levels will be determined using all available valid water level data for the applicable monitoring period and monitoring wells (erroneous measurements will be excluded). Water levels measurements and target/minimum level calculations will be recorded to an accuracy of 1 centimetre (cm).

The target and minimum water levels will be established based on water level data prior to extraction commencing in the MQEE as described in Section 2.3. All of the proposed trigger well locations shown on Figure 2 were installed with instrumentation for continuous data collection by February 2021 or earlier. The collected data will be incorporated in the assessment of appropriate target and minimum water levels as will be presented in the Pre-Extraction Report (refer to Part II Section E).

2.1 Trigger Well Locations

The trigger wells will be installed between the extraction limit and the natural water resources features (wetlands) that are to be protected. The trigger well locations form an alignment located approximately parallel to the extraction perimeter as shown by the proposed trigger well locations presented on Figure 2. Preliminary locations have been proactively installed by Dufferin to facilitate the collection of as much pre-extraction baseline monitoring data as feasible. Well installation information is provided in the GWRA (Section 3).

Adjustments to the trigger well locations may occur prior to the finalization of target levels and will be submitted to the Agencies for review prior to extraction below the water table in the MQEE. The current well locations were sited to optimize site characterization information and are somewhat further (approximately 150 m) from the recharge alignment than typical (approximately 50 to 100 m) as the recharge alignment was subsequently selected to minimize disturbance to Significant Woodlands. The total number of trigger wells and their approximate spacing is not anticipated to change; however, alternate trigger wells may be installed closer to the recharge alignment based on the results of the WMS design and verification program. This is consistent with the accepted approach employed for the establishment of the existing quarry monitoring network. Final trigger well locations and baseline target levels will be submitted to the Agencies for review in the Pre-Extraction Report prior to below water extraction in the MQEE.

If additional or replacement trigger wells are needed in the future, the specific locations and installation methods for new trigger wells will be determined by Dufferin's hydrogeological and ecological consultants in consultation with the agencies based on in-field conditions.

2.2 Monitoring Frequency

The following specifies the minimum groundwater level monitoring frequency at trigger wells for different time periods/events. Actual conditions may result in a higher frequency of monitoring or be used to demonstrate that a lower frequency is appropriate[1].

Pre-Extraction

- Monthly manual water levels
- Automated “continuous” water level recorders (e.g., pressure transducers and data loggers) to be installed in each trigger well to collect water level readings at least daily

Extraction Period

- Minimum manual water level frequency as follows:
  - Weekly following commencement of extraction below the water table within the MQEE extraction limits.
  - If the water level data is available through the WMS SCADA system, weekly manual water levels will not be required; however, measurements should still be collected on a periodic basis for verification of instrument accuracy.
  - Monitoring subsequent extraction within (approximately) 100 m of the recharge alignment will be completed on the day following extraction and continuing for the following 3 business days. Manual monitoring will not be necessary if automated data is available through the WMS SCADA system.
- Automated “continuous” water level recorders (e.g., pressure transducers and data loggers) will be installed in each trigger well to collect water level readings at least daily. The transducer reporting to the WMS SCADA system can be used to satisfy this requirement so long as the level is recorded at least daily.

Post-Extraction/Lake Filling Period

- Manual measurement frequency will decrease from weekly, to bi-weekly (i.e., once every 2 weeks or twice per month), to monthly, and ultimately to quarterly as appropriate.

1 In the event that the minimum frequency is not satisfied due to equipment failure, erroneous reading, or other issues, the operator will review the situation, collect supplemental measurements if warranted, and document lessons learned in the annual monitoring report.

- Manual measurement frequency may be reduced if water levels are available through the WMS SCADA system. Manual measurements should still be collected on a periodic basis for verification of instrument accuracy.
- Automated "continuous" water level recorders (e.g., pressure transducers and data loggers) will be installed in each trigger well to collect water level readings at least daily. The transducer reporting to the WMS SCADA system can be used to satisfy this requirement so long as the level is recorded at least daily.

<u>Post Lake Filling Period</u>

- The monitoring frequency will continue from the post-extraction/lake filling period with an anticipated reduction to monthly or quarterly manual measurements.
- Manual measurement frequency may be reduced if water levels are available through the WMS SCADA system. Manual measurements should still be collected on a periodic basis for verification of instrument accuracy.
- Monitoring will occur for a minimum period of 3 years following completion of lake filling. The need for any follow-up monitoring will be assessed at that time.
- In the event that long-term seasonal groundwater recharge is required for protection of the eastern wetlands, a specific monitoring program will be developed based on the mitigation and monitoring conditions and needs at that time.

2.3 Target Levels

The recharge well flow will be controlled to maintain recharge that supports a groundwater level that is at, or above, the target level in the nearby trigger wells. The target levels will be established based on existing groundwater levels prior to extraction below the water table within the MQEE. The targets will be based on representative long-term baseline average water table conditions consistent with the target level approach for the existing quarry under the AMP. If less than 3 years of monitoring data is available, the target level determination will combine recent water level data with older data from background and other monitoring well data to develop surrogate historical baseline data similar to that derived for the existing quarry.

The protocol for establishing target levels is presented in Section 2.3.1. The targets will be adjusted on an annual basis to reflect changes in climatic conditions. These adjustments will be made using the data collected from background monitoring wells and the protocol presented in Section 2.3.2.

2.3.1 Protocol for Setting Target Levels

Consistent with the AMP, the target levels will be defined for each of four unequal periods of the year based on the natural variation in groundwater levels and associated ecological dependencies during those periods (i.e., four target levels per year for each trigger well). These periods approximately correspond to the four seasons of the year as follows:

- Winter: January – March
- Spring: April – June

- Summer: July – August
- Fall: September – December

The target operating levels for each period will be calculated from the 3 years of baseline data collected (measured or surrogate) prior to extraction. The target levels will generally be determined as the average water level during each period (from the 3 years of data).

The target levels are defined as the desirable minimum water levels that are to be maintained at the trigger wells as discussed in Section 2.1. Actual operating water levels at the trigger wells will generally be at or above the target levels. Small, short-term fluctuations in trigger well water levels below the target levels (i.e., days to weeks) will not create any noticeable adverse ecological effects; however, such fluctuations below the target levels will be taken as triggers to initiate response action.

Actual groundwater levels at trigger wells will vary over time due to two principal factors in addition to variations associated with the defined target levels (i.e., four periods per year). First, somewhat random variations will occur over the shortest term due to natural changes in climatic conditions (e.g., precipitation/infiltration events), as well as routine operating conditions for quarry extraction and recharge system adjustments and maintenance. These variations will be at levels which are generally at/above the target level resulting in the long-term supply of somewhat more groundwater flow (discharge) than would occur under natural conditions. Second, target levels will be adjusted annually to reflect natural changes in climatic trends and groundwater levels (refer to Section 2.3.2).

All target levels related to the MQEE area correspond to the “wetland water level targets” for trigger wells described in the AMP. These target levels reflect groundwater levels that are associated with wetlands, including the reliance upon elevated spring groundwater level conditions to support spring wetland levels. Refer to Section 3.1.3.1 of the AMP for further discussion of the wetland trigger well target levels. There are no trigger wells for the MQEE that warrant the use of “creek water level targets” as described in the AMP for areas adjacent to Sixth Line Tributary.

2.3.2 Transition Between Target Level Periods

As described in the AMP, there will be a gradual transition between the target level periods as the groundwater flow adjusts to changes in the recharge system operation as well as climatic conditions. The transition period is initially planned to be 2-weeks in duration and to occur approximately equally over the end/beginning of the proceeding/following target level periods. The transition from spring to summer will occur starting at the beginning of the summer period to ensure water levels are maintained through the later part of June into early July. To protect the overall water balance, this lagged decline in water levels will be offset by an earlier change for the summer-fall transition.

Two refinements relating to the transition periods have been implemented for the existing quarry to account for variability in climatic conditions at the time of transition and will also apply to the MQEE trigger wells. These climate-dependent transitions for the fall to winter transition and spring to summer transition are documented in the Pre-Extraction Report – Phase 2 Extension (GHD, 2011) and in the 5-Year AMP Review (GHD, 2020) and are described further below.

The standard target level methodology established herein and in the AMP results in artificially high target levels in early winter (January/February) because of the averaging periods used to establish target levels. Natural groundwater levels are typically relatively low in January and February and then increase significantly in March (or April) with the onset of the spring freshet. The winter target levels, established by averaging background water levels over the period of January through March, are therefore typically significantly higher than natural water levels would be early in the winter period because March groundwater levels are included in the average.

The use of an artificially high target level in early winter can require a significant water level increase during the fall/winter transition period at a time when there is no significant natural recharge contribution from precipitation or snowmelt. Because this transition may be difficult to achieve in a 2-week period, and because the artificially high target level is not a minimum or lower limit level needed to prevent an undesirable ecological effect, it is appropriate to lengthen this transition period to provide more time, consistent with climatic conditions, for the recharge system to more practicably achieve the higher winter target level. The full complement of the requirements of the AMP and the transition period refinement described herein ensures the associated features are protected during the transition period. The following refinement was established for the existing quarry AMP and applies during the fall-to-winter transition period:

- The transition period will begin approximately 2-weeks before the end of the fall period
- Recharge flows will be substantially increased, suitable to achieve increasing trigger well groundwater levels during the following transition period - i.e., start appreciably raising groundwater levels in an effort to attain the higher target
- The transition period will continue until the actual groundwater level in the background well(s) is observed to increase to the equivalent target level for the background well (indicating a natural recharge event) and for 2-weeks thereafter
- The winter period minimum level will apply after January 1
- In the event that the fall-to-winter transition can be readily achieved within the previously identified 2-week period, the above refinements should not be applied for the related trigger wells

Similarly, a spring-to-summer transition refinement has been established for the existing quarry AMP to provide further operational flexibility if climatic support in the spring ceases earlier than, or is less than, typical. The following applies to the spring-to-summer transition period:

- The potential for an early transition and commencement thereafter will be identified if the May groundwater level in the background well(s) is observed to be below average. All available background well data indicates that May conditions are an excellent predictor for June conditions, particularly when conditions are dry (i.e., below average/dry conditions in June can be predicted or identified ahead of time based on the May water level).
- A below average May water level, as observed in the background well, will trigger a modified spring-summer transition period for the associated trigger wells for that calendar year. The modified transition will apply from the water level measurement date (mid-May) to the end of June.

- All reasonable and practicable efforts will continue to be implemented using available installed WMS infrastructure to sustain the spring target level through the normal end of the target period, including operating associated recharge wells at their maximum effective capacity. It is anticipated that in most situations it will be possible to fully maintain the target level or a water level very close to the target level.
- No intentional lowering of recharge rates will take place prior to the end of the spring target period (i.e., until the standard summer target level transition - one week before the end of June for creek targets and at the end of June for wetland targets). No change from current practices.
- The spring period minimum level and associated AMP Addendum "Red Zone" requirements will continue to apply as normal (Refer to Part II Section C for information regarding the “Red Zone” requirements).
- Subsequent confirmation of the dry spring condition will be provided through routine (mid-month) monitoring at the background well in June. If the observed May water level was not below average but the June water level is below the June average, the transition period will be immediately initiated along with the other conditions listed above.

The transition plan/period will be further refined if warranted depending upon observed conditions prior to and following commencement of recharge system operation. Any planned modifications will be documented in the annual monitoring report for agency review.

2.3.3 Protocol for Adjusting Target Levels

Consistent with the AMP, the target levels will be adjusted on an annual basis to account for natural (background) trends in climatic and groundwater conditions using the same methodology as the other existing quarry trigger wells. These annual adjustments will allow the mitigation measures to incorporate or reflect shorter-term variations as well as any long-term trends in climatic conditions.

Normal adjustments to target levels will be made based on background monitoring wells installed by Dufferin, as discussed in Part II Section D. Following each year of extraction, the target levels will be adjusted based on the change in the 3-year running average in the background well target levels for each of the target periods. The change in the 3-year average will be applied by prorating any change observed in the background wells to the trigger well water levels. This prorating will be based on the ratio of the natural range of fluctuation in the background well to the natural range of fluctuation in the trigger well observed during the pre-extraction monitoring period. The adjustments will be calculated and applied on a per period basis - i.e., four periods per year as previously defined. A summary of calculation steps and example adjustments are provided in Table 3.2 and Appendix A, respectively, of the AMP.

The system of setting/adjusting target levels will not explicitly reflect very short-term conditions and individual extreme years as these are generally stressors on the wetlands. Reducing/removing these short-term stressors and providing more continuous levels of groundwater discharge will generally serve to enhance ecological conditions. The supplemental monitoring described in Part II Section D will be used to help ensure that the operation of the mitigation measures is adequately protecting water resources. In the event that other considerations or concerns are identified, the procedures defined herein will be amended and will be documented in the annual monitoring report for agency review.

2.4 Minimum Water Levels

Consistent with the AMP, the minimum levels will be determined for each of the four seasons (i.e., same seasons as those for the target water levels). The level for each season will be equal to the lowest water level at the trigger well for the available monitoring period at that trigger well before extraction commences below the water table in the MQEE (refer to Section 3.1). This period will include a long-term baseline based on measured and surrogate baseline water level data as described for target levels in Section 2.3.

The minimum level will be reduced for climate variations if lower background water level conditions are identified in the future. This assessment will be based on an annual assessment of background monitoring data similar to the target water levels (i.e., by making a pro-rated change similar to the target level adjustments). In the event of particularly low background levels, the adjustment of the minimum level may be performed during the current year. Any such adjustments that are made during the operating period will be immediately communicated to the agencies. The term "verified minimum level" will refer to the minimum seasonal water level for a trigger well which has been adjusted using the current background monitoring data.

In the event that a trigger well is replaced or a new trigger well is added, the appropriate historic low water level for the new well will be estimated based on available information for nearby monitoring wells and the historical data for the old well (if applicable), including surrogate data as suitable.

3. Surface Water Target Levels at Wetland U1 and Upper Wetland W36

The MQEE uses the same approach of maintaining target water levels in wetland pools in Wetland U1 and the upper portion of Wetland W36 as is presently used for the existing quarry (Wetlands W7, W8, and V2). The performance monitoring for protection of Wetland U1 and the upper portion of Wetland W36 is based on maintaining the desired seasonal water level regime within the wetlands. It is planned to target a water level regime to maintain a deeper spring pool depth and longer hydroperiod than currently occurs. This water level regime will result in enhancement of the wetland features and functions relative to the current conditions, as described in the Natural Environment Technical Report and EIA.

The water level in the targeted pools will be maintained, as necessary, by the addition of water through diffuse discharges similar to those successfully employed for the existing quarry at Wetlands W7, W8, and V2. The direct addition of water to the wetlands will automatically control the water level to correspond to the seasonal target level. Therefore, monitoring activities are limited and serve only to confirm that the system is performing appropriately and to assist in implementing appropriate response measures in the event that the target level is not being maintained.

3.1 Monitoring Location

The surface water level monitoring is currently undertaken at staff gauges installed in the lowest area of each wetland pool. The current monitoring location for Wetland U1 is SG66 as shown on Figure B.1. Monitoring of the targeted pools in the upper portion of Wetland W36 is currently accomplished through instrumentation of the two pools at the top of the wetland by similar means. The staff gauges currently monitored are SG57 and SG58 (downstream/westerly and upstream/easterly, respectively).

It is anticipated that in conjunction with the diffuse discharge installation, stilling wells will be connected to each wetland and remote monitoring through the SCADA system will facilitate water level control, as is the case with existing on-Site Wetlands V2, W7, and W8. Monitoring of the staff gauges for water level measurement will become redundant and may cease following verification of stilling well performance. Stilling well performance and sensor calibration should be re-verified at least annually following spring thaw if water level monitoring ceases at the staff gauges.

3.2 Monitoring Frequency

The following specifies the minimum surface water level monitoring frequency Wetland U1 and the upper portion of Wetland W36 will be monitored at the minimum surface water level monitoring frequency described below during the typical anticipated hydroperiod (mid-April to August)[1]. Actual conditions may result in a higher frequency of monitoring or be used to demonstrate that a lower frequency is appropriate. In general, less frequent monitoring may occur in the fall and winter based on climatic conditions. Transducers (automatic water level recording) are not required during potentially frozen pond conditions (typically December to March, depending on the year).

Pre-Extraction

- Monthly manual water levels.
- Automated "continuous" water level recorder (e.g., pressure transducer and data logger) to be installed to collect water level readings at least daily during spring and summer.

Extraction Period (following extraction below the water table within the MQEE

- Monthly manual water levels.
- If the water level data is available through the WMS SCADA system, monthly manual water levels will not be required; however, measurements should still be collected on a periodic basis for verification of instrument accuracy.
- Automated "continuous" water level recorder (e.g., pressure transducer and data logger) to be installed to collect water level readings at least daily during spring and summer. The transducer reporting to the WMS SCADA system can be used to satisfy this requirement so long as the level is recorded at least daily.

Post-Extraction/Lake Filling Period

- Monthly manual water levels.

- If the water level data is available through the WMS SCADA system, monthly manual water levels will not be required; however, measurements should still be collected on a periodic basis for verification of instrument accuracy.
- Automated "continuous" water level recorder (e.g., pressure transducer and data logger) to be installed to collect water level readings at least daily during spring and summer. The transducer reporting to the WMS SCADA system can be used to satisfy this requirement so long as the level is recorded at least daily.

Post Lake Filling Period

- Monthly manual water levels.
- If the water level data is available through the WMS SCADA system, monthly manual water levels will not be required; however, measurements should still be collected on a periodic basis for verification of instrument accuracy.
- Monitoring will occur for a minimum period of 3 years following completion of lake filling. The need and requirements for long-term monitoring will be assessed at that time

3.3 Target and Minimum Water Levels

Similar to the AMP, the target surface water level (set points for the wetland inflow system) and minimum surface water levels will be established based on the interpreted historical surface water levels for the wetland and the desired seasonal water depths and hydroperiod to enhance ecological conditions as described in the NETR/EIA (Sections 14.6, 16.1 and 16.2).

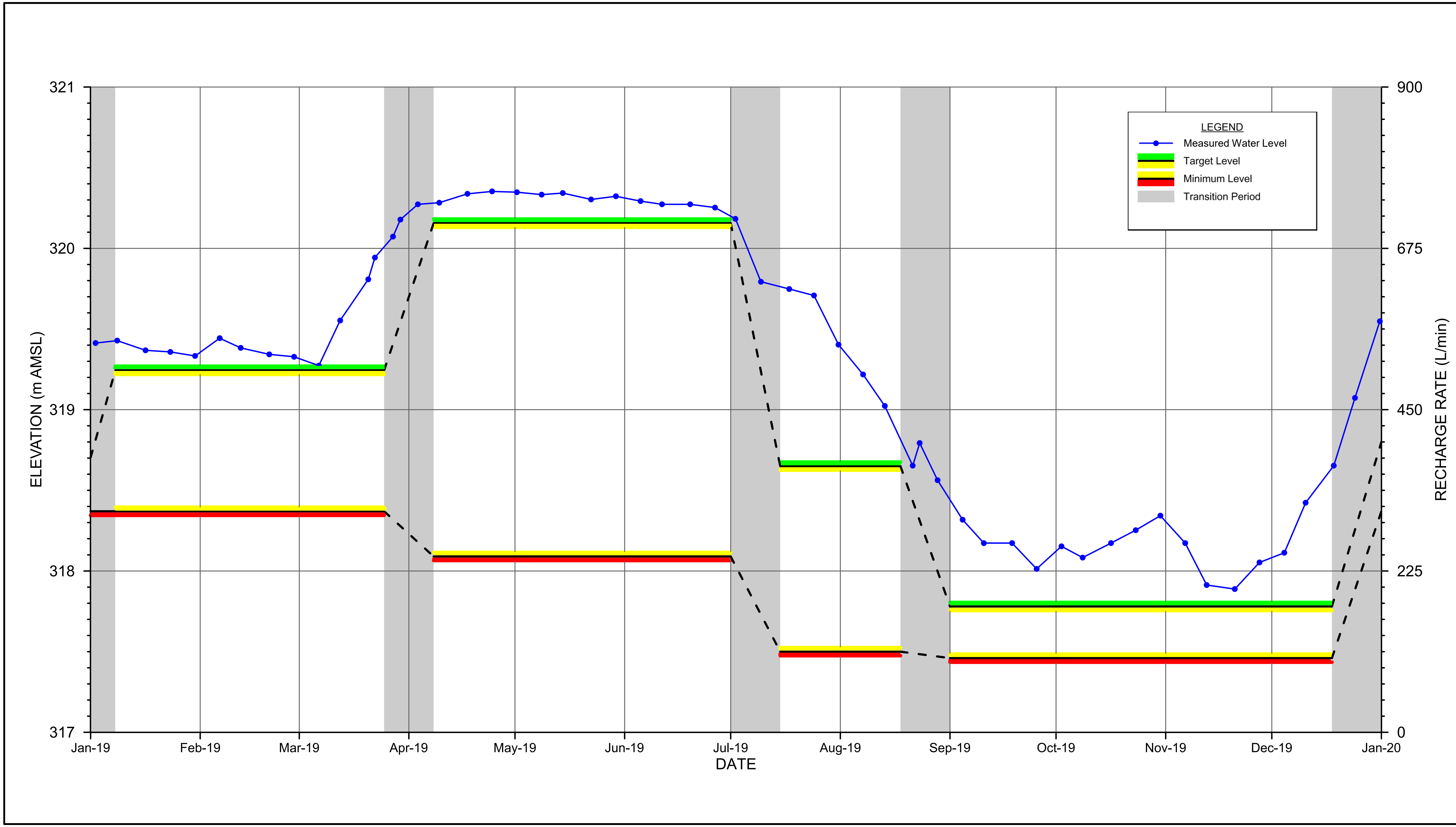
Proposed preliminary target water levels for Wetland U1 are shown on Figure B.2 and for the upper portion of Wetland W36 on Figures B.3 and B.4. The seasonal water depths and hydroperiods are intended to provide optimal conditions for amphibian breeding and reproduction. Target species include Jefferson Salamander, Unisexual Ambystoma (Jefferson Salamander dependent population), Spotted Salamander, Wood Frog, Spring Peeper, Northern Leopard Frog, American Toad and Gray Treefrog. Wetland hydrology in Wetland U1 and the upper portion of Wetland W36 will be enhanced over existing conditions. This enhancement is demonstrated by the proposed targets levels that increase the pool depth and extend the hydroperiod experienced in recent years relative to the measured data as shown on Figures B.2, B.3, and B.4.

The proposed target water levels are preliminary and dependent on, for U1, overburden characteristics, depth to bedrock and actual outlet/overflow elevation, and for the upper portion of W36, wetland microtopography in the SG58 and SG57 area. The target water levels shown on Figures B.2, B.3 and B.4 will be confirmed or updated in the Pre-Extraction Report, once the WMS verification is complete.

It is noted that the target water levels shown for the upper portion of Wetland W36, on Figures B.3 and B.4 are the minimum levels that are believed to be achievable based on available water level data. The target level shown is intended as the minimum proposed target level that is considered to be achievable. The target level will be reviewed and finalized in the Pre-Extraction Report with the goal of establishing a higher target level for additional enhancement of pool depth and hydroperiod if practical.

The intended hydroperiods for Wetland U1 and the upper portion of Wetland W36 are from spring melt (nominally mid-April) to mid-August. Therefore, target and minimum water levels and corresponding response actions will not be applicable from late-August through to late winter.

Adjustments in the target level may be made from time to time based on the recommendations from the ecological monitoring and analysis programs. Minimum levels may be adjusted for climate variations in general accordance with the procedures established for monitoring wells using off-site background water levels (Section 2.3 above); however, discretion will be required due to the intended enhancement approach to mitigation of Wetland U1 and Wetland W36, providing breeding habitat for Jefferson Salamander, Unisexual Ambystoma and other amphibian species. Any modifications to target or minimum levels will be documented in the annual monitoring report for agency review.



Note: Measured water level shown above is maintained at/above the target level as a result of the ongoing operation of the existing quarry groundwater recharge well mitigation system. The target water level reflects the 3-year average seasonal water level based on pre-extraction (existing quarry) baseline water level data.

MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

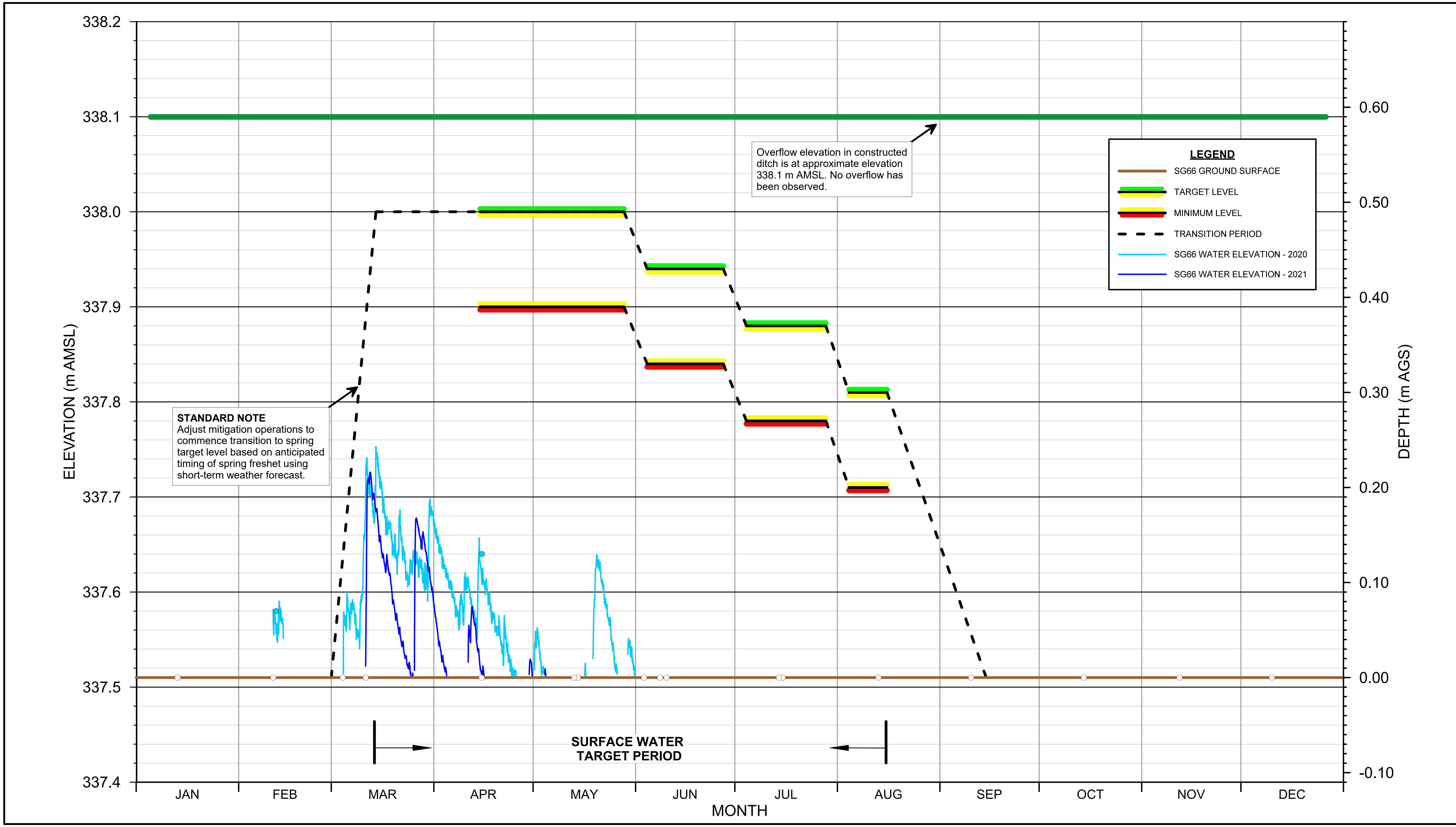
010978-200

Dec 8, 2021

EXAMPLE GROUNDWATER TARGET HYDROGRAPH

FIGURE B.1

WAT File: \\ghdnet\ghd\CA\Waterloo\Projects\662\010978\Workshare\010978-REPORTS\010978-RPT-165 - AMP Addendum\010978-165-Part II\010978-165-Part II-Section B\Figure B.1 - Example Groundwater Target.grf



Note: - The target is the water elevation that is intended to be maintained as a normal minimum wetland level. Precipitation would further raise the water levels. Water Management System to be operated to ensure target is met or exceeded.
- Open circles represent a dry condition and a boxed symbol represent a frozen condition.
- Wetland U1 is currently instrumented by SG66; however, performance monitoring may be accomplished by alternate instrumentation, including the anticipated use of a stilling well.

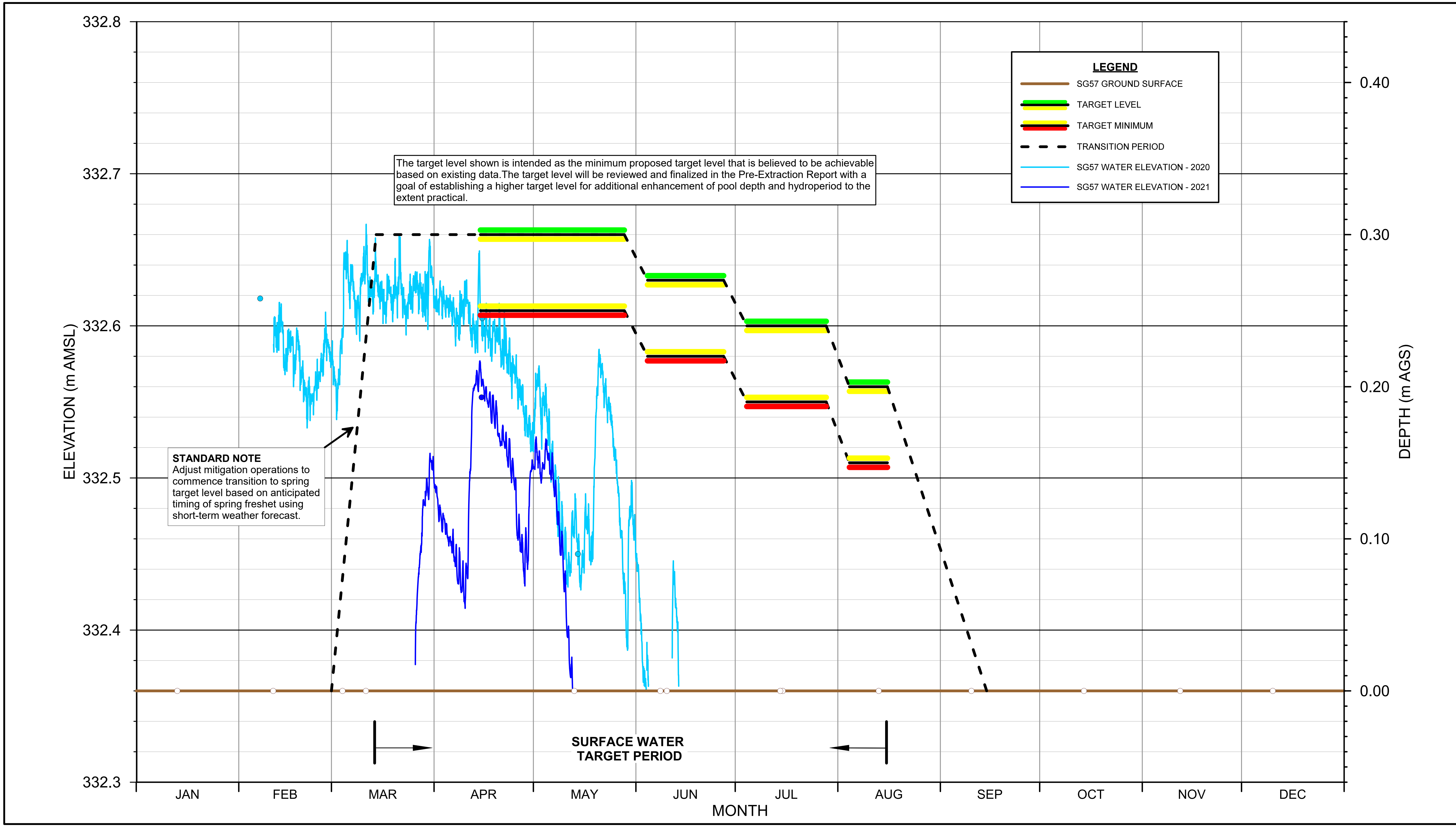
MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

PROPOSED PRELIMINARY SURFACE WATER TARGET
WETLAND U1

010978-200
Nov 18, 2021

FIGURE B.2

WAT File: \\ghdnet\ghd\CA\Waterloo\Projects\662\010978\Workshare\010978-REPORTS\010978-RPT-165 - AMP Addendum\010978-165-Part II\010978-165-Part II-Section B\Figure B.2 - U1 Target.grf



Note: - The target is the water elevation that is intended to be maintained as a normal minimum wetland level. Precipitation would further raise the water levels. Water Management System to be operated to ensure target is met or exceeded.
- Open circles represent a dry condition and a boxed symbol represent a frozen condition.
- The Wetland W36 lower pool is currently instrumented by SG57; however, performance monitoring may be accomplished by alternate instrumentation, including the anticipated use of a stilling well.

GHD

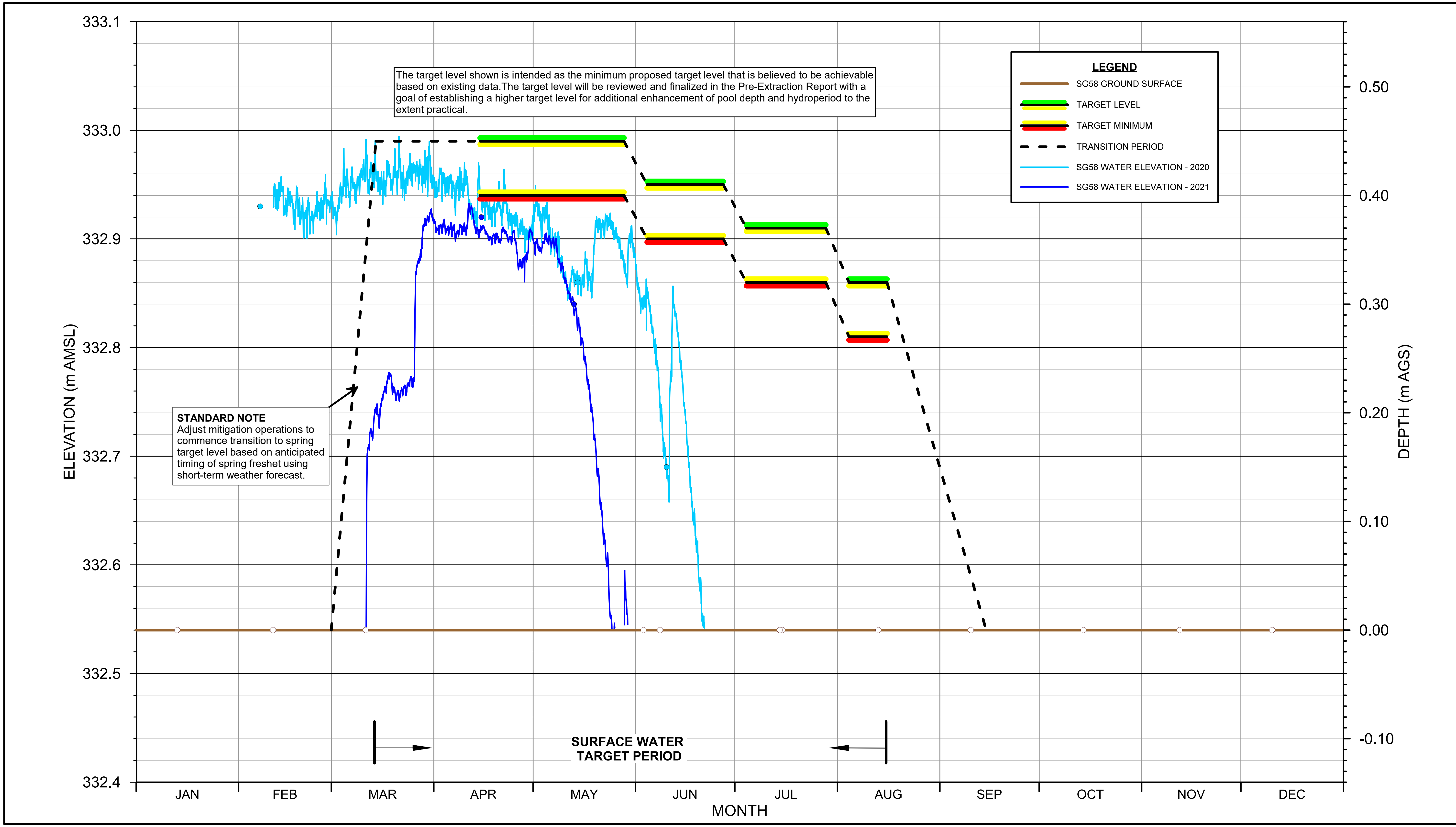
MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

PROPOSED PRELIMINARY SURFACE WATER TARGET
WETLAND W36 - LOWER POOL

010978-200
Dec 8, 2021

FIGURE B.3

WAT File: \\ghdnet\ghd\CA\Waterloo\Projects\662\010978\Workshare\010978-REPORTS\010978-RPT-165 - AMP Addendum\010978-165-Part II\010978-165-Part II-Section B\Figure B.3 - W36 Target - SG57.grf



Note: - The target is the water elevation that is intended to be maintained as a normal minimum wetland level. Precipitation would further raise the water levels. Water Management System to be operated to ensure target is met or exceeded.
- Open circles represent a dry condition and a boxed symbol represent a frozen condition.
- The Wetland W36 upper pool is currently instrumented by SG58; however, performance monitoring may be accomplished by alternate instrumentation, including the anticipated use of a stilling well.

GHD

MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

PROPOSED PRELIMINARY SURFACE WATER TARGET
WETLAND W36 - UPPER POOL

010978-200
Nov 18, 2021

FIGURE B.4

WAT File: \\ghdnet\ghd\CA\Waterloo\Projects\662\010978\Workshare\010978-REPORTS\010978-RPT-165 - AMP Addendum\010978-165-Part II\010978-165-Part II-Section B\Figure B.4 - W36 Target - SG58.grf

Section C
Response Action Plan

Part II – Section C Response Action Plan

Table of Contents

Part II – Section C

Response Action Plan

1. Introduction

During the active life of the quarry and lake filling, target water levels in groundwater, Wetland U1, and the upper portion of Wetland W36 will be maintained by interim mitigation measures that will maintain or enhance the associated water resources. If one or more water levels drop below applicable target level at trigger well locations, or within Wetland U1 or the upper portion of Wetland W36, response actions will be taken in accordance with the Response Action Plan as required to restore the water level and satisfy mitigation objectives. Response actions are described in Part II Section A Subsection 2.6.

The mitigation measures are straight-forward extensions of the proven WMS that has been successfully operating since 2007. The successful operations are evidence of the appropriateness of the existing response action framework in the AMP. Building on this success, the Response Action Plan for the MQEE follows the plan already in operation for the existing quarry under the AMP. For convenience, the plan is reproduced herein to provide this key information in this AMP Addendum and to clarify which aspects of the AMP apply to the MQEE. The principal (although minor) modifications made for the MQEE include:

- Cross-References to AMP report sections were clarified where appropriate
- References to wetland names were adjusted to make them specific to the MQEE
- The provisions specific to the cold water fishery reaches of Sixth Line Tributary to the north of the existing quarry under "red zone" conditions have not been included herein as they are not relevant to the MQEE
- The AMP exemption to the cessation of extraction condition related to wetland target levels (AMP Section 3.4, footnote 1) was removed, providing an increased level of protection to amphibian breeding and reproduction, and species at risk

The mitigation measures for the MQEE are shown on Figure 2 (Part I) and are described in Part II Section A. The target levels are described in Part II Section B. Response actions in the event targets are not satisfied are described herein. Supplemental monitoring in addition to the water level monitoring at trigger locations is described in Part II Section D.

2. MQEE Response Action Plan

The AMP mitigation operation requirements come into effect for the MQEE mitigation components when extraction proceeds below the groundwater table within the MQEE extraction limit. These requirements include the ongoing operation verification procedure and the response action plans.

2.1 Operation Verification Procedure

As for the AMP, the operation verification procedure includes the combined assessment of both the conformance of the measured water levels to groundwater target levels and the availability of water to ensure the mitigation measures are performing as designed with respect to both water levels and water budget considerations. Based on the results of these comparisons, appropriate response or contingency actions will be implemented on a proactive basis to ensure that the environment is protected. Further information on the overall procedure is illustrated on a flowchart included in the AMP as Figure 1.7[1]. While the operation verification procedure illustrated on AMP Figure 1.7 is specific to the groundwater recharge system, it is also applied to the existing wetland diffuse discharges in consideration of the variations between the respective response action plans (refer to Sections 2.2 and 2.3 below).

The same operation verification procedure will also be applied to the MQEE groundwater mitigation and diffuse discharge components in a manner consistent with the application to the existing quarry.

2.2 Groundwater Response Action Plan

Due to the need for a timely response to groundwater levels that may fall below target levels, detailed response action plans are in place through the AMP response action framework. The response action framework is detailed in Section 1.3 of the AMP and summarized in chart form on AMP Figure 1.8. The framework will be applied to the MQEE components of the mitigation system in the same manner as the existing quarry. For convenience, the relevant portion of AMP Section 1.3 describing the response action framework is reproduced herein ***(text in bold italics font)*** along with accompanying footnotes (5 through 11 - numbered to match the AMP).

> ***The framework/chart*** [AMP Figure 1.8] ***provides further clarification of the operating conditions, as well as triggers for response actions and notification to be provided to the agencies.***
>
> ***The response actions*** [framework] ***includes three operating zones[5] or conditions based on the measured water level relative to the target and minimum levels*** [refer to Part II Section B].

1 The operation verification procedure in the AMP is presented specific to the groundwater recharge well system operation; however, the procedure is applied to both the recharge well system and the wetland diffuse discharge system for the existing quarry and will be applied similarly for the MQEE.

5 ***During the transition between seasonal periods (nominally 2-week transition as described in Part II Section B) it is understood that there will be a transition of water levels from one period to the next period. For the purposes of the response action framework described herein, the applicable target and minimum levels will be considered to be the lower of the levels for the two periods related to the transition. Following the transition period, the new target/minimum level will apply. If the measured water level is below the target level at the transition time and the subsequent target level is lower than the target level prior to the transition, the operator must verify that the system can maintain the higher target level at least 1 month prior to next seasonal increase in target level. The overall performance assessment described in Part II Section E Subsections 2.1 and 2.2 will review the long-term appropriateness of the actual operating practices during the transition periods and identify refinements, if appropriate.***

2.2.1 Green Zone

When the measured trigger well water level is at or above the target level[6], the performance objectives are being met and no response action is required or triggered (i.e., normal operations can continue subject to the other monitoring requirements …

2.2.2 Yellow Zone

A trigger well water level that drops below the target level will initiate a series of appropriate response actions designed to address this situation.

Operation in the yellow zone is not a short-term (acute) ecological consideration as the water levels remain above the historic minimum levels; however, long term recurring operations in the yellow zone may have ecological considerations. The potential influence of, and any response to, any repeated short drops below the target levels will be evaluated as part of the overall water management system performance assessment completed as part of the annual and 5-year reviews described in [Part II Section E].

a) Upon identification of a trigger well water level below the target level, the operator will commence implementation of appropriate response actions. This may include verification of the available data[7].

b) If the water level is below the target level and remains below for a period of 1 week or more, an "occurrence"[8] will be recorded for the affected trigger well(s) and the agencies will be notified[9] of this occurrence.

c) If the water level drops below the midpoint between the target and minimum levels, the agencies will be notified as well as provided with information on the conditions and actions being undertaken. In this case, the minimum water level may also be verified[7] relative to the background water level data to determine whether an adjustment is appropriate based on the background data collected to date [refer to Part II Section B].

d) If the water level remains below the target level for a period of 4 weeks or more (i.e., 3 weeks after an occurrence is recorded) the agencies will be notified[9,10] and will be provided with information on the conditions and the actions being taken to address the situation.

---

6 ***Water level measurements and target/minimum level calculations will be recorded to an accuracy of 1 centimetre.***

7 ***Data verification activities are not considered to be operational requirements but rather good operating practices.***

8 ***The term "occurrence" as used in this context does not imply any breach of the AMP or any law, but is a situation which, pursuant to the AMP, requires notification to agencies and response action.***

9 ***Notifications referenced in this section will be provided within 3 business days of the observed event requiring notification.***

10 ***If notification has already been issued under item c for the same occurrence, the 4-week notification is deemed to have been made.***

e) ***If the water level remains below the target level for a period of 8 weeks or more (i.e., 7 weeks after an occurrence is recorded) this will be considered an "incident" and extraction (and Site preparation) that causes further dewatering in the affected area will cease and the procedure described in*** [AMP] ***Appendix F (aggregation) will be initiated. The agencies will be notified (within 3 business days) of the incident as well as provided with an update on the conditions and actions being undertaken to address the situation. As further precautionary measures, the timeframes under action item d and action item e (above) will be temporarily reduced as described below (refer to*** [AMP] ***Flowchart D - Figure 1.9):***

   i) ***After a cessation of extraction has been required under action item e (i.e., the 8-week period) the operating response periods for items d and e will be reduced from 4 and 8 weeks, to 2 and 4 weeks, respectively for the same affected trigger well(s). In the event of a second cessation of extraction for the same affected trigger well(s) under action item e (i.e., while reduced timeframes are in effect), the operating response period for items d and e will be reduced from 2 and 4 weeks, to 1 and 2 weeks, respectively for the affected trigger well(s). The timeframes will not be reduced below these levels.***

   ii) ***The operating response periods for items d and e will be reset to 4 and 8 weeks, respectively, following an appropriate period during which there is no "occurrence" for the affected trigger well(s). This period will be initially established as 3 months in a step-wise manner (i.e., 3 months to reset the operating response period from 2 weeks to 4 weeks, and another 3 months to reset from 4 to 8 weeks). During this period, the mitigation measures must be operating such that the associated trigger well target levels are being readily maintained. This period may be reviewed in the future based on available performance monitoring data.***

f) ***In addition to the actions described in item e (above), Dufferin must continue to assess/implement measures to ensure that the situation that resulted in the cessation of extraction has been addressed. These measures include development of both short-term and/or long-term mitigation measures, including rehabilitation[11],***

---

[11] ***Rehabilitation measures may include committing to one (or more) of the following courses of action or alternative actions, undertaken on a timely basis:***

   i) ***Construction of a buttress against the quarry wall in the affected area. The buttress may be for the sole purpose of reducing the rate of groundwater seepage into the quarry in the affected area. If the buttressing is designed/able to reduce seepage into the quarry such that the groundwater target levels in the affected trigger wells can be achieved, then bedrock extraction activities can recommence (once the target levels have been met). To the extent necessary and appropriate, such re-commencement of extraction will include reasonable measures to prevent the re-occurrence of the previous difficulty in maintaining water levels. For example, the buttressing may be a temporary measure allowing other measures to be implemented (e.g., grouting near recharge alignment) such that the temporary buttress can be removed and bedrock extraction resumed.***

   ii) ***If the buttressing or some other appropriate measure(s) does not result in the target levels being achieved then water filling of part or all of the cell will be considered. Water filling in part of the cell***

in consultation with the agencies. In order to recommence extraction, Dufferin must ensure (through performance monitoring as reviewed by the Agencies) that the area has been mitigated, that continued extraction and mitigation operation is sustainable over the long term, and the system has been operating within the green zone for a period of 1 week or more, in the affected area.

2.2.3 Red Zone

If the measured water level falls below the verified seasonal minimum level, the following procedures will apply:

1. ***If the measured water level remains below the verified seasonal minimum level for more than 1 week, Dufferin must cease extraction that results in further dewatering in the affected area, as well as follow the actions and timeframes defined above.***
2. [Specific to Sixth Line Tributary. Not applicable to the MQEE area]
3. ***If the water level drops below the minimum level after an occurrence is recorded (for the same event), agency notification will occur immediately***[9]

2.3 Wetland Response Action Plan

Once the recharge system is operating for the MQEE area (following commencement of extraction below the water table) it will also be active for the wetlands. Thereafter water inflow to the wetlands will automatically occur if/when the water level drops below the target level regardless of whether the drop is due to quarry dewatering influence. As described for the groundwater recharge well system (Section 2.2), due to the need for a timely response to wetland levels that may fall below target levels, detailed response action plans are in place through the AMP response action framework.

The response action plan for Wetland U1 and the upper portion of Wetland W36 is the same as for the existing quarry on-Site wetlands W7, W8, and V2 as described in the AMP (Appendix F, Section 3.4). While the general concept follows that of the groundwater response action plan (Section 2.2 and AMP Figure 1.8) it is tailored to reflect the characteristics of the wetland and the associated mitigation measures (described in Part II Section A Subsection 2.6). For convenience, the relevant portion of Section 3.4 (from AMP Appendix C), the response action framework for wetlands with diffuse discharge mitigation, is reproduced herein ***(text in bold italics font)***.

> ***The selection and implementation of the appropriate response actions if a water level drops below the target level will depend upon the specific circumstances, including the ecological considerations, and season in which the condition occurs. Given the nature of*** [Wetland U1 and the upper portion of Wetland W36] ***wetlands and their existing and historical hydrogeological and ecological characteristics, it is unlikely that any long-term adverse effects will result from a short-term drop in water levels below the***

could include subdividing the affected cell (e.g., permanent or temporary hydraulic separation by a rock pillar or constructed dyke/dam) and allowing the affected area to flood. Alternatively, the whole cell (to the extent extracted) may be rehabilitated and flooded.

target and even the historic low water levels. While a significant drying of the wetland in a particular year may affect the productivity/growth in that year, the wetland can fully recover when the water levels are restored. Therefore, it may be most appropriate to implement some types of mitigation measures (e.g., those that are intrusive in the wetland) on a longer term basis or during a later season to be able to implement the most appropriate measures with the least amount of ecological disturbance. For example, it is preferable to perform any repairs that involve intrusive work immediately adjacent to a wetland area, such as the inflow structure, during the late fall season when conditions are drier and potential ecological disturbance will be lower.

In the event that the water level in the wetland drops below the target level, Dufferin will promptly respond to restore the water levels by restoring/increasing the inflow of water to the wetland. If the water level can be restored to the target level within a short period of time (i.e., 1 week), such as may be possible if all that is required is an increase in the flow or the repair of a mechanical problem, no further action is required. If the drop in water level is of a more persistent nature (i.e., takes longer period of time to mitigate), the following response framework is provided to assist in ensuring an appropriate response is undertaken.

<u>Response to Continued Low Surface Water Level:</u>

If the surface water level in [Wetland U1 or Wetland W36] ***is below the target water level, the following will apply:***

A. ***Dufferin will notify the agencies of the condition after 1 week.***

B. ***Dufferin has a period of 8 weeks to accomplish one of the following options:***

- ***i)*** ***Restore the wetland water level to the target level; or***
- ***ii)*** ***Provide the plan and timeline to restore the wetland water level to the target level to the agencies for review. Such a plan would include defining the measures to be implemented and rationale as to why they will work.***

C. ***In the event that Dufferin is unable to achieve either of the above options within 8 weeks of the water level dropping below the target level, Dufferin will commit to undertaking one or more of the following actions:***

- ***i)*** ***Implement measures suitable to provide increased flow to wetland in respect of potential flow requirements and the ecological effects of increased flow (refer to Section 4.0*** [of AMP Appendix C]***); and/or***
- ***ii)*** ***Implement a localized grout curtain outside the wetland perimeter and adjacent to the extraction limit (i.e., outside the minimum wetland buffer zone*** [to the extent possible based on the extent of extraction at the time]***) to reduce seepage back to the quarry excavation; and/or***
- ***iii)*** ***Construct a hydraulic buttress against the quarry wall to reduce seepage back to the quarry excavation.***

If the water level is below the verified seasonal minimum level, the above response procedure will continue to apply. In addition, Dufferin will promptly undertake measures to minimize the potential for any long-term effects to the wetland, as appropriate. These measures may include one or more of the following:

- ***Increasing flow to wetland at inflow and/or supplementary location. This could involve the use of an overland water line to maintain open water conditions in the lowest part of the wetland, if necessary; and/or***
- ***Maintain wet/moist substrate conditions using an irrigation sprinkler or similar system; and/or***
- ***Increased use of recharge wells adjacent to wetland and/or installation of temporary recharge wells between wetland and quarry face; and/or***
- ***Cease bedrock extraction that may increase dewatering in the area of the affected wetland until measures are implemented to restore the wetland water level to the seasonal target level.***

Further to undertaking the appropriate actions in accordance with the above, Dufferin will cease extraction that increases dewatering in the affected area if the conditions described below occur.

1. ***If item B (above) is not satisfied; or***
2. ***If the mitigation measures described in the plan (above) to restore the wetland water level are not successful in restoring the water level or are not implemented in accordance with the timeline established in the plan.***

The purpose of such a cessation of extraction is to limit the exacerbation of a situation until such a time as appropriate mitigation measures are determined/implemented with the objective of reducing the possibility that the subject wetland would have water levels below target levels for more than one annual cycle.

Section D
Supplemental Monitoring

Part II – Section D Supplemental Monitoring

Table of Contents

Figure Index

List of figures

(following text)

Part II – Section D

Supplemental Monitoring

1. Introduction

The Supplemental Monitoring Program includes additional monitoring/evaluation components which are not directly related to ensuring the protection of water resources but may provide supplemental information or indicate issues that require further consideration. The supplemental monitoring components established in the AMP include:

- Groundwater and surface water level monitoring, including background locations
- Meteorological and water budget monitoring
- Ecological monitoring
- Residential well monitoring

For these components, the AMP provides a defined program for monitoring, evaluation, and the assessment of the need for any response actions. The current AMP requirements for supplemental monitoring are documented in Section 4 of the AMP.

The additional supplemental monitoring requirements for the MQEE are described in this Addendum. The principal modifications made in the following, include:

- Specification of additional monitoring locations (e.g., additional monitoring wells, surface water level monitoring locations, and ecological monitoring stations)
- Specification of monitoring requirements specific to the MQEE monitoring program (e.g., installation and use of automated water level recorders in selected monitoring wells and wetland pools)
- Specification of how certain monitoring and evaluation requirements of the AMP apply to the MQEE to facilitate clear interpretation of the requirements
- No additional residential well monitoring is required for the MQEE. As described in the GWRA (Section 6.6), due to the location and hydrogeologic conditions of the MQEE there are no groundwater use interference considerations specific to the MQEE. The existing program under the AMP (Section 4.6) adequately addresses all private water supply well considerations for the Milton Quarry

These components are addressed in the following sections of this document which are numbered to match the corresponding AMP Section 4 subsections (i.e., there is no content corresponding to Sections 2 and 3 herein):

Section 4.1 Groundwater and surface water level monitoring

Section 4.2 Background groundwater level monitoring

Section 4.3	Meteorological monitoring
Section 4.4	Water budget monitoring
Section 4.5	Ecological monitoring - Wetlands
Section 4.6	Private Water Supply Well Monitoring is addressed by AMP

2. Placeholder Section Number - Blank

There is no content intended in this section. As indicated above, the section numbering is provided to match Section 4 (below) to AMP section numbering.

3. Placeholder Section Number - Blank

There is no content intended in this section. As indicated above, the section numbering is provided to match Section 4 (below) to AMP section numbering.

4. Supplemental Monitoring Components

4.1 Groundwater Levels and Surface Water Levels

Groundwater level and surface water level monitoring will occur at available monitoring locations in addition to the trigger locations (Part II Sections B.2 and B.3) and background water level monitoring (Section 4.2 below). The purpose of this monitoring is to assess patterns/trends in groundwater levels, quarry dewatering influences, and recharge system operation to ensure the groundwater and surface water conditions are well understood and to assist in understanding the current and future recharge system operations. The components of this program are presented below.

4.1.1 Monitoring Locations

- Existing groundwater monitoring well locations and surface water level monitoring locations as shown on Figure 5 and Table 2. Qualitative observations of flow from the discharge pipe/seep location adjacent to staff gauge SG61 in Wetland W41 as well as the outflow of Wetland W41 will also be undertaken along with surface water elevation observations. These locations have been established and monitoring is underway. Additional wells or surface water monitoring locations may be added to augment the existing monitoring network, as appropriate.
- Recharge monitoring wells. During its operating period, the recharge system may require nearby monitoring wells to help assess recharge well influence on nearby groundwater levels and flow. Recharge monitoring wells may not be required if trigger wells are connected directly to the WMS SCADA system, as was recently completed for the approved Acton Quarry. Many factors including access, cell service, or line of sight can influence this decision. The need for recharge monitoring wells and their locations will be determined as part of the detailed design of

the recharge well system and will be installed prior to initiation of recharge operations for the MQEE.

- Groundwater recharge wells. Recharge well locations will be determined as part of the detailed design of the recharge well system and will be installed prior to initiation of recharge operations for MQEE. Installed recharge wells will be monitored prior to commencement of the recharge system in the MQEE area if readily accessible.

4.1.2 Monitoring Frequency[1]

4.1.2.1 Pre-Extraction and During Extraction in the MQEE

- Monthly manual water levels, unless data collection is automated with telemetry, and levels are available through the water management system (WMS) SCADA system. Manual measurements should still be collected on a periodic basis for verification of instrument accuracy, as may be recommended by the instrument manufacturer or based on operational experience.
- Optional automated "continuous" water level recorders (e.g., pressure transducers and data loggers) may be installed in monitoring locations to collect water level readings. The monitoring interval should be set to collect a level at least daily. Data loggers that are not available through the SCADA system should be downloaded on semi-regular schedule (e.g., quarterly) to minimize data loss in the event of instrument failure.
- Water level recorders in surface water features may be in place on a seasonal basis – i.e., removed from wetlands during typical dry or frozen periods.
- Recharge monitoring wells will be monitored at a minimum frequency similar to the trigger wells or as defined during the detailed design of the recharge system, whichever is more frequent. It is anticipated that recharge monitoring wells will be connected to the WMS SCADA system. In this circumstance manual measurements will not be required except for periodic verification of instrument accuracy.

4.1.2.2 Post-Extraction/Lake-Filling Period in the MQEE

- Monthly manual water levels, decreasing to quarterly measurements as appropriate. Manual measurements may not be required if data collection is automated with telemetry and data area available through the WMS SCADA system. Manual measurements should still be collected on a periodic basis for verification of instrument accuracy, as may be recommended by the instrument manufacturer or based on operational experience.
- Optional automated "continuous" water level recorders may be used to collect water level readings. The monitoring interval should be set to collect a level at least daily. Data loggers that are not available through the SCADA system should be downloaded on semi-regular schedule (e.g., quarterly) to minimize data loss in the event of instrument failure.

[1] In the event that the minimum frequency is not satisfied due to equipment failure, erroneous reading, or other issues, the operator will review the situation, collect supplemental measurements if warranted, and document lessons learned in the annual monitoring report.

- Recharge monitoring wells to be monitored at a minimum frequency similar to the trigger wells. It is anticipated that recharge monitoring wells will be connected to the WMS SCADA system. In this circumstance manual measurements will not be required except for periodic verification of instrument accuracy.

4.1.2.3 Post Lake-Filling Period

- The need for groundwater level monitoring will be established as part of the final rehabilitation studies as described in the AMP (p. 21) and Site Plans.

4.1.3 Data Evaluation

The collected data will be evaluated on a regular basis to assess the issues identified above. In the event that the observed behaviour varies substantially from what was anticipated or a particular concern is identified, further assessment and/or response actions will be undertaken, as appropriate. Any such circumstances will be communicated to the agencies.

As described in Part II Section A.2.1, a specific focus of the supplemental monitoring program will be the central portion of Wetland W36. Monitoring well BH64 will be treated similar to existing monitoring wells BH65, BH66, and OW69-08 for the existing quarry. These wells are compared to their historical water level range and the agencies will be immediately notified in the unexpected event that the measured water level drops below the historic range during the spring period. Figure D.1 presents the historical water level measurements for monitoring well BH64 and the current historical range corresponding to the spring target period refined to a monthly level (to be updated in the Pre-Extraction report, Part II Section E.3.1). Note that measurements from 2003 appear anomalously low and have conservatively been removed from the historical range. Further information on evaluation and potential response actions related to the central portion of Wetland W36 is detailed in Section 4.5.3.

4.2 Background Groundwater and Surface Water Levels

Groundwater and surface water elevations will be monitored at background locations for the purpose of assessing climatic effects on natural water levels. The data collected from the background wells and wetland pools will be used to adjust the target and minimum water levels for the trigger wells and Wetlands U1 and W36 as discussed in Part II Sections B.2.3 and B.3.3.

4.2.1 Monitoring Locations

Background monitoring locations are beyond the study area but in the general vicinity of the Milton Quarry so that they are removed from potential quarry effects but still reflective of similar groundwater conditions. In addition to the existing background monitoring well locations for the Milton Quarry (OW68-08, BH112, OW39-04, OW40-04, and OW41-04), the following additional locations are included in the network of background monitoring locations for the MQEE (refer to Part I Figure 7):

- Existing Acton Quarry background monitoring wells OW106-18 and OW107-18
- Existing Acton Quarry background wetland water level monitoring locations BW1, BW2, and BW3

4.2.2 Monitoring Frequency

- Monthly manual water levels
- Automated “continuous” water level recorders (e.g., pressure transducers and data loggers) to collect water level readings at least daily. Data loggers to be downloaded at least quarterly
- Automated water level recorders in wetlands may be in place on a seasonal basis – i.e., removed from wetlands during typical dry or frozen periods

4.2.3 Data Evaluation

The collected data will be evaluated on a regular basis, similar to the existing quarry, to assess the trends in water levels relative to climatic conditions (refer to Section 4.3) and ultimately to adjust target and minimum water levels as discussed in Part II Section B.

4.3 Meteorological Data

Dufferin will continue to operate a meteorological data collection station at the Milton Quarry as it has done since 1990 and consistent with the requirements of the AMP. The MQEE does not require additional meteorological data collection.

The meteorological data will be used to improve the understanding of climatic conditions with respect to both ongoing conditions and long-term trends. This information will assist in evaluating groundwater level fluctuations at the background monitoring wells as well as other locations. It will also assist in water budget evaluations (refer to Section 4.4, below).

4.4 Water Budget

Dufferin will continue to evaluate the water budget for the entire Milton Quarry on a regular basis to ensure that sufficient water is available for ongoing and future mitigation, operational, and rehabilitation requirements consistent with the AMP (Section 4.3 and Appendix E). The MQEE does not require additional water budget analyses beyond including the MQEE components as part of the WMS. It is noted that the MQEE extraction area will be incorporated into the East Cell for purposes of lake filling evaluations.

The objectives of the water budget evaluation remain unchanged. They are reproduced below ***(bold italics text)*** from AMP Section 4.4 for convenience:

- ***Verify that the amount of water available/in storage is consistent with water budget forecasts to confirm the representativeness of the overall water budget calculations***
- ***Identify if more or less water is available than forecasted such that filling time and associated operational and cost aspects can be appropriately addressed***
- ***Establish the annual distribution of the water from the reservoir in accordance with an agreed water hierarchy***
- ***Establish the amount of "excess" water that may be available***

- ***Confirm the representativeness of key water budget parameter values which have the potential to significantly affect the reliability of the long-term water budget calculations in a negative manner (i.e., potentially less water available that forecast)***
- ***Identify and adapt to any long-term trends in water budget availability that are evidenced by the monitoring data and/or recognized by the scientific community***

4.5 Ecology

The water resources protection components of the performance monitoring program are designed to protect water-dependent natural features, i.e., wetlands. Direct protection of water levels, quantities, and quality protects the specific wetland habitat conditions and associated wildlife. In conjunction with the performance monitoring components, some supplemental monitoring of ecological parameters is proposed. In addition, Wetland U1 and the upper portion of Wetland W36 will be protected.

The purpose of the wetland ecology monitoring is to assess the general characteristics of a number of representative wetlands, to ensure they are continuing to function as expected and specifically to identify any unanticipated changes that warrant initiation of further investigation.

Wetland communities are typically dynamic and variable, changing naturally both with time and in response to a variety of other natural factors (e.g., climatic, beaver activity, pests and diseases, fire, predation, etc.) as well as man-induced changes (e.g., water taking, drainage changes, logging, pasturing, introduction of invasive species, etc.). Therefore, ecological monitoring is most useful over time as sufficient information becomes available to enable reasonable identification of trends. While identification of relationships between the wetland ecology and water resource data becomes more reliable with time, it may still be difficult to clearly identify potential cause and effect relationships. Trends may also be obscured if a number of activities and natural events are acting together to influence features.

4.5.1 Monitoring Locations

The wetland ecology monitoring program encompasses general monitoring of representative wetlands, as well as several specific components that are identified as critical ecological features and/or functions. The locations for each of the wetland ecology monitoring components are shown on Figures 5 and 6, and described below:

1. Surface and groundwater monitoring of the stations in six wetlands (U1, W36, W41[2], W46a, W46b and W56) will be continued as described in Section 4.1 (Above) and Part II Section B.3. Monitoring wetland hydrology in these features will ensure the seasonal fluctuations important to wetland vegetation patterns/zonation, amphibian breeding and other related functions are well understood, so they can be maintained during and following quarrying. Jefferson Salamander and Unisexual Ambystoma (Jefferson Salamander

2 A portion of Wetland 41 was included as monitoring locations in the existing AMP for the approved and operational Milton Quarry Extension. Additional wetland ecology monitoring stations have been added in the newly accessible portions of Wetland W41 for the MQEE.

dependent population) were confirmed breeding in Wetlands U1, W36-upper, W41 and W46a.

2. Fixed-point photographic monitoring of surface water conditions will continue in Wetland W41, and commence in Wetlands U1, W36, newly accessible portions of W41, W46a, W46b and W56, from consistent vantage points, during the amphibian breeding and vegetation growing season. General wetland reconnaissance observations of the overall condition of each wetland station (including any changes to the vegetation, species, or community types, etc.) will also be recorded during the photographic monitoring events.

3. Jefferson Salamander complex egg mass surveys and frog call surveys will be conducted in Wetlands U1, W36-upper, W41 and W46a.

4. Monitoring of vegetation conditions in these representative wetlands will be conducted using 10 m by 10 m vegetation plots and a quantitative photo monitoring technique (see Section 4.5.2 below for details). The specific vegetation and photo monitoring plots will be established to encompass representative wetland vegetation communities. Wetland vegetation monitoring will occur in Wetlands U1, W36, W41, W46a and W56.

4.5.2 Monitoring Techniques

The wetland ecology monitoring techniques described herein are essentially the same as those described in the AMP. Some aspects have been updated based on monitoring experience at the Milton Quarry Extension and Acton Quarry Extension, and the availability of automated, programmable field equipment such as Song Meter SM4 Units, which are used to conduct more rigorous amphibian call count surveys.

The monitoring techniques for the wetland ecology component of the Supplemental Monitoring Program are described below under the following headings:

- 4.5.2.1 Fixed-Point Photography
- 4.5.2.2 General Wetland Field Reconnaissance
- 4.5.2.3 Wetland Vegetation Communities
  - 4.5.2.3.1 10 m x 10 m Wetland Vegetation Monitoring Plots
  - 4.5.2.3.2 Quantitative Photo-Monitoring (QPM)
- 4.5.2.4 Amphibian Breeding Habitats
  - 4.5.2.4.1 Amphibian Call Count Surveys
  - 4.5.2.4.2 Salamander Egg Mass Surveys

4.5.2.1 Fixed-Point Photography

Permanently marked fixed-point photography stations are used to document wetland conditions at important periods during the year. Metal T-bars or similar alternatives are used to permanently mark photo stations at locations that provide good vantage points into wetland features, focused on deeper water sections, wetland margins and flow paths. Where feasible, photo stations are established to include water resources monitoring stations (e.g., staff gauges, piezometers, etc.).

Fixed reference monuments (e.g., wooden stake, re-bar, etc.) or other reference points (e.g., tree, tree stump, etc.) are included as part of each photo station.

Photographs are individually coded by wetland feature, photo-station and date. For example, the code U1-FP01-2020-05-12 would represent a photograph taken at Wetland U1 from station FP01 on May 12, 2020.

The locations of fixed-point photography stations are shown on Figure 6.

4.5.2.2 General Wetland Field Reconnaissance

All wetland features included in the monitoring program undergo general wetland field reconnaissance visits conducted at important periods during the year. This reconnaissance occurs at the same time as fixed-point photography monitoring events and other monitoring activities. The purpose of this general wetland field reconnaissance is to provide an overall view of wetland conditions and to make general wetland observations that would not necessarily be made as part of the other ecological monitoring components.

4.5.2.3 Wetland Vegetation Communities

Similar to the monitoring program for the existing Milton Quarry Extension AMP, wetland vegetation monitoring for the MQEE will include 10 m by 10 m monitoring plots and quantitative photo-monitoring stations. Each technique is described below.

4.5.2.3.1 10 m x 10 m Wetland Vegetation Monitoring Plots (VM)

Standard 10 m x 10 m vegetation monitoring plots are permanently marked using metal T-bars or equivalent at each corner. Plot locations are surveyed with a GPS unit (UTM, NAD 83).

Visual cover estimates are made for each of seven potential vegetative layers, as follows:

- Dominant canopy
- Subdominant canopy
- Saplings and shrubs
- Regeneration
- Seedlings
- Herbaceous plants (i.e., forbs, graminoids, ferns, etc.)
- Ground covers (i.e., mosses, lichens, liverworts)

For each wetland feature to be monitored using more than one plot; one plot is situated where water is deepest (or deeper) during the high-water period and one plot is situated in the nearby wetland margins.

Photographs of each plot are taken during each year of monitoring from the same locations and approximately at the same period of plant growth. Monitoring occurs in late summer or fall. Over time, data will be evaluated to determine trends in the vegetation communities such as increases in woody cover, changes in groundcover composition, establishment and/or increases in invasive species, etc.

4.5.2.3.2 Quantitative Photo-Monitoring (QP)

Van Horn and Van Horn (1996) described a photo-monitoring technique that can be an efficient method for collecting information about vegetation community changes over time. This paper is provided in Appendix B of the AMP. The method proposed by Van Horn and Van Horn (1996) is focused on monitoring the success of restoration efforts but is also appropriate for monitoring changes in existing vegetation communities. The method addresses three quantitative parameters: vegetation density, vegetation height, and water depth. Together with a qualitative appraisal of dominant species present, these parameters will support quantitative analysis of vegetation changes over time.

Van Horn and Van Horn (1996) recommend selecting photo-point sites that provide a representative view of the area being monitored. Permanent 1.8 m (6-foot) long metal stakes are placed 10 m (32.8 feet) apart at the chosen monitoring sites. One post serves as the photo-point, supporting a camera on a removable platform. The other post marks the reference point, toward which the camera is pointed. Prior to taking the photographs the reference point post is covered by a "density board", which is 2.5 m high with alternating 0.5 m black and white bands. This board provides a consistent reference for quantitative measurements of the height and density of the vegetation in the photographs. Two permanently marked 1 m x 1 m subplots are established within quantitative photo-monitoring plot and percent absolute cover of groundcover plant species are determined during each monitoring event. Data from all plots within a given wetland are reviewed after each monitoring event and floristic indicators (e.g., species diversity, mean coefficient of conservatism, mean coefficient of wetness, etc.) are calculated.

Quantitative photo-monitoring stations may be located along some edges of the 10 m x 10 m plots described above, and additional stations can be established to provide further monitoring coverage within a particular wetland feature. Monitoring occurs in late summer or fall.

4.5.2.4 Amphibian Breeding Habitats

The monitoring of amphibian breeding habitats is mainly based on amphibian call count surveys which will be undertaken in Wetlands U1, W36-upper, W41 and W46a. Salamander egg mass surveys will be undertaken in confirmed Jefferson Salamander breeding pools (Wetlands U1, W36-upper, W41 and W46a).

4.5.2.4.1 Amphibian Call Count Surveys

Frog call surveys are conducted at active amphibian pools and ponds located within the identified monitoring features. The monitoring generally follows the Marsh Monitoring Program, with some modifications. Each monitoring location (wetland and/or pool) is monitored a minimum of three times per annual survey, usually when the air temperatures are 6°C, 10°C, and 17°C, respectively, and weather conditions are conducive. Monitoring visits generally commence 30 minutes after sunset and terminate prior to midnight. Only frogs/toads calling from the feature being monitored are recorded (unlike the Marsh Monitoring Program which records frog calls within 100 m of the monitoring location). Each monitoring location is surveyed for at least 5-minutes (unlike the 3-minutes recommended for the Marsh Monitoring Program) and one of three call level codes are used to characterize the intensity of calling activity for each species.

The call level codes are as follows:

- Level 1 = individuals can be counted, calls not overlapping
- Level 2 = number of individuals can be estimated or counted, others overlapping
- Level 3 = full chorus, calls continuous and overlapping, individuals not distinguishable

Song Meter SM4 units or newer models from Wildlife Acoustics will typically used for the amphibian call count surveys. The Song Meters will be programmed to record 10-minute blocks of time starting 30-minutes, 90-minutes and 150-minutes after sunset. Weather station data will be utilized to identify priority timing windows for data analysis.

4.5.2.4.2 Salamander Egg Mass Surveys

Salamander egg mass surveys (presence/absence, from pond margins) are conducted at a seasonally appropriate time in early spring (mid-March to early May), when egg masses are visible within the breeding pools. Searches of the breeding pools are completed by experienced individuals capable of differentiating between the egg-masses of the Spotted Salamander and those of the Jefferson Salamander Complex. Searches are made on sunny days, if possible, and polarized glasses are used by observers. In order to limit the disturbance to the breeding pools each spring, observations are made from the shallow pool margins to demonstrate the presence/absence of egg masses, rather than exhaustively searching each pool to estimate total egg mass numbers; consequently, the egg mass surveys provide a general indication of breeding activity and continued use of the pools by each species. Additional observations on the number and distribution of egg attachment sites, macroinvertebrates and predators are recorded.

More exhaustive egg mass surveys aimed at documenting general abundance/numbers of egg masses, and/or the use of minnow traps, could periodically be undertaken in all or selected breeding pools being monitored, under the authorization of MECP and NDMNRF.

Since it has been established that Jefferson Salamander and Unisexual Ambystoma (Jefferson Salamander dependent population) are widely distributed through the landscape, genetic testing is not proposed as part of the Supplemental Monitoring Program.

4.5.3 Monitoring Frequency

The wetland ecology monitoring surveys as described herein (fixed-point photography, wetland reconnaissance, vegetation monitoring, amphibian call count surveys, salamander egg mass surveys, etc.) will be conducted annually for a minimum of 2 years prior to MQEE extraction. It is noted that monitoring results for many aspects will be available for a substantially longer period than the minimum as a result of the historical and ongoing data collection program. Annual surveys will be conducted during the active extraction phase of quarrying. During the final rehabilitation and lake-filling stage, surveys will be conducted annually for Wetlands U1 and W36, and every two years for Wetlands W41, W46a, W46b and W56. Once the lakes are at their final elevations, data will be collected annually for an additional 3 years. The ecological monitoring frequency may be refined based on the results of the data collection.

4.5.4 Data Evaluation

At the end of the pre-quarrying baseline period, the available wetland ecology data will be assessed to identify general patterns, a preliminary range of year-to-year variation and any initial trends. Related water resource evaluation and weather data will be integrated. The baseline period is still relatively short in terms of establishing historic (pre-quarry) ecological trends and determination of year-to-year variation, however, some general patterns may be evident.

As quarrying proceeds, ecological data will be evaluated by comparing to previously documented conditions and reported upon in the applicable annual report. Any significant findings such as new patterns, anomalies, and/or changes will be identified on the basis of their being an unexpected finding that is clearly outside of expected year-to-year variability, or is an apparent reversal in an evident trend or a specific negative change. This analysis will become easier over time as more data are collected and trends and year-to-year variability become clearer. Significant findings will be further evaluated to establish whether they are related to quarrying activities and whether there is any significant negative impact to ecological features as discussed further below.

If the assessment of ecological conditions identifies a significant negative effect on the wetland features and functions, Dufferin will, unless the issue is clearly not attributable to Dufferin's activities, implement appropriate measures to prevent and/or mitigate the effects. The appropriate response actions will depend on the cause and severity of the change and specifically on the feature being affected, and the extent to which any change is attributable to quarrying activity. The ecological aspects of the overall mitigation system performance are discussed further in the context of the Annual Monitoring Report requirements (Part II Section E.2.1 and, by reference, AMP Section 6.1).

If the change is uncertain or minor, the frequency of monitoring may be increased or other supplemental monitoring conducted to determine whether or not a change is actually occurring or is detrimental. The water resources and climatic data will be carefully scrutinized for any potential relationships or any potentially related change or trend.

As described in Part II Section A.2.1 and Section 4.1.3 (above), the central portion of Wetland W36 will be specifically evaluated to confirm that there are no significant negative impacts to the ecological features of this wetland in this area. The protection and evaluation measures for this area include:

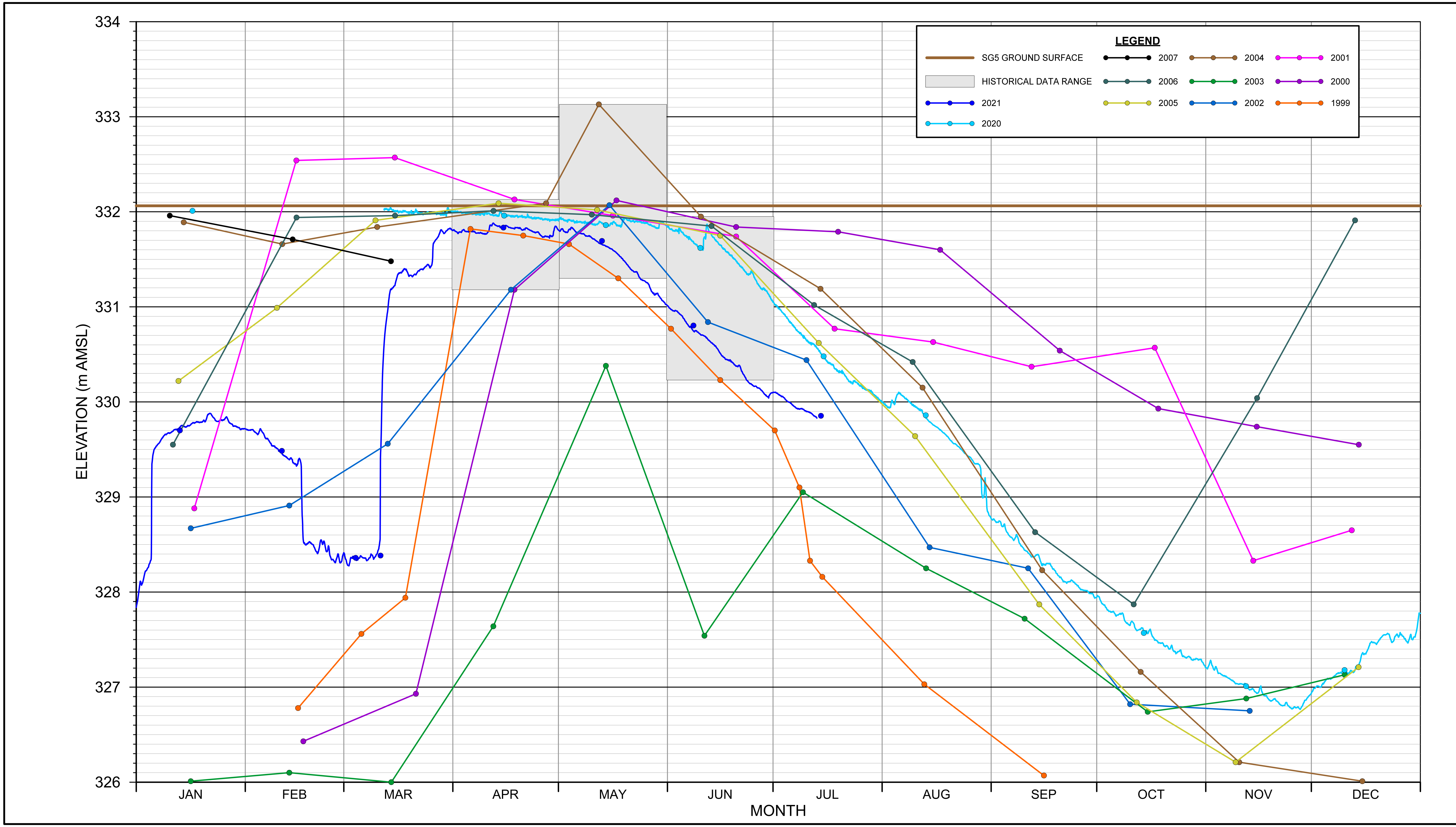
a) Groundwater level monitoring in monitoring well BH64 and comparison to historical water level conditions (refer to Section 4.1.3, above).

b) Mitigation measures will be operated with the objective of preventing a lowering of the groundwater level at BH64 during the spring period (April to June) as described in Section A.2.1. Agencies will be immediately notified if the groundwater level at BH64 drops below the monthly minimum historical level.

c) Surface water level monitoring will occur at staff gauge SG5 as described in Section A.2.2. This monitoring is generally for information purposes as this area of the wetland has been dry throughout 2020 and 2021.

d) Wetland ecology monitoring will occur in the vicinity of staff gauge SG5, including fixed-point photography, general wetland reconnaissance and wetland vegetation monitoring (one 10 m by 10 m plot; two quantitative monitoring stations).

e) In the event that an undesirable influence on wetland conditions is observed in the central portion of W36, an assessment will be provided to the agencies, including consideration of further potential mitigation measures that may include: increased groundwater recharge in the area (e.g., additional recharge wells and/or higher flows); increased flow to the diffuse discharges upstream in Wetland W36 (i.e., near SG57 and SG58); additional diffuse discharge installed in Wetland W36, or other measures. The assessment will also consider and compare a “no further action” alternative.



Note: - Measurements from 2003 appear anomalously low and have conservatively been removed from the historical range.

MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

SUPPLEMENTAL MONITORING WELL BH64
GROUNDWATER LEVELS

010978-200
Nov 18, 2021

FIGURE D.1

WAT File: \\ghdnet\ghd\CA\Waterloo\Projects\662\010978\Workshare\010978-REPORTS\010978-RPT-165 - AMP Addendum\010978-165-Part II\010978-165-Part II-Section D\Figure D.1 - BH64 Year-Over-Year.grf

Section E
Reporting

Part II – Section E Reporting

Table of Contents

Part II – Section E

Reporting

1. Introduction

The AMP includes both regular reporting and circumstance-specific reporting.

Regular reporting includes the annual monitoring report, the 5-year AMP review reports, and the ongoing provision of on-line data access as described in Section 2.0. The annual and 5-year review reports will be made available to the public by Dufferin. The on-line data access will be provided to designated agency technical representatives responsible for assessing Dufferin's implementation of the AMP. The following sections detail the reporting associated with the AMP for the MQEE.

Circumstance-specific reporting includes a pre-extraction report, a mitigation verification report, agency notifications, and other circumstances as described in Section 3.0.

For report submission timing, refer to Part I Sections 3.0 (AMP Requirements) and 4.0 (Ongoing Requirements).

Further information on these reporting requirements is provided below. Note: some of the information reporting may be limited in respect of privacy limitations (e.g., complaints).

2. Regular Reporting

2.1 Annual AMP Monitoring Report

The information related to the MQEE will be incorporated into the comprehensive Milton Quarry Annual Water Monitoring Report (AMR). This report documents the implementation and operation of the mitigation measures and recommendations for future mitigation system requirements in accordance with the AMP. The report will be submitted to the agencies by April 30 of each year covering the previous calendar year. The first report incorporating the MQEE will be for the calendar year following the year in which the licence, Site Plans, and all other necessary approvals are issued.

The information related to the MQEE will be presented and evaluated consistent with the existing reporting requirements under the AMP as described in Section 6.1 of that document.

2.2 5-Year Review Report

Once every 5 years, a review of the AMP performance is conducted for the existing quarry. This assessment considers all aspects of the AMP from a broader context than the annual review.

The MQEE will be incorporated into the AMP 5-year review report currently required by the AMP and submitted to the agencies for review as described in Part I Section 4.0. The information related to the MQEE will be presented and evaluated consistent with the existing reporting requirements under the AMP as described in Section 6.3 of that document. The extent of inclusion and analysis of the MQEE in the first such 5-year review report after MQEE licence may be limited due to the practical timing considerations of the report preparation.

2.3 On-Line Reporting

During the operation of bedrock extraction and/or mitigation measures, suitable monitoring data will be promptly entered into the current electronic database for Milton Quarry, which can be accessed on-line by the appropriate regulating agencies. The information that will be available on-line will include, at a minimum:

- All physical monitoring data such as groundwater levels, surface water levels, flows, and water quality. High frequency transducer data will generally be reduced (sub-sampled) to manage data set size. Some data for off-Site locations may be subject to privacy limitations
- Map of all associated monitoring locations
- Applicable target and minimum levels
- Summary of the current operating condition relative to those levels (e.g., green, yellow, or red zone) and any current occurrences or incidents as described in Part C
- Electronic copies of relevant public and agency reports and agency notifications
- Identification of key personnel and responsibilities as well as associated contact and site access information

Prior to commencing extraction below the bedrock groundwater level within the MQEE, the MQEE data will be made accessible through the on-line (i.e., internet accessible) data access tool to designated agency technical representatives.

3. Circumstance-Specific Reporting

To ensure that the implementation is conducted in a progressive, proactive, and protective manner with clear accountability, a pre-extraction report milestone and a mitigation implementation verification report milestone, as well as other circumstance-specific reporting requirements have been identified in Part I of the AMP Addendum. These requirements are described herein.

3.1 Pre-Extraction Report

A report will be submitted to document the MQEE pre-extraction requirements described in Part I Section 3. The pre-extraction report is required to be completed and submitted prior to extraction below the bedrock groundwater level in the MQEE.

The pre-extraction report will include:

- Location of selected "final" target and supplemental monitoring locations for the MQEE

- Selection of "final" targets for associated monitoring locations including associated analysis and confirmation that the targets are appropriate
- Location of background monitoring locations and existing supplemental monitoring locations
- Summary of baseline water level data for the MQEE, including historic ranges
- Summary of baseline ecological monitoring data for the MQEE
- Summary of key information from mitigation design and implementation verification for the MQEE
- Amount of water in storage in the Main Quarry Reservoir
- Appropriate recommendations, if any, to amend the AMP Addendum relative to available information

The mitigation implementation verification requirements are described separately in Section 3.2 below.

3.2 Mitigation Implementation Verification

Further to Part I of the AMP Addendum, the identified mitigation implementation milestone and associated requirements are described below:

For the groundwater recharge well system component, the verification will include:

- confirmation that there is connectivity between installed recharge wells (i.e., by individual recharge well operation and monitoring)
- Confirmation that all associated trigger wells can be influenced by groundwater recharge operations

For the diffuse wetland discharge components (Wetland U1 and the upper portion of Wetland W36), the verification will include:

- Confirmation that the water level can be raised in each of the 3 identified wetland pools (single pool area in Wetland U1 and 2 pool areas in vicinity of SG57 and SG58 in Wetland W36)

All information and data will be included in a verification report to be submitted to the agencies for review in advance of extraction below the bedrock groundwater level in the MQEE. To the extent that any components of the water management system are in a temporary condition (e.g., manual operation or overland piping) a timetable for permanent operating condition and assessment of suitability of operating with the temporary condition will be included in the verification report.

3.3 Agency Notifications

Agency notifications required pursuant to the response action plan described in Part II Section C will be provided by email (or other acceptable means) to the MNDMNRF ARA Inspector and other agency representatives as typically involved at the time of notification.

Notifications will also be recorded and maintained in the on-line data access tool described in Section 2.3 above.

3.4 Confirmatory Reporting Prior To Lake-Filling

Due to the variability associated with in-field conditions and climate conditions over the long-term, confirmatory studies will be conducted prior to the completion of rehabilitation in accordance with existing Extension Quarry AMP and Site Plans. If necessary suitable refinements, contingency measures, and/or monitoring can be implemented. This assessment will be submitted to MNDMNRF for agency review and circulated to other agencies to provide comments to MNDMNRF and Dufferin.

3.5 Other Circumstances

As necessary, other circumstances will be documented and reports submitted to MNDMNRF and other agencies.

Appendices

Appendix A
Updated Adaptive Environmental Management and Protection Plan (AMP) May 2003-Modified December 2011, Dufferin Aggregates Milton Quarry Extension

UPDATED ADAPTIVE ENVIRONMENTAL MANAGEMENT AND PROTECTION PLAN (AMP) MAY 2003-MODIFIED DECEMBER 2011

WATER RESOURCES AND RELATED ECOLOGICAL FEATURES

MILTON QUARRY EXTENSION
REGION OF HALTON, ONTARIO

Prepared For:
Dufferin Aggregates, a division of Holcim (Canada) Inc.

Prepared By:
Conestoga-Rovers & Associates in Association with Ecoplans Limited and Goodban Ecological Consulting Inc.

Prepared by:
Conestoga-Rovers & Associates

651 Colby Drive
Waterloo, Ontario
Canada N2V 1C2

Office: (519) 884-0510
Fax: (519) 884-0525

web: http://www.CRAworld.com

DECEMBER 2011
REF. NO. 010978 (74)

TABLE OF CONTENTS

TABLE OF CONTENTS

Page

<u>LIST OF FIGURES</u>
(Following Text)

<u>LIST OF TABLES</u>
(Following Text)

LIST OF APPENDICES

PLANNING HIGHLIGHTS

An Adaptive Environmental Management and Protection Plan (AMP) for the protection of water resources and related ecological features has been developed for the Extension of the Dufferin Aggregates Milton Quarry as summarized below:

- Extension Quarry employs mitigation measures to ensure protection of water resources and associated features.
- AMP manages the implementation and operation of mitigation measures as well as integration with quarry operations.
- Flexible system recognizes need to adapt to variable conditions in the natural environment and quarry operations.
- Domestic well water supplies of neighbours are protected and a baseline residential well monitoring program has been established. A specific monitoring and protection program has been defined for the one remaining private residential well in the study area.
- Water resources are protected by maintaining target groundwater levels at trigger wells located between the Extension and the water resources features.
- Protocols for setting and adjusting target levels are provided.
- Water quality monitoring and other supplemental monitoring are also established to provide a comprehensive monitoring and evaluation program.
- Demonstration and verification procedures are defined for the water management system.
- Response action framework is defined to provide a structured response to any conditions where target levels are not being suitably maintained, including agency notification.
- Response actions are defined for both routine and contingency conditions.
- The AMP is a condition of the operating licence.

EXECUTIVE SUMMARY

An Adaptive Environmental Management and Protection Plan (AMP) for the protection of water resources and related ecological features has been developed for the Extension of the Dufferin Aggregates Milton Quarry. The AMP forms the framework for managing the implementation and operation of the mitigation measures to ensure that water resources and associated features are protected. The AMP has been prepared by Conestoga-Rovers & Associates (CRA) in association with Ecoplans Limited and Goodban Ecological Consulting Inc.

Groundwater flow within the Amabel aquifer supports water resources in the study area, including private water supply wells, cold water fisheries, and wetlands. The Extension incorporates comprehensive mitigation measures to prevent any adverse effects on water resources from either a water quantity or water quality perspective. Under active quarry conditions, mitigation measures include a groundwater recharge system based on a series of recharge (injection) wells along appropriate segments of the quarry perimeter and drawing water from a storage reservoir. The groundwater recharge system will maintain the natural groundwater levels around the quarry and beyond. Quarry rehabilitation will involve the creation of three lakes in separate quarry cells. These lakes will serve to passively maintain surrounding groundwater levels and associated water resources. Some active management of water will continue post-rehabilitation, to ensure the lake levels are maintained at appropriate levels and may also include localized seasonal groundwater recharge to the east.

The purpose of the Adaptive Management approach is to recognize the inherent variability in the natural environment, and implement a flexible system of mitigation and monitoring to ensure the mitigation measures provide ongoing protection of water resources. The AMP is based on the planned implementation of proven mitigation measures, and an organized process of design, implementation, monitoring, evaluation, and optimization for the active operation and quarry rehabilitation periods.

The AMP establishes the water resources monitoring program for the Extension. The monitoring components are summarized in Table 1.1. The key performance monitoring aspect for the mitigation measures for the Extension is to maintain groundwater levels at defined trigger monitoring wells that ensures protection of the adjacent water resources and associated features.

Target water levels are required for trigger monitoring wells to regulate the performance of the mitigation measures. The AMP establishes the protocol for defining appropriate

target levels, as well as the methodology for adapting them in the future in response to changes in any relevant factors, including any climate change.

It is also necessary to ensure that the quality of recharged water is acceptable for the protection of adjacent water resources. Water quality monitoring and other supplemental monitoring programs are defined in the AMP to provide a comprehensive monitoring and evaluation program.

The AMP focuses on the protection of ecological water resources as they are more sensitive to water level variations than water supply wells, therefore the protection of ecological features generally provides protection of water supply wells. Dufferin is fully committed to protecting the water supplies (both quantity and quality) for neighbours as is currently done under the domestic well program for the Milton Quarry.

The AMP includes measures to ensure the proactive construction, demonstration, and verification of the water management system. A response action framework is defined to provide a structured response to any conditions where the target levels are not being suitably maintained, including agency notification.

The AMP is a condition of the operating licence. The AMP includes measures to be taken both on a routine basis and as contingencies should water levels in trigger wells approach or fall below their pre-determined target levels; including the cessation of extraction.

The AMP provides a reliable basis for the effective implementation of mitigation measures for the Extension. Based on the overall design, mitigation measures, and the operating basis provided by the AMP, the important water resources and ecological features on the adjacent lands will be protected. Therefore, the Extension of the Dufferin Milton Quarry is acceptable from water resources and ecological perspectives.

1.0 INTRODUCTION

Dufferin Aggregates, a division of Holcim (Canada) Inc., has obtained a Licence to extend the existing Milton Quarry in the Region of Halton, Ontario (the "Extension" or "Extension Quarry"). Extensive field investigations, analysis, and design have been conducted in support of the Extension. An important component of the mitigation measures for the Extension is an Adaptive Environmental Management and Protection Plan (AMP) for the overall protection of water resources and related ecological resources. The AMP is described in this document (including the following text and associated figures, tables, and appendices) that has been prepared by Conestoga-Rovers & Associates (CRA) in association with Ecoplans Limited and Goodban Ecological Consulting Inc.

This December 2011 AMP replaces the previous (May 2003) version. This revision has been undertaken to integrate i) the Joint Board and Cabinet conditions from the Extension approval; and ii) changes previously agreed to by Dufferin and the Ontario Ministry of Natural Resources (MNR), the Region of Halton, and Conservation Halton.

Groundwater flow within the Amabel aquifer supports water resources in the study area, including private water supply wells, creek systems and related fisheries, and wetlands. The Study Area is defined by the limits of the hydrogeologic boundaries as described in Section 6 of the Water Resources Assessment Report (CRA, May 2000). The Extension design incorporates proactive mitigation measures to prevent any adverse effects on water resources and related ecological features. The AMP forms the framework for managing the implementation and operation of the mitigation measures to ensure that water and ecological resources are protected.

The AMP focuses on the protection of ecological water resources as they are more sensitive to water level variations than water supply wells, therefore the protection of ecological features generally provides protection of water supply wells. Dufferin is fully committed to protecting the water supplies (both quantity and quality) for neighbours as is currently done under the domestic well program.

This document defines the AMP for the Extension. An AMP update chronology is presented in Appendix H. The relevant monitoring installations, data collection, and specific target levels are to be established in accordance with this document following issuance of the licence (issued February 2007). The AMP should be considered in conjunction with the following documents that are listed in order of their hierarchy[1]:

1. Aggregate Resources Act Site Plans prepared by MacNaughton, Hermsen, Britton, Clarkson Planning Limited (MHBC) - and approved under Licence No. 608621, 2007 or as amended from time to time subject to approval by MNR.
2. Ontario Water Resources Act (OWRA) Approvals (PTTW and C of A) - Instruments in effect at that time.
3. Updated Adaptive Environmental Management and Protection Plan (AMP). Prepared by CRA in association with Ecoplans and Goodban Ecological Consulting Inc., as may be modified and/or updated in accordance with the above documents and Legal Agreements with the Region of Halton and Conservation Halton.
4. Adaptive Environmental Management and Protection Plan (AMP). Prepared by CRA in association with Ecoplans, August 2001.
5. Water Resources Assessment Report, CRA May 2000.
6. Dufferin Aggregates Milton Quarry Extension Environmental Impact Assessment, Ecoplans, May 2000.

The AMP is organized into the following Sections:

- Section 1.0 - Project and AMP overview;
- Section 2.0 - Mining and Mitigation Timing;
- Section 3.0 - Performance Monitoring and Response Program;
- Section 4.0 - Supplemental Monitoring Program;
- Section 5.0 - Procedures for Minor Variations; and
- Section 6.0 - Reporting.

---

1 The *Aggregate Resources Act* Site Plans and *Ontario Water Resources Act* Approval (PTTW and C of A) are equivalent in the document hierarchy (i.e., neither approval can override the other).

1.1 PROJECT OVERVIEW

Dufferin Aggregates has obtained a licence for an extension of the Milton Quarry in the Region of Halton, Ontario. The Extension is located north and northeast of the previously existing Main and North Quarries in the Towns of Milton and Halton Hills as shown on Figure 1.1. The Extension is located above and to the west of the Niagara Escarpment.

The Extension has an area of approximately 82 hectares (ha), of which approximately 65 ha is for extraction. Dufferin also owns large areas of buffer lands around the previously existing and Extension Quarry areas, as shown on Figure 1.2. The Extension will be mined in three phases, as shown on Figure 1.2:

- Phase 1 – Extension of the North Quarry Cell;
- Phase 2 – West Cell (north of rock pillar dividing North Quarry and West Cell); and
- Phase 3 – East Cell (east of Townline Road).

The aggregate resource that is being extracted is the high quality dolostone of the Amabel Formation and the thin underlying dolostone of the Reynales Formation. The maximum potential reserve in the Extension is approximately 60 million tonnes, which extends the life of the Milton Quarry by approximately 10 to 12 years.

The mining plan includes the dewatering of the Extraction Cells. Groundwater flow within the Amabel aquifer system supports water-based resources in the study area, including private water supply wells, creek systems and related fisheries, and wetlands. The Extension incorporates comprehensive mitigation measures to prevent any adverse effects on water resources from either a water quantity or water quality perspective.

Under active quarry conditions, mitigation measures include a groundwater recharge system based on a series of recharge (injection) wells along appropriate segments of the quarry perimeter and water supply from a large storage reservoir. The groundwater recharge system will maintain the natural groundwater levels around the quarry and beyond, thereby protecting all water resources from quarry dewatering influences.

A North Quarry recharge system was implemented in 2000 using a recharge pond. In 2007, the recharge pond system was replaced by a recharge well system. Dufferin had previously conducted extensive recharge well testing at the Milton Quarry. The North Quarry and Extension recharge components are integrated into an overall water management system for Milton Quarry. The reservoir for recharge water is a component of the Main Quarry rehabilitation plans which Dufferin has implemented on the west side of the Main Quarry.

Quarry rehabilitation will involve the creation of three lakes in separate quarry cells (North, West, and East Cells/Lakes). These lakes will serve to passively maintain surrounding groundwater levels and associated water resources. Some active management of water will continue post-rehabilitation to ensure the lake levels are maintained at appropriate levels and may also include localized seasonal groundwater recharge to ensure the appropriate seasonal fluctuation of water levels in the wetlands to the east of the Extension are maintained.

1.1.1 GOAL OF THE AMP

The goal of the AMP is to form a framework for managing the implementation and operation of the mitigation measures to ensure the water resources and related ecological features are protected as discussed further in Sections 1.2 and 1.3. Further information on the water resources, mitigation measures, and associated impact assessments can be found in the previously referenced reports.

1.2 ADAPTIVE MANAGEMENT PROGRAM

The purpose of the Adaptive Management approach is to recognize the inherent variability in the natural environment. Rather than implement a "static" design which may not be the optimal system for the actual conditions encountered, an adaptable system has been developed which can be expanded or optimized based on observed performance ensuring superior overall mitigation. This approach is widely accepted in ecology and geology-related fields, which are affected by natural variations. It is commonly referred to as Adaptive Environmental Management (CVC, 1998) or the Observational Method (Morgenstein, 1994).

The Adaptive Environmental Management method facilitates addressing the uncertainty in the detailed mitigation implementation requirements through an organized process of design, implementation, monitoring, evaluation, and optimization as illustrated on Figure 1.3. The mining and mitigation plans for the Extension require an Adaptive Environmental Management approach due to the spatially large extent, the gradual development over time, and the natural variability of both the hydrogeological and biological conditions.

The AMP addresses the aspects of the Extension which directly relate to the protection of water resources. The principal focus of the AMP is the period preceding and during the operation of the active mitigation measures (i.e., the groundwater recharge system). Rehabilitation conditions are provided for within the AMP. However, the detailed plans for final rehabilitation and any need for limited ongoing recharge and monitoring will be reassessed/refined as part of the overall monitoring/mitigation program as the quarry is developed and when the final stages of lake filling are approached as described in Section 2.0. This assessment will include further water budget review and refinement and consideration of any potential effects of global climate change that may be much better defined at that time than they are at present. These analyses may be used as a basis for further refinement of the rehabilitation plan in the event that conditions indicate a revised plan would be of greater overall benefit to the water resources and associated features.

As presented in the Water Resources Report, the primary design objectives for the mitigation measures are to:

- Maintain residential water supplies;
- Maintain the existing groundwater levels as required to ensure the natural features and organisms which are directly dependent on groundwater (refer to Tables 1 and 5 in Ecoplans, 2000) are not adversely affected in the short-or long-term from the development of this quarry extension;
- Maximize the degree of "passivity" of the mitigation measures; i.e., minimize the complexity and degree of engineering works/controls required, over the long term;
- Ensure the mitigation measures are "adjustable" and responsive, and can be fine-tuned to adapt to specific needs over time, based on an integrated monitoring and contingency program; and
- Consider functions and values of the environmental receptors in the context of the broader natural systems.

The principal purpose of the mitigation measures is to maintain groundwater levels around the perimeter of the Extension and thereby protect surrounding water resources (including water dependent ecological features and private water supply wells). Maintaining natural groundwater levels adjacent to the extraction limits will ensure that the proper groundwater levels and flows are sustained for the water resource features beyond, as documented in the Water Resources Assessment Report (CRA, 2000). Therefore the water resources features around the Extension will not be subject to unmitigated dewatering influences and the definition of a dewatering zone of influence is not relevant or necessary for the protection of water resources features.

The driving factor for the need for the mitigation measures (particularly the groundwater recharge system) are the water dependent ecological features (creek and wetlands) which are more sensitive to groundwater changes than water supply wells. Given the nature of the water resources in the vicinity of the Extension, the relatively deep and prolific nature of the Amabel Aquifer, the nature of the quarry dewatering influence, and the extensive "buffer" lands owned by Dufferin, private water supply wells will be fully protected with no or little direct mitigation (i.e., groundwater recharge). The protection of the natural environmental features will result in additional protection of the potentially affected private water supply well in the study area via the associated groundwater recharge which will maintain groundwater levels beyond the quarry perimeter.

Regardless, Dufferin is fully committed to protecting the water supplies (both quantity and quality) for neighbours as is currently done under the existing domestic well program. One landowner with a water supply requirement is adjacent to the existing North Quarry (identified as domestic well DW103 on Figure 3.1) and that water supply will be protected by the programs in place for the North Quarry. Section 4.6 of this report documents the residential well monitoring/protection program under this AMP for the Extension. The Tooming (DW113) property has been acquired by Dufferin (closed in 2003) and therefore, the further measures to ensure that water supply previously identified (in the Water Resources Assessment Report, (Section 9.5.1, CRA, May 2000) are no longer applicable.

The groundwater recharge system will be installed around the perimeter of the Phase 2 and Phase 3 quarry cells prior to Dufferin undertaking any extraction activities in these areas[2,3]. This proactive implementation will ensure that the mitigation measures are in

---

2 The installation of mitigation measures prior to any extraction reflects a small but important change from the original plan for mitigation measures as documented in the Water Resources Assessment Report (refer to Section 9.3.1). The change provides a higher degree of water resource protection and simplifies the AMP.

The original plan was to utilize a series of Sentry wells near the limit of extraction to provide forewarning of the need for the groundwater recharge system operation, prior to any appreciable affect at the water resources as monitored by the series of Trigger Wells. Upon lowering of the water level below a prescribed target level at the sentry wells, Dufferin would have constructed the groundwater recharge system in the affected area.

The revised plan, as presented in the AMP, incorporates a commitment by Dufferin to implement (i.e., construct) the groundwater recharge system prior to proceeding with any extraction in the West or East Cell. This proactive implementation does away with the first purpose of the AMP which was to determine the need and timing to implement (i.e., construct) the groundwater place and operational, prior to any potential influence on water resources. Phase 1 of the Extension is a minor extension of the existing North Quarry Cell, and the need for any mitigation measures will be addressed in conjunction with the North Quarry operations.

Given that the principal objective of the mitigation measures is to maintain groundwater levels around the perimeter of the Extension, the principal focus of the AMP is ensuring that this objective is achieved. This is accomplished by establishing a series of trigger wells beyond the quarry extraction perimeter adjacent/near to the water resources, and ensuring that pre-determined "target" water levels are maintained in these wells. The trigger wells will monitor groundwater conditions as close to the protected features as is practical. A decline below target levels at the trigger well will be the "trigger" to commence (or adjust) operation of the relevant portion(s) of the groundwater recharge system as described further in Section 1.3.

The target water levels for the trigger wells will be established based on natural conditions observed from the monitoring data, prior to extraction in Phase 2 of the Extension. It will be assumed that a reduction below the prescribed level will necessitate mitigation. These water levels will be determined based on a minimum 3-year data history for these wells.

In order to ensure no adverse effects from any potential change in water quality resulting from groundwater recharge, objectives for acceptable water quality are also defined for the recharge water. Further supplemental monitoring programs are also established herein, to ensure that all relevant aspects of water resources protection are appropriately considered.

---

recharge system based on the monitoring of a series of sentry wells. The second purpose of the AMP to manage the operation of the mitigation measures remains in effect and is the focus of this document.

Specifically, the mitigation implementation procedures for the construction of the recharge system are not required as previously anticipated, since the system will be installed in advance of extraction (as explained in this report). Evaluation of water level data from the pre-installed recharge wells or recharge monitoring wells, along with other existing monitoring wells (refer to Section 4.1 herein) will, be used as a "sentry" system for mitigation operations to provide a forewarning of the need to initiate/adjust the operation of the recharge system. The term "sentry wells" within the Water Resources Assessment Report (CRA, May 2000) has therefore been amended to the term recharge monitoring wells as described in Section 4.1.

1.3 MITIGATION IMPLEMENTATION/RESPONSE ACTION FRAMEWORK

The water resource mitigation measures will be operated as described in this AMP under the authority of various public agencies. Throughout the AMP, the term "agencies" is used. Agencies refers to the Ministry of the Environment (MOE), the Ministry of Natural Resources (MNR), the Region of Halton (Halton), Conservation Halton (CH), and any other agency to the extent it has authority over the AMP either through operation of law or through separate legal agreement with Dufferin.

As previously described, the groundwater recharge system will be installed in a proactive manner to ensure it is available when required. Flowcharts (Figures 1.5 to 1.7) have been developed to define how the performance will be: demonstrated upon completion of construction; verified on an annual basis before it is in operation; and evaluated under operating conditions. A chart (Figure 1.8) has also been prepared to establish timelines for taking response actions and a minimum water level threshold. These three procedures and the response action chart are described herein.

Demonstration Procedure (Pre-extraction) - Flowchart A (Figure 1.5):

This procedure sets out the demonstration testing that will be carried out following completion of the groundwater recharge system, prior to any bedrock extraction[3] occurring in Phase 2 or Phase 3 of the Extension. The purpose of the testing procedure is to demonstrate that the recharge system is capable of operating as designed and can recharge and distribute water appropriately into the ground.

Prior to conducting the demonstration testing and as soon after installation as practical, hydraulic connectivity testing of each trigger well must be successfully completed. The hydraulic connectivity testing shall include the completion of a trigger well response test (i.e., a single well response test such as a slug test, recovery test, or other suitable test) to ascertain whether the trigger well has a hydraulic connection to the aquifer. In the event that a trigger well does not exhibit a hydraulic connection, appropriate response actions will be completed prior to commencement of any bedrock extraction in Phase 2 or Phase 3. Such actions could include, but are not limited to: a) hydraulic development of the trigger well and retesting, or b) replacement of the trigger well and retesting. MNR

3 Extraction in the context of the AMP does not include excavation related to Site preparation, berm construction, installation of mitigation systems, overburden stripping, or rock extraction for development of the sinking cut (above the water table). However, the phrases "extraction limit" and "limit of extraction" herein, typically refer to the limit of extraction defined on the Site Plans.

is to be notified in advance of commencement of the testing and the documented results provided to the MNR, Halton and CH.

The recharge demonstration program[4] will be conducted as a test (or tests) with the specific objective of demonstrating that the recharge system can raise the groundwater levels at specific recharge monitoring and trigger wells. In the event that initial demonstration testing can not verify a response to groundwater recharge (i.e., injection) at nearby trigger wells due to limited available height for groundwater mounding in the Amabel Aquifer, the demonstration program will be repeated in the subject area when observable drawdown has occurred along the recharge alignment (e.g., greater than 1 metre drawdown at recharge wells). The demonstration testing will also include monitoring of water temperature at appropriate locations and assessment of any thermal effects that may be measured.

In the event that demonstration testing does not verify a response to groundwater recharge at nearby trigger well(s), tracer testing as described in Appendix G or other appropriate measures will be undertaken to assess the situation.

Annual Verification Procedure
<u>(Prior to Sustained Recharge Operation) - Flowchart B (Figure 1.6)</u>:

The annual verification procedure will ensure that the mitigation system remains capable of full operation and can raise water levels to a prescribed level during the period following construction and before the recharge system is operating on a sustained basis (i.e., dewatering is occurring but water levels remain above target levels in trigger wells without recharge system operation).

The verification procedure will also be conducted for an area which experiences a significant and abrupt change in water levels at recharge monitoring wells that is or is likely to be related to quarrying activities. A significant and abrupt change will be determined relative to the observed hydrogeologic response to quarry development at the recharge monitoring wells as well as the results of the pre-extraction recharge testing

---

4 There will be specific monitoring of pre-test, during testing, and post-testing of recharge results specifically designed to assess the effectiveness of the systems. Dufferin will inform the agencies of the testing plans prior to initiating the test(s). It is recognized that the demonstration monitoring requirements will vary at different locations and may vary over time due to climatic conditions and the quarry activities. Essentially the program will mimic a traditional pumping test program. Generally the monitoring will be conducted on a diminishing frequency basis with the initial measurements taken more frequently in closer proximity to the recharge system. Baseline measurements will be taken before the start of the test. The results for completed tests and ongoing monitoring data will be used to refine the subsequent monitoring activities.

results. As an initial guideline, a drop in groundwater levels at the recharge monitoring wells of 3 metres (or more) over a period of 1 month will be considered to be a significant and abrupt change. As data becomes available from the monitoring stations (includes existing monitoring wells and recharge monitoring wells that are to be installed) this information will be used to verify whether 3 metres is an appropriate change to initiate the verification test procedures for any given location at the Site.

The verification program will be conducted in a testing manner similar to the previously described demonstration procedure.

Verification also includes implementing a prescribed range of actions including routine maintenance or modifications to the recharge system and contingency responses to ensure the system is capable of performing as designed. Refer to Section 3.1 for further information on response actions.

Operation Verification Procedure
(Under Sustained Recharge Operation) - Flowchart C (Figure 1.7):

Once the recharge system is being operated on a sustained basis, the annual verifications will be redundant and the operation verification procedure will be in effect. This procedure describes the ongoing verification that the operating mitigation system is performing as designed with respect to both water levels and water budget considerations. Appropriate response or contingency actions will be implemented on a proactive basis to ensure that the environment is protected.

Response Action Chart (Figure 1.8):

The response action framework has been defined as summarized on a chart (Figure 1.8) and described below. The framework/chart provides further clarification of the operating conditions, as well as triggers for response actions and notification to be provided to the agencies.

The response actions include three operating zones[5] or conditions based on the measured water level relative to the target and minimum levels (refer to Section 3.1).

5 During the transition between seasonal periods (nominally 2-week transition as described in Section 3.1.3.1) it is understood that there will be a transition of water levels from one period to the next period. For the purposes of the response action framework described herein, the applicable target and minimum levels will be considered to be the lower of the levels for the two periods related to the transition. Following the transition period, the new target/minimum level will apply. If the measured water level is below the target level at the transition time and the subsequent target level is lower than the target level prior to the transition, the operator must verify that the system can maintain (refer to Flowchart B, Figure 1.6) the higher target level at

These zones (and water levels) will be applied to individual trigger wells as described below and illustrated on Figure 1.8.

Green Zone: When the measured trigger well water level is at or above the target level[6], the performance objectives are being met and no response action is required or triggered (i.e., normal operations can continue subject to the other monitoring requirements and the procedures described above relative to Flowcharts A, B, and C).

Yellow/Red Zone: A trigger well water level which drops below the target level will initiate a series of appropriate response actions designed to address this situation.

Operation in the yellow zone is not a short-term (acute) ecological consideration as the water levels remain above the historic minimum levels; however, long term recurring operations in the yellow zone may have ecological considerations. The potential influence of, and any response to, any repeated short drops below the target levels will be evaluated as part of the overall water management system performance assessment completed as part of the annual and 5-year reviews described in Section 6.0.

a) Upon identification of a trigger well water level below the target level, the operator will commence implementation of appropriate response actions. This may include verification of the available data[7].

b) If the water level is below the target level and remains below for a period of 1 week or more, an "occurrence"[8] will be recorded for the affected trigger well(s) and the agencies will be notified[9] of this occurrence.

c) If the water level drops below the midpoint between the target and minimum levels, the agencies will be notified as well as provided with information on the conditions and actions being undertaken. In this case, the minimum water level may also be verified[7] relative to the background water level data to determine

---

least 1 month prior to next seasonal increase in target level. The overall performance assessment described in Section 6.0 will review the long-term appropriateness of the actual operating practices during the transition periods and identify refinements, if appropriate.

6 Water levels measurements and target/minimum level calculations will be recorded to an accuracy of 1 centimetre.

7 Data verification activities are not considered to be operational requirements but rather good operating practices.

8 The term "occurrence" as used in this context does not imply any breach of the AMP or any law, but is a situation which, pursuant to the AMP, requires notification to agencies and response action.

9 Notifications referenced in this section will be provided within 3 business days of the observed event requiring notification.

whether an adjustment is appropriate based on the background data collected to date (refer to Section 3.1.4).

d) If the water level remains below the target level for a period of 4 weeks or more (i.e., 3 weeks after an occurrence is recorded) the agencies will be notified[9,10] and will be provided with information on the conditions and the actions being taken to address the situation.

e) If the water level remains below the target level for a period of 8 weeks or more (i.e., 7 weeks after an occurrence is recorded) this will be considered an "incident" and extraction (and Site preparation) that causes further dewatering in the affected area will cease and the procedure described in Appendix F (aggregation) will be initiated. The agencies will be notified (within 3 business days) of the incident as well as provided with an update on the conditions and actions being undertaken to address the situation. As further precautionary measures, the timeframes under action item d and action item e (above) will be temporarily reduced as described below (refer to Flowchart D - Figure 1.9):

    i) After a cessation of extraction has been required under action item e (i.e., the 8-week period) the operating response periods for items d and e will be reduced from 4 and 8 weeks, to 2 and 4 weeks, respectively for the same affected trigger well(s). In the event of a second cessation of extraction for the same affected trigger well(s) under action item e (i.e., while reduced timeframes are in effect), the operating response period for items d and e will be reduced from 2 and 4 weeks, to 1 and 2 weeks, respectively for the affected trigger well(s). The timeframes will not be reduced below these levels.

    ii) The operating response periods for items d and e will be reset to 4 and 8 weeks, respectively, following an appropriate period during which there is no "occurrence" for the affected trigger well(s). This period will be initially established as 3 months in a step-wise manner (i.e., 3 months to reset the operating response period from 2 weeks to 4 weeks, and another 3 months to reset from 4 to 8 weeks). During this period, the mitigation measures must be operating such that the associated trigger well target levels are being readily maintained. This period may be reviewed in the future based on available performance monitoring data.

f) In addition to the actions described in item e (above), Dufferin must continue to assess/implement measures to ensure that the situation that resulted in the cessation of extraction has been addressed. These measures include

10 If notification has already been issued under item c for the same occurrence, the 4-week notification is deemed to have been made.

development of both short-term and/or long-term mitigation measures, including rehabilitation[11], in consultation with the agencies. In order to recommence extraction, Dufferin must ensure (through performance monitoring as reviewed by the Agencies) that the area has been mitigated, that continued extraction and mitigation operation is sustainable over the long term, and the system has been operating within the green zone for a period of 1 week or more, in the affected area.

Red Zone: If the measured water level falls below the verified seasonal minimum level, the following procedures will apply:

1. If the measured water level remains below the verified seasonal minimum level for more than 1 week, Dufferin must cease extraction that results in further dewatering in the affected area, as well as follow the actions and timeframes defined above.
2. If the measured water levels in 2 or more trigger wells within a contiguous 300-metre length of a sensitive cold water fishery area of Sixth Line Tributary (i.e., within Reaches B, C, D, and the channel portion of E – refer to Figure 3.1) are below the minimum level, extraction that results in further dewatering in the affected area will immediately cease[12] once an "occurrence" is recorded.

---

[11] Rehabilitation measures may include committing to one (or more) of the following courses of action or alternative actions, undertaken on a timely basis:

i) Construction of a buttress against the quarry wall in the affected area. The buttress may be for the sole purpose of reducing the rate of groundwater seepage into the quarry in the affected area. If the buttressing is designed/able to reduce seepage into the quarry such that the groundwater target levels in the affected trigger wells can be achieved, then bedrock extraction activities can recommence (once the target levels have been met). To the extent necessary and appropriate, such re-commencement of extraction will include reasonable measures to prevent the re-occurrence of the previous difficulty in maintaining water levels. For example, the buttressing may be a temporary measure allowing other measures to be implemented (e.g., grouting near recharge alignment) such that the temporary buttress can be removed and bedrock extraction resumed.

ii) If the buttressing or some other appropriate measure(s) does not result in the target levels being achieved then water filling of part or all of the cell will be considered. Water filling in part of the cell could include subdividing the affected cell (e.g., permanent or temporary hydraulic separation by a rock pillar or constructed dyke/dam) and allowing the affected area to flood. Alternatively, the whole cell (to the extent extracted) may be rehabilitated and flooded.

[12] The requirement to immediately cease extraction shall be understood to mean the extraction is to cease within 1 day or at the earliest possible opportunity thereafter, recognizing practical safety considerations of quarry operations.

3. If the water level drops below the minimum level after an occurrence is recorded (for the same event), agency notification will occur immediately[9].

The Site Plans allow for a final extraction limit that is typically 15 metres from the licence limit. This extraction setback includes the groundwater recharge alignment along portions of the Phase 2 and 3 perimeters. As the mining approaches the extraction limit in the areas adjacent to the recharge alignment, additional proactive measures will be taken to confirm that extraction can continue with a high degree of certainty that the mitigation measures are providing efficient protection of the water resources. These measures which supplement those presented on Flow Chart C (Figure 1.7) and Figure 1.8 are described below.

1. Water level monitoring in the appropriate trigger wells and at least two recharge monitoring wells (along the Section of the advancing working face of the quarry) will be increased to at least once per day (refer to Section 3.1.2) unless the monitoring system has been automated (i.e., is already at/above this frequency) in this area; and
2. As part of the ongoing management of the water system and integration with the overall extraction operations the recharge system will be verified to have sufficient available capacity to increase the combined flow rate of the recharge wells by approximately 50 percent above the current operating rate (or previously required operating rate, whichever is greater) along a length of twice the advancing face length (i.e., the portion of the recharge alignment parallel to the actively advancing portion of the working face plus one-half this length at either end).

The above procedures will provide the safeguards necessary to ensure that the mitigation system is effective and thus the off-Site ecological features are protected.

The on-Site wetlands (W7, W8, V2) as shown on Figure 1.2 (also refer to Figure C.1) will be protected. The specific mitigation and monitoring measures for the on-Site wetlands are included in the water management system as detailed in Appendix C.

In order to maintain the groundwater mitigation systems operating at acceptable levels it will be necessary to proactively monitor the system and anticipate when enhancements to the recharge system will be required. In some instances it may be desirable to move away from an active working face in a particular area for a period of time in order to provide additional time to undertake preventative measures (e.g., install and test the groundwater recharge system enhancements) prior to further extraction in that area. The Phase 2 cell is of limited extent and it may not be practicable (from an operations perspective) to have multiple working faces during certain times of the extraction within this phase (e.g., when both lifts have been opened and the quarry has progressed beyond the mid point in a northerly fashion). Therefore, it is desirable as part of the AMP to have the option to temporarily move extraction into Phase 3 prior to fully completing extraction in Phase 2. A protocol for conducting interim Phase 3 extraction on a temporary basis is presented in Appendix D. Protocols for proceeding with the Phase 3 sinking cut and transition of full production extraction to Phase 3 are also included. Notification of transitions from Phase 2 to Phase 3 will be provided to the agencies.

The monitoring data collected in accordance with the AMP will be promptly entered into an electronic database[13]. This database will be made available on-line to the agencies in a remote access format so that current monitoring/performance information is accessible to the appropriate technical agency staff at all times. The appropriate technical agency staff may audit the data collection activities and methodologies, including accompanying the operator during routine monitoring activities.

1.4 CONTEXT FOR AMP AND FUTURE UPDATES

The AMP provides for an appropriate and proactive performance monitoring program for the Extension and provides the overall operational performance requirements for the mitigation systems. However, it must be recognized that in some cases the AMP requirements as currently documented are advanced beyond the level of monitoring data or engineering detail that is available at this time. Some of the actual supporting data and/or engineering design will not be available until following the issuance of the ARA Licence and the OWRA approvals. Therefore some of the aspects of the AMP are based on concepts of how the hydrogeologic system will perform, and it is expected that some parameters will vary based on data collected (e.g., when all the monitoring and trigger wells are installed and a data history is established) and therefore these aspects of the AMP will be refined when actual "hard data" is available. A pre-extraction report will be prepared to provide an update on information available prior to extraction in Phase 2 of the Extension (refer to Section 6.2).

13 The details of specific timing and means of access to the database will be discussed with and submitted for review by the agencies following the issuance of the licence and/or the OWRA approvals.

It is important to recognize that some natural variations will occur in the hydrogeologic conditions encountered and hence in the monitoring data. As the monitoring programs and mitigation measures are implemented and detailed operational information is obtained, the operator may adjust or make minor variations to the technical/operational aspects of the monitoring programs and/or mitigation measures as described in the AMP to address the existing conditions and practical considerations at that time. Some of these minor variations may need to be undertaken in a "real time" perspective. The procedures for making such minor variations are described in Section 5.0.

In some instances it may be necessary to make amendments to the AMP itself. Some amendments to the AMP may also need to be done in "real time" and in such circumstances any agency review would have to be undertaken in a short period of time. The procedures for making amendments to the AMP are described in Section 6.0.

1.5 ORGANIZATION OF AMP

The AMP consists of three principal components as follows.

1. **Mining and Mitigation Timing**

   The mining plan and mitigation measures will be implemented and operated over an extended period of time. Key aspects of these two highly interrelated components of the Extension are documented (Section 2.0) to ensure consistent understanding by all parties over time, so that they progress in an appropriate order.

2. **Performance Monitoring and Response Program**

   The Performance Monitoring Response Program includes the monitoring and response action components to ensure the long-term protection of water resources. The key performance monitoring aspect is to maintain groundwater level targets at trigger wells. It is also important to ensure that acceptable water quality is maintained in the recharge water. The AMP (Section 3.0) provides a defined program for these components, including how to establish/adjust target levels and appropriate monitoring response actions to be taken to ensure that targets are met.

3. **Supplemental Monitoring Program**

   The Supplemental Monitoring Program provides additional monitoring/evaluation components which are not directly related to ensuring the protection of water resources but may provide supplemental information or indicate issues that require further consideration/assessment. For these components, the AMP provides a defined program for monitoring, evaluation, and assessment of the need for any response actions.

The above three components are presented in the corresponding Sections 2.0, 3.0, and 4.0 of the AMP.

Climatic Variations Terminology

The following terms are utilized in the AMP in reference to variations in climatic conditions:

- **Seasonal:** Variations that occur during the course of the year (e.g., winter versus summer);
- **Cyclic:** Variations that occur from year-to-year, consistent with observed historical behaviour (e.g., wetter or dryer years) but without a identifiable trend in the long-term mean (average) conditions;
- **Long-Term:** Variations that occur over a large number of years or decades which result in a significant change in the long-term mean (average) conditions. May also be referred to as global climate change/variation; and
- **Climatic Variations:** Generally used to collectively refer to the types of variations described above.

2.0 MINING AND MITIGATION TIMING

2.1 GENERAL

This section presents an outline of the sequence and integration for the mining plan and mitigation measures. This will ensure that the mining plan and mitigation measures are properly phased and integrated to ensure the protection of water resources over the operating life[14].

The Extension will be extracted in three distinct phases as described on the Site Plans and summarized below (refer to Figure 1.2). Some overlap will occur when production is developing a new phase and closing out in a completed phase. Interim bedrock extraction from Phase 3 is allowed during Phase 2 extraction in accordance with the purpose identified in Section 1.3 and the protocol presented in Appendix D. Mining of the dolostone will generally be completed in two extraction lifts, while a third lift may be used upon occasion (e.g., excavation depth greater than 30 metres or to mine the Reynales separately).

Phase 1 - North Quarry Cell

The Phase 1 extraction involves the extension of the North Quarry to extract the rock in the two portions of the West Extension that are contiguous to the North Quarry. These include the area at the southeast corner of the North Quarry (i.e., extending the North Quarry to Town Line) and the area along the north perimeter of the east half of the North Quarry up to the rock pillar alignment. The combination of the North Quarry and the Phase 1 West Extension areas is referred to as the North Quarry Cell. Mining within 50 metres of the footprint of the rock pillars will be in accordance with the detailed engineering design for the pillars[14].

Phase 2 - West Cell

The Phase 2 extraction involves the development of the separate cell on the north side of the rock pillar west of Town Line. The sinking cut will be generally advanced in the southeast area of the West Cell and mining will proceed in a northerly and then westerly direction. During the 3-year period of baseline water level data collection for target level determinations (prior to extraction in Phase 2), overburden removal and any sinking cut

---

14 The purpose of Section 2.0 of the AMP is not to provide complete mining and operations plans, as these are documented on the Site Plans. Detailed engineering design of the mitigation measures and rock pillars will be completed following issuance of the Licence for the proposed Extension.

development above the water table in preparation for Phase 2 extraction will be limited to the Phase 2 Site preparation area shown on Figure 2.1 (refer to Section 2.2 for further details)[15].

Phase 3 - East Cell

The Phase 3 extraction involves the development of the separate cell east of Town Line (East Cell). The sinking cut will be advanced in the west-central portion of the East Cell and mining will proceed to the east and north and then to the south. Prior to the collection of the 3 years of baseline monitoring data for target water level determinations, no extraction (or overburden removal or sinking cut development in preparation for extraction) will occur in Phase 3.

The AMP generally pertains to the activities associated with the extraction of Phases 2 and 3 (the West and East Cells) of the Extension, and this is reflected in the following sections of this document.

The general sequence of activities required for the protection of water resources is presented below relative to various stages of quarry development of Phases 2 and 3. A potential schedule for the pre-extraction period is provided on Figure 2.1.

2.2 PRE-EXTRACTION (PHASE 2)

1. Install appropriate monitoring network and initiate background monitoring at least 3 years prior to extraction in Phase 2[15]. Monitoring network includes: trigger monitoring wells, recharge monitoring wells (either recharge wells or dedicated monitoring wells), wetland monitoring stations (refer to Section 4.5), and water level/flow monitoring stations. Dufferin will consult the appropriate agencies with respect to the specific locations.

---

15 Limited Phase 2 site preparation activities may occur during this 3-year monitoring period, including but not limited to: clearing, recharge system construction, berm construction (will include culverts as necessary to maintain natural surface water drainage pathways), and removal of buildings, etc. During this period, extraction preparation activities of site overburden removal and sinking cut development above the water table will be limited to within the site preparation area shown on Figure 2.1. At the midpoint of this period (i.e., 1.5 of 3 years). Dufferin may enlarge the site preparation area if it is demonstrated that such activity would not significantly affect the baseline monitoring data collected for determination of target levels or affect off-Site ecological water resources features. Prior to proceeding with such activities in an enlarged area, Dufferin will provide advance notification of activities and rationale why it is appropriate, to the agencies for review.

2. Commence monitoring programs, in accordance with Sections 3.0 and 4.0.

3. Installation of Extension Quarry groundwater recharge system and associated piping to ensure they are available when necessary during extraction. This includes:
   - Engineering design and permitting;
   - Construction of appropriate initial systems (future increases in numbers of recharge wells and pumping capacity are anticipated); and
   - Commissioning.

4. Establish target levels for Trigger wells based on the methods established in Section 4.0.

5. Ensure sufficient water is in storage in the reservoir (planned for construction in Main Quarry) and that water is of acceptable quality for groundwater recharge. Dufferin has conducted significant evaluation of these aspects to date and will continue to do so as part of the Milton Quarry operations.

6. Complete full evaluation and detailed engineering design of rock pillars/buttresses and related water management features prior to completion of bedrock extraction to final extraction limit, including those areas of the North Quarry Cell that are within approximately 50 metres of the rock pillars. Note: the detailed design for the rock pillar was completed (CRA, 2007) and approved (CH letter dated December 7, 2007 and MNR letter dated February 25, 2008). Related monitoring and evaluation will be conducted as necessary.

7. Complete pre-extraction report and submit it to the agencies (refer to Section 6.2).

2.3 PHASE 2 AND PHASE 3 EXTRACTION (WEST AND EAST CELLS)

1. Initiate/operate dewatering system as required, to maintain dry working conditions. Water is returned to reservoir for storage.

2. Implement/continue performance monitoring program in accordance with AMP.

3. Initiate/operate groundwater recharge system as required to maintain target water levels at Trigger wells.

4. Take response actions as required to ensure continued maintenance of target water levels and maximization of water storage.

5. Progressive rehabilitation of completed quarry areas (e.g., North Quarry) will be ongoing.

6. Conduct water management confirmation study to confirm the appropriate long term water management system parameters such as the final lake level and evaluate the need for long term groundwater recharge (using seasonal recharge ponds and, if necessary, recharge wells) for protection of the off-Site eastern wetlands as described in Section 1.2. It is presently anticipated that this study would include operation of the recharge system to mimic final rehabilitation lake conditions, evaluation of climate variation considerations, and design of appropriate rehabilitation measures (e.g., final land form/ecosystem design, variable elevation intakes on gravity flow culverts connecting the lakes, and emergency storm overflow measures).
7. Refinement, as appropriate, of the engineering design of rock pillars/buttresses and related water management features prior to (and following) completion of bedrock extraction to final extraction limit to confirm actual Site conditions and any amendments to the final design.

2.4 LAKE FILLING

1. Ongoing monitoring of water filling and mitigation, as described in Section 3.0 and Section 4.0.
2. Monitoring period to be continued for a minimum of 3 years following completion of lake filling.
3. Final water resource requirements (after completion of lake filling) will be identified prior to cessation of monitoring and/or decommissioning of groundwater recharge system.

3.0 PERFORMANCE MONITORING AND RESPONSE PROGRAM

The Performance Monitoring and Response Program includes the monitoring and response action components which ensure the protection of water resources, as discussed in Section 1.2. The two Performance Monitoring and Response Program components are:

1. Maintain groundwater level targets at trigger wells; and
2. Ensuring suitable recharge water quality.

The following sections of the AMP (in conjunction with Section 1.3) define the following program aspects for each of these components:

- Monitoring location/activity;
- Monitoring frequency;
- Method for establishing and adjusting target levels; and
- Response actions to be taken to ensure that target levels are maintained.

3.1 GROUNDWATER LEVELS AT TRIGGER WELLS

As discussed in Section 1.2 and in the Water Resources Assessment Report (Section 9.3.1), the principal performance basis for the protection of water resources is to maintain suitable groundwater levels at trigger wells. Maintaining these operating target groundwater levels at the series of trigger wells will maintain the groundwater levels beyond the trigger well alignment, thereby protecting the water resources from potential dewatering influences.

The trigger wells will be located outside of, but as close as practicable to, the limit of the water dependent ecological features that are to be protected from quarry influences (Section 3.1.1). Routine monitoring of trigger well water levels will be conducted at the frequency described in Section 3.1.2.

The groundwater recharge system will be operated to generally maintain the groundwater levels at or above the target operating levels (Section 3.1.3). Trigger well water levels which drop below the target levels will "trigger" the initiation or modification of groundwater recharge activities in the affected area. The target values will be set as long-term, operating target values, not as short-term "minimum threshold" values. That is, the target levels will reflect "average" conditions for various times of the year and will be above the "minimum" level recorded in each monitoring well over time. Therefore, minor water level variations below (or above) the target operating levels are not a short-term concern given the wide range of natural variation in water level above and below the target levels, as discussed in Section 3.1.3. Groundwater level response times are discussed in Section 3.1.4.

The principal response actions available to maintain the target levels are described herein (Section 3.1.4). Ongoing monitoring of the trigger wells will be used to provide confirmation that the target levels are being maintained (or identify that further response action is required).

In accordance with Section 1.3, the "minimum "water levels will be utilized to define when shortened response times are required (i.e., Red Zone). Minimum levels will be calculated as described in Section 3.1.4.

Target water levels will be determined using all available valid water level data for the applicable monitoring period and monitoring wells (erroneous measurements will be excluded). Water levels measurements and target/minimum level calculations will be recorded to an accuracy of 1 centimetre (cm).

The target and minimum water levels will be established based on water level data prior to extraction commencing in Phase 2 (the West Cell) of the Extension (refer to Section 2.2, item 1). In the event that an influence of dewatering from the existing licensed North Quarry is identified on groundwater levels in the vicinity of the trigger wells, the target and minimum water levels will be adjusted to reflect the groundwater levels under the approved rehabilitation condition for the North Quarry[16]. Such an influence may be identified at the trigger wells or at other monitoring wells in their vicinity. The adjustment to the expected groundwater levels at the trigger wells will be analyzed using available monitoring data and/or groundwater simulation results. Monthly water level monitoring is currently underway in the Study Area and this data will be incorporated in the assessment of appropriate target and minimum water levels.

---

16 The approved rehabilitation condition is a lake level in the North Quarry of 314.6 metres above mean sea level (m AMSL) shown on Page 4 of 5 of the Milton Quarry Site Plans (MacNaughton Hermsen, Britton, Clarkson, Planning Limited, 1993, last updated April 2001), or as updated. It is presumed that any adjustment of the minimum levels would be upward based on the expectation that the potential North Quarry influence would occur prior to determining the target levels for the affected area.

3.1.1 TRIGGER WELL LOCATIONS/CONSTRUCTION

The trigger wells will be installed in an alignment located approximately parallel to the extraction perimeter, adjacent to the natural water resources that are to be protected. Potential trigger well locations are presented on Figure 3.1[17]. Some of the locations represent existing monitoring wells. New trigger wells will be installed to ensure that they are adequate for their intended monitoring purposes while minimizing disturbance of the natural environment as described by Ecoplans (May 2000). Following issuance of the Licence the specific locations and construction methods for new trigger wells will be determined by Dufferin's hydrogeological and ecological consultants in consultation with the agencies based on in-field conditions.

3.1.2 MONITORING FREQUENCY

The following specifies the minimum groundwater level monitoring frequency at trigger wells for different time periods/events. Actual conditions may result in a higher frequency of monitoring or be used to demonstrate that a lower frequency is appropriate.

Pre-Extraction

- Monthly water levels to collect a data history.
- Automated water level recorders (e.g., pressure transducers and data loggers) to be installed in a minimum of five trigger wells (plus background monitoring wells per Section 4.2) to collect daily water level readings.

Extraction Period

- Minimum frequency as follows:
  - Initially monthly;
  - Bi-weekly[18] when extraction proceeds below the water table in the adjacent Phase; and
  - Weekly when a quarry dewatering influence is noted at the trigger wells or monitoring wells along the recharge alignment ("recharge monitoring wells"

---

17 Potential trigger well locations are generally similar to the potential trigger well locations identified in the Water Resources Assessment Report, Figure 9.4.

18 Bi-weekly (once every 2 weeks or 26 times per year) and semi-monthly (24 times per year) can be interchanged in the AMP to suit the overall monitoring schedule.

formerly referred to as "sentry wells" in the Water Resources Assessment Report as described in footnote 2 in Section 1.2 of this document) as discussed in Section 4.1 and continuing weekly thereafter.

- Daily water levels for at least 2 weeks in potentially affected area when one or more of the following conditions occur:
  - a) Extraction related response noted at recharge monitoring well locations as discussed in Section 4.1;
  - b) Recharge initiation/modification as discussed in Section 3.1.5; and/or
  - c) When active extraction operations are occurring within approximately 100 metres of the recharge well alignment.

<u>Post-Extraction/Lake Filling Period</u>

- Bi-weekly water level measurements with a transition to monthly measurements as appropriate.
- Daily water levels for at least 2 weeks in potentially affected area following recharge modification or other response action.

<u>Post Lake Filling Period</u>

- Monthly water level measurements for a period of 3 years. The need for any followup monitoring will be assessed at this time.
- In the event that long-term seasonal groundwater recharge is required for protection of the eastern wetlands, a specific monitoring program will need to be developed based on the monitoring conditions and needs at that time.

Automated Water Level Recorders

Automated water level recorders will be used at selected locations, as discussed above, to collect daily readings for 5 years following the commencement of groundwater recharge operations. This information will be used to ensure that the monitoring frequency is adequate to provide a high level of understanding of groundwater level patterns at the trigger wells and to demonstrate performance/compliance with the overall mitigation objectives.

Data loggers which are operated as installed above will be downloaded at least monthly. Manual measurements will be taken on the same wells at the frequencies described above. If assessment of the data from the data loggers indicates a more or less frequent basis for downloading the data is necessary, Dufferin will undertake an appropriate change in the monitoring program.

Depending upon the findings of the monitoring program, the number of automated water level recorders may be reduced or increased to facilitate the monitoring and/or enhance the monitoring at particular locations. Furthermore, some or all of the monitoring activities may be fully automated in the future (e.g., monitoring wells may be equipped with pressure transducers that automatically take periodic readings and relay the information back to the operator's control system in "real time" via radio communications or other means). If this degree of full automation is implemented, specific monitoring equipment and procedures for operation/calibration will be determined during the detailed design/equipment selection process.

3.1.3 TARGET LEVELS

Groundwater level operating targets will be established for the protection of water resource features based on a minimum of 3 years of groundwater monitoring data collected prior to extraction. The protocol for establishing target levels is presented in Section 3.1.3.1. The targets will be adjusted on an annual basis to reflect changes in climatic conditions. These adjustments will be made using the data collected from background monitoring wells and the protocol presented in Section 3.1.3.2.

3.1.3.1 PROTOCOL FOR SETTING TARGET LEVELS

The target levels will be defined for each of four unequal periods of the year based on the natural variation in groundwater levels (refer to Figure 3.2) and associated ecological dependencies during those periods (i.e., four target levels per year for each trigger well). These periods approximately correspond to the four seasons of the year as summarized in Table 3.1. The target operating levels for each period will be calculated from the 3 years of data collected prior to extraction (refer to Section 3.1). The target levels will generally be calculated as the average water level during each period (from the 3 years of data).

The target levels are defined as the desirable minimum water levels that are to be maintained at the trigger wells as discussed in Section 3.1. Actual operating water levels at the trigger wells will generally be at or above the target levels. Small, short-term fluctuations in trigger well water levels below the target levels (i.e., days to weeks) will not create any noticeable adverse ecological effects; however, such fluctuations below the target levels will be taken as triggers to initiate response action.

Actual groundwater levels at trigger wells will vary over time due to two principal factors in addition to variations associated with the defined target levels (i.e., four periods per year). First, somewhat random variations will occur over the shortest term due to natural changes in climatic conditions (e.g., extreme precipitation/infiltration event), as well as routine operating conditions for quarry extraction and recharge system adjustments. These variations will be at levels which are generally at/above the target level resulting in the long-term supply of somewhat more groundwater flow (discharge) than would occur under natural conditions. Second, target levels will be adjusted annually to reflect natural changes in climatic trends and groundwater levels (refer to Section 3.1.3.2).

Slightly different targets are established for two general categories of trigger wells which have been identified based on the dominant adjacent ecological features, as follows.

1. <u>Creek Target Levels</u>: Some trigger wells will primarily reflect groundwater levels that are associated with the potential cold water fishery reaches of the Sixth Line Tributary system. Targets for these trigger wells are referred to as "creek water level targets" or simply "creek target levels."
2. <u>Wetland Target Levels</u>: Another set of trigger wells will primarily reflect groundwater levels that are associated with the wetlands, particularly those to the east. Targets for these trigger wells are referred to as "wetland water level targets" or simply "wetland target levels."

The two types of water resource features have somewhat different performance objectives and hence the mitigation measures will be operated slightly differently for these two types of features to optimize the mitigation results. Specific trigger wells will be designated as being of one type or the other (refer to Figure 3.1 for a general breakdown of the potential trigger well locations).

The following provides a summary of the two types of target levels during the four periods. Further discussion of the target levels follows the summary and example calculations are presented in Appendix A.

1. <u>**Winter Period - January 1 to March 31**</u>
    - **Target set to average level – same for creeks and wetlands (i.e., average level for the 3-month period based on data from 3-year data history).**
2. <u>**Spring Period - April 1 to June 30**</u>
    - **Creek - target set to average minimum monthly level in period (i.e., average of lowest monthly level in the period for each of the 3 years) or summer target (whichever is greater).**
    - **Wetland - target set to average level.**
3. <u>**Summer Period - July 1 to August 31**</u>
    - **Target set to average level – same for creeks and wetlands.**
4. <u>**Fall Period - September 1 to December 31**</u>
    - **Target set to average level – same for creeks and wetlands.**

These selected flow periods and target levels will protect the fishery and wetlands associated with the Sixth Line Tributary and allow for an overall benefit to the fisheries.

CREEK TARGET LEVELS

The objective of the creek target levels is to maintain the groundwater related functions critical to the specific life history requirements of the brook trout identified in the Sixth Line Tributary. However, it is also possible to provide opportunity for beneficial augmentation of low flow conditions as described herein.

The Tributary is characterized by a very large difference between peak and low flows, resulting in a surplus of water availability in the spring period and very minimal flows in the critical summer/early fall periods. Furthermore, the brook trout are not specifically reliant on groundwater during the spring period when temperatures are cool. Based on these characteristics, some re-balancing of groundwater discharge (flow) from high flow conditions to low flow conditions can benefit the natural system as well as assist in maintaining a proper overall water balance. Protection of groundwater discharge to the stream will also protect the wetlands associated with the Tributary. Note that any changes in the creek flow condition resulting from the recharge system operating methods will be small as the groundwater and surface water flow from the north side of the creek, upstream flow, and runoff will be totally or largely unaffected.

As noted above (Section 3.1.3), mitigation system operation will generally result in groundwater levels that are at/above the target levels. Therefore, on average, the mitigation will provide additional groundwater discharge to the fishery features. In order to help ensure sufficient water is available to maintain or enhance these flows during the critical low flow periods, groundwater level targets (and discharge) are lowered somewhat during the high flow period, as indicated in the above summary.

There will be a gradual transition between the target levels[5] as the groundwater flow adjusts to changes in the recharge system. For creek target levels, the transition period is planned to occur approximately equally over the end/beginning of the proceeding/following target level periods. Based on a 2-week transition period, the transition would be distributed over the last/first week of the proceeding/following target level periods. The transition plan/period will be further refined on a regular basis depending upon observed conditions prior to and following commencement of recharge system operation.

These selected flow periods and target levels for the creek will protect the ecological function of the associated portions of the Sixth Line Tributary System and allow beneficial augmentation of low flow conditions.

WETLAND TARGET LEVELS

The objective of the wetland target levels is to maintain key existing conditions for the wetlands not associated with the Sixth Line Tributary. These wetlands (i.e., Eastern and Western Wetlands, Figure 3.1) are generally characterized by large differences between peak and low groundwater levels which result in large variations in seasonal surface water conditions. In general, wetlands have standing water in the spring, but by late-summer or fall they exhibit much drier or completely dry conditions. The standing water in the spring and early summer is critical to amphibian breeding functions, whereas in many of the deciduous swamps in particular, water must drop below the root zone of the mature trees during the latter part of the growing season. It is therefore important to maintain a seasonal variation of groundwater level conditions at the corresponding trigger wells.

As noted above, mitigation system operation will generally result in groundwater levels that are at/above the target levels. Since high spring water levels are important to specific wetland functions, it is not proposed that high water levels can be reduced during the spring period as done for creek target levels, above. Therefore, the recharge operations associated with wetland areas will be operated such that the groundwater levels remain at/near the target levels in order to optimize the quantity of recharge water used (i.e., protect the overall water balance).

As discussed above, there will be a gradual transition between target level periods as the groundwater flow system responds to changes in the recharge system operation. For wetland target levels, the transition period (2 weeks) is planned to occur similar to that for creek target levels, except for the spring-summer transition which will occur starting at the beginning of the summer period to ensure water levels are maintained through the later season amphibian emergence period (e.g., salamanders). To protect the overall water balance, this lagged decline in water levels will be offset by an earlier change for the summer-fall transition (i.e., occur within the last 2 weeks of the summer period).

These selected flow periods and target levels for wetlands will protect the ecological function of the associated wetlands.

3.1.3.2 PROTOCOL FOR ADJUSTING TARGET LEVELS

The target levels will be adjusted on an annual basis to account for natural (background) trends in climatic and groundwater conditions. These annual adjustments will allow the mitigation measures to incorporate or reflect shorter-term variations as well as any long-term trends in climatic conditions.

Normal adjustments to target levels will be made based on background monitoring wells installed by Dufferin, as discussed in Section 4.2. After the initial monitoring period (minimum of 3 years) the initial target levels will be established. Following each year of extraction the target levels will be adjusted based on the change in the 3-year running average in the background well target levels for each of the target periods. The change in the 3-year average will be applied by prorating any change observed in the background wells to the trigger well water levels. This prorating will be based on the ratio of the natural range of fluctuation in the background well to the natural range of fluctuation in the trigger well observed during the pre-extraction monitoring period. The adjustments will be calculated and applied on a per period basis - i.e., four periods per year as previously defined.

These changes will be applied at a particular monitoring well[19] using the steps described in Table 3.2. An example calculation is presented in Attachment A of Appendix A.

---

19 The degree of correlation between background and trigger well water levels will be assessed during the initial monitoring period. It may be that all wells are reasonably well correlated with differences being primarily in the magnitude of variation. In this case, the average change observed in the background wells would be utilized. Alternatively, it may be determined that trigger and background wells can be split into two or more groups with a higher degree of correlation. If two or more groups are identified, then the procedure for adjustment will be implemented on a group-by-group basis. Dufferin will provide the original correlation assessment to the agencies for review. Any subsequent revisions will also be provided for review as described in Sections 1.4, 5.0, and 6.0.

Adjustment of the target levels on an annual basis will ensure that the mitigation measures reflect ongoing trends in climatic conditions. The system of setting/adjusting target levels will not explicitly reflect very short-term conditions and individual extreme years as these are generally stressors on the creeks/wetlands. Reducing/removing these short-term stressors and providing more continuous levels of groundwater discharge will generally serve to enhance ecological conditions, particularly brook trout habitat.

The supplemental monitoring described in Section 4.0 will be used to help ensure that the operation of the mitigation measures is adequately protecting water resources. In the event that other considerations or concerns are identified, the procedures defined herein will be amended as discussed in Section 5.0.

3.1.4 MINIMUM WATER LEVELS

The minimum levels will be determined for each of the four seasons (i.e., same seasons as those for the target water levels). The level for each season will be equal to the lowest recorded water level at the trigger well for the available monitoring period at that trigger well before extraction commences (refer to Section 3.1). This period will be 3 years or more as previously discussed.

The minimum level will be reduced for climate variations if lower background water level conditions are identified. This assessment will be based on an annual assessment of background monitoring data similar to the target water levels (i.e., by making a pro-rated change similar to the target level adjustments). In the event of particularly low background levels, the adjustment of the minimum level may be performed during the current year. Any such adjustments that are made during the operating period will be immediately communicated to the agencies. The term "verified minimum level" will refer to the minimum seasonal water level for a trigger well which has been adjusted using the current background monitoring data.

In the event that a trigger well is replaced or a new trigger well is added, the appropriate historic low water level for the new well will be estimated based on available information for nearby monitoring wells and the historical data for the old well (if applicable).

3.1.5 MONITORING RESPONSE ACTIONS

The following response actions will be implemented to maintain the target groundwater levels at specific trigger well locations around the extraction/licensed area. The potential response actions are presented in two general categories, based on the overall effort/significance associated with their implementation. As an overriding principle, Dufferin will maintain target groundwater levels as discussed in Sections 1.3 and 3.1.

The requirement is to maintain water levels at specific locations at or above the target levels set for that specific location. This will require adjusting the water recharge rates on a regular basis. The following response actions would typically be the routine operating practices. Also presented are specific contingency measures that could be implemented if the routine practices are not meeting the objective of maintaining the specific groundwater target levels. It is intended that Dufferin will undertake both the routine and contingency response actions in a timely manner.

If unable to suitably maintain these levels, Dufferin will cease further extraction that causes further dewatering in the affected area (to prevent further groundwater drawdown) and implement appropriate further response measures. No further extraction will occur in such an area, until measures are taken to ensure the water levels can be maintained both during and after further extraction.

Routine Response Actions to maintain target water levels at specific locations:

- Increase flow to individual recharge wells by adjusting valve settings at individual wells;
- Increase flow to groundwater recharge system by increasing pumping rates;
- Refurbish[20] or replace existing recharge wells that are not performing adequately.
- Add additional groundwater recharge wells (vertical or inclined, as appropriate) – progressive spacing reductions from initial spacing (e.g., from 100-metre spacing to 50-metre spacing to 25-metre spacing) as appropriate;
- Implement supplemental monitoring to further characterize conditions;
- Evaluate potential for other dewatering influences;
- Suspend extraction below the groundwater level in the affected area; and

---

20 In the event that a chemical is to be introduced to a recharge well as part of a program to refurbish (rehabilitate) the well, such activity will follow the precautions and procedure identified in Section 3.2.4.

- Increase overall capacity of flow system by completing planned pumping station upgrades (e.g., upgrade pumps and/or add pumps in accordance with recharge system design).

Contingency Response Actions:

- Increase overall capacity of recharge system by adding a new header/forcemain (e.g., connect a second header main into the perimeter recharge forcemain and/or installation of a booster pumping station if required);
- Implementation of an automated monitoring and control system to optimize recharge rates (i.e., minimize water used to maintain target levels);
- Modify blasting activities in close proximity to recharge system to minimize local effects of blast-induced fracturing between the recharge wells and the quarry face;
- Localized grouting of bedrock[21] to reduce recirculation of recharge water back into the quarry through higher permeability features;
- Construct an engineered buttress (dyke) against quarry face to reduce recirculation in affected area (only where suitable based on rehabilitation and lake recharge requirements);
- Look at other suitable means of supplying water to the affected area (e.g., move recharge location; recharge ponds/trenches; direct surface discharge of water); and
- Cease extraction below the groundwater level in the affected area.

Based on the analyses conducted by Dufferin, it is predicted that the routine response actions will be effective in maintaining water levels. The contingency response items are not generally expected to be necessary, but are provided as safeguards.

Contingency response actions (above) may also include moving extraction to a different area while a response is being implemented (subject to the protocols described in Appendix D if moving from Phase 2 to Phase 3). Additional actions (as presented herein) may be required, in conjunction with any suspension/cessation of extraction in the affected area, to ensure target levels are maintained for the protection of water

---

21 Bedrock grouting is a standard engineering technique used to limit water movement in bedrock or other materials. It is a process of drilling holes into the bedrock (usually vertical or near vertical) and using these holes to inject an inert liquid "grout" material into the bedrock openings surrounding the hole. The grout material blocks the openings in the bedrock, limiting the flow of groundwater. A line of closely spaced holes can be used to create a "grout curtain" (or "wall") which acts to limit the horizontal movement of groundwater. Grouting materials can vary and include standard grout materials which will not adversely affect the quality of groundwater (e.g., Portland Cement).

resources. In an extreme situation if the contingency response actions are not effective, extraction on the entire phase would have to cease as described in Section 1.3.

The rate of groundwater level response to changes in recharge system operation and quarry operations will be variable around the perimeter of the Extension and will be assessed on an ongoing basis as part of the AMP. The results of the recharge testing already completed at Milton Quarry do, however, provide preliminary planning information to assist in understanding the rate at which the groundwater levels can be raised by the recharge system and the potential rate of groundwater level decline in the event of a reduction (e.g., transition to lower target level) or temporary cessation of recharge operations. This information, as described below, illustrates the feasibility of maintaining target groundwater levels. Any associated changes in surface water levels will be much slower than the groundwater level changes indicated below.

The recharge test results indicate that changes in the recharge system operation will generally develop a measurable response in trigger well water levels within about a day. Observed increases in water levels indicate the rate of water level increase at a trigger well can be on the order of 25 cm to over 100 cm (1 metre) per week.

The recharge testing results indicate that the rate of decline of groundwater levels between the recharge system and the trigger wells may generally be somewhat more gradual in the event of a recharge interruption or change in dewatering stress without a corresponding increase in recharge. The observed rate of decline following the end of the recharge testing period was approximately 25 to 30 cm per week for the water table within its normal range of fluctuation (this decline included decline due to climatic effects which were approximately one quarter of this amount). Note that the natural rate of decline may have been somewhat less than normal during the recharge test due to the extremely dry conditions in the spring of 1999. The observed natural rate of groundwater level decline is routinely observed to be on the order of 25 cm per week at monitoring wells on the Extension.

3.2 WATER QUALITY IN RECHARGE SYSTEM

In order to ensure no adverse effects from any potential change in water quality resulting from groundwater recharge, suitable water quality targets must be defined for the recharge water. The recharge water will be drawn from a large reservoir and the anticipated water quality is good. Ongoing monitoring of water inflows and water in storage will verify that the recharge water quality remains suitable for recharge or identify whether modifications to the operations are required to maintain suitable water quality. The overall water quality objective for the recharge system is to maintain suitable water quality for the protection of ecological receptors[22].

3.2.1 MONITORING LOCATION

Recharge water quality will be monitored at various locations, including:

1. Reservoir sampling location distant from the pumping station using an appropriate sampling method depending on the location. Sampling at this location will also provide information on the quality of water discharging to the Hilton Falls Reservoir Tributary;
2. From a sampling port on the recharge forcemain at the pumping station (i.e., reservoir water quality at intake); and
3. A remote location on the recharge system (i.e., at well/sampling port location on the north side of the Extension).

Additional samples will be collected on a monthly basis (or as appropriate) from other sources of water inflow into the reservoir. The measured water quality from these sources will be generally compared to the water quality targets to ensure no unacceptable influence on recharge water. The water quality targets will not be strictly applied to these sources of water since minor short-term influences will not have a discernable effect on overall recharge water quality due to the large storage volume in the Reservoir. Specific management actions will be implemented if any significant water quality issues are identified (e.g., diversion of water with elevated suspended solids to settlement area - possibly to Main Quarry Operations area similar to current practice). The appropriate monitoring locations and frequency will be determined during detailed design of the dewatering and recharge systems and are specified in the OWRA approvals.

3.2.2 MONITORING FREQUENCY

Recharge water quality samples will be collected from the reservoir at a minimum frequency of once per month during the operating period of the recharge system. Samples will still be collected monthly from the reservoir when the recharge system is

---

22 This objective differs from that stated in the Water Resources Assessment Report (May 2000), but is reasonable based on the explanation provided herein (Section 1.2) and the importance of protecting ecological receptors.

not in operation. The sample collection from the reservoir will commence at least 3 years prior to the start of extraction in Phase 2.

3.2.3 MONITORING PARAMETERS AND TARGET LEVELS

The Ontario Provincial Water Quality Objectives (PWQOs) form the appropriate water quality monitoring parameters and concentration objectives for protection of the receiving surface water system. As stated by MOE (Water Management: Policies, Guidelines, Provincial Water Quality Objectives, 1994-Revised/Reprinted in 1999):

> ***"The Provincial Water Quality Objectives (PWQOs) will protect aquatic life and recreation uses…PWQOs are set at a level of water quality which is protective of all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure to the water. The PWQOs for protection of recreational water uses are based on public health and aesthetic considerations."***

The same document also confirms that the PWQOs are the appropriate objectives for the groundwater recharge water for the Extension (as described in Sections 1.2 and 3.2):

> ***"In specific instances where groundwater is discharged to surface waters, PWQOs may also be applied to the groundwater"***

The appropriate water quality parameters and corresponding acceptable target concentrations will be developed in general accordance with Dufferin's existing surface water discharge monitoring program and PWQOs. Specific criteria are specified in the OWRA approvals (Certificate of Approval).

3.2.4 MONITORING RESPONSE ACTIONS

Potential monitoring response actions for water quality considerations include:

- Modification of quarry operating practices depending upon cause (e.g., improved management of suspended solids, alterations to blasting practices/explosives, alternate management of more mineralized water from deep sumps or water with elevated suspended solids, and control of water fowl).
- Water pretreatment prior to storage in reservoir (e.g., settling pond, pH adjustment, etc.).
- Filtration or other treatment of recharge water.

Any response actions that are implemented to address water quality issues will be designed and monitored to ensure that any adverse environmental effects are insignificant. For example, if a recharge well needs to be treated with chlorine to mitigate biofouling, the remedy will be applied to individual well(s) over a short-term (i.e., not as an ongoing injection into the well) and the treatment solution will be pumped back out of the well as necessary to ensure that the treatment solution is removed from the immediate vicinity of the recharge well to minimize migration. Note that the recharge wells are located at significant distance from the environmental features being protected and as such there should be significant dilution and attenuation occurring before the recharge waters reach these features. Treatments such as carbon dioxide addition or other pH adjustments will be quickly neutralized by the carbonate bedrock.

The following procedure will be utilized when considering the introduction (by injection or other means of placement) of any chemicals into a recharge well:

1. Identify the chemical proposed for use and the rationale for its use;
2. Monitor activities and potential effects;
3. Assess whether method is acceptable for further use; and
4. Assess whether additional monitoring of chemical effectiveness is appropriate.

4.0 SUPPLEMENTAL MONITORING PROGRAM

The Supplemental Monitoring Program includes additional monitoring/evaluation components which are not directly related to ensuring the protection of water resources, but may provide supplemental information or indicate issues that require further consideration. These components include:

1. Groundwater level monitoring;
2. Background groundwater level monitoring;
3. Meteorological monitoring;
4. Water budget monitoring;
5. Ecological monitoring - including Sixth Line Tributary and wetlands; and
6. Residential well monitoring.

For these components, the AMP provides a defined program for monitoring, evaluation, and the assessment of the need for any response actions.

4.1 GROUNDWATER LEVELS

Groundwater level monitoring will occur at available groundwater monitoring locations in addition to the trigger and background water level monitoring. The purpose of this monitoring is to assess patterns/trends in groundwater levels, quarry dewatering influences, and recharge system operation to ensure the groundwater flow systems are well understood and to assist in understanding the current and future recharge system operations. In this manner, all the wells listed below serve as "sentry" monitoring wells (as indicated in Section 3.1.2 and described further in footnote 2 in Section 1.2 of this document, the term "sentry wells" used in the Water Resources Assessment Report has been amended to "recharge monitoring wells" herein). The components of this program are presented below.

Monitoring Locations

- Existing groundwater monitoring well locations. To be selected prior to extraction in the proposed Extension, in conjunction with trigger well siting/installation. Additional wells will be added to augment the existing monitoring network, as appropriate. In particular, additional monitoring wells will be installed adjacent to the on-Site wetlands in Phase 3.

- Recharge monitoring wells[23] - during its operating period, the recharge system will require nearby monitoring wells to help assess recharge well influence on nearby groundwater levels/flow.
- Groundwater recharge wells[23], prior to initiation of recharge operation.

Monitoring Frequency

- Monthly.
- Frequency of monitoring to be increased (as appropriate) as extraction commences in the vicinity of specific monitoring wells.
- Recharge wells and recharge monitoring wells to be monitored at a minimum frequency similar to the trigger wells or as defined during the detailed design of the recharge system, whichever is more frequent.

Data Evaluation

The collected data will be evaluated on a regular basis to assess the issues identified above. In the event that the observed behaviour varies substantially from what was anticipated or a particular concern is identified, further assessment and/or response actions will be undertaken, as appropriate. Any such circumstances will be communicated to the agencies.

4.2 BACKGROUND GROUNDWATER LEVELS

Groundwater elevations will be monitored at background locations for the purpose of assessing climatic effects on natural groundwater levels. The data collected from the background wells will be used to adjust the target and minimum water levels for the trigger wells as discussed in Section 3.1.3.

Monitoring Locations

Background monitoring locations are beyond the study area but in the general vicinity of the Milton Quarry so that they are removed from potential quarry effects but still reflective of similar groundwater conditions. Locations will be selected to minimize the

23 The recharge monitoring wells are to be installed 3 years prior to initiating extraction in Phase 2 of the Extension (refer to Section 2.2). Alternatively, the recharge wells may be installed first and used as monitoring wells prior to recharge operations.

opportunity for man-made water level changes due to future land development or water taking/management, and natural influences such as beaver dams influencing surface water levels.

A minimum of four background monitoring locations will be utilized, including:

- Existing two background monitoring well locations (BH112 and BH113); and
- A minimum two additional background monitoring well locations to be installed at the same time as the trigger wells. Consideration will be given to placing these wells on public lands in the site region (e.g., Road Allowances, Conservation Halton lands, Region of Halton lands, etc.).

Monitoring Frequency

- Minimum frequency of monthly following installation.
- Automated water level recorders will be used to collect daily readings for the pre-extraction period and for a minimum of 5 years following the commencement of groundwater recharge operations. This information will be used to ensure that the monthly monitoring frequency is adequate and to provide a high level of understanding of groundwater level patterns at the background monitoring wells and their relationship to climate.

Data Evaluation

The collected data will be evaluated on a regular basis to assess the trends in groundwater levels relative to climatic conditions (refer to Section 4.3) and ultimately to adjust target and minimum water levels as discussed in Section 3.1.

Reviews will be conducted to identify any activities in the surrounding area which have the potential to influence the groundwater levels in the background monitoring wells. These reviews will include:

- Observation of the areas surrounding the monitoring wells;
- Check for any new permits to take water issued in the vicinity of the background monitoring wells; and
- Water level data from the background locations will be compared to assess whether any anomalous trends are evident which might indicate a groundwater level interference.

4.3 METEOROLOGICAL DATA

Dufferin will continue to operate a meteorological data collection station at the Milton Quarry as it has done since 1990. This data will be used to improve the understanding of climatic conditions with respect to both ongoing conditions and long-term trends. This information will assist in evaluating groundwater level fluctuations at the background monitoring wells as well as other locations. It will also assist in water budget evaluations, as discussed in Section 4.4.

Meteorological Parameters

Meteorological data will be collected for the following parameters:

- Precipitation
- Evaporation;
- Temperature; and
- Barometric pressure.

Note that the meteorological station was relocated adjacent to the recharge pumping station in 2007 to harmonize with the rehabilitation plans for the Main Quarry.

Duration and Frequency of Monitoring

The meteorological station will be operated seasonally during the spring-summer-fall period, similar to past operations by Dufferin. During the winter period (i.e., under freezing conditions), meteorological data will be obtained from the Georgetown meteorological station (or other nearby location as appropriate).

Data will be collected using automated recording equipment to record a minimum of six readings per day (i.e., every 4 hours).

Data Evaluation

The monitoring data will be evaluated as discussed above and reported as identified in Section 6.0.

4.4 WATER BUDGET

The water budget for the entire Milton Quarry will be evaluated on a regular basis to ensure that sufficient water is available for ongoing and future mitigation, operational, and rehabilitation requirements. The objectives of the water budget evaluation include:

- Verify that the amount of water available/in storage is consistent with water budget forecasts to confirm the representativeness of the overall water budget calculations;
- Identify if more or less water is available than forecasted such that filling time and associated operational and cost aspects can be appropriately addressed;
- Establish the annual distribution of the water from the reservoir in accordance with an agreed water hierarchy;
- Establish the amount of "excess" water that may be available;
- Confirm the representativeness of key water budget parameter values which have the potential to significantly affect the reliability of the long-term water budget calculations in a negative manner (i.e., potentially less water available that forecast); and
- Identify and adapt to any long-term trends in water budget availability that are evidenced by the monitoring data and/or recognized by the scientific community.

The principal basis for assessment will be through measurement of the reservoir water level (i.e., amount of water in storage) and the progression of rehabilitation lake filling for the North Quarry Cell and Extension Quarry Cells. On an annual basis, this data will be compared to predicted water budget conditions (Appendix E of Water Resources Assessment Report as updated in CRA's December 2003 Witness Statement in relation to Consolidated Board Hearings – Case No: 03-086) to ensure the water budget is acceptable and to define "excess water" that is potentially available for other purposes. As part of the 5-year review, the water budget will be re-calibrated to reflect the information collected to date.

The water budget program for the AMP is described below. This program described herein will be subject to annual review to evaluate whether the objectives of the water budget verification are being achieved and whether it is appropriate to modify the monitoring and/or analysis program.

Monitoring Locations

- Water levels will be measured in the reservoir at the pumping station.

- Water levels will be measured in the lake/wetland area in the Main Quarry (south of the reservoir).
- Water levels will be measured in the North Quarry Cell, Phase 2 (West Cell), and Phase 3 (East Cell) once extraction is complete and lake filling has commenced.
- Water flow will be monitored from individual dewatering/transfer points (e.g., West Cell, East Cell, Reservoir, etc.) and individual recharge wells (or local groups of wells) as defined during detailed design.
- Water flow will be monitored for the discharge to Hilton Falls Reservoir Tributary (HFRT) and for operational water use.

Monitoring Frequency

- Water levels will be measured at a minimum frequency of weekly.
- Reservoir water levels will be measured on a "continuous" basis using an automated water level recorder at the pumping station.
- Water flows will be measured continuously (i.e., totalizing flow meters). Readings will be recorded at the following minimum frequencies:
  - Once per week at dewatering/transfer/HFRT discharge points; and
  - In accordance with recharge well water level observations at recharge wells (refer to Section 4.1).

Other Monitoring Information:

In order to determine anticipated water storage levels, an accurate topographic survey will be conducted following completion of extraction and rehabilitation earthworks in each water storage area, including the Reservoir (prior to the initiation of water filling). The survey will be used to calculate a stage-storage curve for each area. Using the available information and the water budget information presented as part of the Water Resources Assessment Report, currently estimated filling times (i.e., water levels) can be refined based on the measured storage volumes.

In order to facilitate water budget assessments, additional data will be collected such as meteorological data (Section 4.3), dewatering and recharge flows (to be defined as part of detailed design of these systems), and operational use of water (e.g., dust control).

Data Evaluation

The measured water levels will be compared to the anticipated water storage levels in each of the Reservoir, North Quarry Lake, West Lake, and East Lake over time to assess the water budget and lake filling progression in accordance with the objectives identified above. The analysis of the water budget will be completed in accordance with the following procedure and Figure 1.7:

1. Complete water budget analysis as described herein. This analysis occurs at different levels of detail at different frequencies:
   - Ongoing - assessment of flow and storage data relative to previous measurements, forecasted water budget conditions, and ongoing operations and climatic conditions;
   - Annual - review of data relevant to individual monitoring parameters and overall water budget; and
   - 5-Year Review - analysis of overall water budget considerations and recalibration of water budget with updated forecast of future conditions.

   Further technical information on how the water budget analysis will be conducted is provided in Appendix E of this report.

2. Identification of whether actual water budget conditions are consistent with forecasted conditions, or whether more/less water is available.

3. In the event that significantly less water is available or there is other indication that there are other potentially significant discrepancies between the actual and forecast water budget, further assessment of the water budget and water use, including groundwater recharge operations, will be undertaken and appropriate response actions implemented, if necessary. These measures may include:
   - Further evaluation of monitoring data, parameter estimates, water budget calculations, water management system operation;
   - Completion of micro-water budgets for sub-components of the overall water budget;
   - Specific field investigation/monitoring programs to collect additional information (e.g., installation of additional monitoring wells, flow meters, lysimeters, etc.); and/or
   - Further review of the scientific literature for related water budget consideration.

The timeframes for the foregoing measures will be based on the objective that the quarry progression will be limited during this period if necessary, to ensure that the Water Management System is sustainable based on the current water budget parameterization. In the unexpected event that appropriate response actions do not appear to be available based on longer term evaluation (i.e., annual and 5-year reviews) the appropriateness of continuing extraction over the long term will be evaluated to determine whether a cessation of extraction activities that result in further water consumption is necessary in some or all areas.

4. In the event that there is more water available than forecast, the amount of "excess water" will be established and dealt with in accordance with the agreed water hierarchy.

As the final lake filling stage is approached, the water budget will be further reviewed and refined to ensure that sufficient water will be available and to identify how much excess water will be available under the final "lakes filled" condition. This assessment will include an analysis of any changed circumstances, including the potential effects of global climate change which may be much better defined at that time than they are at present. Such assessments will include review and, if necessary, additional assessment of anticipated water budget parameters associated with revegetation/rehabilitation conditions, as required to confirm the sustainability of the rehabilitation conditions. These analyses may be used as a basis for further refinement of the rehabilitation plan and ultimate land use plans in the event that conditions indicate a revised plan would be of greater overall benefit to the water resources and associated features.

4.5 ECOLOGY

The water resources protection components of the performance monitoring program are designed to protect directly dependent natural features, and specifically the Brook Trout habitat and many of the wetlands where groundwater discharge supports specific habitat conditions. Direct protection of water levels, quantities, and quality protects the specific habitat conditions, and therefore the associated wildlife and fisheries. In conjunction with the performance monitoring components, some supplemental monitoring of ecological parameters is proposed. In addition, the on-Site wetlands (as described in Section 1.3) will be protected (as described in Appendix C).

The purpose of the ecological monitoring is to assess the general characteristics of a number of representative natural systems around the Extension, to ensure they are continuing to function as expected and specifically to identify any unanticipated changes that warrant initiation of further investigation.

Ecological communities are dynamic and variable, changing naturally both with time and in response to a variety of other natural factors (e.g., climatic, beaver activity, disease, fire, predation) as well as man-induced changes (e.g., water taking, angling, drainage changes, clearing, logging, pasturing, weed introduction). Therefore, ecological monitoring is most useful over time as sufficient information becomes available to enable reasonable identification of trends. While identification of relationships between the ecological and water resource data becomes more reliable with time, it may still be difficult to clearly identify potential cause and effect relationships. Trends may also be obscured if a number of activities and natural events are acting together to influence features.

4.5.1 MONITORING LOCATIONS

The ecological monitoring program encompasses general monitoring of representative water-dependent natural features, as well as several specific components that are identified as critical habitat elements or features. The locations for each of the ecological monitoring components are described below:

1. Surface and groundwater monitoring of the stations in the five representative eastern wetlands (W10, W15, W17, W21, and W41) will be continued, subject to access availability. This monitoring will ensure the seasonal fluctuation patterns important to amphibian breeding as well as vegetation growth habitat diversity and other related functions are well understood so they can be maintained during and following quarrying. Jefferson Salamander were confirmed or probably breeding in these wetlands. A staff gauge and trigger groundwater monitoring well will also be installed in/immediately adjacent to W5, the western wetland, as shown by the trigger well location on Figure 3.1.
2. Photographic monitoring of surface water conditions in the above six (6) wetlands, from a consistent vantage point, will also be conducted during the breeding and growing season. General observations of the overall state of each wetland station (including any changes to the vegetation, species, or community types, etc.) will also be recorded during the photographic monitoring event.
3. Jefferson Salamander complex egg mass surveys and frog calling surveys in the above six (6) wetlands.

4. Monitoring of vegetation conditions in these representative wetlands will be conducted using 10 m by 10 m vegetation plots and a quantitative photo monitoring technique (see Section 4.5.2). The specific vegetation and photo monitoring plots will be established to encompass representative deciduous and mixed swamp communities.

5. A Brook Trout redd or spawning survey will be completed along the reaches of the Sixth Line Tributary up and downstream of Town Line. The spawning areas should be representative of areas of groundwater discharge to the stream. While their numbers and some of the locations vary year to year, the persistence of spawning activity and regular use of some locations provide an indirect indication of groundwater discharge.

6. Two long term benthic monitoring stations will be established upstream of Town Line, one within approximately 200 metres downstream of the pond (i.e., Reach B) and one within approximately 200 metres of Town Line (i.e., Reach C/Upper Reach D). While specific groundwater discharge/spring indicator species were generally not present in the sampling to–date, there are a number of species that are considered sensitive and reflective of higher quality headwater streams. Abundance is relatively low, so considerable variation may occur year to year. The community will also change in response to other physical habitat factors (shading or opening , beaver influence etc). The data will be most useful in the longer term, and in the context of the broader monitoring network that Conservation Halton is considering.

7. Groundwater temperature monitoring will be implemented at four trigger well monitoring locations along the key cold water fishery reaches north of the Extension using data loggers. Locations will be selected both upstream and downstream of Town Line Road. The trigger wells to be monitored will be selected by Dufferin's fishery biologist (e.g., Ecoplans) in consultation with an appropriate agency representative. Monitoring of the creek temperatures will be completed at adjacent locations identified to be of the most relevance from an ecological and hydrogeological perspective (e.g., refuge areas, redds, etc.) using data loggers. Monitoring of recharge water temperatures will also be completed at the Reservoir pumping station and in the recharge system near these four monitored trigger wells.

8. Measurements will be taken of the water flow from the discharge pipe(s) of the former pumphouse which has been abandoned but still stands (surface water monitoring location SW4, located on the East Extension buffer lands).

4.5.2 MONITORING TECHNIQUES

Standard 10 m x 10 m vegetation monitoring plots will be permanently marked. Visual cover estimates will be made for each of seven potential vegetative layers (e.g., dominant canopy, subdominant canopy, saplings and shrubs, regeneration, seedlings, herbs (herbs, sedges, grasses) and ground cover (mosses, lichens, liverworts). The vegetation plot monitoring will be conducted in the selected wetlands (W10, W15, W17, W41, and W5, subject to access availability) between August and early October.

The quantitative photo monitoring technique (adapted from Van Horn and Van Horn, 1996, see Appendix B) provides a relatively simple, efficient and consistent method of collecting standardized monitoring information. Three quantitative parameters [vegetation density, vegetation height and water depth (where appropriate)] are measured, together with a qualitative appraisal of dominant species present. This technique has been used successfully in other wetland locations. The photo monitoring will be conducted in the selected wetlands (W10, W15, W17, W21, W41, and W5) between August and early October. General observations of the overall state of each wetland station (including any changes to the vegetation, species, or community types, etc.) will also be recorded during the photographic monitoring event.

The Jefferson Salamander egg mass surveys will be conducted in early spring before most egg masses begin to hatch (typically mid-April). Visual estimates of the general abundance of Jefferson Salamander complex egg masses and Spotted Salamander egg masses will be made based on surveys of each selected wetland by an individual experienced in identifying these types of egg masses. Observations will be made only from the margins of the breeding sites, to avoid unnecessary disturbance. It is recognized that this approach only provides a general indication of salamander breeding activity and that egg masses may be underestimated or missed due to factors such as the extent of pools visible from the margins, presence of debris or wetland vegetation in the water column, tannin-stained water, deeper water and/or cloudy/overcast weather conditions. A general visual estimate of the relative number/proportion of viable versus non-viable Jefferson Salamander complex egg masses will also be made.

The frog call surveys will be conducted in general accordance with the Canadian Wildlife Service's Marsh Monitoring Program. Each selected wetland will be visited on three (3) nights, no less than 15 nights apart, during the spring and early summer. Visits should commence 30 minutes after sunset and terminate prior to midnight. The minimum nighttime air temperatures should be at least 5°C for the first visit, 10°C for the second visit and 17°C for the third visit. Each monitoring location within the selected wetlands will be surveyed for 3 minutes and one of three Call Level Codes will be used to characterize the intensity of calling activity for each frog species (i.e., Level 1 = individuals can be counted, calls not overlapping, Level 2 = number of individuals can be estimated or counted, others overlapping, Level 3 = full chorus, calls continuous and overlapping, individuals not distinguishable).

The redd survey will utilize standard observational procedures during the appropriate spawning window (late October, November to early December, and refined annually depending on specific weather conditions, documented activity, consultation with Conservation Halton staff, and past experience at the Site). The survey will be completed by a fisheries biologist or technologist. Both confirmed redds (attendant fish documented) and unconfirmed redds and scrapes will be recorded and mapped generally. The general characteristics of the various redd sites will be recorded, and photographs taken where feasible. In-stream water temperature monitoring at the observed redds (and locations of redds in previous year) will be measured as part of the survey to confirm that no detrimental changes in the thermal regime have occurred. Redd sites used in previous years will be specifically checked during following redd surveys.

The groundwater and surface water monitoring in the off-Site wetlands is ongoing and will be continued in the same manner. The surface water level photos will be taken from either the gauge or the vegetation monitoring station for consistency.

The water temperatures will be taken with calibrated temperature probes. Specific monitoring equipment and procedures will be determined during the detailed design and equipment selection process.

Monitoring of discharge water flow at SW4 will be conducted using a timed-volume method (i.e., using a graduated bucket and a stopwatch).

4.5.3 MONITORING FREQUENCY

The ecological monitoring surveys (redd, benthics, vegetation, salamander egg masses, frog calling) will be conducted annually for a minimum of 3 years prior to extraction in Phase 2 to refine the pre-quarrying database (refer to Section 2.2, item 1). Annual surveys will be conducted for an additional 5 years after quarrying commences in Phase 2. Thereafter, data will be collected every 2 years for 10 years and then every 5 years for the balance of quarrying and filling of the lakes. For a period of 5 years following onset of significant and sustained recharge operation along the east perimeter of the East Cell, surveys will be conducted annually. Once the lakes are at their final elevations, data will be collected annually for an additional 3 years. The ecological monitoring frequency may be refined based on the results of the data collection, and may include the possible discontinuation of ecological monitoring in W5 and Jefferson Salamander egg mass sampling in the off-Site wetlands as described in Section 4.5.4.

The water levels at the wetland stations are monitored monthly at present. The surface water program will be enhanced to double the frequency (every 2 weeks) during the period of April through July). Photos and specific documentation as to when the standing water dries up will be recorded.

Water temperature monitoring of the trigger wells and creek will be conducted at a minimum frequency of monthly with weekly measurements during January[24], February[24], July, August, and September or continuously using data loggers.

Discharge water flow at SW4 will be measured on a monthly basis with weekly measurements during July, August, and September during the period of Phase 3 bedrock extraction.

In general, less frequent surface water monitoring may occur in the winter based on climatic conditions.

4.5.4 DATA EVALUATION

At the end of the pre-quarrying period, the 3 years (or more where available) of ecological data will be assessed to identify general patterns, a preliminary range of year-to-year variation and any initial trends. Related water resource evaluation and weather data will be integrated. The 3-year period is still relatively short in terms of establishing historic (pre-quarry) ecological trends and determination of year-to-year variation, however, some general patterns may be evident.

As quarrying proceeds, ecological data will be evaluated by comparing to previously documented conditions and reported upon in the applicable annual report. Any significant findings such as new patterns, anomalies, and/or changes will be identified on the basis of their being an unexpected finding that is clearly outside of expected year-to-year variability, or is an apparent reversal in an evident trend or a specific negative change. This analysis will become easier over time as more data are collected

---

24 If winter ice thickness is such that measuring creek water temperatures may jeopardize associated redds (i.e., by penetrating ice cover), measurements will not be taken until suitable conditions re-occur.

and trends and year-to-year variability become clearer. Significant findings will be further evaluated to establish whether they are related to quarrying activities and whether there is any significant negative impact to ecological features as discussed further below.

The purpose of the ecological monitoring of wetland W5 is to facilitate the evaluation of interim conditions when the groundwater recharge system is active, rather than for long-term monitoring of ecological conditions. During the extraction of Phase 2 of the Extension, W5 will be monitored to confirm that there are no significant negative impacts to the ecological features of this wetland. The results of the W5 monitoring and assessment will be considered as described in the protocols for transition of extraction to Phase 3 (Appendix D). Ecological monitoring of W5 may be discontinued once extraction has shifted to Phase 3[25].

Under the long-term rehabilitation conditions (i.e., when the groundwater levels are maintained by the quarry lakes) some change in the water level regime in wetland W5 and therefore the character of the wetland is anticipated, as described in the Water Resources Assessment Report (CRA, 2000). Specifically, it is anticipated that wetland W5 may maintain some standing water throughout the year (i.e., not dry out in late summer) and possibly experience lower spring high water levels.

The photo monitoring and redd surveys provide general quantitative measures which can be easily compared. However, year-to-year variation in spawning activity will occur naturally, and both the vegetation and spawning activity will be affected by a range of other natural and man-induced changes.

Temperature data will be assessed as part of the ecological monitoring evaluation and documented in the annual monitoring report. In the event that it is identified that the temperature of the recharge water is having a detrimental effect on the fish habitat, suitable measures to address the situation will be implemented. Such measures may include the addition of more/colder water (through the recharge system or by direct discharge of water to the creek) to maintain the critical aspects of the thermal regime in the creek (e.g., instream summer temperatures in fish refuge areas). The 5-year AMP review will include an assessment of the temperature effects of the recharge system. If

---

25 Prior to discontinuing monitoring of W5, the justification for discontinuing monitoring will be submitted to the agencies for review.

the monitoring results demonstrate that there is no measurable effect on the water habitat, the temperature monitoring and reporting will be reduced or discontinued[26].

The discharge flow data from SW4 will be evaluated in conjunction with the other ecological monitoring data. In the event of a reduction in discharge which may result in an adverse effect on the fish habitat, the flow of water could be increased using the recharge system, by direct surface water discharge at the existing abandoned pumphouse, or by direct discharge to the Sixth Line Tributary.

If the assessment of ecological conditions identifies a significant negative impact to ecological features, Dufferin will (unless the issue is clearly not attributable to Dufferin's activities) implement appropriate measures to prevent and/or mitigate the effects. The appropriate response actions will depend on the cause and severity of the change and specifically on the feature being affected, and the extent to which any change is attributable to quarrying activity. The ecological aspects of the overall mitigation system performance are discussed further in Section 6.0.

If the change is uncertain or minor, the frequency of monitoring may be increased or other supplemental monitoring conducted to determine whether or not a change is actually occurring or is detrimental. The water resources and climatic data will be scrutinized carefully for any potential relationships or any potentially related change or trend.

4.6 RESIDENTIAL WELL MONITORING

Dufferin will conduct a residential well monitoring program as described herein. The program includes a baseline survey and annual monitoring for residential wells beyond the study area of the Extension and routine monitoring of residential wells within the study area as set out below and shown on Figure 4.1.

In Section 6.7 of CRA's May 2000 Water Resources Assessment Report (CRA, 2000) and Figure 6.17 of that same report a discussion is presented on the location and status/characteristics of the known/accessible/available residential wells at that time

26 Temperature monitoring would only be considered for discontinuation following a suitable evaluation period of the recharge system operation. In the event that temperature monitoring is discontinued, some temperature monitoring of the recharge water from the Reservoir would continue in order to provide information relative to any significant changes in water temperature in the Reservoir. Consideration of the appropriateness of reinstitution of some of the discontinued temperature monitoring activities will be provided in the annual report if a significant change in Reservoir water temperature occurs.

(based on a door to door survey and inspection program). In addition, the report highlights that the wells that are located to the north and west of the Sixth Line tributary are "beyond the hydrogeologic features that define the boundaries of the study area for the proposed Extension and will not be affected by the proposed Extension". Since that time, this comprehensive AMP has been prepared which provides monitoring requirements for a series of recharge monitoring wells as well as trigger monitoring wells which are located at the water resource features (creek and wetlands). The AMP also provides for initial and ongoing verification of the performance of the groundwater mitigation system and defines response times to rectify any performance issues. The protection provided to these water resource features by definition provides the necessary protection and monitoring verification for off-Site residential wells to the north and west of the Sixth Line Tributary.

Given the above, there is no technical need to have a monitoring program for the residential wells beyond the study area. Regardless of this conclusion, Dufferin agrees to maintain (or collect where not currently available) baseline survey information from all accessible private residential water supply wells in the baseline survey zone as described below. Dufferin also agrees to collect water level and water quality data for the accessible private residential water supply wells in this baseline survey zone.

4.6.1 MONITORING LOCATIONS

The baseline survey zone residential monitoring program includes all accessible private residential water supply wells located north or west of the Extension and south of No. 15 Sideroad, and between Sixth Line (including properties on the west side with frontage on Sixth Line Road) and the unopened First Line road allowance.

The study area monitoring zone includes residential properties in the study area of the Extension (bounded by the Sixth Line Tributary to the north and west) that are not owned by Dufferin Aggregates. There is presently only one such residential well in this area (DW103) as shown on Figure 4.1. This well is monitored and protected as part of the North Quarry OWRA approvals.

The identified water supply wells located in the "study area monitoring" and "baseline survey" zones (which are not owned by Dufferin) are shown on Figure 4.1.

The residential monitoring program is subject to the agreement of the landowners to allow access to their property.

Dufferin may at its discretion continue to do additional monitoring as part of their ongoing neighbour relations program which has historically included monitoring of properties over a larger region than necessary as well as periodic water quality sampling.

4.6.2 MONITORING ACTIVITIES

The residential well monitoring program will include two principal components as described below:

1. Baseline Survey Zone Monitoring Program:

   An update to the existing baseline residential well survey will be completed prior to the start of bedrock extraction in the Extension. Such a survey has already been completed by Dufferin; however, conditions will be reviewed to ensure all the appropriate information has been obtained. This survey will be undertaken on all water supply wells that are to be included in the residential well monitoring program (either through technical/regulatory requirements or Dufferin's neighbour relations program). The baseline survey will include all accessible water supply wells in the baseline survey zone, as previously identified (refer to Figure 4.1). In the future, if additional residential wells are added to the program then these wells will also have a baseline survey conducted.

   The baseline survey consists of the following:

   - The well condition and well record (if available from MOE, Region, or landowner) will be reviewed. This will include an interview or written survey with the landowner regarding the well conditions;
   - Water level monitoring access will be established if this can be readily achieved. This may require minor wellhead modifications. Some wells may remain inaccessible due to practical access limitations and therefore can not be included;
   - Water samples will be collected for analysis. Water samples will be analyzed for general chemistry, metals, and biological parameters consistent with the Ontario Drinking Water Quality Standards (ODWQS) in effect at the time and standard practice for water supply monitoring; and
   - The location and elevation of the well will be surveyed.

Groundwater levels will be measured and water quality samples will be collected at all identified and accessible residential wells in the baseline survey zone during an annual monitoring event. Water quality samples will be analyzed for general chemistry, metals, and biological parameters consistent with ODWQS in effect at the time and standard practice for water supply monitoring.

2. Study Area Monitoring Zone Program

   Groundwater levels will be measured on a quarterly basis in accessible wells within the study area monitoring zone (see Figure 4.1). The annual baseline survey water level monitoring (above) will constitute one of the four required quarterly monitoring events. In the event that domestic wells in the monitoring zone are not accessible for regular water level monitoring, Dufferin will monitor adjacent monitoring wells. There is presently only one existing domestic well (DW103) in the study area on land that is not owned by Dufferin. Dufferin will continue to monitor well BH37 [or suitable replacement(s)] which is adjacent to DW103 when/if measurements can not be obtained directly from the DW103.

4.6.3 DATA EVALUATION AND RESPONSE ACTIONS

Water Level Monitoring: The collected data will be evaluated on a regular basis to assess the trends in groundwater levels relative to climatic conditions. In the event that a significant dewatering trend is identified (unless the issue is clearly not attributable to Dufferin's activities), Dufferin will contact the affected landowner(s) to discuss the situation and undertake to assess the situation to ensure an appropriate residential water supply is maintained.

If a real (verified) water supply issue is identified, Dufferin will (unless the issue is clearly not attributable to Dufferin's activities) take measures necessary to ensure an appropriate water supply is available. These measures may include, changes to the groundwater recharge system, deepening the existing water supply well(s), drilling a new water supply well(s), or provision of a water system and supplied water. If the effect is significant (i.e., normal residential supply is not available) and Dufferin can not promptly mitigate the influence using the groundwater recharge system, Dufferin will notify the agencies. As required by the OWRA, these measures would be undertaken at Dufferin's cost (unless the issue is clearly not attributable to Dufferin's activities).

Over the long-term, the lake filling will passively maintain the groundwater levels and therefore there will not be any water supply problems related to the Extension.

Trucking-in of water (if unexpectedly required as a contingency during the active quarry operation) will not be required as a long-term supply under these circumstances.

Annual Water Quality Monitoring: The collected residential water quality data will be evaluated on an annual basis to assess the trends in groundwater quality. In the event that sample results indicate non-potable water conditions and/or a significant decline in water quality, Dufferin will contact the affected landowner(s) to discuss the situation and undertake to assess the situation to ensure an appropriate residential water supply is maintained (unless the issue is clearly not attributable to Dufferin's activities).

If a real (verified) water quality issue is identified, Dufferin will (unless the issue is clearly not attributable to Dufferin's activities) take measures necessary to ensure the water supply is potable and suitable for normal domestic consumption (including treatment, if appropriate). In particular, Dufferin will ensure the water supply meets all ODWQS that were met during the baseline water quality survey (and during baseline survey zone annual monitoring events not influenced by Dufferin’s activities) and that there is no significant degradation of any parameters that were in excess of applicable ODWQS under baseline (and annual monitoring) conditions. These measures may include changes to the groundwater recharge system, treatment of the affected water supply, deepening the existing water supply well(s), drilling a new water supply well(s), or provision of a water system and supplied water (note: Region of Halton does not consider long-term "trucking-in" of water to be a suitable alternative). If such measures are necessary, Dufferin will notify the agencies and, as required by the OWRA, implement these measures at Dufferin's cost (unless the issue is clearly not attributable to Dufferin's activities).

Complaint Response Procedure: If Dufferin receives a complaint that their operations have caused a water shortage or a change in water quality in any domestic (residential) well not owned by Dufferin, Dufferin (or their agent) will undertake the following actions:

- Dufferin will notify the MOE and Region;
- Dufferin will promptly provide a suitable short-term supply of potable water to the residents;
- Dufferin will initiate immediate investigations of the cause of the water shortage or change in water quality;
- If preliminary findings indicate that Dufferin's operations may be the cause of significant problems, Dufferin will promptly ensure an interim whole-house supply of suitable quality and quantity of water; and

- If Dufferin's operations are confirmed to be the cause of the problems, Dufferin will ensure a permanent whole-house supply of suitable quality and quantity of water.

These measures would be undertaken to the satisfaction of MOE and would be undertaken at Dufferin's cost.

If the issues are clearly not related to Dufferin's activities (e.g., is a plumbing issue) then it would be the landowner's responsibility to rectify.

Where the affected landowner(s) has not allowed Dufferin an opportunity to complete the baseline residential well survey or to monitor the well on a regular basis, Dufferin will still respond to complaints in order to assess the cause of the supply problem, provided Dufferin or its contractor has access to the well and related facilities. However, if the issue is clearly attributable to cause(s) other than Dufferin's activities, the above response actions do not apply.

5.0 PROCEDURES FOR MINOR VARIATIONS

As discussed in Section 1.4, it is appropriate to provide for some minor variations (exceptions) to address data anomalies and/or unique circumstances in accordance with the procedures described herein. These procedures are based on the following principles:

- Minor variations are by their definition minor in nature and only require a minor adjustment in the application of the AMP for a localized area or unique situation. These variations are in keeping with the overall intent of the AMP;
- Since the minor variations are in keeping with the overall intent of the AMP they do not require amendment of the AMP; and
- The agencies will be notified of any variation at an appropriate time (as below) and all minor variations will be appropriately documented in the annual report, including the rationale, technical justification, and any related water resources considerations.

The circumstances to which minor variations may be applied are divided into two categories which have differing timelines and agency involvement.

Anomalies/Glitches: The first category represents anomalies or glitches which include circumstances such as data errors, non-verifiable/non-reproducible results, and/or missed sampling events (due to valid reasons such as physical conditions - e.g., storm or flooding events). Anomalies/glitches are typically straightforward operational issues that should be promptly dealt with by Dufferin with no input or decision making required by the agencies prior to implementation. Dufferin will maintain records of such anomalies/glitches and document in the annual report, including review of appropriateness to continue to consider issues as anomalies/glitches.

Modifications: Some circumstances may occur where it is appropriate to make a timely minor variation in the application of the AMP to address particular circumstances. In these circumstances there is some interpretation required as to the minor variation to be made and an opportunity for agency review is appropriate prior to implementation. The procedure for handling such minor variations is described below.

Minor Variation Procedure for Modifications:

1. Dufferin will notify the agency representative(s) prior to implementing a minor variation corresponding to a modification. This notification will include a full

explanation of the rationale, technical justification, and related water resource considerations for the minor variation and why it is considered a minor variation.

2. Dufferin will maintain written records of variations and document them in the annual report, including review of the appropriateness of continuing to consider such issues as minor variations.

6.0 REPORTING

6.1 ANNUAL REPORT

A comprehensive annual report will be prepared documenting the implementation and operation of the mitigation measures and recommendations for future groundwater mitigation system requirements in accordance with the AMP. The report will be submitted to the agencies for their information and review, commencing after the issuing of the licence and after the trigger and background wells have been installed and a year of monitoring data is available.

The annual report will include the following:

- Status and summary of quarry operations (e.g., development, extraction, and rehabilitation);
- Status and summary of mitigation system development and implementation;
- Complete presentation of monitoring results, including summary of any notifications provided under the response action framework (Section 1.3);
- Summary of response actions taken to maintain target levels (and effectiveness of actions);
- Explanation and assessment of potential for impacts resulting from any period or area in which water level or water quality targets were not continuously maintained;
- Target levels and minimum water levels[27] (once initial levels are set and then adjusted levels for following years);
- Assessment of supplemental monitoring program findings, including ecological aspects;
- Evaluation of overall water budget and determination of "excess water" for the subsequent year[28];
- Discussing groundwater mitigation system requirements for the subsequent year as the quarry develops;

---

27 Target water levels for future operating seasons will be provided to the agencies at least 3 months prior to the start of the relevant operating season. It is anticipated that this would typically be done in conjunction with the annual report plus a supplemental submission in the summer or fall of the calculated target and minimum water levels for the first period or first two periods of the following year.

28 Further information on water budget evaluation and reporting is provided in Section 4.4 and Appendix E.

- Documentation of any anomalies/glitches that occurred and/or any minor variations that were implemented throughout the year (refer to Section 5.0);
- Review appropriateness of response/notification timelines identified in Section 1.3 and Appendix F as well as the reset period for the operating response period described in Appendix F;
- Evaluation of the suitability of the interim extraction area and any continued/future interim extraction;
- Summary of any amendments/updates to the AMP which were agreed to throughout the year;
- Conclusions; and
- Recommendations, including any proposed amendments to the AMP reflecting knowledge gained from actual operating conditions and monitoring results (e.g., reduction in minimum monitoring frequency).

In addition to the above aspects, the annual reporting will include an overall evaluation of the performance of the mitigation measures to confirm that the mitigation performance objectives are being achieved and that continued extraction and mitigation operation is sustainable over the long term. This evaluation will consider all aspects of the operation and monitoring activities described in the AMP. Some specific considerations that will be addressed include the following questions.

1. Are the operating practices consistent with the mitigation performance objectives? Specifically, are the water levels at the trigger wells being maintained relative to the target levels in a manner that is protective of the water resources? The appropriate pattern of water level variations relative to the target levels will become more evident as operating data becomes available; however, it is the intended performance objective that the water levels will be maintained at or above the target levels for the majority of the time, without large fluctuations in water level above or below the target levels, and that the duration of such fluctuations will be kept to a minimum (i.e., a few days versus weeks).

   It is also intended on an overall and seasonal basis to supply the ecological features with a quantity of water which is equivalent to the supply at the target levels, therefore, it is not intended to predominately exceed the target levels as this may adversely affect the water budget.

   In the unexpected event that short term (less than 8 weeks) drops below target levels are occurring on a repeated basis and are adversely affecting the achievement of the above-noted performance objectives, further precautionary measures (i.e., aggregation) will be implemented as described in Appendix F (refer also to Section 1.3 and Figure 1.9).

2. Are the mitigation measures protective of the groundwater dependent ecological features? The ecological monitoring information will be evaluated in conjunction with the other monitoring data to identify whether the off-Site and on-Site ecological features are being protected. In the event that a significant negative impact to ecological features is indicated (unless the change is clearly not attributable to Dufferin's activities - e.g., climate, upstream issues, etc.), further investigation and assessment will be undertaken to determine what response actions may need to be implemented to ensure the protection of the groundwater dependant ecological features.

In the event it is determined that an amendment to the AMP is needed and appropriate and this amendment cannot wait until the annual report then separate documentation of the need and appropriateness of the amendment will be submitted to the agencies for review. Any changes to the AMP will be documented in the subsequent annual report.

6.2 PRE-EXTRACTION REPORT (PHASE 2)

Prior to commencing extraction within Phase 2 of the Extension, the following information on trigger wells and targets, engineering design, and data collection will be submitted to the agencies for their information and review:

- Location and performance evaluation for the installed trigger and background wells;
- Recommendations for additional trigger/background wells, if any;
- Analysis of correlation between background wells and trigger wells;
- Establishment of initial target water levels and minimum water levels for each trigger well;
- Review appropriateness of response/notification timelines identified in Section 1.3;
- Any pertinent information arising from the detailed design for the recharge system;
- Results of the recharge demonstration testing (including thermal monitoring), as described in Section 1.3;
- Details of the monitoring database, including timing for data input and access permissions;
- Location of temperature monitoring stations;

- List of automated equipment including locations, parameters recorded and confirmation of calibration;
- Water budget table updated to reflect the proposed extraction and reservoir/lake filling schedules;
- Identification of key personnel and associated roles and responsibilities for agency contact purposes. This information will be updated as appropriate in conjunction with access to the on-line database;
- An Emergency Response Plan for Grouting (ERPG) that shall be available to the operator at all times; and
- Appropriate recommendations, if any, to amend the AMP relative to this information.

6.3 5-YEAR REVIEW REPORT

Once every 5 years following commencement of extraction in Phase 2 of the Extension, a re-assessment of the AMP will be conducted and reported in conjunction with the annual monitoring reports. This assessment will consider all aspects of the AMP from a broader context than the annual review, including:

- Monitoring programs;
- Target levels[29];
- Mitigation measures;
- Mitigation objectives in relation to effects of long-term climate variation;
- Water budget[28];
- AMP procedures;
- Overall evaluation of performance of the mitigation measures in achieving the primary objective of the system:

  "The principal purpose of the mitigation measures is to maintain groundwater levels around the perimeter of the Extension and thereby protect surrounding

---

29 Includes data and procedures used to set target levels. Inclusion of multi-target levels within a single season and, as an alternative, the concept of setting target levels based on the exclusion of transition periods between seasons and the timing of data collection (e.g., mid-month) will be explored during the first 5-year review.

As part of the first 5-year review, the establishment of spring period creek target levels using average minimum monthly levels will be reviewed to assess whether there is any evidence of significant unanticipated impacts on the creek.

water resources (including water dependent ecological features and private water supply wells)." [Section 1.2];

- Validation of the long-term structural integrity of the pillars based upon on-Site monitoring and any issues arising from published relevant case histories; and
- Reporting.

All of Which is Respectfully Submitted,

CONESTOGA-ROVERS & ASSOCIATES

William T. Armes, P. Eng.

J. Richard Murphy, P. Eng.

ECOPLANS LIMITED

GOODBAN ECOLOGICAL CONSULTING INC.

Anne MacMillan, B.Sc., M.B.A.

Anthony G. Goodban, B.Sc., M.E.S. (Pl.), MCIP RPP
Consulting Ecologist and Natural Heritage Planner
GOODBAN ECOLOGICAL CONSULTING INC.

REFERENCES

Conestoga-Rovers & Associates, May 2000. *Water Resources Assessment Report, Milton Quarry Extension, Region of Halton, Ontario.* Prepared for: Dufferin Aggregates.

Conestoga-Rovers & Associates, August 2001. *Adaptive Environmental Management and Protection Plan (AMP), Water Resources and Related Ecological Features, Milton Quarry Extension, Region of Halton, Ontario.* Prepared for: Dufferin Aggregates.

Conestoga-Rovers & Associates, November 2007. *Detailed Geotechnical Engineering Design Report, Extension Rock Pillars, Milton Quarry.* Prepared for: Dufferin Aggregates.

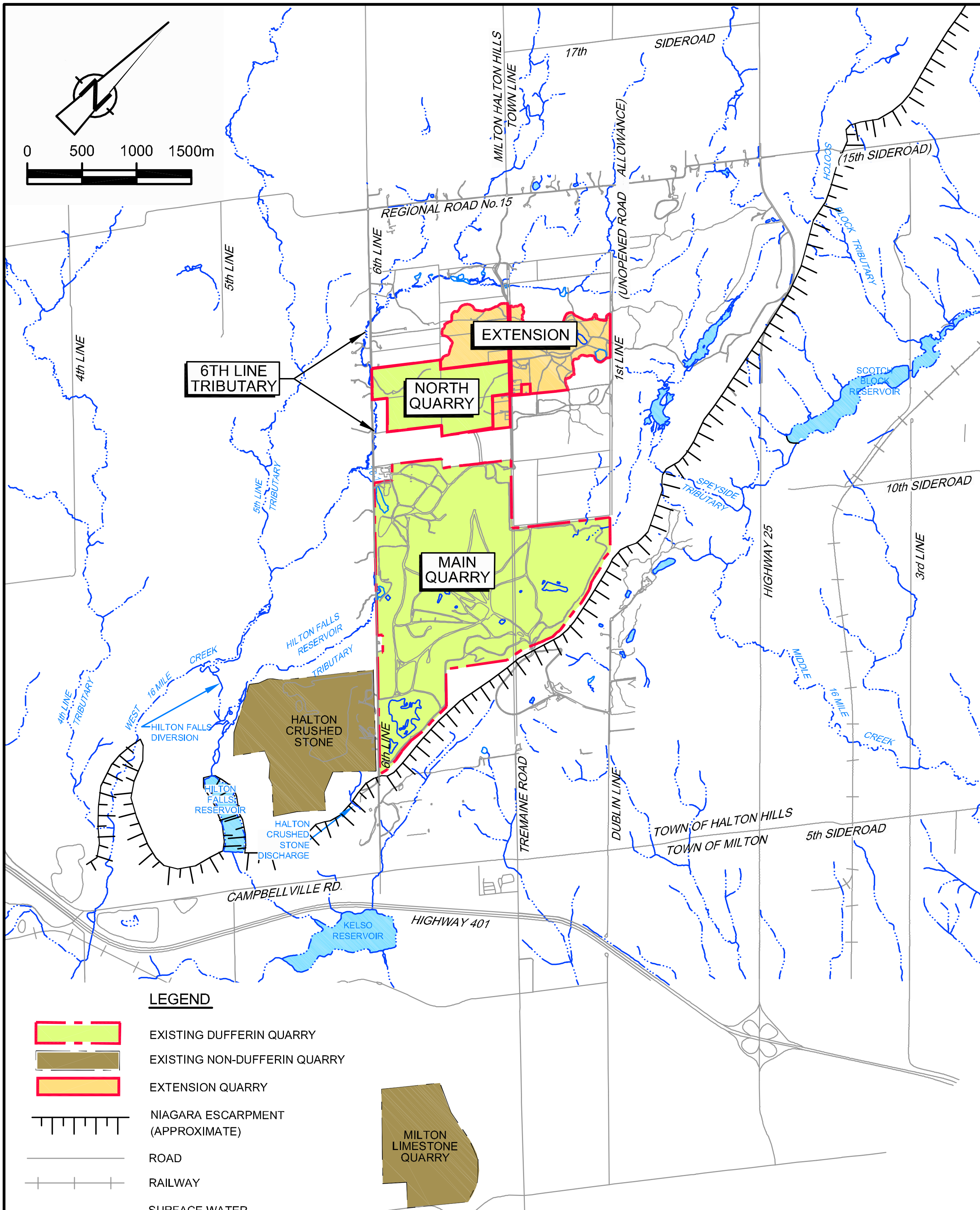
Conestoga-Rovers & Associates, March 2010. *2009 Annual Water Monitoring Report, Dufferin Milton Quarry, Region of Halton, Ontario.* Prepared for: Dufferin Aggregates.

Ecoplans, May 2000. *Dufferin Aggregates Milton Quarry Extension Environmental Impact Assessment.*

CVC, 1998. *Caledon Creek and Credit River Subwatershed Study – Draft Impact Assessment Report (Subwatersheds 16 and 18),* Credit Valley Conservation Authority, Prepared for Region of Peel and Town of Caledon.

Morgenstern, July 1994. *The Observational Method in Environmental Geotechnics*. Proceedings of the First International Congress of Environmental Geotechnics, Edmonton, Alberta.

Van Horn, M. and K. Van Horn. 1996. *Quantitative Photomonitoring for Restoration Projects*. Restoration & Management Notes 14(1):30-34.

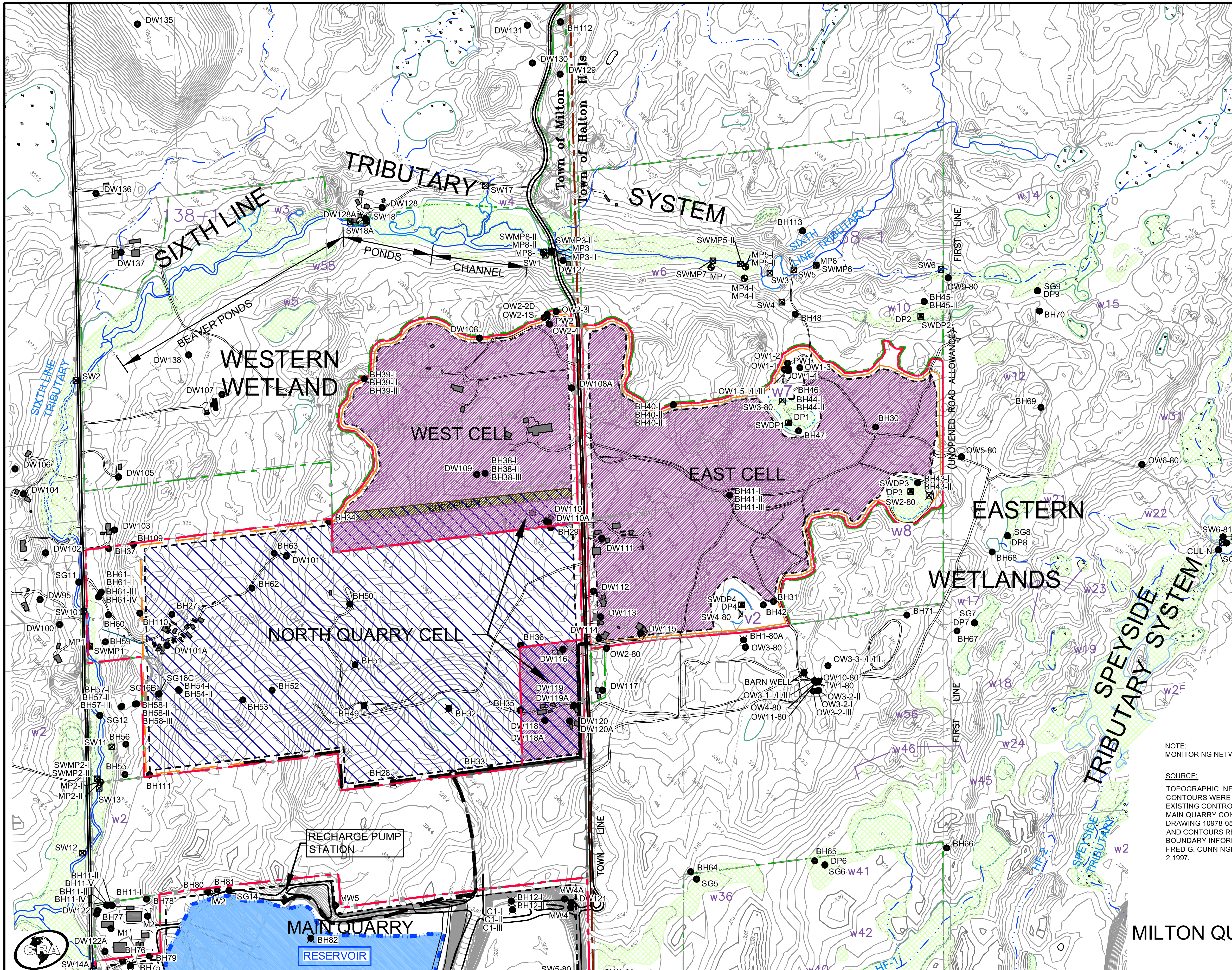


SOURCE:
BASE MAPPING PRODUCED BY MACNAUGHTON HERMSEN BRITTON CLARKSON PLANNING LIMITED AND CONESTOGA-ROVERS & ASSOCIATES UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES © QUEEN'S PRINTER 1997.

figure 1.1

SITE LOCATION
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA001 JUN 23/2011



LEGEND

- MONITORING WELL LOCATION
- DW103 — DOMESTIC WELL LOCATION
- TW1-80 PW1 — TEST PUMPING WELL LOCATION
- MP1 — MINI PIEZOMETER LOCATION
- SW10 — SURFACE WATER MEASUREMENT LOCATION
- SWMP1 — SURFACE WATER MONITORING POINT
- SG8 — STAFF GAUGE LOCATION
- DP8 — DP MONITORING WELL LOCATION
- ABANDONED MONITORING LOCATION
- PROPERTY LINE
- LICENSED LIMIT OF EXTRACTION
- MUNICIPAL BOUNDARY
- DUFFERIN OWNED BUFFER
- DUFFERIN MILTON QUARRY LICENCE
- DUFFERIN LEASED
- DUFFERIN EXTENSION LICENCE
- NIAGARA ESCARPMENT (APPROXIMATE)
- WETLAND IDENTIFIED AS PROVINCIALLY SIGNIFICANT
- EXTENSION AREA EXTRACTION
- NORTH QUARRY CELL INCLUDING CONTIGUOUS EXTENSION AREAS
- EXTENSION AREA RECHARGE ALIGNMENT
- POTENTIAL NORTH QUARRY RECHARGE ALIGNMENT
- FORCEMAIN
- POTENTIAL NORTH QUARRY FORCEMAIN

NOTE:
MONITORING NETWORK SHOWN AS IT EXISTED IN MAY 2003.

SOURCE:
TOPOGRAPHIC INFORMATION OBTAINED FROM NORTHWAY MAP TECHNOLOGY LIMITED. CONTOURS WERE DRAWN FROM SPRING 1997 AERIAL PHOTOGRAPHY UTILIZING EXISTING CONTROL. CONTOUR INTERVAL IS 1 METRE.
MAIN QUARRY CONTOURS REVISED TO REFLECT 2001 EXISTING CONDITIONS (CRA DRAWING 10978-05(PRES015)GN-WA001). NORTH QUARRY IS CURRENTLY BEING MINED AND CONTOURS REFLECT PRE-MINING CONDITIONS.
BOUNDARY INFORMATION COMPILED FROM SURVEYS AND SKETCHES PREPARED BY FRED G. CUNNINGHAM, ONTARIO LANDS SURVEYORS, MILTON, ONTARIO, DECEMBER 2,1997.

figure 1.2

STUDY AREA FEATURES
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA002 JUN 23/2011

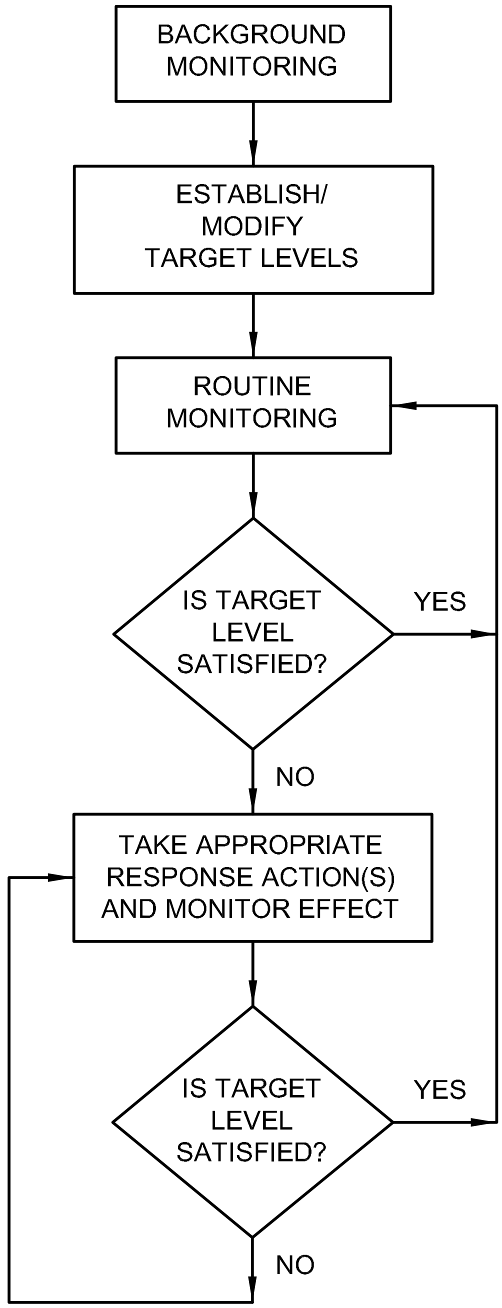
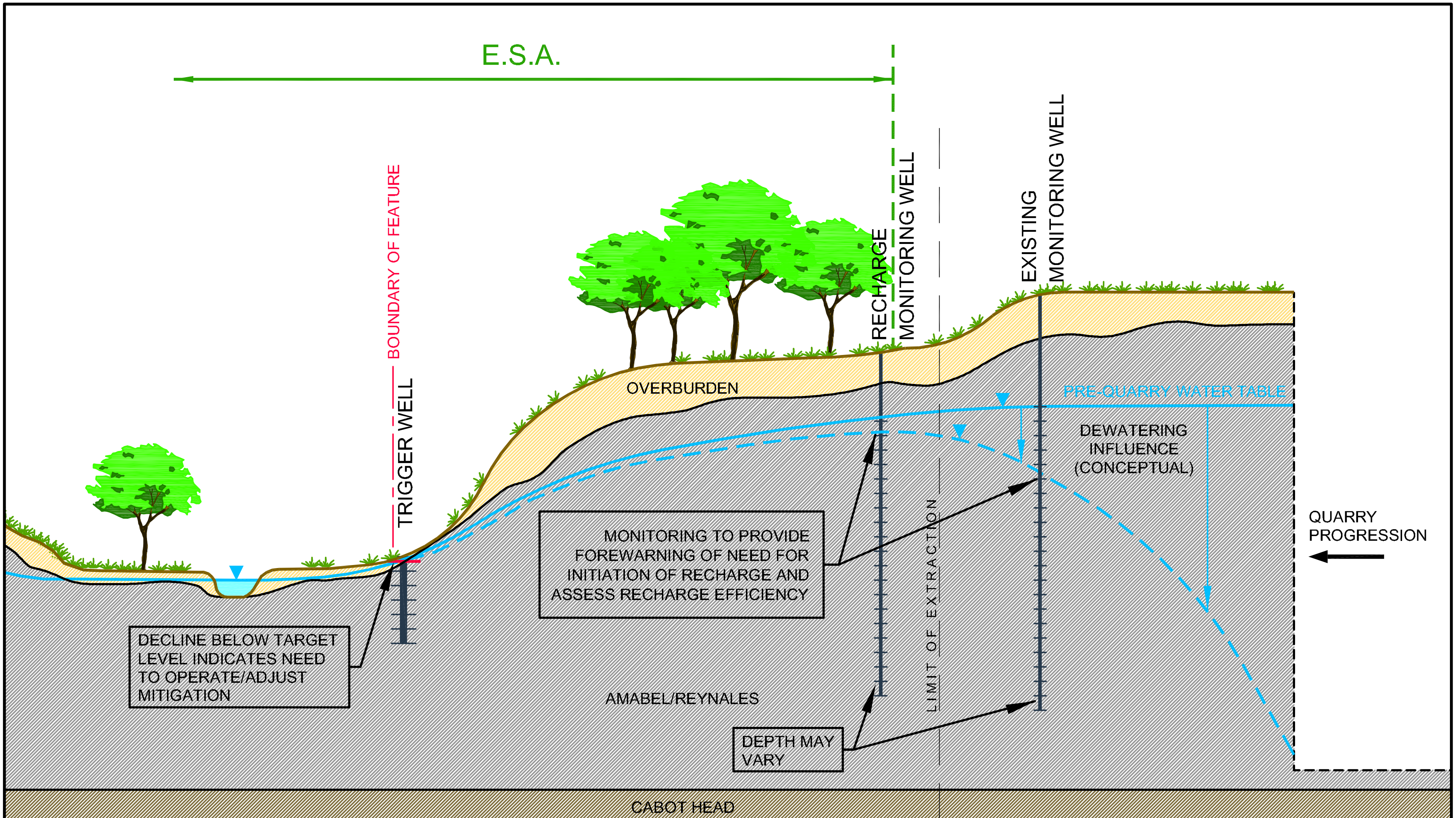


figure 1.3

GENERAL PERFORMANCE MONITORING FLOWCHART
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA003 JUN 23/2011

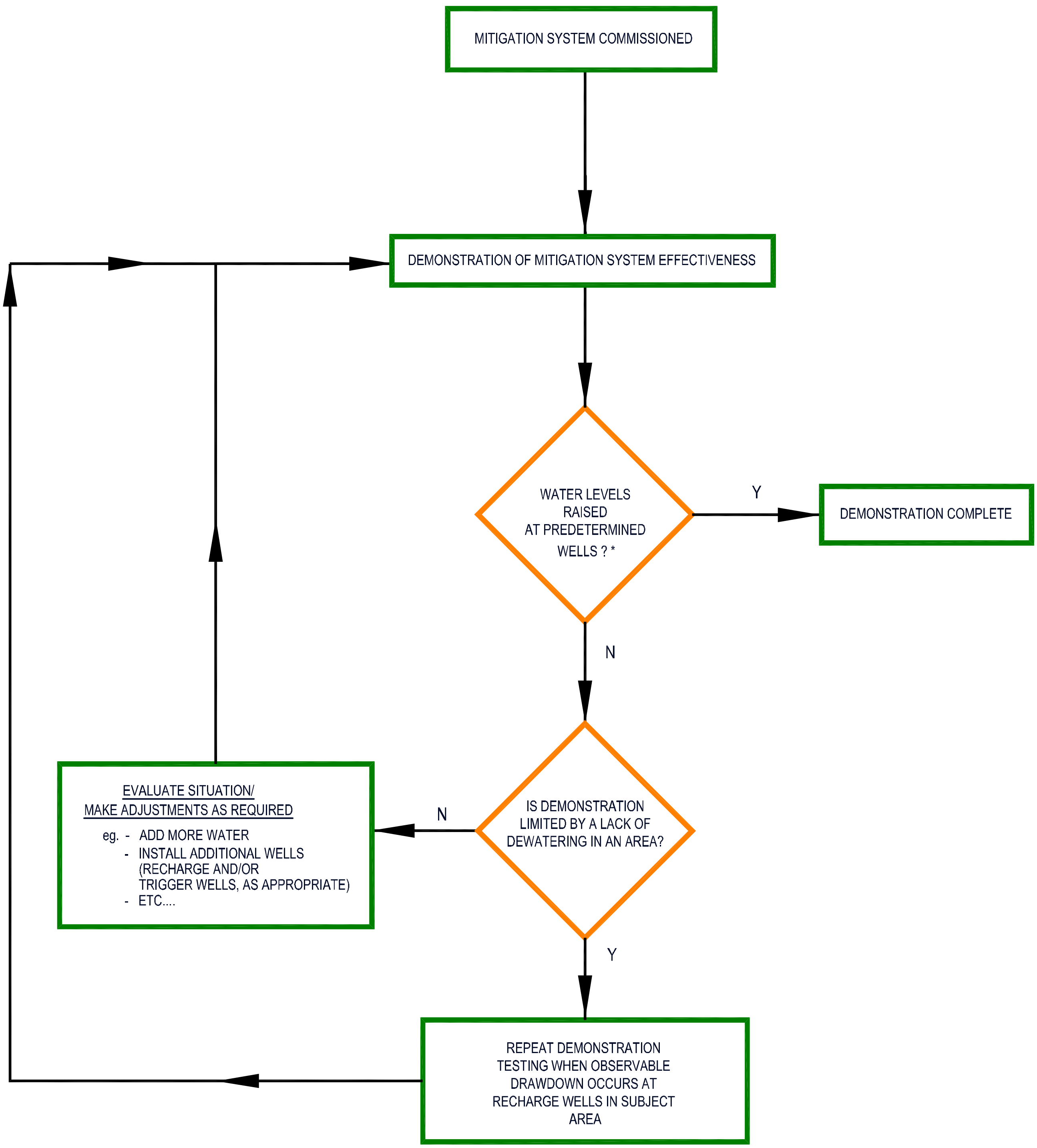


NOT TO SCALE

figure 1.4

TRIGGER WELL - RECHARGE SYSTEM SCHEMATIC
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA004 JUN 23/2011



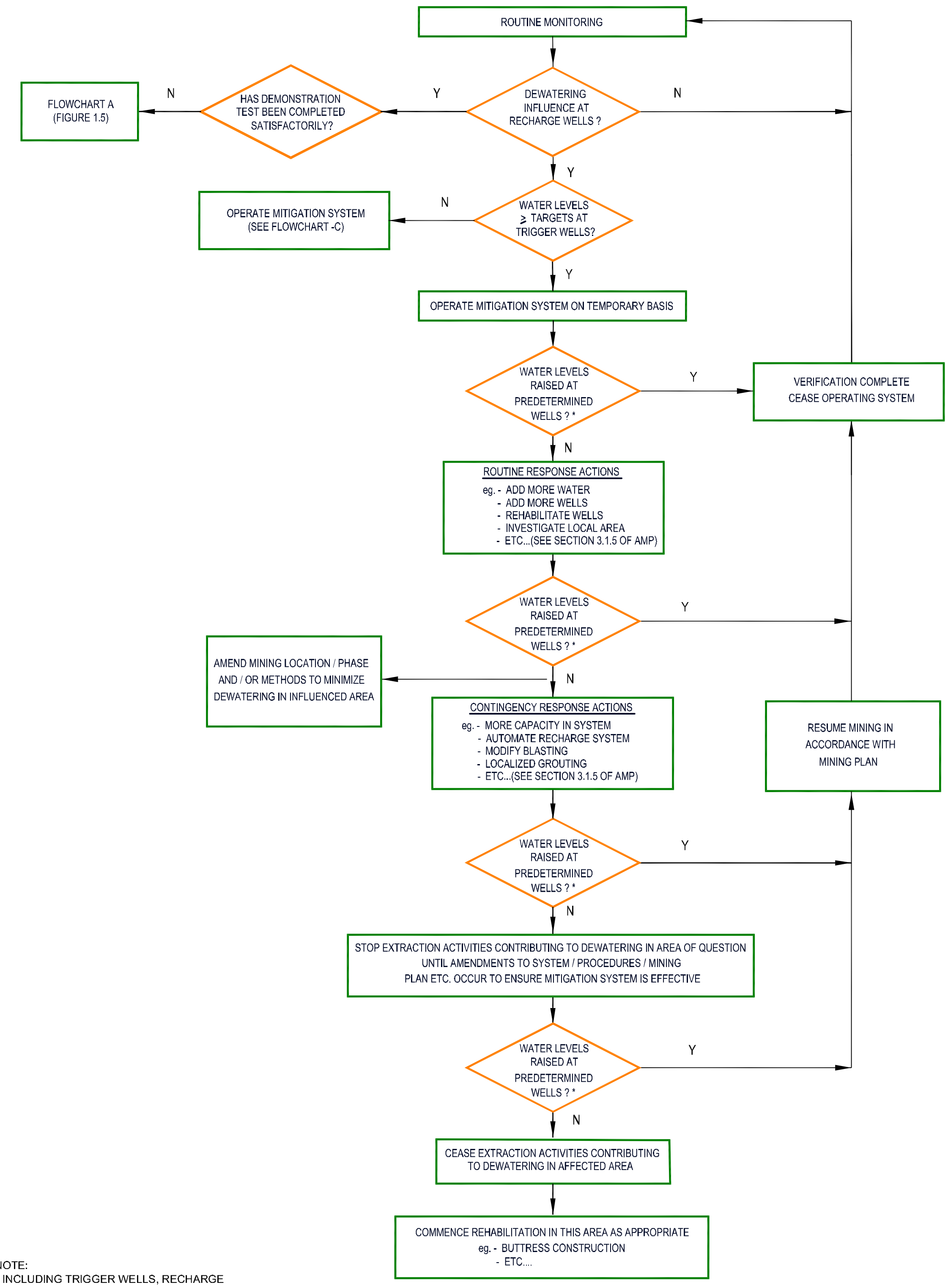
NOTE:
* INCLUDING TRIGGER WELLS, RECHARGE WELLS AND MONITORING WELLS, AS APPROPRIATE.

figure 1.5

FLOWCHART A - DEMONSTRATION PROCEDURE
PRE EXTRACTION
GROUNDWATER MITIGATION SYSTEM
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

NOTE: DOES NOT APPLY TO PHASE I

10978-68(074)GN-WA005 JUN 23/2011



NOTE:
* INCLUDING TRIGGER WELLS, RECHARGE WELLS AND MONITORING WELLS, AS APPROPRIATE.

figure 1.6

FLOWCHART B - ANNUAL VERIFICATION PROCEDURE PRIOR TO SUSTAINED RECHARGE OPERATIONS
GROUNDWATER MITIGATION SYSTEM
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

CRA

10978-68(074)GN-WA006 JUN 23/2011

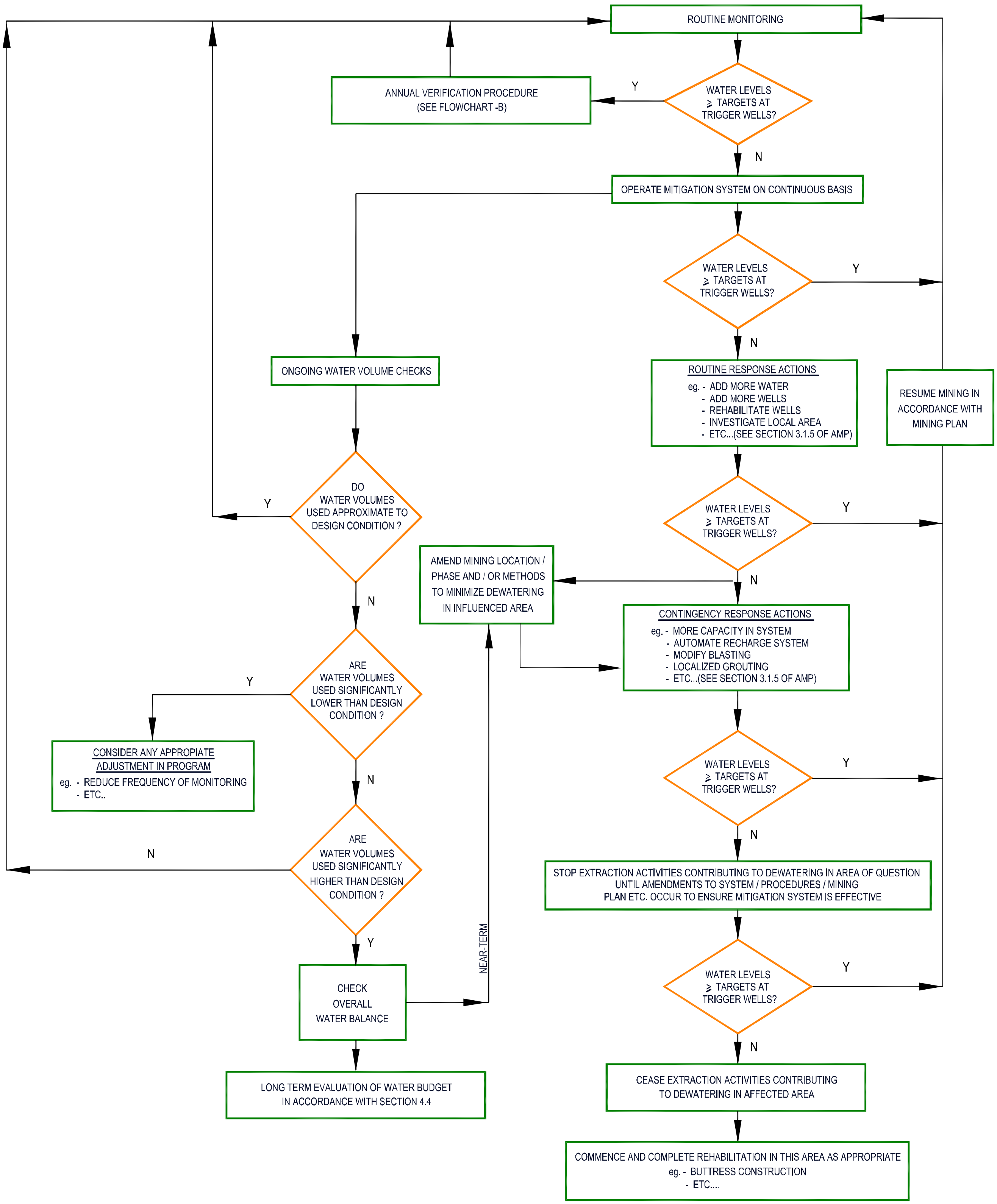


figure 1.7

FLOWCHART C - OPERATION VERIFICATION PROCEDURE
UNDER SUSTAINED RECHARGE OPERATION
GROUNDWATER MITIGATION SYSTEM
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

CRA

10978-68(074)GN-WA007 JUN 23/2011

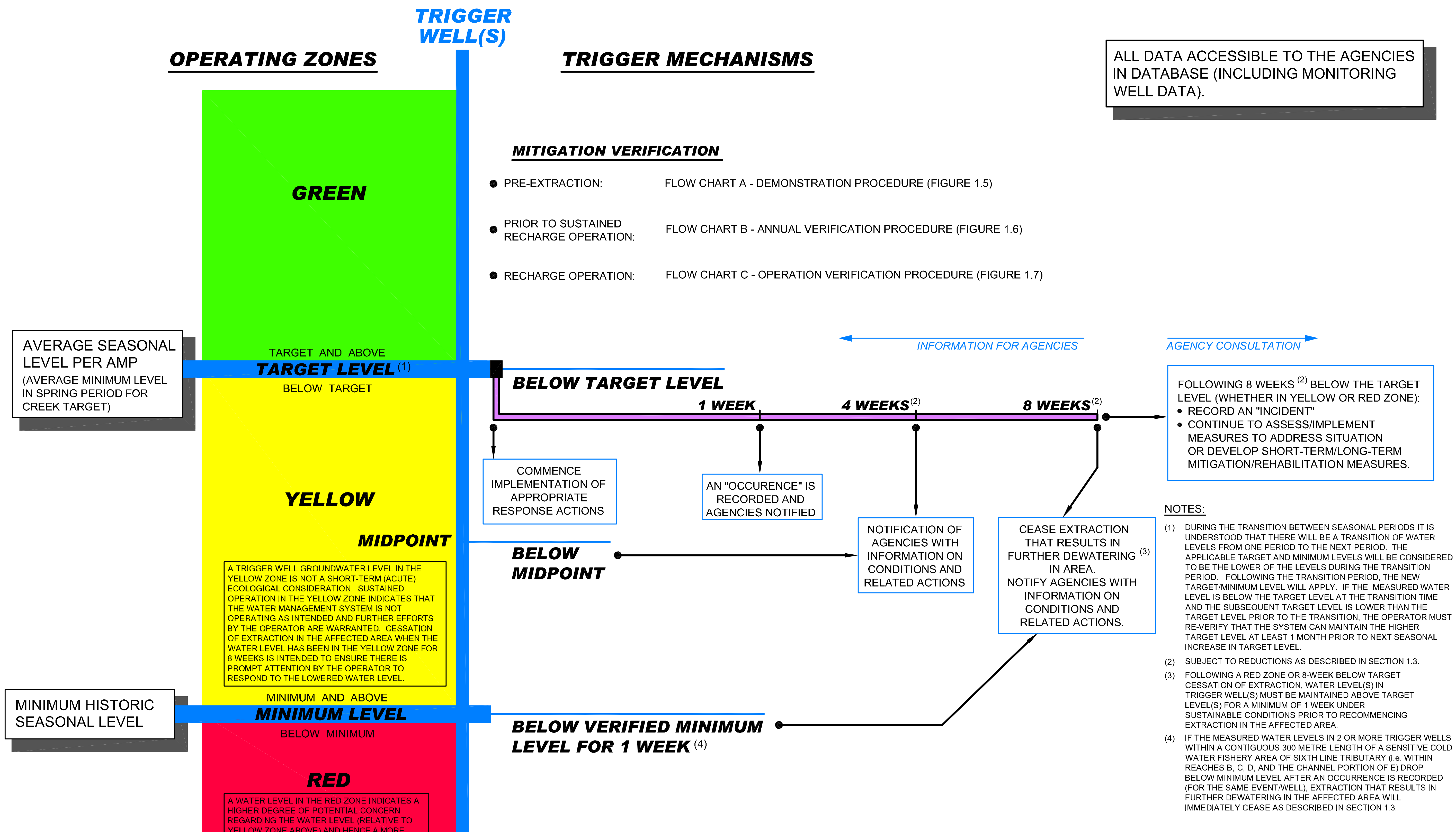


figure 1.8

RESPONSE ACTION CHART
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA008 JUN 23/2011

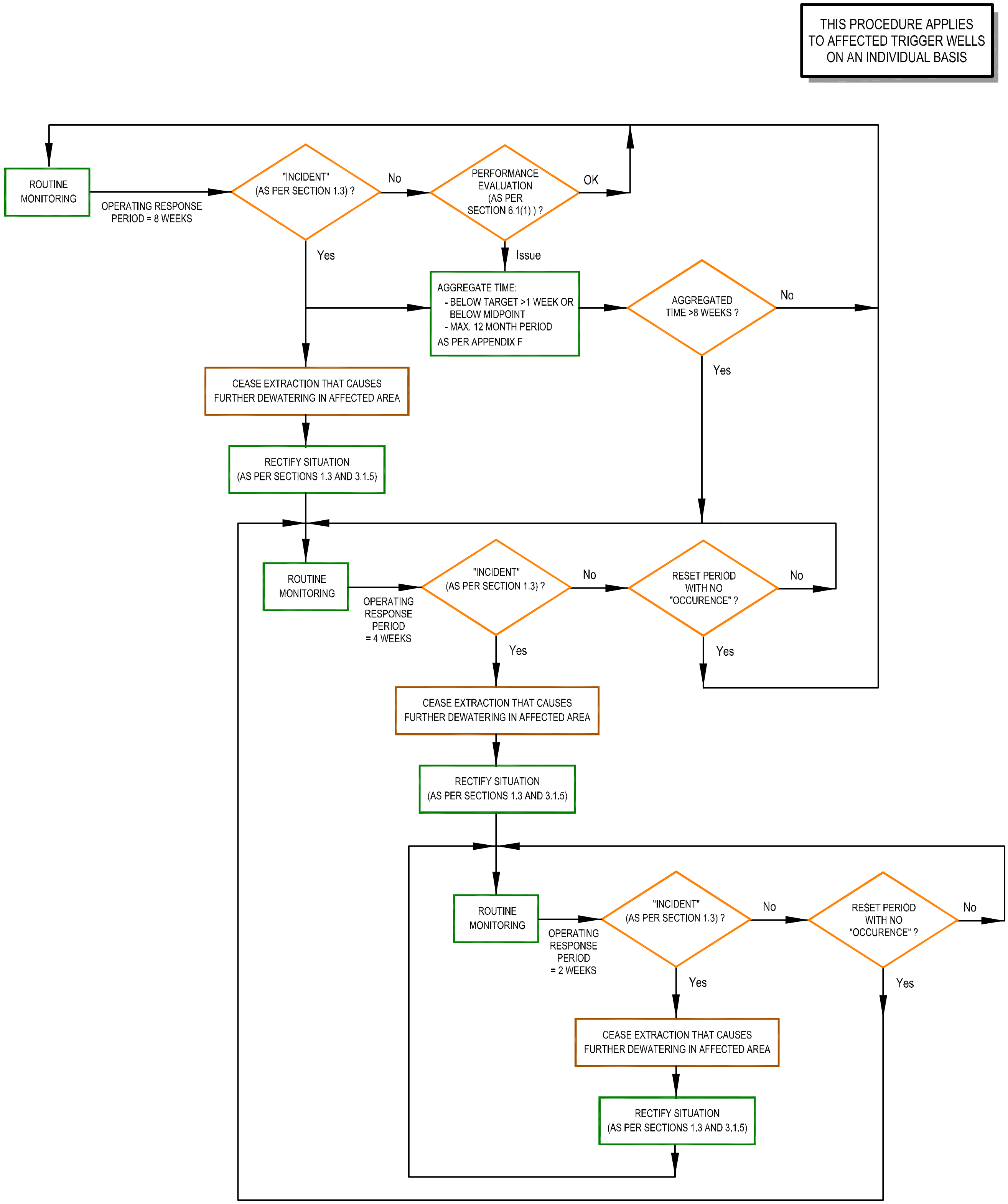


figure 1.9

FLOWCHART D - OPERATING RESPONSE TIME
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA009 JUN 23/2011

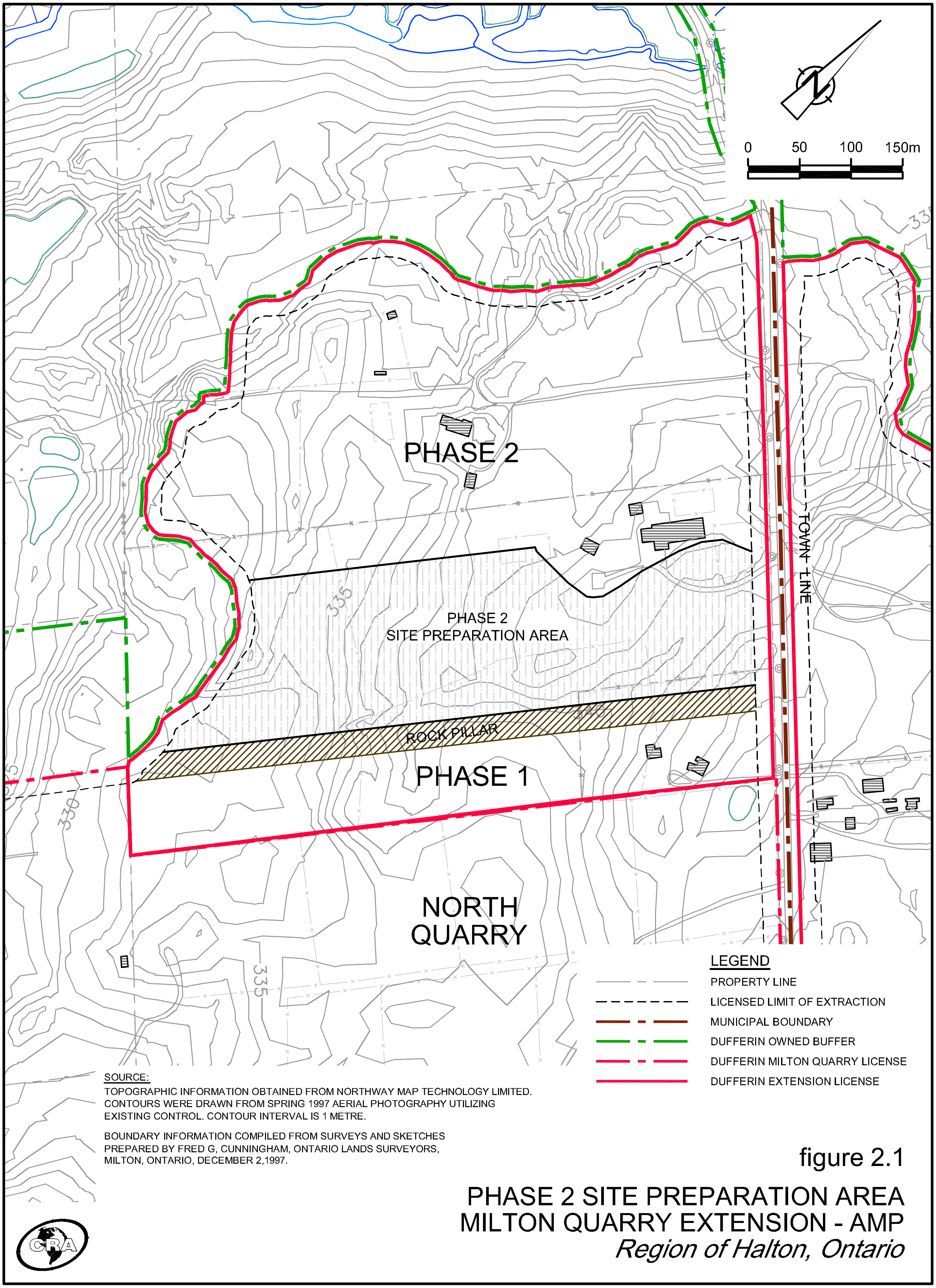
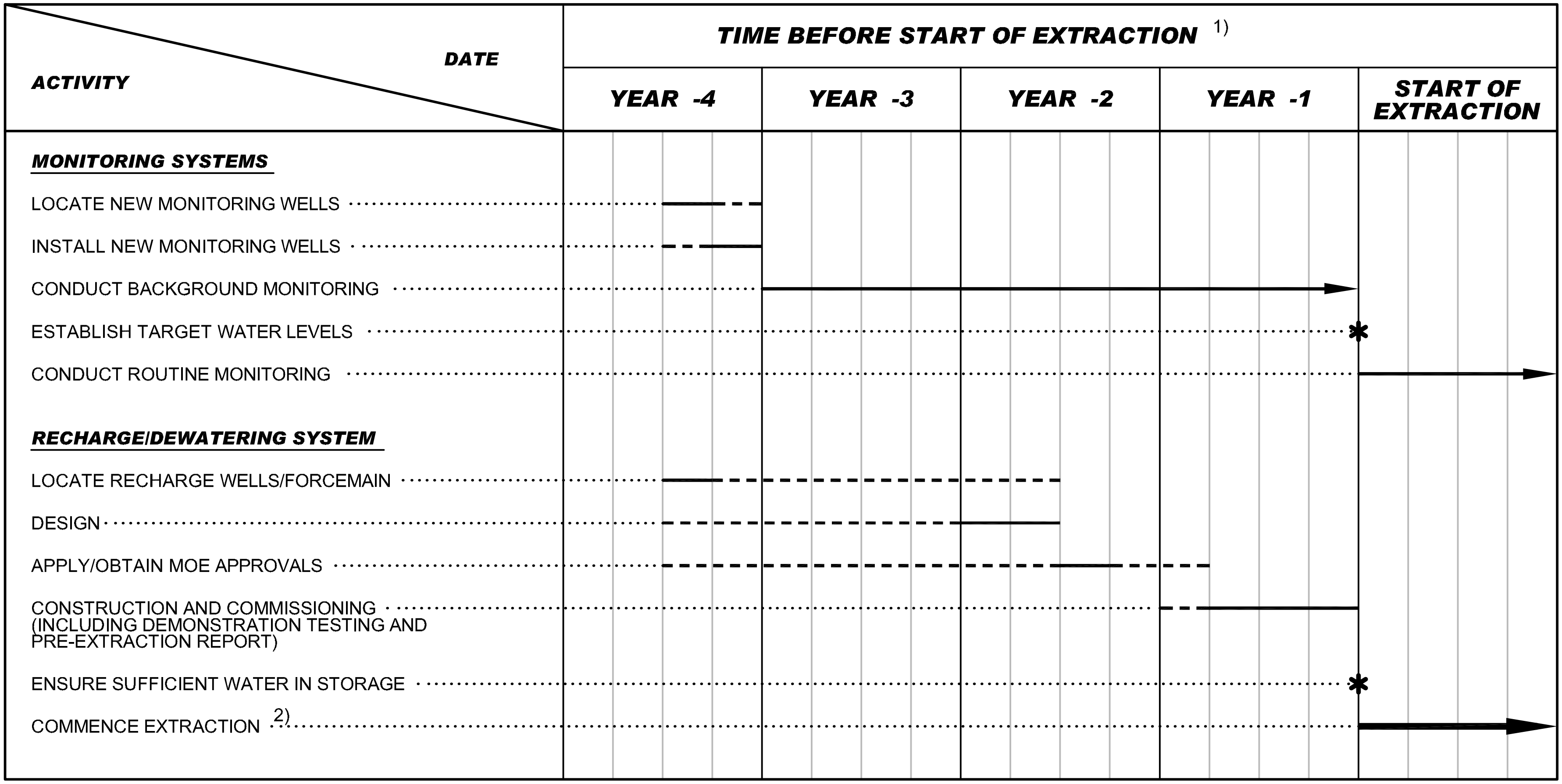


figure 2.1

PHASE 2 SITE PREPARATION AREA
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario



LEGEND

- ——— CONTINUOUS ACTIVITY
- - - - - INTERMITTENT ACTIVITY
- * MILESTONE/EVENT

NOTES:

1) SCHEDULE PRESENTED FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL TIMELINE MAY VARY IN ACCORDANCE WITH AMP/MITIGATION OBJECTIVES.

2) REFERS TO PHASE 2/3 EXTRACTION AS EXPLAINED IN SECTION 1.2

figure 2.2

GENERAL PRE-EXTRACTION SCHEDULE
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA011 JUN 23/2011

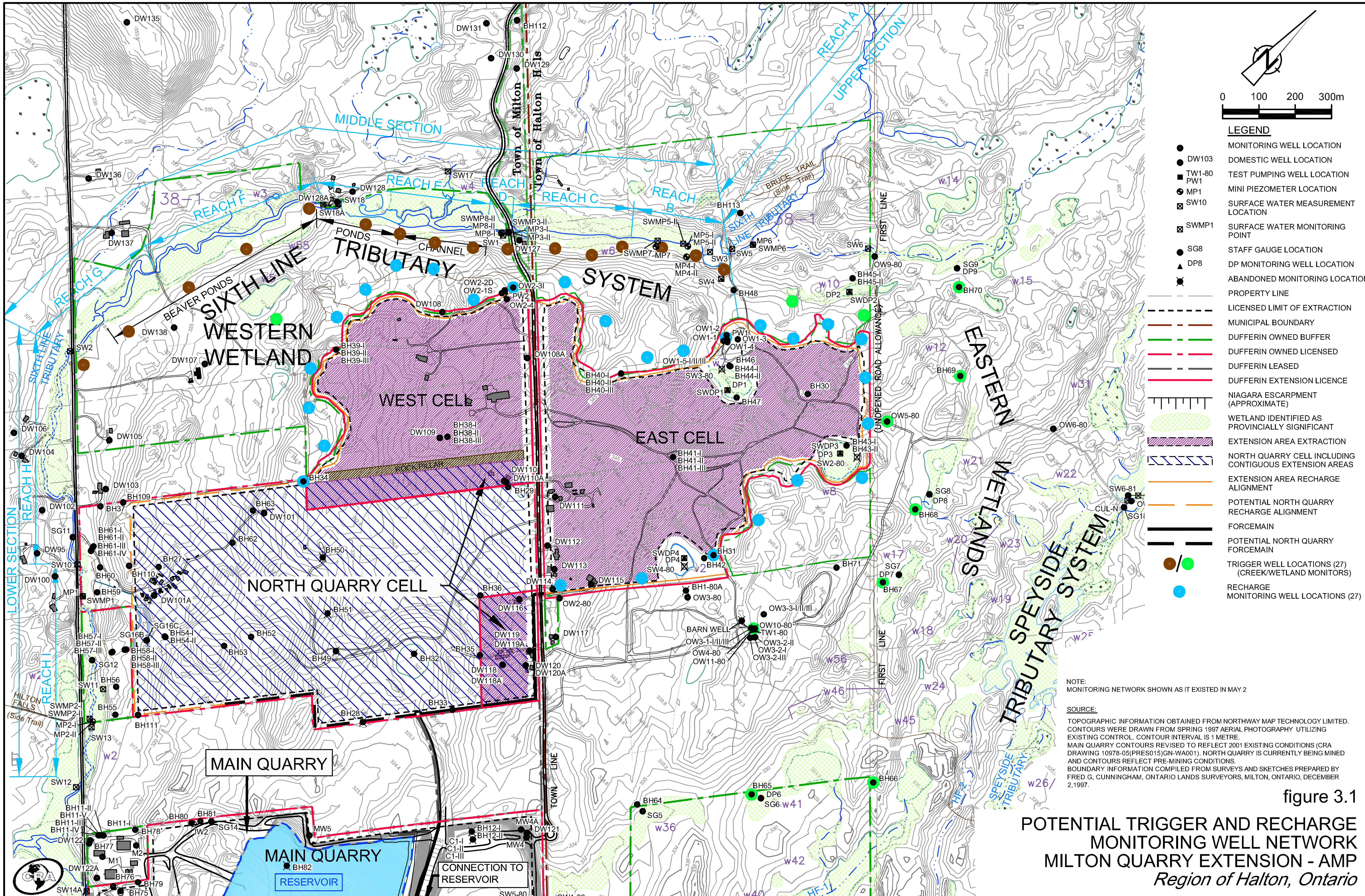


figure 3.1

POTENTIAL TRIGGER AND RECHARGE MONITORING WELL NETWORK MILTON QUARRY EXTENSION - AMP

Region of Halton, Ontario

10978-68(074)GN-WA019 JUN 23/2011

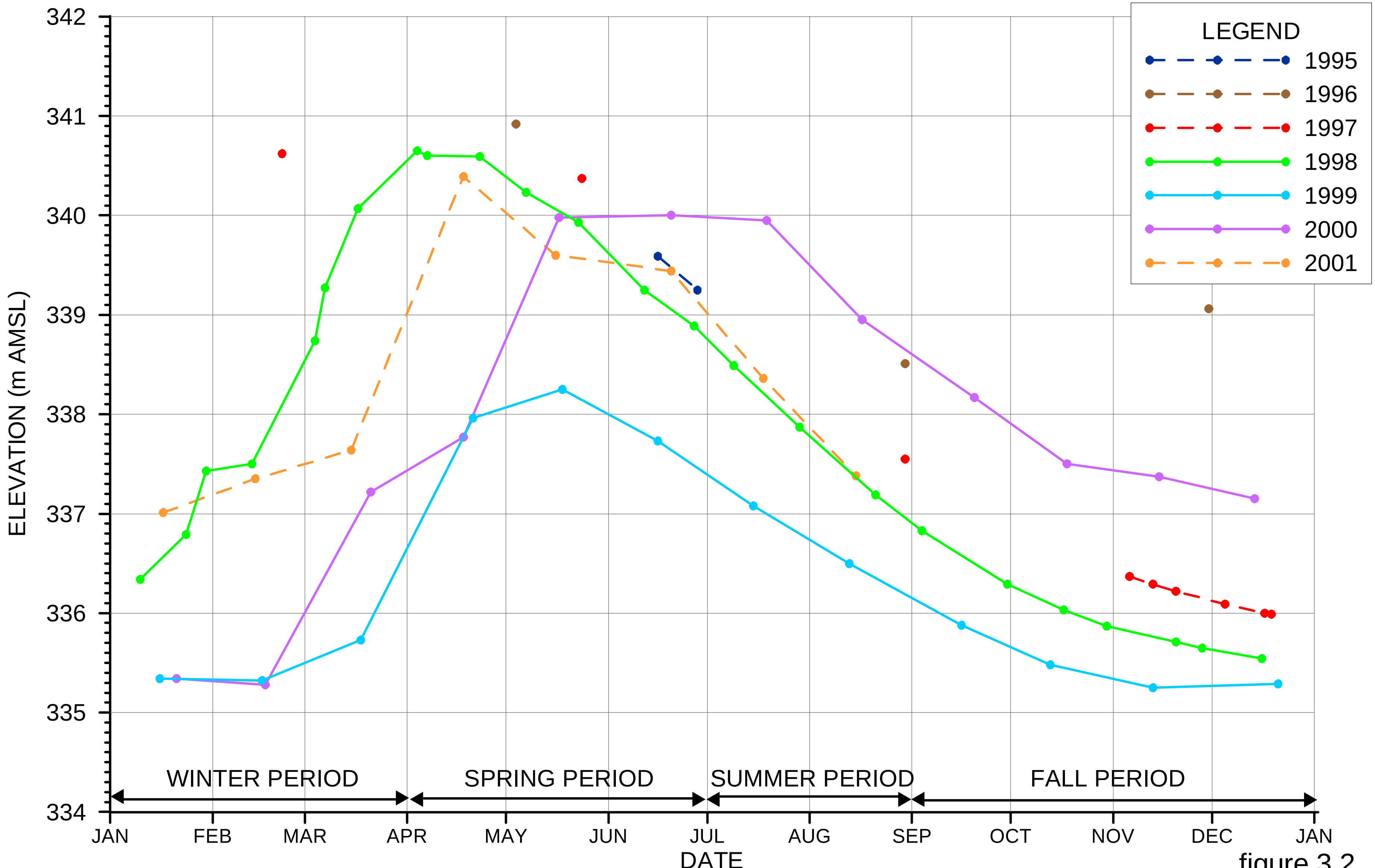


figure 3.2

TYPICAL GROUNDWATER LEVEL HYDROGRAPH (BH31)
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

010978 (074)

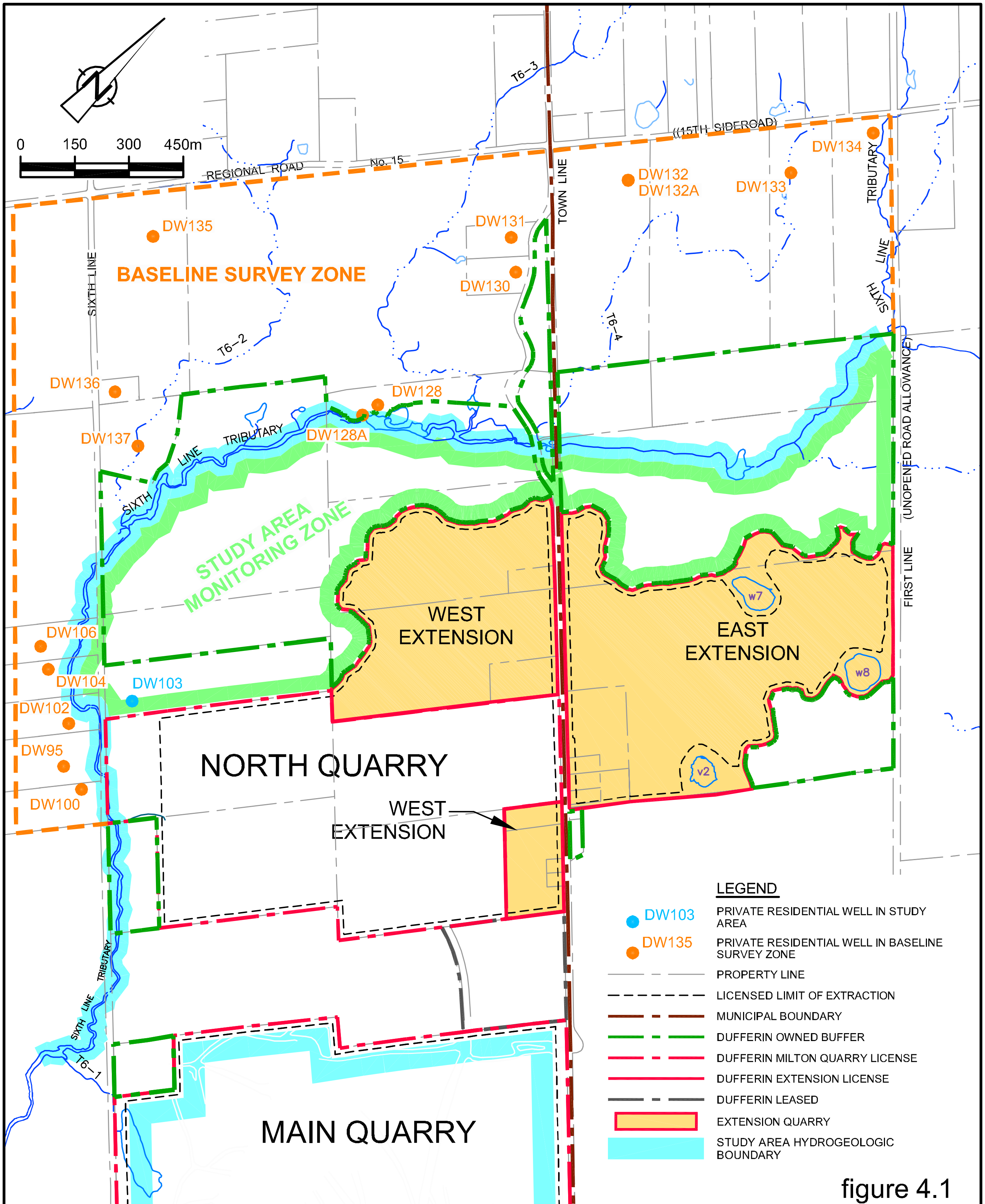


figure 4.1

PROPOSED RESIDENTIAL WELLS
FOR MONITORING/BASELINE SURVEY
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

SOURCE:
BASE MAPPING PRODUCED BY MACNAUGHTON HERMSEN BRITTON CLARKSON PLANNING LIMITED AND CONESTOGA-ROVERS & ASSOCIATES UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES

10978-68(074)GN-WA013 JUN 23/2011

TABLE 1.1

SUMMARY OF AMP MONITORING
MILTON QUARRY EXTENSION - AMP
REGION OF HALTON, ONTARIO

Monitoring Section/Component	*Locations*	*Minimum Frequency*
PERFORMANCE MONITORING/RESPONSE PROGRAM		
3.1 Groundwater Levels at Trigger Wells	Existing or future wells installed approximately as shown on Figure 3.1.	**Pre-Extraction** (a) Monthly (b) Daily with automated water level recorders at 5 wells **Extraction Period** (a) Monthly with transition to weekly (refer to Section 3.1.2) (b) Daily for at least 2 weeks in a potentially affected area (c) Daily with automated water level recorder at 5 wells **Post-Extraction/Lake Filling Period** (a) Biweekly (once every 2 weeks) with transition to monthly (b) Daily for at least 2 weeks in a potentially affected area **Lakes Filled Period** (a) Monthly for a period of 3 years (b) Contingency for long-term monitoring program if ongoing seasonal recharge is required
3.2 Water Quality in Recharge System	i) Reservoir - distant from pumping station ii) Recharge pumping station iii) Remote location on recharge system iv) Inflows to Reservoir	Monthly

Note:

Monitoring program, including frequency, is subject to modification based on observed performance data as described in the text of the AMP.

TABLE 1.1

SUMMARY OF AMP MONITORING
MILTON QUARRY EXTENSION - AMP
REGION OF HALTON, ONTARIO

Monitoring Section/Component	*Locations*	*Minimum Frequency*
SUPPLEMENTAL MONITORING PROGRAM		
4.1 Groundwater Levels	i) Selected existing/new groundwater monitoring well locations ii) Groundwater recharge monitoring wells or recharge wells (refer to Section 4.1)	i) Monthly (minimum) ii) At a minimum frequency similar to the trigger wells (refer to Section 4.1)
4.2 Background Groundwater Levels	Minimum of four background monitoring locations beyond the study area in the general vicinity of the Milton Quarry (BH113 and BH113 plus two additional locations)	i) Monthly (minimum) manual measurements following installation ii) Daily with automated water level recorders until at least 5 years of recharge system operation
4.3 Meteorological Data	i) Milton Quarry Meteorological Station ii) Georgetown Meteorological Station	i) Six readings per day using automated recording equipment through the spring-summer-fall period ii) As available
4.4 Water Balance	i) Water levels in the reservoir at the pumping station ii) Water levels in the lake/wetland area in the Main Quarry iii) Water levels in the North Quarry Cell, West Cell and East Cell when post extraction/lake filling has commenced iv) Water flow at the inflow/transfer/outflow points[1]	i) "Continuous" with automated water level recorder ii) Weekly (minimum) iii) Weekly (minimum) iv) Totalizing flow meters with weekly readings (minimum)

1 Monitoring includes flow to on-Site wetlands in accordance with Appendix C (Section 4.0).

TABLE 1.1

SUMMARY OF AMP MONITORING
MILTON QUARRY EXTENSION - AMP
REGION OF HALTON, ONTARIO

Monitoring Section/Component	*Locations*	*Minimum Frequency*
SUPPLEMENTAL MONITORING PROGRAM (cont'd.)		
4.5 Ecological	i) Surface water and groundwater levels at 5 wetland stations (W10, W15, W17, W21, and W41) plus new station at western wetland (W5) ii) Photos and general observations at photographic stations in minimum of 6 wetlands (as above) iii) Jefferson Salamander egg mass and frog calling surveys in minimum of 6 wetlands (as above) iv) Wetland vegetation monitoring in 6 wetlands (as above) v) Brook Trout redd survey in Sixth Line Tributary north of proposed Extension vi) Benthic monitoring at two stations upstream of Townline Road vii) Groundwater temperature monitoring at four trigger wells and associated creek locations and recharge system locations viii) Water discharge from former pumphouse (SW4)	i) Monthly (biweekly for April-July) ii) Seasonally (refer to Section 4.5) iii) Seasonally (refer to Section 4.5) iv) Annually (refer to Section 4.5) v) Seasonally (refer to Section 4.5) vi) Seasonally (refer to Section 4.5) vii) "Continuous" with data loggers viii) Monthly with weekly during July, August, and September.
4.6 Residential Well	i) Update of baseline survey (well survey, water level, water quality) and annual groundwater level and water quality monitoring ii) Residential wells in study area monitoring zone (Figure 4.1) (groundwater levels)	i) Survey: Once, pre-extraction or for new residential wells when identified Monitoring: Annually ii) Quarterly (four times per year including above annual event)

TABLE 1.1

SUMMARY OF AMP MONITORING
MILTON QUARRY EXTENSION - AMP
REGION OF HALTON, ONTARIO

Monitoring Section/Component	*Locations*	*Minimum Frequency*
ON-SITE WETLANDS MONITORING PROGRAM - APPENDIX C		
Appendix C Section 3.1 - Surface Water Level Monitoring in Wetlands	Staff gauge (or alternate means)	Pre-Extraction • Monthly Extraction Period • Initially monthly • Bi-weekly when extraction below water table in Phase 3 • Twice per week when water level below target level Post-Extraction/Lake Filling • Transition to monthly or quarterly
Appendix C Section 4.0 - Ecological Monitoring	i) Photo monitoring ii) Jefferson Salamander egg mass survey iii) Frog calling survey	i) Semi-annually ii) Annually iii) Annually

TABLE 3.1

TARGET LEVEL PERIOD SUMMARY
MILTON QUARRY EXTENSION – AMP
REGION OF HALTON, ONTARIO

1. **Winter Period - January 1 to March 31**
   - Creek - maintain critical low flow discharge during critical cold winter/egg incubation period (January and February) when risk of ice scour is highest during the combined low flow/cold temperature period
   - Wetland - maintain low flow discharge (similar to existing conditions) during cold winter period (January and February) as this may be important to over-wintering functions in some wetland
   - Inclusion of March raises average level during this period and in spring period (for creek and wetland targets)
2. **Spring Period - April 1 to June 30**
   - Creek - period of surplus streamflow when groundwater discharge is less important
   - Wetland - period of high groundwater/wetland surface water conditions. Ensure water levels maintained for later season breeding Amphibians
3. **Summer Period - July 1 to August 31**
   - Creek - maintain critical low flow during high temperature summer period
   - Wetland - maintain natural trend of decreasing water levels and depletion of associated standing water (important in deciduous swamps)
4. **Fall Period – September 1 to December 31**
   - Creek - maintain critical groundwater discharge during low flow spawning and early egg incubation period
   - Wetland - maintain natural trend of decreasing water levels during the later growing season

TABLE 3.2

CALCULATION STEPS FOR ADJUSTING TARGET LEVELS
MILTON QUARRY EXTENSION – AMP
REGION OF HALTON, ONTARIO

Step 1	At the end of initial monitoring period, calculate average water level for each period at each trigger and background monitoring well. These correspond to the target levels with the exception of the Period 2 level for fisheries.
Step 2	Calculate range between spring [Period 2 - peak] and fall [Period 4 - minimum] average at each monitoring well. This is the "normalizing" range for all future adjustments.
Step 3	At the end of a future monitoring period (say year 1), repeat calculations of Step 1 for most recent 3 years of monitoring data at background monitoring wells.
Step 4	Calculate difference between 3-year average (Step 3) and initial monitoring period (Step 1). Divide difference by normalizing range for background well (Step 2) to calculate "normalized difference".
Step 5	Calculate corresponding change in trigger well target level by multiplying normalized difference (Step 4) by normalizing range for specific trigger well (Step 2).
Step 6	Add difference (Step 5) to target levels (value will be positive or negative, depending on whether levels are increasing or decreasing).

APPENDIX A

EXAMPLE TARGET WATER LEVELS

APPENDIX A

EXAMPLE TARGET WATER LEVELS
MILTON QUARRY EXTENSION - AMP
REGION OF HALTON, ONTARIO

This appendix presents the calculation of example target water levels consistent with the methodology presented in Section 3.1.3 of the report. The example target water levels are provided for existing (non-trigger) monitoring wells for only illustrative purposes. Actual target levels will be established for trigger wells at the appropriate time, as discussed in the report.

Example target water levels are calculated for both creek targets and wetlands targets, as discussed in Section 3.1.3. One suitable monitoring well was selected for each kind of target calculation based on the location and available data record for existing monitoring locations. The selected example well for creek targets is PW1 and the selected example well for wetland targets is BH31 (refer to Figure 3.1).

The example target levels are calculated using the 3-year data period from January 1998 to December 2000. The creek target levels are calculated based on the average water level during each period for the 3 years of data, except for the spring period when the average minimum level during the period is used, as discussed in Section 3.1.2.1. The wetland target levels are calculated based on the average water level during each period for the 3 years of data, as discussed in Section 3.1.2.2. The following presents the calculation of these average and minimum (spring) period water levels.

CALCULATION OF PERIOD AVERAGE WATER LEVELS

The water levels used in the calculations of target water levels are obtained from the raw data that contains the date and groundwater elevation for the selected monitoring locations, as summarized in Table A.1.

To obtain an average over the January 1998 to December 2000 time period for a particular location, data from this time range was separated into the four flow periods (Winter - January 1 to March 31; Spring – April 1 to June 30; Summer - July 1 to August 31; and Fall - September 1 to December 31). The average water level per period was calculated using one groundwater elevation measurement per month to ensure equal weighting. If there are multiple readings taken in a month, these multiple readings were averaged resulting in a single value for just that month, as shown below for BH31.

Example for BH31:

Date (mm/dd/yy)	*Water Level (m AMSL)*		
1/9/98	336.34		WINTER PERIOD
1/23/98	336.79	January average = 336.85	
1/29/98	337.43		
2/12/98	337.50	February = 337.50	Winter period Average for 1998 = 337.90
3/3/98	338.74		
3/6/98	339.27	March average = 339.36	
3/16/98	340.07		

The period average for all 3 years (1998, 1999, 2000) was averaged for each flow period, resulting in an overall period average value for each of the four periods, as shown in Table A.2.

SPRING PERIOD MINIMUM AVERAGES FOR CREEK TARGETS

For the creek spring period, the average of the minimums was calculated by finding the minimum groundwater elevation within the 3-month period using only one value per month. Again, if there are multiple readings taken in a month, those readings are averaged resulting in a single value for that month, as shown below:

Example (ii) for BH31:

Date (mm/dd/yy)	*Water Level (m AMSL)*		
4/3/98	340.65		SPRING PERIOD
4/6/98	340.60	April = 340.61	
4/22/98	340.59		
5/6/98	340.23	May = 340.08	Minimum for 1998 = 339.07
5/22/98	339.93		
6/11/98	339.25	June = 339.07	
6/26/98	338.89		

The three minimum values obtained for the 3 years are then averaged resulting in the overall minimum average for the spring period as shown in Table A.3 for PW1.

RESULTANT TARGET LEVELS

The example target levels resulting from the calculations presented herein are summarized in Table A.4 and illustrated on Figures A.1 and A.2 for the creek and wetland targets, respectively.

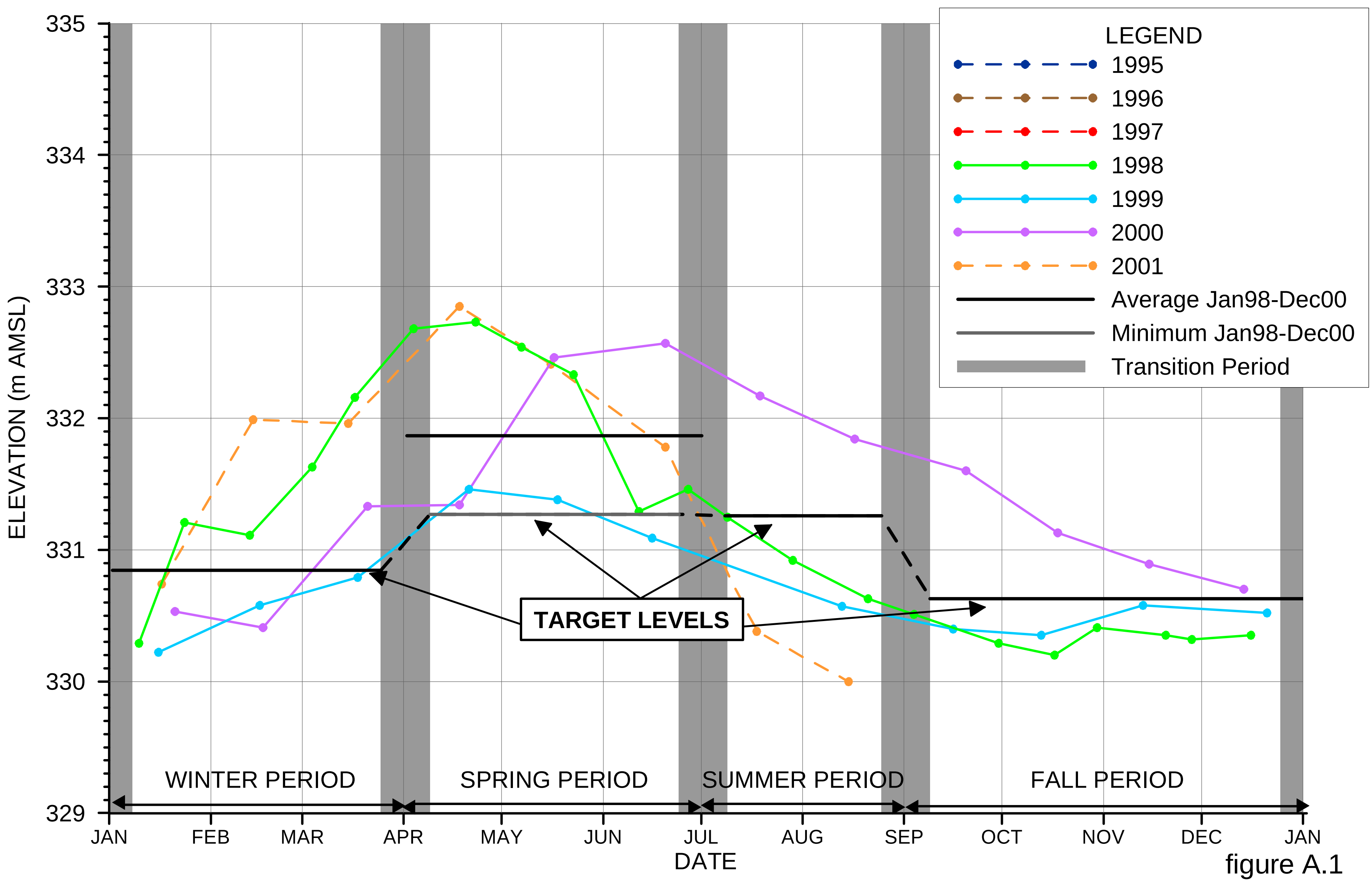


figure A.1

CREEK TARGET WATER LEVELS (PW1)
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

CRA

010978 (74)

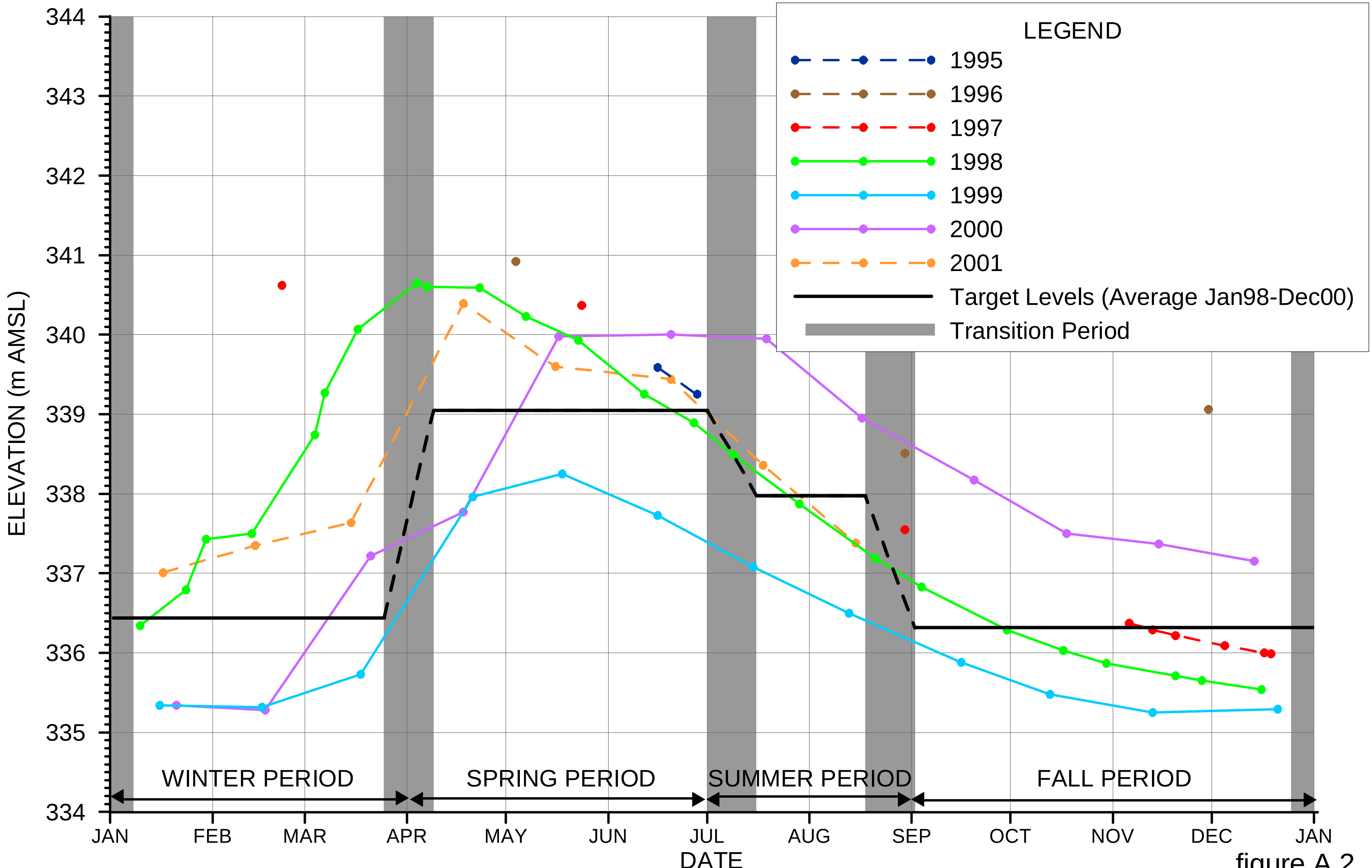


figure A.2

WETLAND TARGET WATER LEVELS (BH31)
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

010978 (74)

TABLE A.1

OBSERVED GROUNDWATER ELEVATIONS
DUFFERIN MILTON QUARRY-AMP
REGION OF HALTON, ONTARIO

Date	*PW1 (m AMSL)*	*BH31 (m AMSL)*
1995		
6/15/1995	--	339.59
6/27/1995	--	339.25
1996		
5/3/1996	--	340.92
8/29/1996	--	338.51
11/29/1996	--	339.06
1997		
2/21/1997	--	340.62
5/23/1997	--	340.37
8/29/1997	--	337.55
9/2/1997	--	--
11/3/1997	--	--
11/5/1997	--	336.37
11/12/1997	--	336.29
11/19/1997	--	336.22
12/4/1997	--	336.09
12/16/1997	--	336.00
12/18/1997	--	335.99
12/22/1997	--	--
1998		
1/9/1998	330.29	336.34
1/23/1998	331.21	336.79
1/29/1998	--	337.43
2/12/1998	331.11	337.50
3/3/1998	331.63	338.74
3/6/1998	--	339.27
3/16/1998	332.16	340.07
4/3/1998	332.68	340.65
4/6/1998	--	340.60
4/22/1998	332.73	340.59
5/6/1998	332.54	340.23
5/22/1998	332.33	339.93
6/11/1998	331.29	339.25
6/26/1998	331.46	338.89
7/8/1998	331.25	338.49
7/28/1998	330.92	337.87
8/20/1998	330.63	337.19
9/3/1998	330.51	336.83
9/29/1998	330.29	336.29
10/16/1998	330.20	336.03
10/29/1998	330.41	335.87
11/19/1998	330.35	335.71
11/27/1998	330.32	335.65
12/15/1998	330.35	335.54
1998 Statistics		
Minimum	330.20	335.54
Maximum	332.73	340.65
Average	331.17	337.99
1999		
1/15/1999	330.22	335.34
2/15/1999	330.58	335.32
3/17/1999	330.79	335.73
4/20/1999	331.46	337.96
5/17/1999	331.38	338.25
6/15/1999	331.09	337.73
7/14/1999	--	337.08
8/12/1999	330.57	336.50
9/15/1999	330.40	335.88
10/12/1999	330.35	335.48
11/12/1999	330.58	335.25
12/20/1999	330.52	335.29
1999 Statistics		
Minimum	330.22	335.25
Maximum	331.46	338.25
Average	330.72	336.32
2000		
1/20/2000	330.53	335.34
2/16/2000	330.41	335.28
3/20/2000	331.33	337.22
4/17/2000	331.34	337.77
5/16/2000	332.46	339.98
6/19/2000	332.57	340.00
7/18/2000	332.17	339.95
8/16/2000	331.84	338.95
9/19/2000	331.60	338.17
10/10/2000	--	--
10/17/2000	331.13	337.50
11/14/2000	330.89	337.37
12/13/2000	330.70	337.15
2000 Statistics		
Minimum	330.41	335.28
Maximum	332.57	340.00
Average	331.41	337.89
2001		
1/16/2001	330.74	337.01
2/13/2001	331.99	337.35
2/14/2001	--	--
3/14/2001	331.96	337.64
4/17/2001	332.85	340.39
5/15/2001	332.41	339.60
6/19/2001	331.78	339.44
2001 Statistics		
Minimum	330.74	337.01
Maximum	332.85	340.39
Average	331.96	338.57
1995-2001 Statistics		
Minimum	330.20	335.25
Maximum	332.85	340.92
Average	331.23	337.74

Note:

All water elevations reported in metres AMSL.

TABLE A.2

CALCULATION OF PERIOD AVERAGE WATER LEVELS
DUFFERIN MILTON QUARRY-AMP
REGION OF HALTON, ONTARIO

		Monthly Value/Average	*Averages on a Yearly Basis*	*Overall Period Averages*
PW1				
	Winter Period			
1998	January	330.75		
	February	331.11	331.25	
	March	331.90		
1999	January	330.22		
	February	330.58	330.53	330.85
	March	330.79		
2000	January	330.53		
	February	330.41	330.76	
	March	331.33		
	Spring Period			
1998	April	332.71		
	May	332.44	332.17	
	June	331.38		
1999	April	331.46		
	May	331.38	331.31	331.87
	June	331.09		
2000	April	331.34		
	May	332.46	332.12	
	June	332.57		
	Summer Period			
1998	July	331.09		
	August	330.63	330.86	
1999	July	--		
	August	330.57	330.57	331.14
2000	July	332.17		
	August	331.84	332.01	
	Fall Period			
1998	September	330.40		
	October	330.31		
	November	330.34	330.35	
	December	330.35		
1999	September	330.40		
	October	330.35		
	November	330.58	330.46	330.63
	December	330.52		
2000	September	331.60		
	October	331.13		
	November	330.89	331.08	
	December	330.70		

TABLE A.2

CALCULATION OF PERIOD AVERAGE WATER LEVELS
DUFFERIN MILTON QUARRY-AMP
REGION OF HALTON, ONTARIO

		Monthly Value/Average	*Averages on a Yearly Basis*	*Overall Period Averages*
BH31				
	Winter Period			
1998	January	336.85		
	February	337.50	337.90	
	March	339.36		
1999	January	335.34		
	February	335.32	335.46	336.44
	March	335.73		
2000	January	335.34		
	February	335.28	335.95	
	March	337.22		
	Spring Period			
1998	April	340.61		
	May	340.08	339.92	
	June	339.07		
1999	April	337.96		
	May	338.25	337.98	339.05
	June	337.73		
2000	April	337.77		
	May	339.98	339.25	
	June	340.00		
	Summer Period			
1998	July	338.18		
	August	337.19	337.69	
1999	July	337.08		
	August	336.50	336.79	337.98
2000	July	339.95		
	August	338.95	339.45	
	Fall Period			
1998	September	336.56		
	October	335.95		
	November	335.68	335.93	
	December	335.54		
1999	September	335.88		
	October	335.48		
	November	335.25	335.48	336.32
	December	335.29		
2000	September	338.17		
	October	337.50		
	November	337.37	337.55	
	December	337.15		

Note:

All water elevations reported in metres AMSL.

TABLE A.3

CALCULATION OF SPRING PERIOD LEVELS FOR CREEK TARGETS
DUFFERIN MILTON QUARRY-AMP
REGION OF HALTON, ONTARIO

		Monthly Value/Average	*Minimum of the Values/ Averages on a Yearly Basis*	*Overall Average of Minimum Values*
PW1				
	Spring Period			
1998	April	332.71		
	May	332.44	331.38	
	June	331.38		
1999	April	331.46		
	May	331.38	331.09	331.27
	June	331.09		
2000	April	331.34		
	May	332.46	331.34	
	June	332.57		

Note:

All water elevations reported in metres AMSL.

TABLE A.4

CREEK AND WETLAND EXAMPLE TARGET LEVELS
DUFFERIN MILTON QUARRY-AMP
REGION OF HALTON, ONTARIO

	Groundwater Level Target
Creek Target Water Levels (PW1)	
Winter Period - Overall Average	330.85
Spring Period - Overall Minimum Average	331.27
Summer Period - Overall Average	331.14
Fall Period - Overall Average	330.63
Wetland Target Water Levels (BH31)	
Winter Period - Overall Period Average	336.44
Spring Period - Overall Period Average	339.05
Summer Period - Overall Period Average	337.98
Fall Period - Overall Period Average	336.32

Note:
All water elevations reported in metres AMSL.

APPENDIX A - ATTACHMENT A

EXAMPLE TARGET LEVEL ADJUSTMENT
MILTON QUARRY EXTENSION – AMP
REGION OF HALTON, ONTARIO

This attachment to Appendix A of the AMP provides an example calculation for the adjustment of target levels based on climatic trends at background wells. The calculations follow the procedure presented in Section 3.1.3.2 of the report and reproduced below. All elevations are in metres AMSL and lengths (heights) are in metres.

Step 1 At the end of initial monitoring period, calculate average water level for each period at each trigger and background monitoring well. For the trigger wells, these correspond to the target levels with the exception of Period 2 levels for the creek targets.

- Assuming calculated period average water elevations as follows:

Location	*Winter*	*Spring*	*Summer*	*Fall*
Trigger well	329.5	330.0	329.0	328.5
Background well	334.0	335.0	334.0	333.0

Step 2 Calculate range between Spring [Period 2 – peak] and Fall [Period 4 – minimum] averages at each monitoring well. This is the "normalizing" range for all future adjustments.

- Calculated based on values in Step 1:

Location	*Normalizing Range*
Trigger Well	1.5
Background well	2.0

Step 3 At the end of a future monitoring period (say year 1), repeat calculations of Step 1 for most recent 3 years of monitoring data at background monitoring wells.

- Assuming calculated period averages water elevations as follows:

Location	*Winter*	*Spring*	*Summer*	*Fall*
Background well	334.4	335.4	334.0	332.6

Step 4 Calculate difference between 3-year average (Step 3) and initial monitoring period (Step 1). Divide difference by normalizing range for background well (Step 2) to calculate "normalized difference".

- Using values above:

Location	*Winter*	*Spring*	*Summer*	*Fall*
Difference (Background)	0.4	0.4	0.0	-0.4
Normalized Difference	0.2	0.2	0.0	-0.2

Step 5 Calculate corresponding change in trigger well target level by multiplying normalized difference for the background well (Step 4) by normalizing range for specific trigger well (Step 2)

- Multiply Normalized Difference by factor of 1.5 from Step 2:

Location	*Winter*	*Spring*	*Summer*	*Fall*
Trigger Level Change	0.3	0.3	0.0	-0.3

Step 6 Add difference (Step 5) to target levels (value will be positive or negative, depending on whether levels are increasing or decreasing).

- Assume Period Average for trigger well (Step 1) is previous target level (corresponding to wetland targets):

Location	*Winter*	*Spring*	*Summer*	*Fall*
Previous Target Level at Trigger Well	329.5	330.0	329.0	328.5
New Target Level at Trigger Well	**329.8**	**330.3**	**329.0**	**328.2**

APPENDIX B

QUANTITATIVE PHOTO MONITORING
VAN HORN AND VAN HORN, 1996

Quantitative Photomonitoring for Restoration Projects

by Mia Van Horn and Kent Van Horn

A simple way to get numbers out of photographs.

Photomonitoring is an efficient means of collecting information about restoration projects. The method is seldom used, however, because it typically does not provide the quantitative information needed in evaluating the success of restoration projects. The method we describe provides three quantitative parameters: vegetation density; vegetation height; and water depth. These, together with a qualitative appraisal of dominant species present, provide the information needed for a quantitative interpretation of vegetation change that cannot be made with standard methods of photomonitoring. This method can be used alone, when resources are limited, or can be used in conjunction with more labor-intensive methods. If properly carried out on carefully selected sites it can provide data adequate for the evaluation of restoration projects for most purposes.

Introduction

The Land Stewardship Division (LSD) of the South Florida Water Management District is mandated by state Save Our Rivers (SOR) legislation to manage SOR lands in order "to restore and maintain their natural state and condition" (Florida Statute 373.59). The natural ecological processes of many lands purchased through this program have been altered or diminished as a result of artificial drainage, exotic plant and/or animal infestations, and fire suppression. LSD program staff plan and implement restoration projects on these lands and conduct long-term management to maintain the natural character of the restored land.

The general goal of the LSD restoration program is to shift the unnatural successional pattern of a degraded community to a successional pattern that will lead the community back toward healthy, natural functioning. This is accomplished by reinstating one or more natural elements (usually fire and hydrological regimes) that have been altered or suppressed, and, when appropriate, by controlling or eliminating exotic species.

For the LSD restoration program, the specific criteria used to document the success of restoration efforts are one or more of the following: 1) an increase in the diversity of native species; 2) a reduction in coverage or elimination of exotic plants or animals; and 3) a shift in the distribution, density and/or coverage of native plants toward the natural or historic condition.

While these are clearly useful criteria, their value depends on how they are applied. Attempts to evaluate the success of ecological restoration projects have been criticized for at least four reasons. First, project goals often are not clearly defined, and hypotheses regarding the outcome of the restoration are often undefined (Noss and Cooperrider, 1994). Second, conclusions are often based on intuition or impressions rather than on quantitative data (Bradshaw, 1993). For example, Osborn (1940) described a photomonitoring method used by the Soil Conservation Service to assess the effectiveness of different vegetation types at preventing soil erosion. Osborn took photos before planting and at intervals following planting. He provided, however, no means of expressing vegetative cover in numerical terms as a means of comparing photos. Third, to be effective, monitoring methods must be set up so data can be collected consistently on difficult sites and over time (Stohlgren and Quinn, 1992). Lack of standardization in resource evaluation procedures makes it difficult or impossible to assess recovery both within and between projects. Lastly, monitoring programs are often interrupted or curtailed as a result of budgetary and time constraints (Zaber, 1991; Briggs et al., 1994; Noss and Cooperrider, 1994). In a review of riparian restoration projects, for example, Briggs and his colleagues discovered that most published evaluations of riparian restorations covered only two to three years following project completion. This type of assessment cannot provide information about long-term survival of planted trees and plants, or about long-term establishment of the vegetation.

The LSD program is currently engaged in restoration activities on 12,000 hectares (30,000 acres) of land distributed among 15 properties in nine counties in south Florida. The program includes a comprehensive environmental-monitoring protocol that includes wildlife surveys, quantitative vegetation sampling and photomonitoring of vegetation at restoration sites. However, because of the large acreage and number of restoration projects in progress, the staff cannot implement all parts of the protocol on each project.

To responsibly evaluate our restoration projects we developed a photomonitoring protocol that, when used in conjunction with carefully defined goals and criteria for success, provides a cost-effective evaluation that has proved adequate for at least some of our projects. Many land managers have used photopoints in ecological projects as a means of evaluating vegetation change (Dick Roberts, Jonathan Dickinson State Park, FL, personal communication; National Park Service, 1991; Eric Menges, Archbold Biological Station, FL, personal communication; Menges and Main, 1992; Stevenson, 1993). These methods do not involve collection of quantitative data however, and some do not include a reference point. The photomonitoring method we describe here addresses the monitoring concerns mentioned earlier because: 1) We chose photomonitoring locations according to the goals of restoration. For example, we set up photopoints at locations where no visible change was expected, and also at locations where vegetation change was expected (Bradshaw, 1993; Noss and Cooperrider, 1994); 2) each photograph is associated with quantitative vegetation density values; 3) because of the presence of a permanent reference point, consistent, long-term monitoring is possible; and 4) the method is inexpensive and requires less staff time than detailed, quantitative vegetation-monitoring.

Methods

We begin by selecting photopoint sites that provide a representative view of the effects of a planned restoration activity. We place two permanent, 1.8-meter (6-ft.) long metal stakes 10 meters (32.8 ft.) apart at designated monitoring sites. One serves as the photopoint and the other as a marker for the reference point. To minimize variation in the land area included in successive photos over time, photopoint posts were buried to 1.4 meters (4 1/2 ft.) above ground-level, and a removable platform that fits over the photopoint post is used as a camera mount.

Prior to taking the photograph we carry a "density board" to each site and place it against the reference post. The board provides a consistent reference and a background against which we can make quantitative measurements of the height and density of the vegetation in the photographs. The board is 30-cm (1-ft.) wide and 2.5 m (8.2 ft.) tall. It is made of 3/8-inch plywood, and is painted in alternating black-and-white, 0.5-meter-wide bands (Nudds, 1977). The board is hinged in the middle so that it can be folded for easier transport.

While standing at the photopoint post the observer views the vegetation

Table 1: **Quantitative data collected when each photo was taken**

	Photo 1 preburn	Photo 2 11 days postburn	Photo 3 12 months postburn	Photo 4 22 months postburn
Dominant Plant Species				
Canopy	None	None	None	None
Shrub	*Lyonia lucida*	None	*Serenoa repens*	*Ilex glabra*
(height cm)	(155 cm)		(100 cm)	(150 cm)
Herb	*Aristida* sp.	None	*Aristida stricta*	*Aristida stricta*
(height cm)	(51 cm)		(61 cm)	(50 cm)
Percent Coverage of Blocks on Density Board				
0.0-.5 m	100	5	70	100
0.5—1.0 m 100	100	0	15	90
1.0—1.5 m	90	0	10	0
1.5—2.0 m	20	0	0	0
2.0—2.5 m	5	0	0	0
Water Depth (cm)	0	0	0	0

against the density board located at the reference post. Estimates of the fraction of each band covered by vegetation (including dead plants) are made in increments ... smaller than 5 percent. At the same time the observer collects additional quantitative measurements, including the height and identification of the dominant trees, shrubs and/or herbaceous plants between the photo and reference points, and the depth of water at the reference point. These data are then used to describe quantitatively the structure of the vegetation in each photograph.

For consistency we find that it is best if the same individual conduct the visual percent-coverage estimates at a particular site. We find that variations in the visual estimates made by a single observer can be reduced if the observer, while estimating the coverage of each 0.5-meter band, visualizes that band as if it were divided into four equal sections, and if the observer places his or her chin on the camera mount while performing the estimate. We find the most accurate coverage estimates are made in the field rather than from the photos themselves.

Once these observations have been ..., a horizontal picture is taken with the density board appearing in the middle of the photo, and the camera placed on the camera mount. We use a 35-mm camera with a 28-mm lens focused to infinity and loaded with 100 ASA color-slide film. The photo provides a qualitative representation of the plant species composition, and the density board allows us to make a quantitative description of on-site vegetation structure.

For hydrologic restoration projects, we take slides semi-annually, once during the wet season (May-September) and once during the dry season (October-April). This allows for comparisons among seasons in different years because vegetation in Florida can vary dramatically between the wet and dry seasons. On sites subject to prescribed burns, we generally take photos and collect data immediately before and after burns, and approximately three, six and twelve months afterward (Figure 1). After that we routinely take two photos— ... during the wet and one during the dry ...on. We believe the methods presented here characterize short-term changes in vegetation. Depending on project and monitoring goals however, the method, if applied at longer time intervals, can also be used to document long-term changes in vegetation structure.

Where statistical rigor in sampling is necessary the number of photomonitoring sites could be increased to meet sample-size requirements. We doubt, however, that this would prove any more cost-effective

Photo 1.

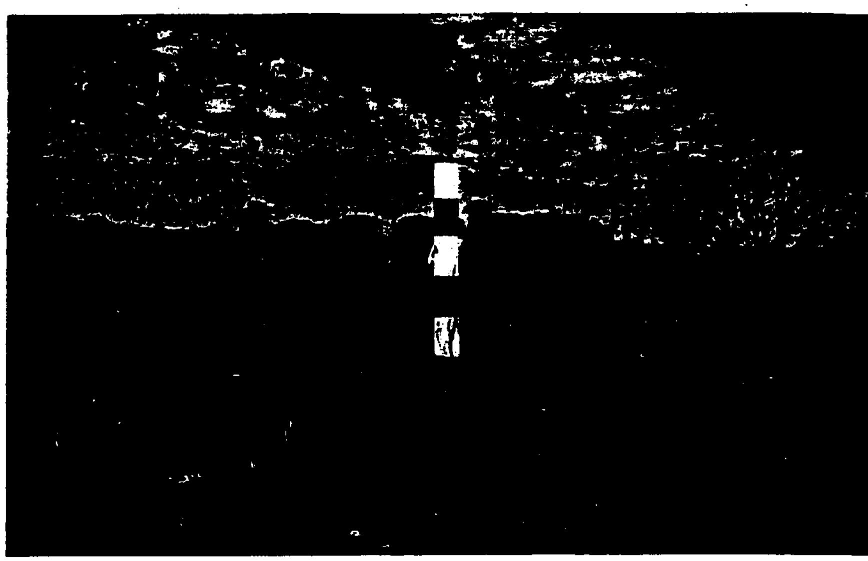


Photo 2.

Figure 1. Photopoint views of a dry prairie restoration site on the KICCO Management Area at River Ranch, Florida immediately preceding a prescribed burn (1) and at 11 days (2), 12 months (3) and 22 months (4) following the burn. There is a drastic change in vegetation density and height between the preburn and 11-day post-burn photo, and then a gradual increase in vegetation density and height in photos 3 and 4. The same vegetation density and height

than standard methods for quantitative monitoring of vegetation. For projects requiring detailed monitoring, our method is .t used as a back-up, or to supplement more detailed quantitative data.

Results

A series of photos collected over a 22-month period at a dry-prairie restoration site is provided in Figure 1. Corresponding quantitative and qualitative data collected at the time each photo was taken are provided in the accompanying Table. The goal at this site is to maintain structural and plant-species diversity through prescribed burning (Van Horn *et al.*, 1993). The specific objective of this prescribed burn was to reduce the density of the shrub layer. The dense, shrubby coverage evident in Photo 1 and in the corresponding data is undesirable because it suppresses herbaceous plants, reducing the diversity of plant species (Abrahamson and Hartnett, 1991). Subsequent photos reveal the reduction and subsequent regeneration of shrubby cover following a prescribed burn. Our plan is to use this method to monitor and describe how long different management actions successfully maintain desired vegetation structure.

Photo 3.

Photo 4.

shifts can be observed in the data presented in Table 1. The shrub layer is dominated by the leafy shrub, *Lyonia lucida* in the first photo. However, even 22 months after the burn (photo 4), 'hough present, this species has yet to regain dominance. *Photos courtesy of the authors*

Discussion

Both the photos and data collected using this method have proved useful in describing changes in vegetation structure associated with restoration efforts on our sites. We have found it to be most useful in shrub-dominated communities, but we have used it with success in forested communities that possess a distinct subcanopy or shrubby layer. In short-stature grasslands the method is most useful as a way of recording information about large-scale changes in species dominance. For example, in a grass-dominated pasture we used it to document the appearance of a large population of asters (*Aster* sp.) following a prescribed burn.

We acknowledge that data collected in this fashion may not be adequate for a detailed analysis of vegetation. At the same time, costs and labor are commonly the limiting factors in the evaluation of restoration projects, and detailed analysis may not be necessary. In any event, a general, quantitative survey such as this system provided is much better than none at all—or than a merely qualitative, impressionistic survey, which is what most restoration sites commonly get. We have found that a series of photopoints carefully placed throughout the restoration area can provide the basis for a comprehensive and reasonably thorough evaluation of the project. When using this method as the sole means of evaluating a restoration project it is important to locate photopoints strategically throughout the restoration area so that regions where different results are expected are covered. For example, we have a hydrologic restoration project in Orange County, Florida involving 240 hectares (600 acres) and are using seven photopoints to monitor this project. The photopoints are distributed among three natural community types and two transition zones. We have established photopoints at locations where we expect the effects of our efforts to become evident within one year, and also at other sites where we expect little change in vegetation in response to changes in hydroperiod.

This method has proven to be a useful, efficient means of evaluating restoration projects. The quantitative parameters data support qualitative observations based on the photographs. In addition, the photographs alone are useful in describing projects to others and in making the case for public and agency support for environmental restoration.

Acknowledgements

We would like to thank Eric Menges from the Archbold Biological Station, Dick Roberts from Jonathan Dickinson State Park, Bob Goodrick, Ray Miller and Bill Helfferich from the South Florida Water Management District, and Bill Jordan, *R&MN* editor, for helpful comments on the manuscript.

References

Abrahamson, W.G. and D.C. Hartnett. 1991. Pine flatwoods and dry prairies. *In:* Ecosystems of Florida. Orlando: University of Central Florida Press. R.L. Myers and J.J. Ewel, eds. Pages 103-149.

Bradshaw, A.D. 1993. Restoration ecology as a science. *Restoration Ecology* 1(2):71-73.

Briggs, M.K., B.A. Roundy, and W.W. Shaw. 1994. Trial and error: assessing the effectiveness of riparian revegetation in Arizona. *Restoration and Management Notes* 12(2):160-167.

Menges, E., and K. Main. 1992. Proposed ABS photo point monitoring protocol. Archbold Biological Station, P.O. Box 2057, Lake Placid, FL, 33852.

National Park Service. 1991. Western Region fire monitoring handbook. Guidelines for establishing photopoints. U.S. Department of Interior, National Park Service, San Francisco, CA.

Noss, R.F. and A.Y. Cooperrider. 1994. Saving nature's legacy: protecting and restoring biodiversity. Washington, D.C.: Island Press.

Nudds, T.D. 1977. Quantifying the vegetative structure of wildlife cover. *Wildl. Soc. Bull.* 5:113-117.

Osborn, B. 1940. A photographic transect for determining soil-cover index of vegetation. *Ecology* 21:416-419.

Stevenson, J. 1993. Park managers meeting the challenge. *Resource Management Notes* 5:15-16.

Stohlgren, T.J. and J.F. Quinn. 1992. An assessment of biotic inventories in western U.S. national parks. *Natural Areas Journal* 12:145-154.

Van Horn, K., R. C. Glancy, J. R. Goodwin, and R. D. Driggers. 1993. KICCO fire management plan, FY-1993-94. South Florida Water Management District, Land Stewardship Division, 3301 Gun Club Road, West Palm Beach, FL, 33416.

Zaber, D. 1991. Bio-monitoring: how much is enough? *Endangered Species Update* 8:6.

Mia Van Horn is an ecologist and Kent Van Horn is a land manager with the South Florida Water Management District, Land Stewardship Division, P.O. Box 24680, 3301 Gun Club Road, West Palm Beach, FL 33416; (407) 687-6639, FAX (407) 687-6436.

APPENDIX C

ON-SITE WETLANDS

TABLE OF CONTENTS

Page

LIST OF FIGURES
(Following Text)

1.0 INTRODUCTION

The physical water management system for the protection of the on-Site wetlands, W7, W8, and V2, will be installed at the same time as the rest of the recharge system (refer to Figures C.1 through C.4). The seasonal water levels in W7, W8, and V2 will be maintained by simple and direct water level control of water inflow into the wetland (e.g., in the form of a float-controlled switch). The AMP program for monitoring and mitigation of the on-Site wetlands is to ensure that the wetland mitigation measures appropriately maintain the wetlands.

The specific objectives include:

- Establish the seasonal surface water level targets or "set points" and the minimum water levels for the surface water level in W7, W8, and V2;
- Adjust the seasonal targets and minimum levels based on off-Site background monitoring data;
- Conduct surface water level monitoring in W7, W8, and V2 to provide the performance monitoring basis to ensure the equipment is operating properly and pond levels are being appropriately maintained for the protection of the wetlands;
- Implement appropriate response actions in the event of any issues associated with the above;
- Ensure the water regime is maintained in an appropriate manner from an ecological perspective (e.g., seasonal water level conditions and water inflow rate); and
- Conduct periodic ecological monitoring.

The AMP program for wetlands W7, W8, and V2 is presented in the following sections of this appendix:

- Section 2.0 Mitigation Implementation/Response Action Framework;
- Section 3.0 Surface Water Level Monitoring and Response Actions; and
- Section 4.0 Ecological Monitoring of On-Site Wetlands.

2.0 MITIGATION IMPLEMENTATION/RESPONSE ACTION FRAMEWORK

The performance monitoring program for protection of W7, W8, and V2 is based on maintaining the seasonal surface water level regime within these wetlands. Surface water level monitoring in W7, W8, and V2 provides the performance monitoring basis to ensure the wetland is appropriately maintained. The procedures for demonstration and verification of the performance of the mitigation system are described below.

Target and minimum water levels will be defined for surface water levels in W7, W8, and V2 consistent with the protocols defined for off-Site wetland trigger wells (refer to Section 3.0 of this appendix and Section 3.1 of the AMP), although the on-Site wetland targets will incorporate monthly target levels during the spring period.

The groundwater recharge system, including the systems to provide surface water augmentation to the wetlands (W7, W8, and V2), will be installed in a proactive manner to ensure it is available when required. Performance testing of the surface water inflow for the wetlands will be incorporated with testing of the recharge system upon completion of construction and during the subsequent annual verification procedures prior to sustained operation of the mitigation system. The purpose of the verification testing is to confirm that the surface water inflow system functions properly and is effective at raising the surface water level in the wetland. The testing will involve a very limited increase in the wetland water level so that the wetland ecology is not unnecessarily influenced and water conservation is maximized. Annual testing will be compared to previous results.

Once the recharge system is operating for the West Cell it will also be activated for the on-Site wetlands. The inflow to the wetlands will therefore automatically occur if/when the water level drops below the target level regardless of whether the drop is due to quarry dewatering influence. If the water levels remain at or above the seasonal target levels, no inflow of water will occur. This early activation of the wetland inflow system precludes the need for a monitoring and decision making process for determination of when the system should be put into operation as it will automatically operate when appropriate.

Once the wetland inflow system is being operated on a sustained basis, the performance monitoring program described in Section 3.0 of this appendix will provide ongoing verification that the operating mitigation system is performing in an appropriate manner. If the wetland surface water level falls below the target level, suitable response actions or contingency actions will be implemented on a proactive basis to ensure that the wetlands are protected (refer to Section 3.4).

Further to the monitoring and response measures described in the following sections, Dufferin will proceed with Phase 3 extraction such that only one on-Site wetland is approached at a time. In this manner, the additional knowledge gained from the approach to each wetland will be utilized to optimize the approach to the subsequent wetlands (recognizing the variable wetland and hydrogeologic characteristics of these wetlands).

3.0 SURFACE WATER LEVEL MONITORING AND RESPONSE ACTIONS

The performance monitoring for protection of W7, W8, and V2 is based on maintaining the seasonal water level regime within these wetlands. The water levels in W7, W8, and V2 will be maintained, as necessary, by the direct addition of water once the groundwater recharge system is activated. The direct addition of water to the wetlands (e.g., in the form of a float-controlled switch, or in the long term an overflow system with an adjustable elevation overflow may be implemented) will automatically control their water levels to correspond to the seasonal targets. Therefore monitoring activities are limited and serve only to confirm that the system is performing appropriately and to assist in implementing appropriate response measures in the event that the target levels are not being maintained.

3.1 MONITORING LOCATIONS

The surface water level monitoring will be undertaken at a staff gauge (or alternate means) permanently installed in the lowest area in the wetland.

3.2 MONITORING FREQUENCY

The following specifies the minimum surface water level monitoring frequency for the wetlands for different time periods/events. Actual conditions may result in a higher frequency of monitoring or be used to demonstrate that a lower frequency is appropriate. In general, less frequent monitoring may occur in the winter based on climatic conditions.

Prior to Extraction in the West or East Extension Cells

- Monthly water levels to collect a data history.

Extraction Period in the West and East Extension Cells

- Initially monthly;
- Bi-weekly (i.e., once every 2 weeks or twice per month) when extraction proceeds below the water table in Phase 3; and
- Twice per week if the water level is below the target level (appropriate frequency to be determined by Dufferin's ecologists if ice/snow buildup limit access/visibility during such a period).

Post-Extraction/Lake Filling Period

- Transition to monthly or quarterly measurements as appropriate.

3.3 TARGET AND MINIMUM WATER LEVELS

The target surface water levels (set points for the wetland inflow system) and minimum surface water levels will be established based on historical surface water levels for the wetlands. These target and minimum levels will be established following the procedures defined for setting target and minimum groundwater levels for trigger wells associated with the off-Site wetlands (Section 3.1 of the AMP), although the on-Site wetland targets will incorporate monthly target levels during the spring period, recognizing any wetland specific considerations (e.g., seepage flow in W7 under low flow conditions). In particular, target levels will be established based on seasonal values for the three-year average water level, and minimum levels will be based on the lowest historic seasonal water level.

Standing water is only seasonally present in V2. Therefore, target and minimum water levels and corresponding response actions will not be applicable from mid/late summer through to late winter.

The target levels and minimum levels will also be adjusted for climate variations in accordance with the procedures established for monitoring wells using off-site background groundwater levels.

The detailed evaluation and calculation of target and minimum levels will be documented in the pre-extraction report (refer to Section 6.2 of the AMP). This information will include the aspects described above as well as practical considerations such as specific water level set points (operating water level band) based on the available monitoring data, detailed engineering design, and ecological considerations.

3.4 MONITORING RESPONSE ACTIONS

The water levels in the on-Site wetlands can be effectively maintained at the target levels using the proposed mitigation measures. In a situation where the water level drops below the target level, routine measures can be implemented to raise the water level. These measures have one of two general objectives:

- Increase the flow of water to the wetland; and

- Reduce the leakage from the wetland.

A variety of routine response measures and contingency actions are available to accomplish these objectives as described herein.

<u>Routine Response Actions to Maintain Target Surface Water Levels in Wetlands W7, W8, and V2:</u>

- Perform inspection/maintenance on wetland inflow system to ensure proper operation;
- Increase flow to the wetland by adjusting/replacing the valve at inflow;
- Inspect areas in the vicinity of the wetland (e.g., quarry face) to ascertain whether there is apparent leakage into the quarry;
- Increase flow to the wetland by increasing the overall recharge system pumping flow rate;
- Increase capacity of wetland inflow system (e.g., replace/augment water filling line from recharge watermain to increase capacity). This may be accomplished with an overland line on a temporary basis;
- Increase groundwater recharge (via recharge wells) in area of wetland to raise groundwater level; and
- Implement supplemental monitoring to further characterize conditions (e.g., additional monitoring wells adjacent to wetlands to better define quarry dewatering influences).

<u>Contingency Response Actions to Maintain Target Surface Water Levels in Wetlands W7, W8, and V2:</u>

- Modify blasting activities in close proximity to wetland to minimize local effects of blast-induced fracturing between the wetland and the quarry face;
- Localized grouting of bedrock between the wetland and the extraction face to reduce recirculation of water from the wetland back into the quarry through higher permeability features; and
- Construct an engineered buttress (dyke) against quarry face to reduce recirculation in affected area (only where suitable based on rehabilitation).

The selection and implementation of the appropriate response actions if a water level drops below the target level will depend upon the specific circumstances, including the ecological considerations, and season in which the condition occurs. Given the nature of the on-Site wetlands and their existing and historical hydrogeological and ecological characteristics, it is unlikely that any long-term adverse effects will result from a short-term drop in water levels below the target and even the historic low water levels. While a significant drying of the wetland in a particular year may affect the productivity/growth in that year, the wetland can fully recover when the water levels are restored. Therefore, it may be most appropriate to implement some types of mitigation measures (e.g., those that are intrusive in the wetland) on a longer term basis or during a later season to be able to implement the most appropriate measures with the least amount of ecological disturbance. For example, it is preferable to perform any repairs that involve intrusive work immediately adjacent to a wetland area, such as the inflow structure, during the late fall season when conditions are drier and potential ecological disturbance will be lower.

In the event that the water level in the wetland drops below the target level, Dufferin will promptly respond to restore the water levels by restoring/increasing the inflow of water to the wetland. If the water level can be restored to the target level within a short period of time (i.e., 1 week), such as may be possible if all that is required is an increase in the flow or the repair of a mechanical problem, no further action is required. If the drop in water level is of a more persistent nature (i.e., takes longer period of time to mitigate), the following response framework is provided to assist in ensuring an appropriate response is undertaken.

Response to Continued Low Surface Water Level:

If the surface water level in any of W7, W8, or V2 is below the target water level, the following will apply:

A. Dufferin will notify the agencies of the condition after 1 week.

B. Dufferin has a period of 8 weeks to accomplish one of the following options:

   i) Restore the wetland water level to the target level; or

   ii) Provide the plan and timeline to restore the wetland water level to the target level to the agencies for review. Such a plan would include defining the measures to be implemented and rationale as to why they will work.

C. In the event that Dufferin is unable to achieve either of the above options within 8 weeks of the water level dropping below the target level, Dufferin will commit to undertaking one or more of the following actions:

   i) Implement measures suitable to provide increased flow to wetland in respect of potential flow requirements and the ecological effects of increased flow (refer to Section 4.0); and/or

ii) Implement a localized grout curtain outside the wetland perimeter and adjacent to the extraction limit (i.e., outside the minimum wetland buffer zone) to reduce seepage back to the quarry excavation; and/or

iii) Construct a hydraulic buttress against the quarry wall to reduce seepage back to the quarry excavation.

If the water level is below the verified seasonal minimum level, the above response procedure will continue to apply. In addition, Dufferin will promptly undertake measures to minimize the potential for any long-term effects to the wetland, as appropriate. These measures may include one or more of the following:

- Increasing flow to wetland at inflow and/or supplementary location. This could involve the use of an overland water line to maintain open water conditions in the lowest part of the wetland, if necessary; and/or
- Maintain wet/moist substrate conditions using an irrigation sprinkler or similar system; and/or
- Increased use of recharge wells adjacent to wetland and/or installation of temporary recharge wells between wetland and quarry face; and/or
- Cease bedrock extraction that may increase dewatering in the area of the affected wetland until measures are implemented to restore the wetland water level to the seasonal target level.

Further to undertaking the appropriate actions in accordance with the above, Dufferin will cease extraction that increases dewatering in the affected area if the conditions described below occur.

1. If item B (above) is not satisfied; or
2. If the mitigation measures described in the plan (above) to restore the wetland water level are not successful in restoring the water level or are not implemented in accordance with the timeline established in the plan.

The purpose of such a cessation of extraction is to limit the exacerbation of a situation until such a time as appropriate mitigation measures are determined/implemented with the objective of reducing the possibility that the subject wetland would have water levels below target levels for more than one annual cycle. This cessation requirement[1] is applicable to only W7 and W8 which have a strong correlation between groundwater and surface water levels. V2 has a natural perching condition where the surface water level[2] naturally remains well above the groundwater level demonstrating that the cessation of extraction requirement is not relevant to the protection of V2.

1 Once the quarry dewatering influence has lowered the groundwater level substantially below the base of an individual wetland, the cessation of extraction requirements will no longer apply for that wetland. The relevance of this cessation requirement (i.e., the extent of quarry dewatering) will be assessed on the basis of water level data from monitoring wells located between the wetland and the active extraction face and reported on in the annual report. For initial planning purposes, a water level in a monitoring well adjacent to the wetland that is 3 metres or more below the base of the wetland will be considered to indicate that the cessation requirement is no longer relevant and would not apply.

2 V2 is only seasonally wet under natural conditions.

4.0 ECOLOGICAL MONITORING OF ON-SITE WETLANDS

Supplemental monitoring will be conducted in addition to the performance monitoring described in Section 3.0 (above) to ensure the water level and flow regime in the wetland are appropriate to maintain the existing wetland ecosystem.

Monitoring Locations

Ecological monitoring will include photo monitoring, Jefferson Salamander egg surveys, and frog calling surveys at wetlands W7, W8, and V2 using the methodologies described in Section 4.5 of the AMP.

Monitoring Frequency

Photographic monitoring of wetlands W7, W8, and V2 will be conducted semi-annually (i.e., twice per year). The Jefferson Salamander egg mass survey and frog calling survey will be conducted annually.

Data Evaluation/Response Actions

The annual ecological monitoring will serve to document the wetland conditions over time. Furthermore, the monitoring information should be of value in developing the wetland components of the final rehabilitation works. The ecological monitoring, in conjunction with the other available information (e.g., inflow data) will be used to identify any significant deleterious changes occurring to the wetland functions so that measures can be implemented to minimize these changes. These measures could include routine/contingency response actions as identified in Section 3.4 of this appendix and the potential cessation of extraction that may increase dewatering in the area.

In the event of a significantly increasing flow[3] (either abrupt changes or longer term trend) to a wetland which corresponds to increased leakage from the wetland (i.e., into the quarry excavation), the contributing factors will be evaluated and the potential for adverse effects will be assessed in conjunction with the ecologists. In the event that significant deleterious effects are identified or anticipated, measures would be implemented to address these effects as described in Section 3.4 of this appendix.

---

3 Recharge system flow monitoring as described in Section 4.4 of the AMP will include the measurement of the flow of water into the wetlands W7, W8, and V2 from the water inflow system (i.e., coming from the recharge system watermain).

For W7, W8, and V2: If appropriate measures are not implemented or a plan submitted to the agency to address the situation within 8 weeks of identifying an actual or anticipated deleterious effect associated with the rate of water flow into the wetland, Dufferin will cease extraction that increases dewatering in the affected area[2].

To provide an appropriate context for comparison of inflow data to pre-existing conditions, monitoring data will be collected and analyzed to estimate the combined "water throughput" of the on-Site wetlands, including both surface water and groundwater pathways. This will be based on assessment of groundwater flow gradients as determined by the supplemental monitoring wells which will be installed in the vicinity of the wetland (refer to Section 4.1 of the AMP) as well as climate data for precipitation/stormwater runoff flows and evaporation effects. The estimated historical flows will be assessed as part of the pre-extraction report (refer to Section 6.2 of the AMP) based on the data available at that time.

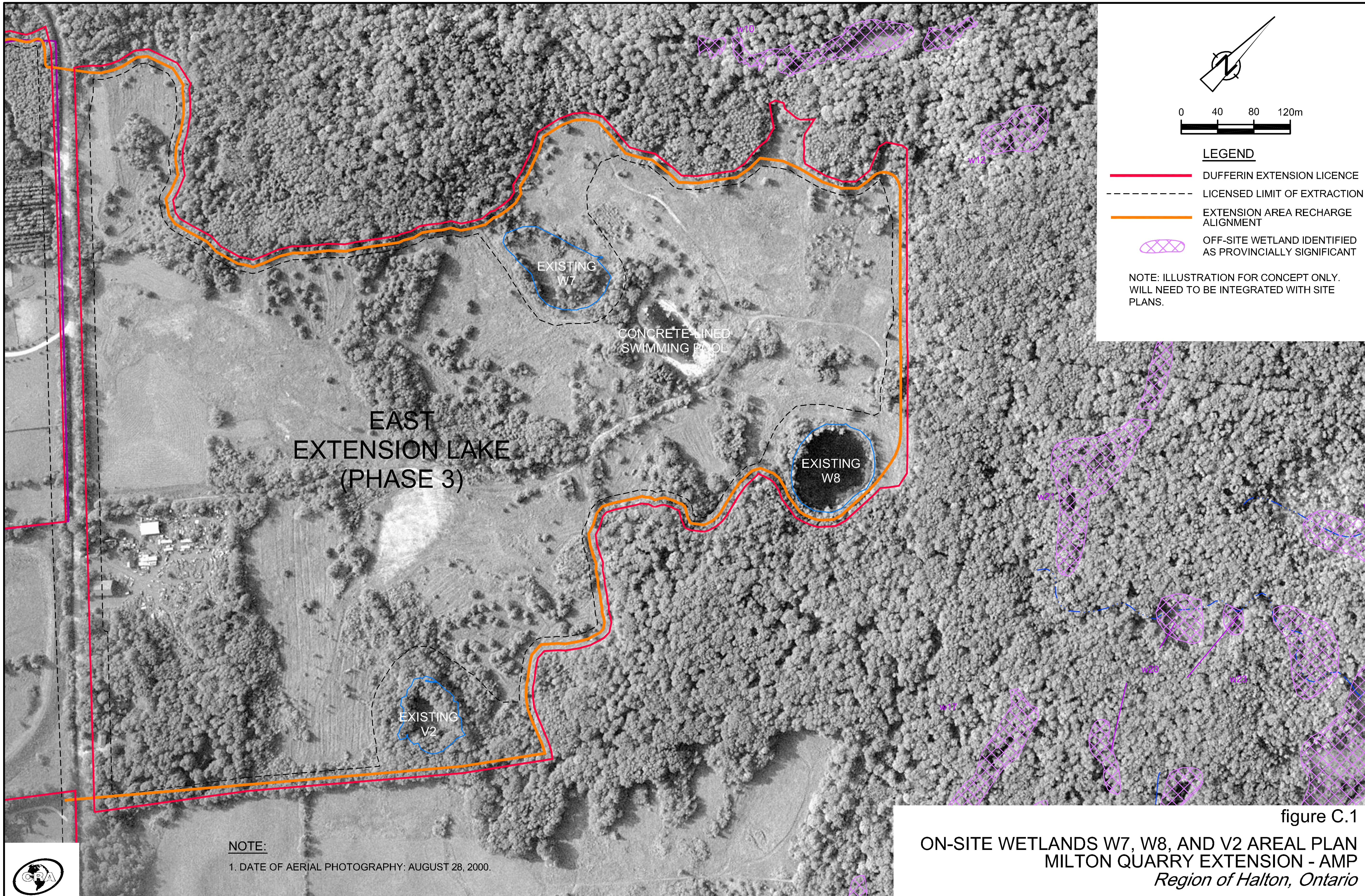
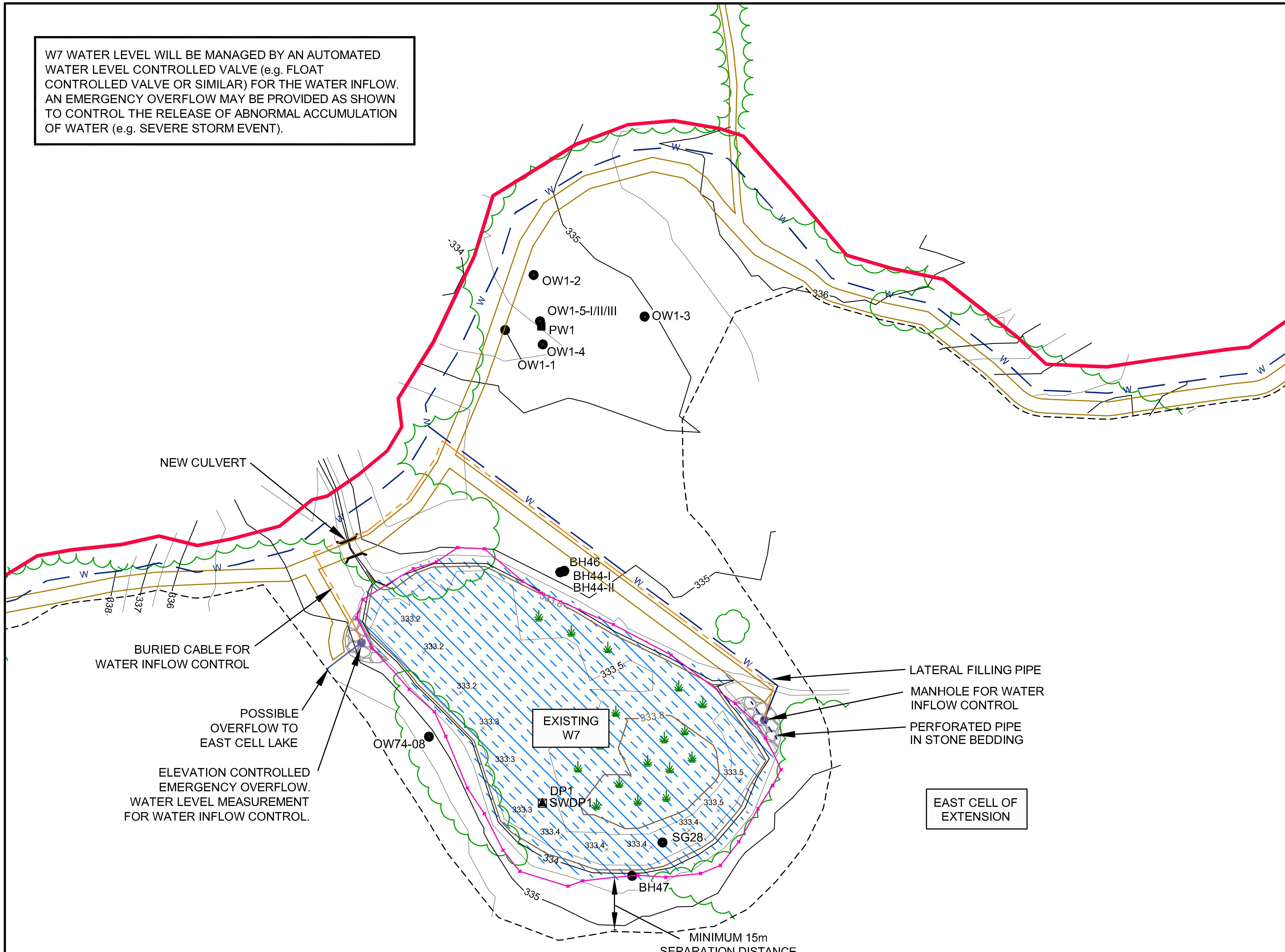


figure C.1

ON-SITE WETLANDS W7, W8, AND V2 AREAL PLAN
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA015 JUN 23/2011

W7 WATER LEVEL WILL BE MANAGED BY AN AUTOMATED WATER LEVEL CONTROLLED VALVE (e.g. FLOAT CONTROLLED VALVE OR SIMILAR) FOR THE WATER INFLOW. AN EMERGENCY OVERFLOW MAY BE PROVIDED AS SHOWN TO CONTROL THE RELEASE OF ABNORMAL ACCUMULATION OF WATER (e.g. SEVERE STORM EVENT).



LEGEND

- 335 CONTOUR LINE
- PROPERTY LINE
- DUFFERIN EXTENSION LICENCE
- FLAGGED WETLAND LIMIT
- LICENSED LIMIT OF EXTRACTION
- W WATERMAIN (LOCATION APPROXIMATE)
- VEGETATION
- PROPOSED SURFACE ACCESS ROUTE
- PROPOSED BURIED CABLE FOR WATER INFLOW CONTROL
- SWDP1 ⊠ SURFACE WATER MEASUREMENT LOCATION
- BH44-I ● MONITORING WELL LOCATION
- DP1 ▲ DP MONITORING WELL LOCATION
- 333.4 × SPOT ELEVATION
- PROPOSED STONE BEDDING
- MAXIMUM EXTENT OF W7 WATER LEVEL AT 334.3m AMSL

SOURCE:
TOPOGRAPHIC INFORMATION FROM MARCH 11, 2002 SURVEY USING 0.5 METRE CONTOUR INTERVAL.

NOTE:
* MINIMUM SEPARATION DISTANCE WILL BE MAINTAINED RELATIVE TO WETLAND LIMIT DEFINED BY GOODBAN ECOLOGICAL CONSULTING IN 2002, IN ACCORDANCE WITH ONTARIO WETLAND EVALUATION SYSTEM: SOUTHERN MANUAL (3RD EDITION - OMNR 1993 WITH UPDATES).

figure C.2

WETLAND W7 - CONCEPTUAL DESIGN
MILTON QUARRY EXPANSION - AMP
Region of Halton, Ontario

CRA

10978-68(074)GN-WA016 JUN 23/2011

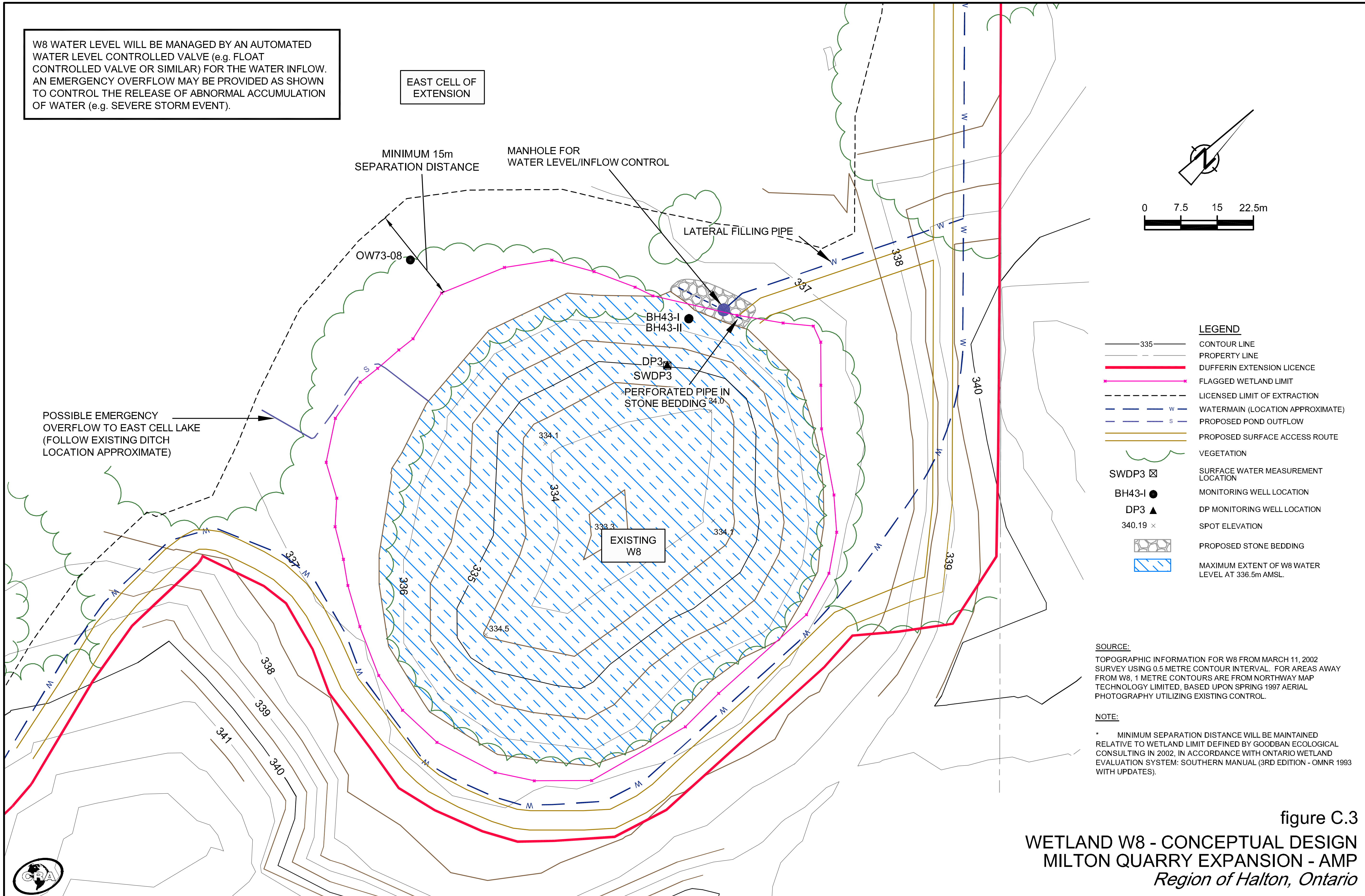


figure C.3

WETLAND W8 - CONCEPTUAL DESIGN
MILTON QUARRY EXPANSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA017 JUN 23/2011

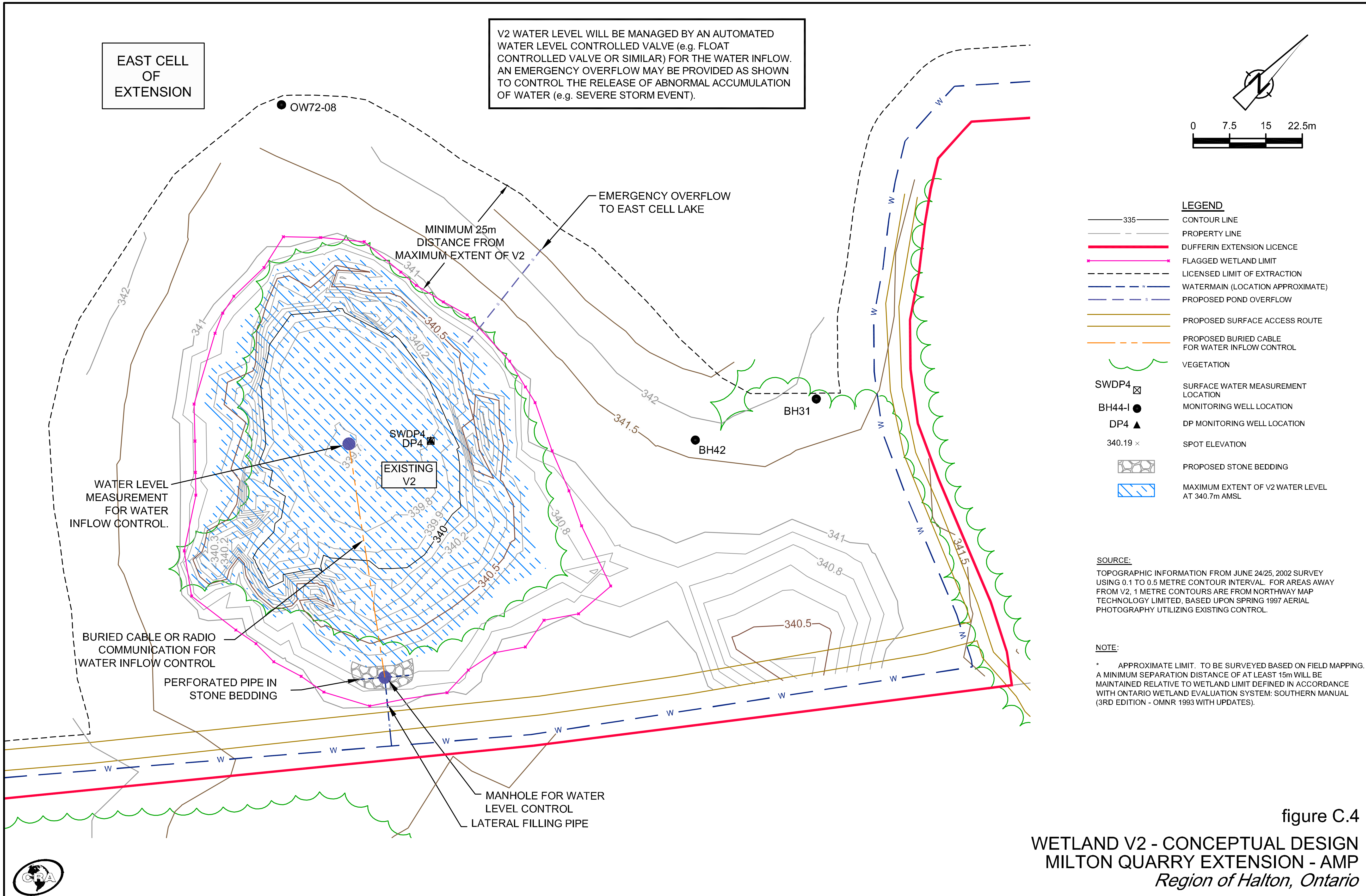


figure C.4

WETLAND V2 - CONCEPTUAL DESIGN
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

10978-68(074)GN-WA018 JUN 23/2011

APPENDIX D

PROTOCOLS FOR TRANSITION OF EXTRACTION FROM PHASE 2 TO PHASE 3

APPENDIX D

PROTOCOLS FOR TRANSITION OF EXTRACTION FROM PHASE 2 TO PHASE 3

This appendix defines the protocols for commencing three modes of bedrock extraction in Phase 3. The three modes are as follows:

1.0 Phase 3 Sinking Cut;

2.0 Interim Extraction in Phase 3; and

3.0 Phase 2 to Phase 3 Transition.

The protocols for these three modes are separate, although they have some similar aspects and related quarry operations considerations.

1.0 PHASE 3 SINKING CUT

From an operational perspective, transition of production extraction to Phase 3 can not occur until an appropriate sinking cut has been completed in Phase 3. A sinking cut may take up to 2 years to complete. Therefore, in order to be able to proactively shift extraction from Phase 2 to Phase 3, the sinking cut needs to be previously established. The following protocol will apply to the development of the sinking cut in Phase 3 to ensure the mitigation measures have been suitably demonstrated prior to the bedrock extraction for the sinking cut.

Protocol For Phase 3 Sinking Cut Development:

1. Prior to commencing bedrock extraction below the water table for the Phase 3 sinking cut, the mitigation measures must be successfully demonstrated in accordance with the procedures described in Section 1.3 of the AMP (i.e., Flowchart A) and at least one annual verification study must have been completed (i.e., Flowchart B). These demonstration and verification requirements will have been documented in the corresponding annual reports which are submitted for agency review.
2. Dufferin will provide notice to the agency representative(s) prior to the sinking cut extraction commencing below the water table and document progress in the annual report.

2.0 INTERIM EXTRACTION IN PHASE 3

BACKGROUND

The performance of the groundwater mitigation system will be demonstrated and verified prior to the commencement of a sustained operation in Phase 2 as described in Section 1.3 of the AMP. This will be documented in the annual reports and in more detail in the 5-year review reports (refer to Section 6.0 of the AMP) as well as on an ongoing basis by the performance tracking/response action procedures during active mitigation operations as described in Section 1.3 and Section 6.0 of the AMP.

In the event that during Phase 2 extraction a situation develops which would stress the mitigation system's ability to reliably maintain water levels at the target levels, it is desirable that Dufferin have the capability to undertake a variety of measures to proactively address this type of situation. It may, therefore, be beneficial to proactively stop or reduce extraction in Phase 2 on an interim basis and move bedrock production extraction to Phase 3. The temporary transition of some or all of the production extraction to Phase 3 would minimize or eliminate the potential for unnecessarily imposing stress on the Phase 2 area mitigation system until suitable measures can be implemented to provide an enhanced ability to provide water resources protection for continued Phase 2 extraction. Such a transition of production extraction to Phase 3 allows Dufferin to proactively take steps to provide a higher level of assurance of environmental protection, rather than relying on a more reactive time-restricted approach to a specific situation.

The following protocol applies to any such interim transition of extraction from Phase 2 to Phase 3.

Protocol For Interim Transition To Phase 3 Extraction:

1. The transition can not occur until such a time as the mitigation system has been satisfactorily demonstrated and verified to meet the mitigation objectives under sustained operating conditions relative to dewatering impacts from full-depth (i.e., upper and lower production benches) extraction. The verification of the successful implementation of the mitigation measures includes the verification of the demonstrated ability to maintain the target water levels on a sustained basis plus verification that the water budget is sustainable in accordance with the predicted performance. It also includes the verification that no significant

negative impacts[1] to the off-Site ecological features are evident[2]. These aspects of the performance verification documentation will be included in the corresponding annual report(s) or a supplemental report(s) prepared for this specific purpose (i.e., verification of the successful implementation of the mitigation measures) consistent with Section 6.1 of the AMP. The applicable report(s) will be submitted to the agencies for review.

2. The Phase 2 extraction must be operating with the water level regime in the on-Site wetlands being maintained in an appropriate manner from an ecological perspective, as described in Appendix C and documented as described in item 1 (above).

3. The Phase 2 extraction must be operating with water levels at or above the target levels (i.e., in the green zone) at the time of transition. In the event of an occurrence in relation to Phase 2 while conducting interim extraction in Phase 3, the interim extraction in Phase 3 must cease if the occurrence in Phase 2 is related to an issue which indicates that the mitigation system can not effectively maintain the functions of the groundwater dependant features.

4. The potential area of interim production extraction is limited to the west-central portion of Phase 3 as shown on Figure D.1 or as otherwise amended in the Pre-Extraction Report (refer to Section 6.2 of the AMP). Within this area, extraction can not occur any closer to the Licence extraction limit to the north or east than has been experienced in Phase 2 with verified mitigation operation. Interim production extraction would only be completed within the upper bench in the interim extraction area.

5. The above limitations do not apply to the opening of the sinking cut to the base elevation of the Amabel. This will commence while extraction is underway in the West Cell (Phase 2) and this work may be spread out over a 2-year period. The sinking cut development will follow the protocol described above (Section 1.0).

6. Dufferin will provide notice to the agency representative(s) prior to commencing extraction in Phase 3. Supporting documentation will be provided with the notice to explain the reason for the transition, what mitigation measures will be implemented and the associated timelines for completion, and an explanation of why these measures and implementation time are required (versus implementing some other measures in a more rapid manner).

---

1 Unless the issue is clearly not attributable to Dufferin's activities.

2 Relative to off-Site seasonal wetlands, this assessment will be based on evaluation of conditions in wetland W5 as described in Section 4.5.4 of the main report.

7. The interim extraction is not intended to continue over the long term. If the interim extraction is to occur for more than 1 year on a sustained basis, Dufferin will submit associated plans and rationale to the agency representative(s) for review.
8. Dufferin will document quarry progression in the annual report, including an evaluation of the suitability of the interim extraction area and any continued/future interim extraction.

The above protocol pertains only to the interim transition of extraction from Phase 2 to Phase 3 and does not apply to the routine operational transition as the Phase 2 extraction nears completion (refer to Section 3.0 below).

3.0 PHASE 2 TO PHASE 3 TRANSITION

The protocol for making a full transition of bedrock extraction from Phase 2 to Phase 3 is described herein. This protocol is similar to but separate from the requirements for interim extraction and the sinking cut in Phase 3 that are described above.

The successful performance of the groundwater mitigation system for meeting the overall objectives of the mitigation system will be thoroughly demonstrated under full operating conditions in Phase 2 prior to the transition to full bedrock extraction in Phase 3. This performance will be documented in the annual reports as well as on an ongoing basis by the performance tracking/response action procedures during active mitigation operations as described in Section 1.3 and Section 6.0 of the AMP. The following protocol describes the specific items that will be confirmed by Dufferin prior to making a full transition of bedrock extraction to Phase 3.

Protocol For Transition of Full Extraction to Phase 3:

1. The following requirements will be met prior to the transition:
    a) The Phase 2 extraction has been essentially completed to its maximum horizontal extent (i.e., upper bench is nearly complete and lower bench is well advanced) for the majority of Phase 2, and therefore, the mitigation system has essentially been stressed to its maximum level for Phase 2.
    b) The mitigation system has been satisfactorily demonstrated and verified to meet the mitigation objectives under sustained operating conditions relative to dewatering impacts from full-depth (i.e., upper and lower production benches) extraction. The verification of the successful

implementation of the mitigation measures includes the verification of the demonstrated ability to readily maintain the target water levels on a sustained basis plus verification that the water budget is as best it can be determined at that time sustainable over the long term in accordance with the predicted performance.

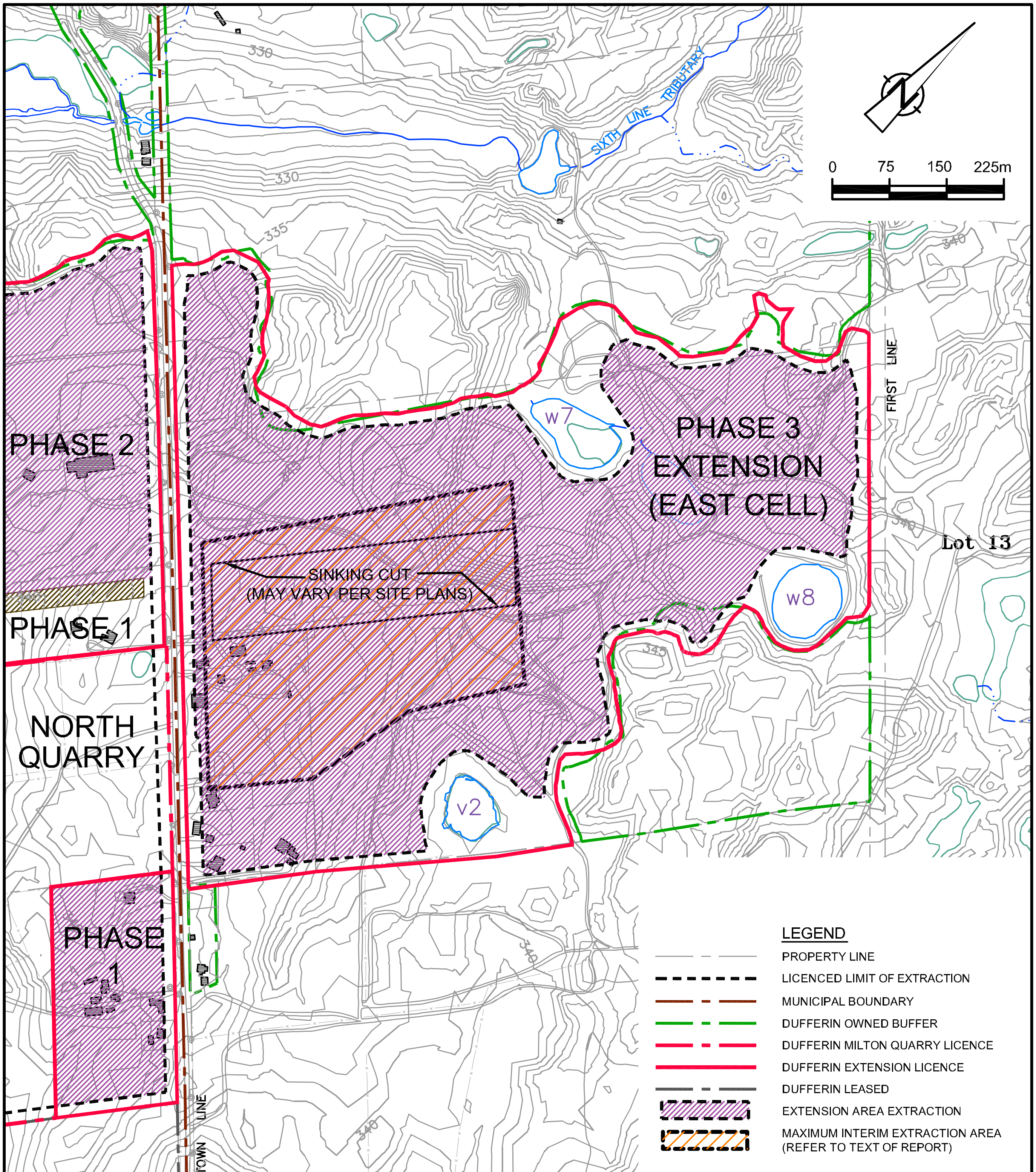
c) The off-Site (i.e., beyond licence limit) ecological conditions have been evaluated and no significant negative impacts to off-Site ecological features are evident.

d) These aspects of the performance verification documentation will be documented in the corresponding annual report(s) or a supplemental report(s) prepared for the purpose of the transition to Phase 3, consistent with Section 6.1 of the AMP. The applicable report(s) will be submitted to the agencies for review.

2. The area of extraction within Phase 3 will be as shown on the Site Plans, subject to the following limitation. The limit of extraction in Phase 3 can not approach the alignment of the groundwater recharge wells any closer in Phase 3 than the minimum separation distance between the actual final extent of Phase 2 extraction (as per item 1.a above) and the alignment of the adjacent recharge wells. The minimum separation distance must be for areas where the mitigation is concluded to be operating in a manner that allows the associated target levels to be readily maintained on a long-term performance basis.

   Expansion of the Phase 3 extraction area beyond this area (but within the licensed extraction limit) can be conducted if it is demonstrated that the mitigation measures are suitable to meet the mitigation objectives under such conditions. The demonstration may include: mitigation performance in Phase 2 (and the North Quarry); specific field testing/demonstration; detailed evaluation and planning of operations to provide satisfactory measures to ensure mitigation objectives are met; or other demonstration. The demonstration of any such amendment to the Phase 3 extraction limit will be documented and submitted to the agency representative(s) for review prior to commencing extraction in the subject area.

3. Dufferin will provide notice to the agency representative(s) prior to commencing production level extraction in Phase 3. Supporting documentation will be provided to the agencies to demonstrate that the above requirements have been satisfied and to identify the limit of extraction in accordance with Item 2 (above).



SOURCE:
TOPOGRAPHIC INFORMATION OBTAINED FROM NORTHWAY MAP TECHNOLOGY LIMITED. CONTOURS WERE DRAWN FROM SPRING 1997 AERIAL PHOTOGRAPHY UTILIZING EXISTING CONTROL. CONTOUR INTERVAL IS 1 METRE.

BOUNDARY INFORMATION COMPILED FROM SURVEYS AND SKETCHES PREPARED BY FRED G, CUNNINGHAM, ONTARIO LANDS SURVEYORS, MILTON, ONTARIO, DECEMBER 2,1997.

figure D.1

PHASE 3 INTERIM EXTRACTION AREA
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

CRA

10978-68(074)GN-WA014 JUN 23/2011

APPENDIX E

WATER BUDGET VERIFICATION

TABLE OF CONTENTS

LIST OF FIGURES
(Following Text)

LIST OF TABLES
(Following Text)

1.0 INTRODUCTION

The original water budget assessment for the Extension is documented in Appendix E of the Water Resources Assessment Report (CRA, May 2000 - Appendix E updated April 2001). The main body of the AMP (Sections 4.4 and 6.0) describes the program under the Adaptive Environmental Management and Protection Plan (AMP) to evaluate the water budget on a regular basis. This appendix provides further clarification and additional information regarding the details of the water budget verification program of the AMP, including the means and process by which the filling status and the water budget used to calculate the filling rate of the reservoir will be assessed[1].

The water budget for the proposed Extension is highly integrated with other aspects of the Milton Quarry and therefore the water budget is evaluated on the basis of the entire Milton Quarry water management system as was done in the Water Resources Assessment Report.

The water balance for the entire Milton Quarry will be evaluated on a regular basis to ensure that sufficient water is available for ongoing and future mitigation, operational, and rehabilitation requirements. The objectives of the water balance evaluation include:

- Verify that the amount of water available/in storage is consistent with water budget forecasts to confirm the representativeness of the overall water budget calculations;
- Identify if more or less water is available that forecasted such that filling time and associated operational and cost aspects can be appropriately addressed;
- Establish the annual distribution of the water from the reservoir in accordance with an agreed water hierarchy;
- Establish the amount of "excess" water that may be available;
- Confirm the representativeness of key water budget parameter values which have the potential to significantly affect the reliability of the long-term water budget calculations in a negative manner (i.e., potentially less water available that forecast); and
- Identify and adapt to any long-term trends in water budget availability that are evidenced by the monitoring data and/or recognized by the scientific community.

---

1 The information presented herein describes the intended framework for evaluating the water budget. It is recognized, however, that the specific methods of analysis will vary based on the available information and professional judgment. Full details of the annual water balance calculations will be provided in conjunction with the annual reporting (refer to Section 4.0 of this appendix).

The principal basis for assessment will be through measurement of the reservoir water level (i.e., amount of water in storage) and the progression of rehabilitation lake filling for the North Quarry Cell and Extension Quarry Cells. On an annual basis, this data will be compared to predicted water balance conditions (Appendix E of Water Resources Report as updated in CRA's December 2003 Witness Statement in relation to Consolidated Board Hearings - Case No. 03-086) to ensure the water balance is acceptable and to define "excess water" that is potentially available for other purposes. As part of the 5-year review, the water budget will be re-calibrated to reflect the information collected to date.

It is important to recognize that this water budget was prepared in support of an application for construction of a reservoir in the Dufferin Aggregates Quarry that was to have commenced in the year 2000. This timeline has not been met and following approval of the proposed reservoir and the associated rehabilitation site plan, a new timeline will be established that includes a revised construction schedule for the reservoir. Following preparation of the revised timeline, the water budget will also be updated accordingly.

The Water Budget Verification procedure incorporates the data from the comprehensive monitoring program and thereby serves to verify and refine the calibration of the water budget over time. Part of the ongoing evaluation of the water budget will be to review the monitoring and verification program described herein to evaluate whether the objectives are being achieved and whether it is appropriate to modify the monitoring and/or analysis program.

The following sections of this appendix are organized as follows:

Section 2.0	Water Budget Analysis Verification Procedure - a detailed breakdown of the parameters, assumptions and calculations contained within the water budget; as well as a step-by-step description of how each parameter will be compared to the monitoring data;
Section 3.0	Monitoring Program - outlining the location of monitoring equipment and the data that will be collected; and
Section 4.0	Reporting Structure - outlines the level of detail that will be submitted in the Annual and the 5-year Review Reports pertaining to the water budget.

The water budget evaluation and reporting process is described in Section 4.0 of this appendix. An introduction is provided below:

- On a regular basis, the actual water storage within the Quarry water management system will be compared to the predicted water budget conditions to assess the storage and water budget status;
- On an annual basis, the water budget parameters will be reviewed relative to the monitoring data to identify any significant differences and verify the overall suitability of the water budget calculations and storage conditions; and
- On a 5-year review basis, the water budget parameters and the groundwater flow model will be revised based on the up to date monitoring data and recalibrated to update the water budget calculations/forecast.

2.0 WATER BUDGET PARAMETER VERIFICATION PROCEDURE

The following sections describe the individual parameters used in development of the water budget, how they were developed for the calculated future water budget and how they will be updated as part of the verification procedure. Key parts of the water budget definitions previously provided in Appendix E of the Water Resources Assessment Report are indicated in *Italics* immediately following the section heading (paraphrased/modified in regular font, as appropriate). A description of the parameter update frequency and method of verification follow the parameter definition in a separate paragraph(s) using regular text.

The water budget formulation is summarized in Tables E.1 and E.2 and shown graphically on Figure E.1. Note that Table E.2 is consistent with Table E.2 from the Water Resources Assessment Report with the following two revisions which were made for the purpose of clarifying this document:

1. It has been updated to reflect the discharge of 700,000 cubic metres (m^3) per year of water to Hilton Falls Reservoir Tributary as agreed by Dufferin and Conservation Halton (CH) rather than the discharge of 521,000 m^3 per year as presented in the Water Resources Assessment Report; and
2. The water budget is presented for the application scenario, not for the design sensitivity analysis scenario (Table E.2 from Water Resources Assessment Report includes both scenarios).

Figure E.1 is the same as that presented in the Water Resources Assessment Report (Figure E.1). Furthermore the parameters and numbers noted after the column/subsection identifiers (in parentheses) refers to the column numbers listed in these tables and in the following.

2.1 TIME PARAMETERS

2.1.1 START TIME

This column represents the starting year for the increment.

This is a numeric parameter (year) that was developed with the original application package and quarrying plans and indicates that construction of the reservoir and filling activities commenced in 2000. The years/dates will be revised to reflect the actual completion date of construction of the Main Quarry Reservoir and commencement of Reservoir and Lake filling activities. All subsequent start dates will be revised in accordance with the calculated filling times for each lake in series and any subsequent refinements of the mining and lake filling sequence plans.

The sequence and timing will be reviewed on an annual basis as milestone events in development of the quarry are achieved. The water budget will be recalibrated every fifth year to account for the progression of time and new data.

2.1.2 END TIME

This column represents the ending year for the increment.

This is a numeric parameter (year) that will be reviewed annually based on the calculated filling times for the reservoir and each lake. The water budget model will be revised every fifth year to account for the progression of quarrying, rehabilitation and lake filling.

2.1.3 EVENT AT END OF INCREMENT (1)

This is a comment regarding milestone events during the period of study.

This column is a text comment field used to describe the anticipated mining progress and the milestone events representing a significant achievement in development of the quarry. As the start and end periods are updated, this comment will be revised to reflect significant occurrences in the progress of development of the quarry.

2.2 AREA PARAMETERS

2.2.1 TOTAL QUARRIED AREA (2)

Refers to total extracted area of quarry as per the Site Plans. A linear interpolation was applied to calculate intermediate areas between milestone dates.

This area was delineated from current site plans for the Main Quarry based on physical surveys of the quarry floor. Areas of future completed stages of the North Quarry and Milton Quarry Extension were based on the current/proposed site plans.

This parameter will be updated annually based on the approved site plans (as amended) and progression of mining activities. Areas mined may be measured from aerial photos and/or physical surveys delineating the extent of the mining activities.

2.2.2 <u>AREA OF NO-FLOW CELLS</u> (3)

Total area of no-flow cells in groundwater model. This is a numeric value that represents the area of the no-flow cells are a by product of the finite difference groundwater model developed for the watershed…. The area of no flow cells must therefore be noted such that an appropriate infiltration rate may be applied to this area.

A linear interpolation was used to calculate the area of no-flow cells between milestone dates in the water budget study period.

This numeric value of area will be updated every 5 years when the groundwater model is updated and recalibrated. The area of the no flow cells represents a measured area based on the perimeter of the active quarry and the corresponding finite difference cells used in the model.

2.2.3 <u>APPROXIMATE LAKE AREA</u> (4)

This column calculates the cumulative area that is developed into lakes/wetlands.

For the Rehabilitation Case, the areas for dry quarry recharge and lake quarry recharge represent the Main Quarry only. The North Quarry and Extension lands recharge are included in the groundwater model i.e., they are not no-flow cells.

This area was calculated from current and proposed site plans and rehabilitation plans for the quarry.

The lake area will be updated annually to represent the actual area of the lakes that exists (partial or completely filled with water). The lake area will be measured from aerial surveys or physical surveys.

2.2.4 DRY QUARRY FLOOR AREA (5)

This column calculates the area of the quarry that is dry i.e., not a lake. The Dry Quarry Floor Area = Total Quarried Area - Approximate Lake Area.

For the Rehabilitation Case areas, dry quarry recharge, and lake quarry recharge represent the Main Quarry only. The North Quarry and Extension lands are included in the groundwater model i.e., not no-flow cells.

This area was calculated from the area delineated from current physical surveys of the quarry floor and current mining plans for development of the Site.

This parameter will be updated annually based on the progress of extraction (dry quarry floor area) and lake filling (approximate lake area) activities.

2.2.5 APPROXIMATE UPSTREAM AREA (6)

This column states the upstream drainage area that contributes runoff into the quarries. This value does not include portions of upstream quarries that will be retained when excavated.

Under initial conditions, this area was delineated from topographic mapping of the region surrounding the Quarry. Areas used to represent future conditions were calculated based on currently proposed mining site plans and anticipated development of the Quarry. This parameter will be updated annually based on the progress of mining activities. Areas will be calculated based on progression of quarry development.

2.3 INFLOW PARAMETERS

All principal inflows (numeric values) to the lake and reservoir system will be either directly measured during rainfall events or via pump records for the central sump. Precipitation will be measured at the on site weather station. Flows discharged to the reservoir and lakes via the central sump will be continuously[2] recorded. The development of the water budget required that the components of the flow entering the central sump be segregated into the following parameters in order to calculate the net

---

2 Reference to continuous monitoring or recording means data collection using automated equipment to obtain and record readings at a relatively frequent interval (e.g., a water level recorder which records water elevations on an hourly or daily basis).

inflow. This partitioning of the flow may become redundant once the system is operational, however, it is necessary at this time to consider the individual components of the flow to the reservoir to gain an understanding of the volume of water that will potentially be discharged to the reservoir.

2.3.1 DRY QUARRY RECHARGE (7)

The Dry Quarry Recharge column is calculated as the precipitation rate minus the evaporation rate. In operational (unvegetated, bare rock) quarry areas, the evaporation rate is 300 mm/year and no transpiration occurs. Therefore, the net precipitation is 588 mm/year (888 mm/year minus 300 mm/year). This net precipitation represents the available water in the combined form of groundwater and surface water runoff.

The Dry Quarry Recharge column is corrected to consider the area of No-Flow Cells that are dry quarry areas. An infiltration rate of 200 mm/year was used universally in the groundwater model. The Dry Quarry Recharge column was corrected by multiplying the total quarry area by a recharge rate of 588 mm/year minus the area of No-Flow Cells multiplied by 200 mm/year that were already accounted for in the groundwater model.

For the Rehabilitation Case areas, dry quarry recharge represents the Main Quarry only. The North Quarry and Extension lands recharge are included in the groundwater model i.e., not no-flow cells. The dry quarry recharge in rehabilitation cases is based on a recharge rate of 366 mm/year (i.e., 888 mm/year precipitation minus 522 mm/year natural conditions evapotranspiration). Areas of No Flow Cells are corrected by subtracting an additional 200 mm/year for those areas.

The Dry Quarry Recharge parameter represents the surface runoff/storage within the dry quarry floor area that is eventually collected at the Central Sump and pumped into the reservoir. This parameter represents the difference between the total amount (depth) of precipitation and the actual evapotranspiration from the quarry floor.

The total precipitation will be assessed annually using the on site weather station and supplemented with the AES corrected Georgetown precipitation data. The water budget recalibration will utilize a running average precipitation value updated to the time of analysis. The appropriate period of averaging will be based on the data history in accordance with scientific understanding and protocols available at that time.

The evapotranspiration value used in the water budget was calculated from the water budget analysis of the Main Quarry based on the actual historical monitoring data as the evapotranspiration rate from the quarry floor can not be directly measured and theoretical methods are not well proven in this setting (refer to Appendix E of the Water Resources Report for further details). Therefore this calculated evapotranspiration value will continue to be utilized in the future. If there is a significant discrepancy between the calculated evapotranspiration value and the future conditions, it will be revealed during the water budget analyses and recalibration studies. If such a discrepancy is noted, further study may be undertaken to refine this parameter value. For example, quarry floor evapotranspiration, particularly when soil and vegetation may develop, can be evaluated using a theoretical estimation (e.g., Thornthwaite and Mather) based on the lake evaporation value from the data collected at the evaporation pan located at the Weather Station. A standard Class A pan correction factor will be incorporated into the raw data collected from the evaporation pan to represent the evaporation rate within the dry quarry floor area. The transpiration rate will be determined based on the area and density of plant coverage on the dry quarry floor area.

2.3.2 LAKE QUARRY RECHARGE (8)

The Lake Quarry Recharge column represents the net precipitation available [as] water in the combined form of groundwater and surface water runoff in the lake areas. In lakes, reservoirs, and large ponds, no transpiration occurs. Lake evaporation has been recorded at the on-site weather station and an average value of 618 mm/year is used in this analysis that is based on the recorded data. The net precipitation in lake areas of the quarry after evaporation and transpiration therefore is 888 mm/year minus 618 mm/year or 270 mm/year. In wetland areas, the combined evaporation and transpiration (evapotranspiration) is equivalent to lake evaporation, and thus the net precipitation is equal to the Lake Quarry Recharge (270 mm/year).

The Lake Quarry Recharge parameter represents the difference between the annual precipitation and lake evaporation in the Reservoir and Lake areas. This parameter will be updated annually.

The total precipitation will be calibrated using the on site Weather Station supplemented with the AES corrected Georgetown precipitation data. The total lake evaporation will be calculated from the pan evaporation data collected during the year at the Weather Station. A correction factor will be incorporated into the evaporation data to convert the pan evaporation data to equivalent lake evaporation.

2.3.3 GROUNDWATER INFLOW (9)

The Groundwater Inflow column was calculated using the groundwater flow model. The groundwater model incorporates a 200 mm/year infiltration rate and water injected into the groundwater system by the Main Quarry, North Quarry and Extension mitigation systems. Therefore, the Groundwater Inflow volumes are considerably larger than the drainage area surrounding the quarry multiplied by 200 mm/year. This is the result of re-circulation mitigation system injection water back into the quarry. In the fully rehabilitated case, the groundwater inflow term incorporates a component for pond surplus/augmentation flows required to maintain a constant water level in the lakes.

The groundwater model was simulated for specific stages of quarry development. The groundwater inflow was linearly interpolated between event simulations.

The Groundwater Inflow Volume can be estimated by measuring the volume of water that is pumped from the dewatering stations (i.e., Central Sump, North Quarry Sump, West Cell Sump, and East Cell Sump) during drought and baseflow conditions. Baseflow conditions are those that may occur generally after a period of greater than approximately three days following a rainfall event. It is assumed that during drought or baseflow conditions no surface runoff (i.e., from storm events) will be discharged to the Central Sump. It is further assumed that direct net groundwater inflow into the Reservoir (i.e., inflow from north and west minus seepage outflow to south and east) will be negligible.

The Groundwater Inflow Volume will be updated in conjunction with the recalibration of the groundwater flow model as part of the 5-year review.

2.3.4 UPSTREAM RUNOFF (10)

The Upstream Runoff Column calculates the volume of surface runoff that does not infiltrate and may eventually flow into the quarry. The natural area surrounding the quarry has an evapotranspiration rate of 522 mm/year, resulting in a net precipitation of 366 mm/year (i.e., 888 mm/year minus 522 mm/year). The groundwater model assumes a net infiltration rate of 200 mm/year. Therefore, the remaining 166 mm/year (366 mm/year minus 200 mm/year) is discharged to the quarry through surface water runoff.

This parameter was calculated through application of a hydrologic analysis of the contributing drainage area.

The Upstream Runoff parameter represents the volume of surface runoff that does not infiltrate and eventually flows into the quarry from catchments upstream of the quarry. This volume will be calculated through evaluation of the discharge flow records at the dewatering sumps and subtraction of the observed baseflow. The calculated runoff volume will be compared to the value calculated using the estimated runoff rate over the catchment area. The runoff rate for the catchment area will be estimated from the annual precipitation minus the infiltration and evapotranspiration rates.

2.4 OUTFLOW PARAMETERS

The outflow parameters represent draws of water from the reservoir and lake system and are summarized in the following sections.

2.4.1 RECHARGE SYSTEM (12)

The Recharge System column represents water withdrawn from the system (e.g., Main Quarry sump or reservoir) and injected into the groundwater system via the combined North Quarry and Extension mitigation system. It includes recirculation from recharge system to quarry face. As previously described, the groundwater model was simulated for specific stages of quarry development and the recharge volumes were linearly interpolated between event simulations.

This parameter was calculated as part of the design of the recharge system. The system will be metered and continuously monitored at the withdrawal point from the Reservoir (i.e., at the Recharge Pumping Station). The annual recharge volume will be updated annually based on the flow records.

2.4.2 MAIN QUARRY RECHARGE (13)

The Main Quarry Recharge column represents water withdrawn from the system (e.g., Main Quarry sump or reservoir) and injected into the groundwater system via the Main Quarry mitigation system. As previously described, the groundwater model was simulated for specific stages of quarry development and the main quarry recharge volumes were linearly interpolated between event simulations.

This allowance has been provided for within the water budget should Dufferin choose to install a contingency mitigation system for the northwest corner of the Main quarry (e.g., if Dufferin chooses to conduct further extraction in this area). If this system is installed then the water usage will be metered and continuously monitored at the withdrawal point from the Reservoir at the Recharge Pump Station. The annual recharge volume will be updated annually based on the flow records.

2.4.3 QUARRY OPERATIONS (14)

The Quarry Operations column represents water lost from the system due to use in quarry operations such as dust control and aggregate washing. The Quarry operation water requirements are based on the following existing and estimated demands:

	Dust Control (m^3/year)	*Aggregate Washing (m^3/year)*	*Total (m^3/year)*
Existing	*50,000*	*75,000*	*125,000*
Future	*150,000*	*90,000*	*240,000*

Details of the basis for each of the above numbers has been provided below.

Dust Control:

Water use for dust control is presently estimated at approximately 50,000 m^3/year based on information obtained from RWDI (personal communication).

The water requirement for dust control was estimated by RWDI to increase to 150,000 m^3/year for the combined existing and Extension operations.

Aggregate Washing and Sumps Settling Pond Evaporation:

Water loss through pond fine production is estimated to be 22,000 m^3/year, and water shipped off-Site in aggregate is estimated to be 37,500 m^3/year. This results in a total water use for aggregate washing of 60,000 m^3/year.

Quarry operations will advance from the main quarry to the quarry extension. Water consumption for aggregate washing is not anticipated to increase, however, as the aggregate production rates will remain unchanged.

It was assumed that an additional 15,000 m^3/year of water evaporates from the quarry sumps, settling pond, and aggregate stockpiles, based on an evaporation rate of 1 m/year from shallow water bodies.

Water evaporation from sumps and settling ponds will increase as new sumps are developed within the Extension Areas. The number of sumps and settling ponds was assumed to double and the operational water evaporative losses was increased from 15,000 m^3/year to 30,000 m^3/year.

Water used by Quarry operations for dust control and aggregate washing will be supplied from the Reservoir and/or from the recharge water watermain in the extension quarry; this water usage will be metered at the Recharge Station, Central Sump Station, or the takeoff point from the watermains. Annual water usage volumes will be recorded and this parameter will be updated annually.

2.4.4 <u>OUTFLOW TO HFRT</u> (15)

The Outflow to HFRT column represents the water discharged from the Main Quarry sump to the Hilton Falls Reservoir Tributary...

Dufferin has agreed to provide a minimum discharge of 700,000 m^3/yr of water to the Hilton Falls Reservoir Tributary. The Reservoir outfall structure is designed to provide a consistent flow under sustained release conditions, even under gravity drainage conditions, through the use of a flow control device. Additional water may be released at the Reservoir operator's discretion.

The Outflow to the HFRT will be continuously monitored using a calibrated weir with a Milltronics Open Channel Flow Monitor (OCM) or similar device to provide continuous measurement of discharge in the outflow channel from the Reservoir to the Hilton Falls Reservoir Tributary. The OCM will provide flow rate and total discharge volume. This parameter will be updated annually.

2.4.5 <u>ESCARPMENT LEAKAGE</u> (16)

The Escarpment Leakage column represents horizontal groundwater flow to the Niagara Escarpment Face and Halton Crushed Stone. This column is included because this outflow was not included in the groundwater model of the active quarry areas. All leakage to the Niagara Escarpment face originates from the Main Quarry leakage. The horizontal leakage rate from the Main Quarry ponds/wetlands to the Escarpment and the Halton Crushed Stone Quarry was assumed to be 244,030 m^3/year, based on results presented by Dames and Moore Canada in "Creation of Reservoir in Completed Quarry, Milton Main Quarry", April 1998.

The Escarpment Leakage can not be readily quantified from existing information, however, it is a minor component in the water budget and has been represented at what is likely an overestimated value. The ongoing water budget evaluation program will review whether there is any indication of a significant discrepancy in this parameter value.

The Lake/Wetland area should have a relatively neutral water budget demand based on the Escarpment Leakage value utilized in the water budget (i.e., no significant gain/loss of water). Monitoring results that may indicate a discrepancy in this parameter value would include the amount of overflow of water from the Lake/Wetland area to the Central Sump or the need for significant addition of water from the Reservoir to top-up the Lake/Wetland area. In the event that a discrepancy is suspected, further evaluation can be undertaken, including a micro water budget analysis of the Lake/Wetland area. The top-up flow from the Reservoir will be measured similar to the discharge for the Hilton Falls Reservoir Tributary (above). If appreciable discharge from the Lake/Wetland area is noted, an automated flow monitoring station will be installed at the Berm B overflow to quantify this component of the water budget.

2.4.6 VERTICAL LEAKAGE (17)

The Vertical Leakage column represents vertical groundwater flow through the underlying aquitard to the deeper aquifer. Calculation of this outflow was not included in the groundwater model of the active quarry areas (i.e., in the no flow zones only). The vertical leakage rate from quarry ponds was assumed to be 4.7 mm/year and 9.5 mm/year for the dry quarry floor and the rehabilitated lake areas, respectively. These leakage rates were based on a hydraulic conductivity of 10^{-7} cm/s for Cabot Head Shale, a vertical anisotropy ratio of 10 (K_h/K_v), and vertical gradients of 1.5 and 3.0 for the dry quarry floor and rehabilitated lake areas, respectively.

The Vertical Leakage can not be readily quantified, however, it is a very minor component in the water budget. In the unlikely event that the ongoing water budget evaluation identifies any indication of a significant discrepancy in this parameter value, further assessment will be undertaken.

2.5 WATER SURPLUS

The water surplus is calculated as the difference between the quarry inflows and quarry outflows. A safety factor is included in this calculation in recognition of the inherent variability in climatic and hydrogeologic conditions as well as some uncertainty and variations in the overall water *budget calculations. The Main Quarry climatic data and pumped discharge records presented in the Annual Monitoring Reports evidence this variability. The safety factor (500,000 m^3/year) is not considered to be available for use or lake filling. In the event that this amount is available, it will increase the water surplus available for other uses and/or decrease lake filling times as discussed in Section 4.0 of this appendix.*

2.5.1 AVAILABLE ANNUAL (18)

The Available Annual column represents the total available annual surplus. It is calculated as the total Inflows minus the total Outflows (per year not per time increment) minus the safety factor of 500,000 m^3/year.

Table E.1 presents the formula for calculation of this value.

2.5.2 CUMULATIVE SURPLUS (19)

This column tracks the available accumulated surplus of water…

The volume of cumulative surplus represents that volume of water that is available in storage or has been released downstream over and above the committed 700,000 m3/yr discharge (in the event that storage is not available at the time that the available annual amount occurs).

3.0 MONITORING PROGRAM

The data collected as part of the Monitoring Program is critical to the evaluation and recalibration of the water budget over the long term. The monitoring program includes a weather station to collect meteorological information; a series of flow meters to measure water usage; and a series of water level meters to assess the capacity and filling rate of the Reservoir, the Main Quarry Lake and Wetland area, the North Quarry Lake, and the Extension Lakes. Table E.3 provides a summary of the monitoring stations and type of data to be measured.

4.0 REPORTING

4.1 ANNUAL REPORTING

On an annual basis the data collected from the monitoring program will be summarized and compared to the parameters used in the water budget calculations to verify that the water budget is representative. The water budget analysis will be documented in the annual report and will include the following:

- Description and assessment of the assumptions used in the water budget;
- An assessment of the parameter values used in the water budget in comparison to their observed values;
- Comparison between the predicted and actual water levels in the reservoir and lake system using the water budget;
- Assessment of whether the reservoir-filling rate is in a surplus or deficit situation when compared to that predicted using the water budget;
- Determination of "excess water" for the subsequent year; and
- Conclusion regarding the future sustainability of the water budget for the near term and long term.

4.2 FIVE-YEAR REPORT

Every 5 years, a comprehensive analysis of the water budget will be prepared and presented in the 5-year report, including the following:

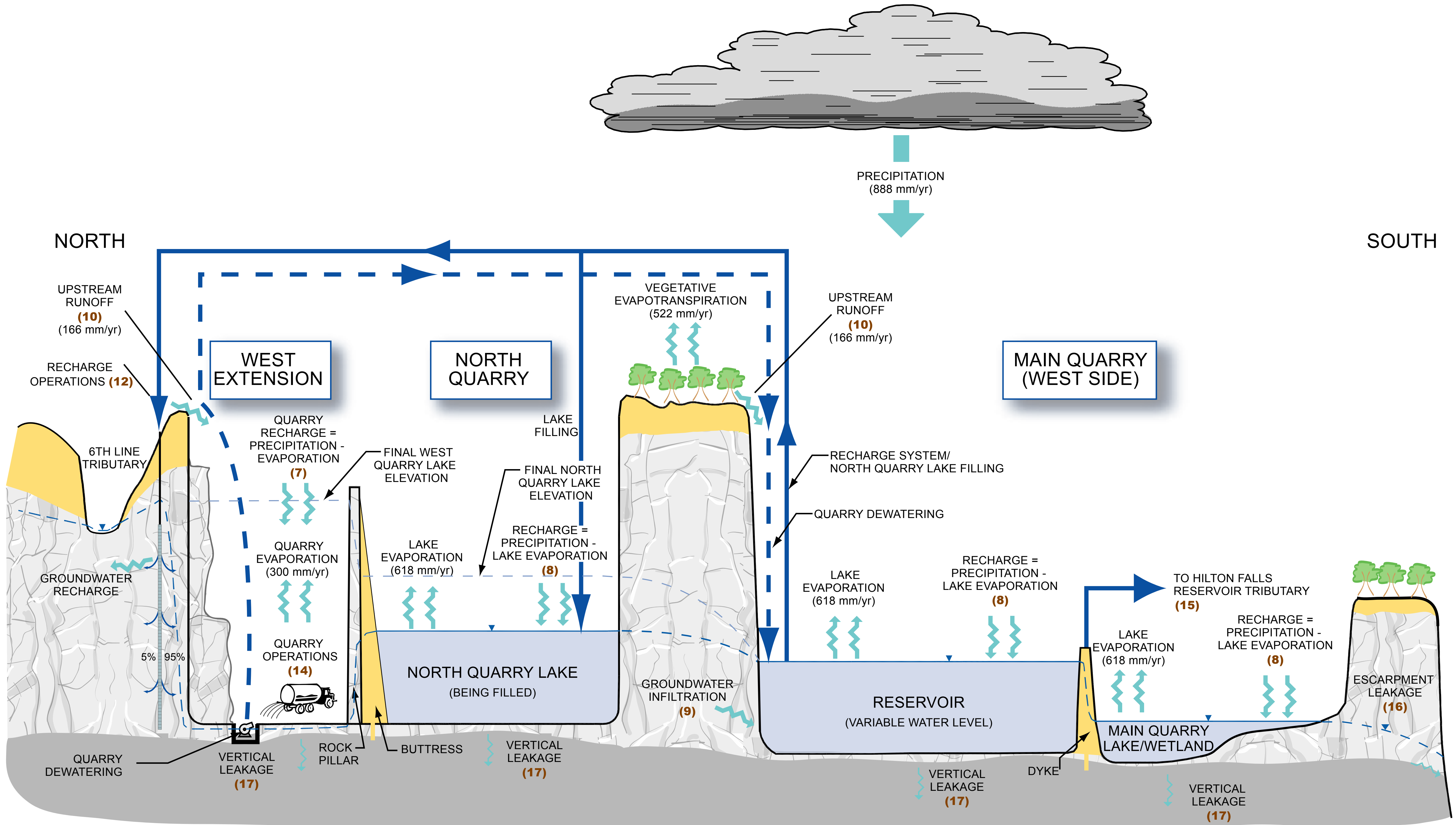
- Information normally provided in the annual report;
- A summary table presenting the observed parameter values over the preceding 5 years;
- The monitoring data collected over the preceding 5 years will be assessed for trends in the parameters to validate the parameters used in the original water budget;
- The water budget parameters will be calibrated and refined based on the observed monitoring data and scientific literature review. The re-calibrated water budget will be used for the subsequent 5-year period. This will include the update and recalibration of the groundwater model, as appropriate;
- Identification of whether any excess water is available;

- Determination of the appropriateness of the safety factor amount, based on the water budget verification results to date, and the progression of quarry activities;
- Potential for future allocation of excess water to various uses;
- Future predictions for lake filling times as well as verifying/amending HFRT outflow will be discussed;
- Conclusion regarding the future sustainability of the water budget for the near term and long term;
- Any gaps or losses of data will be identified and appropriate data sources and measurement points will be identified to supplement the existing data in the water budget. This includes the potential need for further study to confirm/refine input parameter values; and
- Recommendations to improve operations at the Site to more effectively utilize the available water resources.

Various water budget related analyses will be conducted as determined to be appropriate during monitoring period. The objective of such analysis will be to confirm the validity of parameters at the earliest opportunity when sufficient data is available to do so. These will include conducting local water budget analyses and checks to confirm various aspects of the water budget. For example, local water budget calculations are anticipated for geographic sub-areas including the Lake/Wetland area, the Reservoir, the North Quarry, West, and East Extraction Cells. These local water budget analyses will vary depending upon the situation, available information, and analysis objectives and relevant results would be reported in the applicable annual monitoring report or 5-year review report. As additional data is collected over time which increases the confidence level in various parameters, the scope and frequency of such analysis would be modified as appropriate.

As an example an analysis of the Lake/Wetland area to assess net seepage from the area could be conducted as follows.

- Calculate inflows minus outflows from all other (non-seepage) related pathways.
- Precipitation plus flow from Reservoir minus evaporation/evapotranspiration (and surface outflow to central sump, if any) to calculate net seepage inflow/outflow.
- If net seepage flow is significantly different than water balance calculations, those calculations and/or input parameters will be further reviewed. Further study will be undertaken to characterize and/or quantify seepage if findings indicate such is appropriate/necessary. If warranted, measures would be implemented to reduce the seepage.



LEGEND

- Overburden
- Amabel/Reynales Formation
- Cabot Head Shale

NOTES:
- NOT TO SCALE: VERTICAL AXIS HAS BEEN EXAGGERATED BY FACTOR OF 25 IN ORDER TO SHOW THE VARIOUS FEATURES
- APPROXIMATELY BASED ON FIGURE 4.2 OF MAY 2000 CRA WATER RESOURCES ASSESSMENT REPORT
- (7) NUMBERS REFER TO NOTES ON TABLE E.2

figure E.1

WATER BUDGET SCHEMATIC
MILTON QUARRY EXTENSION - AMP
Region of Halton, Ontario

010978-68_fg_water-budget-schematic_v03.ai / 05.03

TABLE E.1

WATER BUDGET FORMULATION
DUFFERIN MILTON QUARRY - AMP
REGION OF HALTON, ONTARIO

The following summarizes the formulation of the water budget calculations documented in Appendix E of the Water Resources Assessment Report (CRA, May 2000, as revised April 2001). Refer to Figure E.1 and Table E.2.

Cumulative Available Water Volume, $Q_{20} = Q_{20\ \text{from previous year}} + Q_{19}$

Q_{19} = **Annual available surplus volume or flow of water**
Q_{19} = Q_{18} – Safety Factor
Q_{18} = $Q_{inflows} - Q_{outflows}$

Therefore:

Q_{19} = **$(Q_7 + Q_8 + Q_9 + Q_{10}) - (Q_{12}+Q_{13}+Q_{14}+Q_{15}+Q_{16}+Q_{17})$ – Safety Factor (500,000 m^3/yr)**

Notes:

- Cumulative Available Water Volume represents that volume of water that is available in storage (or has been released downstream over and above the committed 700,000 m^3/yr discharge in the event that storage was not available).
- Q_{19} refers to the flow or annual volume represented by column 19 of Table E.2 and on Figure E.1.

Inflows:

Q_7 = **Dry Quarry Recharge**
= Dry Quarry Floor Area X (Precipitation – Dry Quarry Floor Evaporation)

Q_8 = **Lake Quarry Recharge**
= Lake Area X (Precipitation – Lake Evaporation)

Q_9 = **Groundwater Inflow to Quarry** (flow value from groundwater flow model – combination of natural plus recharge recirculation). Includes net inflows from Main Quarry, North Quarry, and Extension Quarry (i.e., total inflow minus total outflow seepage). Present values estimated using groundwater flow model but will be confirmed by measurements in future.

Q_{10} = **Upstream Runoff**
= Upstream Area X (Precipitation – Evapotranspiration - Infiltration to Groundwater)

TABLE E.1

WATER BUDGET FORMULATION
DUFFERIN MILTON QUARRY - AMP
REGION OF HALTON, ONTARIO

Outflows:

Q_{12} = **Recharge System Flow** (includes flow that re-circulates back to quarry through groundwater). Includes North Quarry and Extension Quarry Flows. Present values from groundwater model but will be measured in future.

Q_{13} = **Main Quarry Recharge System Flow** (includes flow that re-circulates back to quarry through groundwater). Represents flow from contingency Main Quarry recharge system if implemented. Present values from groundwater model but will be measured in future.

Q_{14} = **Quarry Operations Water Use** (Dust Control and Aggregate Washing). Present values estimated but will be measured in future.

Q_{15} = **Outflow to HFRT.** Value will be measured.

Q_{16} = **Escarpment Leakage.** Present value is an approximation of potential increased leakage and will be confirmed in future if data indicates significantly higher.

Q_{17} = **Vertical Leakage.** Present value is an approximation of potential vertical leakage to lower units and will be confirmed in future if data indicates significantly higher.

TABLE E.2

UPDATED EXTENSION QUARRY WATER BUDGET
MILTON QUARRY EXTENSION - 700,000 m3/YR TO HFRT
REGION OF HALTON, ONTARIO

Note: This water budget update was completed to reflect the current rehabilitation timelines for the Main Quarry and current estimates of the water storage volumes.

Estimated Timeline				*Areas*						*Inflows*				*Outflows*							
Start Time	*End Time*		*(1) Event at End of Increment*	*(2) Total Quarried Area (m^2)*	*(3) Area of No-Flow Cells (m^2)*	*Lake Being Filled*	*(4) Approx. Lake Area (m^2)*	*(5) Dry Quarry Floor Area (m^2)*	*(6) Approx. Upstream Area (m^2)*	*(7) Dry Quarry Recharge (m^3/yr)*	*(8) Quarry Recharge (m^3/yr)*	*(9) Groundwater Inflow (m^3/yr)*	*(10) Upstream Runoff (m^3/yr)*	*(12) Recharge System (m^3/yr)*	*(13) Main Quarry Recharge (m^3/yr)*	*(14) Quarry Operations (m^3/yr)*	*(15) Outflow to HFRT (m^3/yr)*	*(16) Escarpment Leakage (m^3/yr)*	*(17) Vertical Leakage (m^3)*	*(18) Available Annual (m^3)*	*(19) Cumulative (m^3)*
2005.0	2006.0	1.0	Main Quarry completed	3,397,100	3,073,500	MQ Wetland	840,000	2,557,100	1,245,818	1,454,858	210,797	1,068,743	206,806	0	736,088	125,000	700,000	244,300	19,998	615,817	615,817
2006.0	2006.2	1.2	Mine North Quarry	3,422,350	3,095,381	MQ Wetland	840,000	2,582,350	1,477,233	1,469,079	210,749	1,188,754	245,221	127,252	736,088	240,000	700,000	244,300	20,117	546,046	710,829
2006.2	2008.0	3.0		3,687,333	3,325,000	MQ Reservoir	1,720,000	1,967,333	1,477,233	1,118,128	430,597	2,448,182	245,221	1,462,666	736,088	240,000	700,000	244,300	25,586	333,487	1,319,776
2008.0	2009.0	4.0		3,832,450	3,450,750	MQ Reservoir	1,720,000	2,112,450	1,477,233	1,200,042	430,139	3,137,902	245,221	2,193,999	736,088	240,000	700,000	244,300	26,269	372,647	1,692,423
2009.0	2010.0	5.0		3,977,567	3,576,500	MQ Reservoir	1,720,000	2,257,567	1,477,233	1,281,922	429,714	3,827,621	245,221	2,925,332	736,088	240,000	700,000	244,300	26,951	411,807	2,104,230
2010.0	2011.0	6.0		4,122,683	3,702,250	MQ Reservoir	1,720,000	2,402,683	1,477,233	1,363,772	429,319	4,517,341	245,221	3,656,665	736,088	240,000	700,000	244,300	27,633	450,966	2,555,196
2011.0	2012.0	7.0	Finish NQ&West Mining	4,267,800	3,828,000	MQ Reservoir	1,720,000	2,547,800	1,477,233	1,445,596	428,951	5,207,060	245,221	4,387,998	736,088	240,000	700,000	244,300	28,315	490,126	3,045,322
2012.0	2013.0	8.0	Mine East Extension	4,333,417	3,874,783	MQ Reservoir	1,720,000	2,613,417	1,290,603	1,481,370	427,992	5,479,250	214,240	4,666,434	736,088	240,000	700,000	244,300	28,623	487,408	3,532,730
2013.0	2014.0	9.0		4,399,033	3,921,567	MQ Reservoir	1,720,000	2,679,033	1,290,603	1,517,116	427,063	5,751,441	214,240	4,944,869	736,088	240,000	700,000	244,300	28,931	515,670	4,048,400
2014.0	2015.2	10.2		4,475,529	3,976,107	MQ Reservoir	1,720,000	2,755,529	1,290,603	1,558,754	426,013	6,068,760	214,240	5,269,469	736,088	240,000	700,000	244,300	29,291	548,618	4,687,980
2015.2	2017.0	12.0		4,595,883	4,061,917	North Quarry	2,377,000	2,218,883	1,290,603	1,253,144	586,556	6,568,012	214,240	5,780,176	736,088	240,000	700,000	244,300	33,010	388,378	5,400,342
2017.0	2018.0	13.0	All Quarry Areas Mined	4,661,500	4,108,700	North Quarry	2,377,000	2,284,500	1,359,157	1,289,103	585,413	6,840,202	225,620	6,058,611	736,088	240,000	700,000	244,300	33,319	428,020	5,828,362
Rehabilitation Case (11)																					
2062			All lakes full, east Main Quarry vegetated	4,661,500	3,073,500	MQ Reservoir	1,720,000	1,677,100	1,359,157	581,867	431,631	1,337,483	225,620	355,678	725,341	0	700,000	244,300	36,234	15,048	28,250,194

Notes:

(1) Actual timings are subject to change pending finalization of Site Plans.
(2) Refers to total extracted area of quarry. Linear interpolation applied between simulations.
(3) Total area of no-flow cells in groundwater model i.e., area which does not account for precipitation recharge. Linear interpolation applied between simulations.
(4) Cumulative area that is developed into lakes/wetlands (excluded from groundwater model).
(5) Area that is dry. Dry Quarry Floor Area = Total Quarried Area - Approx Lake Area.
(6) Upstream drainage area which contributes runoff into quarries; does not include portions of upstream quarries which will be retained when excavated.
(7) Precipitation recharge over (5) based on a recharge rate of 0.588 m/year for operation case and 0.366 m/year for rehabilitation case. minus 200 mm/yr correction for portion of difference between (2) and (3). Dry Quarry recharge rate of 0.588 m/year is based on 0.888 m/year of precipitation minus 0.300 m/year of dry quarry floor evaporation. Under rehabilitation conditions the recharge rate is 0.366 m/year based on 0.888 m/year of precipitation minus 0.522 m/year of natural evapotranspiration.
(8) Precipitation recharge over (4) based on a recharge rate of 0.270 m/year (i.e., 0.888 m/year precipitation - 0.618 m/year lake evaporation) minus 0.200 m/year correction for portion of difference between (2) and (3).
(9) Simulated groundwater inflow into quarry area(s). Includes flow from recharge system. Linear interpolation applied between simulations. Rehabilitation Case includes pond surplus/augmentation flows required to maintain final water level in the lakes.
(10) Runoff from upstream drainage area into open quarry based on effective precipitation runoff of 0.166 m/year.
(11) For the Rehabilitation Case, dry quarry recharge, and lake quarry recharge represent the Main Quarry only. The North Quarry and Extension lands recharge are included in the groundwater model. i.e. no longer no-flow cells.
(12) Simulated recharge system flows. Includes recirculation from recharge system to quarry face. Linear interpolation between simulatior
(13) Recharge system flow for complete extraction of Main Quarry, if required.
(14) Quarry operations water consumption for expansion, including dust control and aggregate washing.
(15) Main Quarry discharge requirement to Hilton Falls Reservoir Tributary (700,000m^3/yr).
(16) Horizontal leakage from quarry face. From Dames & Moore, 1998.
(17) Vertical leakage from quarry areas. Based on a leakage rate of 4.7 mm/yr for dry areas and 9.5 mm/yr for lakes.
(18) Available Annual Surplus = Total Inflow - Total Outflows - 500,000 m^3/year safety factor in consideration of potential variability in actual climactic and hydrogeological conditions. Calculated per year not per time increment.
(19) Cumulative surplus is stored in lakes and, if no storage is available, discharged to stream.
(20) Lake filling volumes estimated from available topographic information (December 2003):

Area	Volume (m^3)	Elevation (m amsl)	
Main Quarry Lake/Wetland	710,000	302.5	
Reservoir	3,977,000	306	(total of 5,100,000 m^3 to 309 m amsl)
North Quarry Lake	9,839,000	318.5	
West Extension Lake	3,965,000	326	
East Extension Lake	9,545,000	333	

TABLE E.3

SUMMARY OF MONITORING LOCATIONS AND DATA TO BE COLLECTED
DUFFERIN MILTON QUARRY EXTENSION
REGION OF HALTON, ONTARIO

Location	***Data Collected***
Sump / Transfer Pump Stations	Metered Flow to Reservoir
Recharge Pump Station	Metered Flow to Recharge System Metered Flow to Quarry Operations Reservoir Level
Reservoir Outfall Structure	Metered Flow to HFRT Metered Flow to Lake / Wetland Lake / Wetland Level
On-Site Weather Station	Precipitation Evaporation Ambient Air Temperature Barometric Pressure
Central Pump Station	Metered Flow Into Reservoir Metered Flow Out Of Reservoir Sump Level

Note:

All metered flow data, meteorological data, water level data identified above will be collected on a continuous basis using electronic loggers.

APPENDIX F

RESPONSE TIME AGGREGATION PROCEDURE

APPENDIX F

RESPONSE TIME AGGREGATION PROCEDURE

The following procedure defines criteria for temporarily reducing the response action timeline. This procedure is further to the temporary reduction of response action timelines described in Section 1.3 (Response Action Chart item e and Figure 1.9) and Section 6.1 (overall performance evaluation item 1) of the AMP. The procedure is for the aggregation of time periods for an affected trigger well.

1. This procedure applies to the affected trigger well following an "incident" (refer to Section 1.3) or if determined to be appropriate through the analysis described in Section 6.1 of the AMP.

2. Aggregation only applies during active bedrock extraction in the affected area (i.e. not during a cease extraction period) and when the operating response period (Section 1.3, Yellow/Red Zone, item e) is 8 weeks.

3. Time periods are aggregated when either:
   - the water level is below the target level for more than 1 week; or
   - the water level is below the midpoint.

4. Time periods are aggregated within the applicable period for a maximum of 12 months.

5. If a total period of 8 weeks below the target level at the affected trigger well is aggregated, the operating response periods will be reduced for items d and e (of Section 1.3 of the AMP, Yellow/Red Zone) from 4 and 8 weeks, to 2 and 4 weeks, respectively for the same affected trigger well.

6. The aggregated time is reset to zero by one of the following means:
   - when the operating response period (Section 1.3, Yellow/Red Zone, item e) is reset from 4 weeks to 8 weeks; or
   - following an appropriate period during which there is no requirement for notification to the agencies for the affected trigger well. This period will be initially established as 3 months based on the expectation that quarry progression and mitigation conditions would have sufficiently changed over this time to represent a different operating condition. The reset period and basis may be reviewed in the future based on available performance monitoring data.

7. The aggregation requirement described above will apply until such a time as it is demonstrated to not be necessary based on the analysis described in Section 6.1 (overall performance evaluation item 1). The rationale for removing the aggregation requirement for a particular well will be documented in the annual report.

APPENDIX G

TRACER TEST PROTOCOL

APPENDIX G

TRACER TEST PROTOCOL
DUFFERIN MILTON QUARRY

BACKGROUND

The Milton Quarry Extension includes the installation and operation of a groundwater recharge well system to maintain groundwater levels around the quarry to mitigate the dewatering effects of the Extension Quarry. The recharge system relies on a series of recharge wells injecting water into the bedrock system and thereby maintaining surrounding water levels as measured and evaluated at a series of trigger monitoring wells and other adjacent monitoring wells.

Prior to extraction in the Phase 2 quarry area, the recharge well system must be installed and demonstrated to work by showing a positive correlation between recharge wells and specific trigger and recharge monitoring wells - i.e., show that each trigger well or recharge monitoring well water level can be raised by injection of water into one or more recharge wells [refer to the Demonstration Procedure (Pre-Extraction) – Flowchart A (refer to Section 1.3 of the AMP)].

In the event that such a correlation is not evident for a particular monitoring well, or if a corresponding situation is encountered in the Annual Verification and/or Operation Verification Procedures (refer to Section 1.3 of the AMP), further analysis and/or recharge system adjustments are required in accordance with the AMP. If there is no observable point of surface discharge of water, then this situation may be a logical and beneficial opportunity to apply a tracer test. The Tracer Test would assist in identifying any preferential groundwater flow pathways between the recharge well(s) and a point of groundwater discharge by illustrating the location of the discharge feature linked to the recharge well(s). Identification of the discharge location for a particular recharge well with a preferential flow pathway would assist in planning and implementing appropriate Response and/or Contingency Actions in accordance with the AMP.

PURPOSE

The purpose of the tracer test is to assist in identifying the discharge location of recharge water that does not affect trigger or recharge monitoring well groundwater levels in the expected manner and/or location.

TRACER TEST PROGRAM

In the event that the need is identified to apply a tracer test for the purpose described above, the following program shall be implemented. The program may be refined as necessary and appropriate by the qualified person responsible for the test based on the conditions at the time of the test.

1. The agencies will be notified in advance[1] by email message (or alternate means) that a tracer test is going to be conducted.
2. One or more relevant Recharge Wells will be identified to use for conducting the test.
3. One or more relevant monitoring or trigger wells will be identified for monitoring during the test.
4. Potential discharge areas or locations to be monitored will be identified. For example, this includes specific wetland, seep or spring locations, specific locations in Sixth Line Tributary, and/or nearby locations in the quarry excavation.
5. If operating domestic wells may be affected, the potentially affected well users will be notified, a monitoring program established, and alternate water supply arranged for the duration of the testing program plus additional time to allow for dissipation of the tracer as necessary. At the present time, only one domestic well within the potentially affected area (Study Area) is in use that is not owned by Dufferin. Other Dufferin owned wells may remain in use. Suitable precautions will be implemented for all potentially affected wells.
6. The parameters of the test will be established based on the specific conditions being evaluated and past experience from previous testing or recharge system operation. Key parameters include:
    a) Tracer types(s) – select tracer/dye based on current best practice and regulatory guidance available at the time of testing. More than one tracer may be employed for multiple recharge tests in a local area or tests involving more than one recharge well.
    b) Volume and duration of tracer injection – selected based on test configuration.
    c) Duration of post injection monitoring period – selected based on recharge operating and other tracer test experience.
    d) Protection of any potentially affected domestic well water supplies. This may include, as appropriate, provision of a suitable alternate potable water supply during the testing period and sampling to ensure the tracer (if any) has dissipated in the domestic supply well prior to resumption of use of the well.
7. Set up temporary system for introduction of the tracer into a recharge well (e.g., introduction and mixing of tracer directly into water feed line to the well).
8. Conduct injection of tracer into recharge well(s).
9. Conduct monitoring for tracer at identified monitoring locations.
10. Analyze results of tracer test, including the location, level, and duration of tracer detection (or absence) at monitoring locations.
11. Advise any potentially affected domestic well users when the test and any potential effects on their well are complete.
12. Document the results for inclusion in Pre-Extraction Report or Annual Monitoring Report, as appropriate.
13. Conduct follow-up activities such as implementation of Response or Contingency Actions where appropriate.

---

[1] Advance notice will normally be a minimum of 48 hours unless such notice is not possible for the prudent operation of the water management system.

APPENDIX H

AMP UPDATE CHRONOLOGY

APPENDIX H

AMP UPDATE CHRONOLOGY
MILTON QUARRY EXTENSION
REGION OF HALTON, ONTARIO

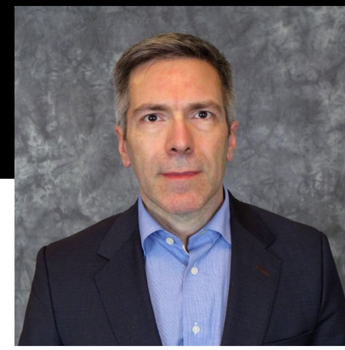
Date	*Title*	*Authors*	*Approval*	*Revisions*
August 2001	Adaptive Environmental Management and Protection Plan (AMP) Water Resources and Related Ecological Features	CRA in association with Ecoplans	--	--
May 2003	Updated Adaptive Environmental Management and Protection Plan (AMP) Water Resources and Related Ecological Features	CRA in association with Ecoplans Limited and Goodban Ecological Consulting	Conditional Approval from Ontario Municipal Board	Revisions to obtain agreement with Agencies
July 2011	Updated Adaptive Environmental Management and Protection Plan (AMP) Water Resources and Related Ecological Features	CRA in association with Ecoplans Limited and Goodban Ecological Consulting	--	Integration of Joint Board and Cabinet conditions and requests from Region and CH

Appendix B
Curriculum Vitae

A GHD Principal

J. Richard Murphy M.A.Sc., B.A.Sc.

Engineer, Hydrogeologist
Operations Manager



Location

Waterloo, Ontario, Canada

Experience

30 years

Qualifications/Accreditations

- 1991, M.A.Sc., Civil Engineering (Water Resources)
- 1989, B.A.Sc., Systems Design Engineering

Key technical skills

- Hydrogeology and Water Resources
- Contaminated Site Assessment and Remediation
- Aggregate Resource Development

Memberships

- Professional Engineers of Ontario (PEO)
- National Groundwater Association (NGWA)
- Ontario Stone Sand & Gravel Association (OSSGA)

Relevant experience summary

Mr. Murphy is a professional engineer specializing in hydrogeology and water resources evaluation and design.

Mr. Murphy's project experience over three decades includes contaminated site assessment and remediation, numerical and analytical modeling, aggregate resource development, landfills, and water supply; working in both overburden and bedrock environments.

Mr. Murphy capably manages/executes all project aspects ranging from technical evaluations, project management, strategic planning, agency and public consultation, to providing expert witness evidence.

Mr. Murphy is also the Operations Manager for GHD Ontario Property and Environment Markets.

Aggregate Resources Development Services

Mr. Murphy has been responsible for the evaluation of water resources, hydrogeology, and environmental management matters pertaining to aggregate resource development. The scope of work has included site investigation, impact assessment, water management design and engineering for dewatering and mitigation systems, stakeholder consultation and approvals, expert witness testimony, and implementation of approved systems. Representative projects include:

- Armbro Pinchin Aggregate Pit, Town of Caledon, Ontario
- Dufferin Milton Quarry, Regional of Halton, Ontario
- Dufferin Acton Quarry, Regional of Halton, Ontario
- Dufferin Flamboro Quarry, City of Hamilton, Ontario
- Dufferin Paris Pit, Paris, Ontario
- Dufferin Cedar Creek Pit, Cambridge, Ontario
- Dufferin Bark Lake Quarry, Haliburton, Ontario
- Caledon Sand and Gravel Inc. Pit, Town of Caledon, Ontario
- Proposed Rockfort Quarry, Town of Caledon, Ontario
- Armbro Esker Lake Pit, Brampton, Ontario
- Lafarge Ravena Plant and Quarry, Albany County, New York
- Lafarge Woodstock Plant and Quarry, Ontario
- Lafarge Joppa Plant and Quarry, Illinois
- Nelson Quarry, Burlington, Ontario
- Penny's Lawrence Pit, Douglas County, Kansas
- River Valley Developments Dolime Quarry, Guelph, Ontario

Remedial Investigation/Feasibility Studies

Mr. Murphy has been responsible for evaluating hydrogeologic conditions for a number of Remedial Investigation/Feasibility Studies. Duties included hydrogeologic characterization, planning of supplemental investigations, calculation of groundwater flow and contaminant migration rates, prediction of required pumping rates and durations for potential remedial alternatives and recommendation of hydrogeologically suitable remedial alternatives. Evaluation techniques involved both analytical and

T +1 519 340-4314 | **E** richard.murphy@ghd.com

numerical simulation techniques. Representative projects are listed below:

- Novak Farm Site, Chenango County, New York
- Former Hart Chemical, Guelph, Ontario
- Bristol Aerospace, Winnipeg, Manitoba
- Phelps Dodge Landfill Remediation, Maspeth, New York
- VacAir Alloys Division, Frewsburg, New York
- Fons and Old Wayne Landfills, Ypsilanti Township, Michigan
- Textile Road Site, Ypsilanti Township, Michigan
- Pristine Site, Reading, Ohio
- Henkel Site, Hamilton, Ontario
- Sealand Restoration Site, Lisbon, New York

Remedial Design/Remedial Actions

Mr. Murphy has been responsible for the design of groundwater and soil remediation systems. Duties have included hydrogeologic characterization, planning of supplemental investigations, determination of suitable cleanup objectives, specification of the locations and flow rates for groundwater extraction systems, prediction of performance impacts due to design and operational variations. Evaluation techniques have involved both analytical and numerical simulation methods.

Representative projects are listed below:

- Summit National Superfund Site, Deerfield, Ohio
- Spiegelberg Site, Livingston County, Michigan
- Hyde Park Landfill, Niagara Falls, New York
- Buffalo Avenue Plant, Niagara Falls, New York
- S-Area Site, Niagara Falls, New York
- Former Hart Chemical, Guelph, Ontario
- Former Uniroyal Chemical, Elmira, Ontario
- G&H Landfill, Macomb County, Michigan
- Pfohl Brothers Landfill, Cheektowaga, New York
- Libbey Glass, Toledo, Ohio
- Caterpillar, East Peoria, Illinois
- Miami County Incinerator Site, Miami County, Ohio
- Fisher Calo Site, Kingsbury, Indiana
- Rockaway Borough Well Field Site, Rockaway Borough, New Jersey
- Schenectady International, Inc. Site, Rotterdam Junction, New York
- Hooker/Rucco Site, Hicksville, New York
- Rocky Hill Municipal Well/Montgomery Township Housing Development Superfund Sites, Somerset County, New Jersey
- JIS Landfill, South Brunswick, New Jersey

Water Supply/Wellhead Protection Studies

Mr. Murphy has been responsible for the evaluation of hydrogeologic impacts and wellhead protection areas for municipal and commercial groundwater supplies. Evaluation of techniques employed include numerical steady state and transient groundwater flow and capture zone simulations, vulnerability assessment, and evaluation of studies by others. Representative projects are listed below:

- Waterloo Landfill Site. Confirmation of findings of Erb Street Well Field Evaluation, Region of Waterloo, Ontario
- Sauble Beach Groundwater Supply Study, Township of Ambel, Ontario
- Fisher Calo Site, Kingsbury, Indiana
- Ontario Source Water Protection Projects:
  - Various client site assessments
  - Saugeen/Grey Sauble Vulnerability Study and Threats Assessment

Solid Waste Management Sites

Mr. Murphy has been responsible for planning and carrying out water quality impact assessments for existing and proposed solid waste management sites. Duties included site characterization, contaminant migration simulation, impact prediction, and recommendations for engineered systems. Simulation techniques range from analytical models to numerical models involving unsaturated and multidimensional solution domains. Representative projects are listed below:

- Waterloo Landfill, Waterloo, Ontario
- Keele Valley Landfill, Toronto, Ontario
- St. Marys Landfill, St. Marys, Ontario
- Valentine Road Landfill, Kincardine, Ontario
- Mid Huron Landfill, Goderich, Ontario
- Greenlane Landfill, Southwold, Ontario
- Sarnia Landfill, Sarnia, Ontario
- Cedartown Municipal Landfill, Cedartown, Georgia
- Wauconda Landfill, Chicago, Illinois
- East Bethel Landfill, East Bethel, Minnesota

Other Related Areas of Interest

Recognized (Certifications/Trainings)

- Licensed Professional Engineer: Ontario
- Designated Consulting Engineer: Ontario
- Clayey Barriers for Mitigation of Contaminant Impact, University of Western Ontario, 1992

Expert Testimony

Mr. Murphy has provided expert witness testimony (depositions, Trial, and Hearings) on various aspects of hydrogeology, water resources, site investigation, analysis and remediation, including groundwater flow and contaminant transport issues, water resources, and engineering, for the following projects:

- Royal Oak Site, Royal Oak, Michigan
- Proposed South Quarry Landfill Development, Town of Flamborough, Ontario
- Armbro Pinchin Aggregate Pit Development, Town of Caledon, Ontario
- 217 Fay Avenue, Addison, Illinois
- Rocky Hill Municipal Well/Montgomery Township Housing Development Superfund Sites, Somerset County, New Jersey
- Dufferin Aggregates Milton Quarry Extension, Region of Halton, Ontario
- Proposed Rockfort Quarry Development, Town of Caledon, Ontario
- Proposed Nelson Quarry Extension, Burlington, Ontario
- Halton Regional Official Plan Amendment No. 38, Region of Halton, Ontario
- Dufferin Aggregates Acton Quarry Extension, Town of Halton Hills, Ontario
- Dufferin Paris Pit, Brant County, Ontario

Publications/Presentations

- Protecting Water Resources with a Groundwater Recharge Well System at the Dufferin Aggregates Milton Quarry", International Association of Hydrogeologists Canadian National Conference, October 27 30, 2015 (with W.T. Armes and N. Fitzpatrick).
- "Safeguarding our future" OSSGA, Avenues, Volume 4, Issue 1 (with Brian Zeman).
- "Adaptive Management Plans in Aggregate Resources: A Good Idea and/or The New Normal?", Ontario Stone Sand and Gravel Association Annual General Meeting February 2012 (with D. Hanratty, J. Buhlman, and B. Clarkson).
- "Predicting Redox Dependent Natural Attenuation at the Plattsburgh Air Force Base", The Fifth International Symposium on In Situ and On Site Bioremediation, San Diego, California, April 19 22, 1999 (with G.R. Carey, P.J. Van Geel, E.A. McBean, and F.A. Rovers).
- "Visualizing Natural Attenuation Trends", The Fifth International Symposium on In Situ and On Site Bioremediation, San Diego, California, April 19 22, 1999 (with G.R. Carey, P.J. Van Geel, E.A. McBean, and F.A. Rovers).
- "BIOREDOX MT3DMS: A Coupled Biodegradation Redox Model for Simulating Natural and Enhanced Bioremediation of Organic Pollutants V2.0 User's Guide and Verification Manual", Conestoga Rovers & Associates, Waterloo, Ontario, Canada, 1999 (with G.R. Carey and P.J. Van Geel).
- "Coupled Biodegradation Redox Modeling to Simulate Natural Attenuation Processes at the Plattsburgh Air Force Base (New York)", MODFLOW'98, Golden, Colorado, October 5 7, 1998 (with G.R. Carey, P.J. Van Geel, E.A. McBean, and F.A. Rovers).
- "An Efficient Screening Approach for Modeling Natural Attenuation", MODFLOW'98, Golden, Colorado, October 6 8, 1998 (with G.R. Carey, P.J. Van Geel, and E.A. McBean).
- "Full Scale Field Application of a Coupled Biodegradation Redox Model (BIOREDOX)", First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, May 18 21, 1998, Monterey, California (with G.R. Carey, P.J. Van Geel, E.A. McBean, and F.A. Rovers).
- “Application of an Innovative Visualization Method for Demonstrating Intrinsic Remediation at a Landfill Superfund Site", Petroleum Hydrocarbons & Organic Chemicals in Ground Water Conference, American Petroleum Institute and National Ground Water Association, Houston, TX, November 1996 (with G.R. Carey, M.G. Mateyk, G.T. Turchan, E.A. McBean, and F.A. Rovers).
- "Two Phase Flow in a Variable Aperture Fracture", Water Resources Research, Vol. 29, No. 10, October 1993 (with N.R. Thomson).

Career history

2018 - present	GHD, Operations Manager
1991 - present	GHD, Principal
1990	J.F. Sykes & Associates Limited
1990	Neil Thomson Engineering Services
1989 - 1991	University of Waterloo, Teaching Assistant
1988 - 1989	GHD

Kyle Fritz B.A.Sc.

Engineer, Hydrogeologist

Location

Waterloo, Ontario, Canada

Experience

10 years

Qualifications/Accreditations

– B.A.Sc., Honors Civil Engineering, Water Resources Option, 2013

Key technical skills

– Hydrogeology and Water Resources
– Contaminated Sites Assessment and Remediation
– Aggregate Resource Development

Memberships

– Professional Engineers of Ontario (PEO)

Relevant experience summary

Mr. Fritz is a professional engineer specializing in hydrogeology and water resources evaluation and design. Project experience includes hydrogeologic investigation and assessment, water resource evaluation, numerical modelling, water management design and implementation, and bedrock grouting. Mr. Fritz has a good grasp on environmental science including the interactive relationships of meteorology, hydrology, hydrogeology, and geology. Mr. Fritz has dealt with water management and resource conservation on numerous projects and has a strong understanding of both the quality and the quantity of water in above and below ground resources. In addition to this experience, Mr. Fritz participates in strategic planning and agency and public consultation.

Milton Quarry

Project Manager |
Dufferin Aggregates | Region of Halton, Ontario, Canada | May 2009 - Current

Responsible for providing or coordinating engineering, hydrogeology, water managements operations, and compliance services to Dufferin Aggregates, a division of CRH (Canada) Inc., at their Milton quarry in the Region of Halton, Ontario.

GHD operates the water management (mitigation) system (WMS), conducts all water related performance and compliance monitoring, and supports the client with consulting assistance for all environment related considerations at this site.

Key roles include:

– Hydrogeologic evaluation and plan development for future WMS improvements
– Development of multi-year CAPEX forecasts based on mine development plans and anticipated hydrogeologic conditions
– Ongoing data evaluation and communication of emerging issues to the client
– Preparation of an annual report in satisfaction of PTTW, ECA, and legal requirements
– Presentation of monitoring results to agencies at the annual meeting

Acton Quarry

Project Manager |
Dufferin Aggregates | Acton, Ontario, Canada | May 2017 - Current

Responsible for providing or coordinating engineering, hydrogeology, operation, and compliance services to Dufferin Aggregates, a division of CRH (Canada) Inc., at their Acton quarry in the Town of Halton Hills, Ontario.

Key roles include:

– Ongoing water management between watersheds, water budgeting, and conservation
– Coordination and review of ECA sampling and PTTW monitoring programs
– Ongoing assessment of compliance in reflection of changing site conditions
– Ongoing and annual evaluation of water resources and associated reporting
– Water management system design and engineering for water handling systems

- Preparation of an annual report in satisfaction of PTTW, ECA, and legal requirements
- Presentation of monitoring results to agencies at the annual meeting

Paris Pit

Project Engineer | Hydrogeologist
Dufferin Aggregates | Paris, Ontario, Canada |
May 2016 - Current

Responsible for providing or coordinating engineering, hydrogeology, operation, and compliance services to Dufferin Aggregates, a division of CRH (Canada) Inc., at their Paris Pit in Paris, Ontario.

Key roles include:

- Coordination and review of ECA sampling and PTTW monitoring programs
- Ongoing review of conditions to ensure compliance with environmental “triggers”
- Hydrogeologic evaluation of pumping effects on bedrock and overburden aquifers used for municipal water supply

Guelph Dolime

Project Engineer | Hydrogeologist
River Valley Developments Inc. | Guelph, Ontario |
May 2013 - Current

Worked closely with stakeholders to develop long-term closure and rehabilitation plans.

- Involved a substantial evaluation of wellfield pumping effects from a multi-aquifer municipal water supply system
- All borehole logs, water levels, and pumping records for the southwest quadrant were reviewed during the evaluation
- Numerical modelling was undertaken for assessment of current and future proposed conditions

Beardmore Tannery

Project Manager |
Maple Leaf Foods | Acton, Ontario, Canada |
May 2013 - Current

Ongoing management and coordination of a multi disciplinary team conducting environmental monitoring. Completion of data evaluation, program review, and reporting in satisfaction of the environmental compliance approval (ECA) for the site.

- Coordination and review of the environmental monitoring program and management of a multi-disciplinary team.
- Ongoing review and evaluation of groundwater, surface water, and landfill gas monitoring results.
- Monitoring and assessment of drawdown associated with adjacent construction dewatering (pumping) in an overburden aquifer.
- Preparation and submission of environmental monitoring reports in satisfaction of the ECA requirements.

Career history

2013 - present	GHD
2009 – 2012	GHD (Engineering Work Terms)

Goodban Ecological Consulting Inc.

ANTHONY G. GOODBAN, B.Sc., M.E.S.(Pl.), MCIP, RPP
879 Cabot Trail, Milton, Ontario L9T 3W4
E-mail: anthony.goodban@sympatico.ca
Phone: (905) 693-9064

Consulting Services in Field Botany, Ecology and Natural Heritage Planning

EDUCATION

1995 M.E.S.(Planning), Environmental Planning, York University, North York, Ontario

1992 Honours B.Sc., Ecology, University of Guelph, Guelph, Ontario

PROFESSIONAL ASSOCIATIONS

Ontario Professional Planners Institute - Full Member
Canadian Institute of Planners - Full Member

PROFESSIONAL TRAINING

2017 Completed the 3-day *Ontario Reptile & Amphibian Field Survey Course* presented by Blazing Star Environmental, NRSI, Ontario Ministry of Natural Resources and Forestry (MNRF). The course was held on Beausoleil Island in Georgian Bay.

2014 Completed the 2-day RX-100 *Low Complexity Prescribed Burn (LCPB) Worker Course* provided by Tallgrass Ontario in Bloomingdale, Ontario.

2013 Completed the Trees Ontario 2-day *Ontario Tree Seed Collector Training Course* in Angus, Ontario.

2013 Completed the Ministry of Natural Resources and Forestry (MNRF) Butternut Health Assessment "Refresher" Training at the Royal Botanical Gardens (RBG), Burlington, Ontario.

2009 Completed the MNRF *Butternut Health Assessment Workshop* at the Royal Botanical Gardens, Burlington, Ontario.

2008 Completed the MNRF 5-day training course in the use of the *Ecological Land Classification System for Southern Ontario* (ELC) at Ball's Falls Conservation Area, Jordan, Ontario.

1994 Completed the MNRF 5-day training course in the use of the *Ontario Wetlands Evaluation System: Southern Manual* (Third Edition) in Tweed, Ontario.

PROFESSIONAL EXPERIENCE

1999-Present	Consulting Ecologist and Natural Heritage Planner, Goodban Ecological Consulting Inc.
1992-1998	Ecologist and Natural Heritage Planner, Ecoplans Limited
1991-1992	Botanist and Ecologist, Hamilton-Wentworth Natural Areas Inventory Project
1990	Field Botanist, Hamilton Region Conservation Authority and Hamilton Naturalists' Club

PROFILE

Mr. Anthony Goodban's academic background is in botany, ecology and environmental planning at the undergraduate and graduate level and he has over 30 years of field and professional experience. He has expert knowledge of the vegetation and flora of southern Ontario, being especially familiar with the flora of the Hamilton and Halton Region. Mr. Goodban has been the principal of Goodban Ecological Consulting Inc. since 1999 and he works either as an independent consultant or as a subconsultant to other firms. Past and present clients include other consulting firms, aggregate companies, developers, municipalities, conservation authorities, provincial ministries, naturalist clubs and private citizens. Mr. Goodban has worked on a broad variety of projects involving species at risk, including many different plant and wildlife species. He often undertakes detailed field ecological field surveys for a wide range of projects, including Official Plan updates, aggregate applications, land development projects, park planning exercises, natural areas inventories, restoration and monitoring projects. Mr. Goodban has worked on many wetland projects, including wetland evaluations, boundary delineations, impact assessments and monitoring programs. He provides project input relating to planning matters such as the natural heritage components of the Provincial Policy Statement, Greenbelt Plan and the Endangered Species Act, and has prepared numerous environmental impact statements for a wide variety of development proposals. Mr. Goodban prepared and updated the Flora of Hamilton, in association with the Hamilton Conservation Authority. He has expertise dealing with rare vegetation communities, including alvars and prairies, and has written several papers and reports on prairie and savanna vegetation in the Hamilton and Halton areas. He is certified to complete wetland evaluations under the *Ontario Wetland Evaluation System: Southern Manual (3rd Edition)* and to use the *Ecological Land Classification System for Southern Ontario* (ELC). Mr. Goodban has appeared as an expert witness before the Ontario Municipal Board and the Joint Board.

PROJECT EXPERIENCE

Species at Risk

- Mr. Goodban has worked on many projects involving Threatened and Endangered Species in recent years. Projects dealing with wildlife species include Jefferson Salamander, Butler's Garter Snake, Eastern Fox Snake, Gray Rat Snake, Bank Swallow, Barn Swallow, Bobolink, Chimney Swift and Eastern Meadowlark. Projects dealing with plant species include American Chestnut, American Columbo, American Ginseng, Butternut, Flowering Dogwood and Kentucky Coffee-tree.

- Mr. Goodban has completed a series of detailed studies of the Endangered Jefferson Salamander and its habitats. Work has included detailed monitoring of six breeding pools from 2004 to the present (including frog call surveys, egg mass surveys, fixed-point photography, water temperature, vegetation, etc), egg mass surveys of 30+ breeding pools in Halton, Hamilton, Peel, Waterloo and Wellington, spring migration studies with drift fencing and pitfall traps, larval surveys in breeding pools, etc. In 2014, Mr. Goodban began monitoring almost 1 km of drift fence and 60+ pitfall traps set up to capture salamanders migrating to breeding pools in the early spring.

- Mr. Goodban is a certified Ontario Butternut Health Assessor (BHA) who has completed many Butternut Health Assessments in recent years. In 2014 he assessed 27 Butternut trees on the Oro Moraine, of which 6 were retainable (Category 2) trees, and 6 Butternut trees on the Niagara Escarpment in Halton Hills which were all non-retainable (Category 1). Mr. Goodban has also overseen compensatory Butternut planting programs required by *Endangered Species Act* Stewardship Agreements and through the registry process allowed under O.Reg 242/08.

Resource Management - Watersheds and Natural Heritage System Planning

- Responsible for the development of Natural Heritage Systems for the Sixteen Mile Creek watershed, Township of Oro-Medonte and North Oakville.

Resource Management – Wetlands, ANSI's and ESA's

- Responsible for numerous wetland evaluations and impact assessments for a range of development proposals across Ontario, including such wetlands as: Dorchester Swamp, Strasburg Creek Wetland Complex, Forks of the Credit Wetland Complex, Creditview Swamp, Victoria Point Wetland Complex and Halton Escarpment Wetland Complex. Many of these projects required the preparation of environmental impact studies/assessments, often including the detailed review and integration of water resources (hydrogeology, hydrology, stormwater engineering) and ecological (wetlands, fisheries) data.

Resource Management – Wetlands, ANSI's and ESA's (continued)

- Main environmental consultant to the City of Orillia during an OMB hearing that focused on the issue of large-scale development within a Provincially Significant Wetland (Victoria Point Bog).

- Main environmental consultant to local residents in the Town of Essex during a 2002 OMB hearing that examined an 18-hole golf course proposal within a Provincially Significant Wetland (Marshfield Woods).

- Participant in evaluations and impact assessments for development proposals adjacent to Environmentally Sensitive Areas (ESAs) across southern Ontario, including: Sixteen Mile Creek Valley (ESA 16) and Hilton Falls Complex (ESA 25) in Halton Region, Doon Pinnacle Hill (ESPA 35) in Waterloo Region, Major Spink Area (ESA No. 97) in Durham Region and Hayesland Complex (ESA No. 28) in Hamilton.

Transportation Projects

- Participated in the preparation of a number of highway Environmental Assessments, including: the Bradford Bypass, the Leslie Street Extension in Toronto, the Parry Sound and Mactier sections of Highway 69 and Highway 7 from Kitchener to Guelph.

- Participant in Class Environmental Assessments for sensitive river, wetland and valley crossings, including: the northerly and southerly crossings of Twelve Mile Creek in Oakville, the Mountainview Road crossing of Silver Creek in Georgetown and Sixth Line crossing of Sixteen Mile Creek in Milton.

Aggregates

- Participant in multi-disciplinary studies in support of sand and gravel pit license applications, including the Lockyer Brothers pit in Mono Township, Armbro Pinchin Pit in Caledon. Responsible for several MTO wayside permit applications (one quarry and three pits) in eastern Ontario.

- Participant in multi-disciplinary studies in support of limestone/dolostone quarry license applications, including the Tomlinson Brothers quarry in Stittsville, Holmenin quarry near Buckhorn, Dufferin Aggregates' Milton Quarry and Acton Quarry Extensions and James Dick Construction Limited's proposed Rockfort Quarry in Caledon.

- Responsible for the development and implementation of wetland vegetation monitoring programs adjacent to aggregate operations, as components of adaptive management plans (AMP).

- Consulting Botanist/Ecologist to aggregate companies for biodiversity plans, enhancement plans and rehabilitation plans at a number of pits and quarries in southern Ontario.

Vegetation and Flora - Inventory, Management and Monitoring

- Responsible for completing detailed botanical inventories of numerous sites in southern Ontario, including Bronte Creek Provincial Park (Halton), the Red Hill Valley (Hamilton-Wentworth) and the Dundas Valley (Hamilton-Wentworth).

- Consulting botanist and ecologist to Natural Areas Inventory Projects in southern Ontario, including Hamilton (2001-2002; 2010-2014), Halton (2003-2004) and Niagara (2006-2008).

- Developed vegetation management plans and strategies for a number of significant natural areas and communities, including:
    - Ontario Hydro's right-of-way at Bronte Creek Provincial Park (Oakville)
    - prairie and other vegetation at Bronte Creek Provincial Park (Oakville)

- prairie and oak woodland vegetation at Spencer Gorge Wilderness Area (Dundas/Flamborough)
- prairie vegetation at the Ancaster Prairie (Ancaster)
- rare species and significant communities in the Albion Falls - Buttermilk Falls portion of the Red Hill Valley (Hamilton)

RELATED EXPERIENCE AND COMMUNITY INVOLVEMENT

1995 to present

Mr. Goodban is the first author of a research paper on the historical and present extent and floristic composition of prairie and savanna vegetation in the vicinity of Hamilton, Ontario, prepared with the assistance of two other authors (W.D. Bakowsky and B.D. Bricker). This paper was presented at the 23rd Natural Areas, 15th North American Prairie, and Indiana Dunes Ecosystems Conferences held at St. Charles, Illinois, on October 26, 1996. It was published in the Proceedings of the 15th North American Prairie Conference (1999). Mr. Goodban is currently undertaking further research on prairie, savanna and oak woodland vegetation in the western Lake Ontario region of Ontario. He has authored several papers and studies on the prairie and oak woodland vegetation at Bronte Creek Provincial Park.

1995 to 1999

Mr. Goodban was a participant in the **International Alvar Conservation Initiative** or **'Alvar Working Group'**. This was a collaborative project aimed at documenting and protecting alvar sites in the Great Lakes basin. Participants from across eastern North America examined sites in Michigan, New York, Ohio and Ontario. Mr. Goodban's masters level research on alvar vegetation on the Flamborough Plain was integrated into this broader study. He prepared the text for a 24-page full color brochure and poster for the Federation of Ontario Naturalists, as one of the products generated by the Alvar Working Group, entitled *Great Lakes Alvars*. Mr. Goodban has studied alvar vegetation in all of the main alvar regions in Ontario. He has also visited alvar sites in New York and Ohio.

1991 to present

Mr. Goodban has led numerous naturalist and field botanist field trips in southern Ontario on behalf of the Field Botanists of Ontario. He has given presentations on rare vegetation communities (e.g., prairies, alvars) at conferences, meetings and naturalist club events.

1991 to present

Mr. Goodban has worked in collaboration with the Hamilton Region Conservation Authority to document the flora of the City of Hamilton. The first edition of *The Vascular Plant Flora of the Regional Municipality of Hamilton-Wentworth, Ontario,* was produced in 1995. Mr. Goodban prepared a Second Edition of the Flora in 2003 and a Third Edition in 2014, documenting more than 1400 vascular plant taxa in the City of Hamilton.

1995 to 2000

Member of the Regional Municipality of Hamilton-Wentworth's **ENVIRONMENTALLY SIGNIFICANT AREA IMPACT EVALUATION GROUP** (ESAIEG). ESAIEG considers development proposals located within or adjacent to Environmentally Significant Areas (ESAs) and provides advice to planning staff.

1991 to 1995

Member of the Regional Municipality of Halton's **ECOLOGICAL AND ENVIRONMENTAL ADVISORY COMMITTEE** (EEAC). The basic function of EEAC is to provide technical advice, through the Planning and Development Department, to staff and Council on all environmental matters affecting Halton.

SELECTED PUBLICATIONS AND REPORTS

Goodban, A.G. 2014. The Vascular Plants of Hamilton, Ontario. pp. 1 to 91, In: Schwetz, N. (ed.), Hamilton Natural Areas Inventory Project 3rd Edition, Nature Counts 2, Species Checklist Document. Hamilton Conservation Authority, Ancaster, Ontario.

Goodban, A.G. 2014. The Vegetation Communities of Hamilton, Ontario. pp. 92 to 111, In: Schwetz, N. (ed.), Hamilton Natural Areas Inventory Project 3rd Edition, Nature Counts 2, Species Checklist Document. Hamilton Conservation Authority, Ancaster, Ontario.

Goodban, A.G. and A.C. Garofalo. 2010. Rare Vegetation Types of the Niagara Region, Ontario: A Preliminary Checklist. Chapter 7 In: Natural Areas Inventory 2006-2009 – Niagara Peninsula Conservation Authority Watershed, Volume 1. Niagara Peninsula Conservation Authority, Welland, Ontario.

Crins, W.J., W.D. McIlveen, A.G. Goodban and P.G. O'Hara. 2006. The Vascular Plants of Halton Region, Ontario. pp. 1-79 In: Dwyer, J.K. (ed.), Halton Natural Areas Inventory 2006: Volume 2 – Species Checklists. Halton/North Peel Naturalists' Club, South Peel Naturalists' Club, Hamilton Naturalists' Club, Conservation Halton and the Regional Municipality of Halton.

Goodban, A.G. 2003. The Vascular Plants of Hamilton, Ontario. pp. 1-1 to 1-99, In: Dwyer, J.K., Nature Counts Project, Hamilton Natural Areas Inventory 2003, Volume 1 – Species Checklists. Hamilton Naturalists' Club, Hamilton, Ontario.

Goodban, A.G. 2003. The Vegetation Communities of Hamilton, Ontario. pp. 2-1 to 2-22, In: Dwyer, J.K., Nature Counts Project, Hamilton Natural Areas Inventory 2003, Volume 1 – Species Checklists. Hamilton Naturalists' Club, Hamilton, Ontario.

Goodban, A.G. *In prep.* Bronte Creek Provincial Park (North Section): Grasslands Study. Bronte Creek Provincial Park, Burlington, Ontario Parks.

Goodban, A.G. *In prep.* A life science inventory and assessment of Bronte Creek Provincial Park (North Section). Bronte Creek Provincial Park, Burlington, Ontario Parks.

SELECTED PUBLICATIONS AND REPORTS (continued)

Goodban, A.G. 1999. An Overview and Assessment of Prairie and Oak Woodland Vegetation at Bronte Creek Provincial Park. pp. 263-274. In: M. Pollock-Ellwand et al., Parks and Protected Areas Research in Ontario, Proceedings of the Parks Research Forum of Ontario (PRFO) Annual General Meeting. Faculty of Environmental Studies, University of Waterloo, Waterloo, Ontario.

Goodban, A.G., W.D. Bakowsky and B.D. Bricker. 1999. The historical and present extent and floristic composition of prairie and savanna vegetation in the vicinity of Hamilton, Ontario. pp. 87-103. In: Proceedings of the 15th North American Prairie Conference. *Edited by* C. Warwick. Natural Areas Association, Bend, Oregon.

Goodban, A.G. 1998. Significant Flora Survey: Ontario Hydro Right-of-Way, Bronte Creek Provincial Park Nature Reserve Zone Area of Natural and Scientific Interest. Prepared for Ontario Hydro. 11 pp + map.

Goodban, A.G. 1997. A survey of the rare vascular plant flora of the Albion Falls - Buttermilk Falls area in the City of Hamilton, Ontario. Hamilton Region Conservation Authority, Ancaster, Ontario. 14 pp. + appendix + map.

Goodban, A.G. 1996. The vegetation and flora of the Red Hill Valley and environs. pp. 17-66. In: Biological Inventory of the Red Hill Valley, Hamilton Naturalists' Club (eds.), Hamilton, Ontario.

Goodban, A.G. 1995. Alvar Vegetation on the Flamborough Plain: Ecological Features, Planning Considerations and Conservation Recommendations. Major Paper. Faculty of Environmental Studies, York University, North York, Ontario. 88 pp. + appendices.

Goodban, A.G. 1994. *Carex virescens* (Cyperaceae) new to the Regional Municipality of Hamilton-Wentworth. Field Botanists of Ontario Newsletter 7(1): 11-12.

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

Kyle Fritz
Kyle.Fritz@ghd.com
519.340.3754

Richard Murphy
Richard.Murphy@ghd.com
519.340.4314

www.ghd.com