Proposed Milton Quarry East Extension
JART COMMENT SUMMARY TABLE – Geology and Water Resources

Please accept the following as feedback from the Milton Quarry Joint Agency Review Team (JART). Fully addressing each comment below will help expedite the potential for resolutions of the consolidated JART objections and individual agency objections. **Additional, new comments may be provided once a response has been prepared to the comments raised below and additional information provided**.

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Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
1.	No "major" karst features (described as caves, sinkholes or large conduits) have been reported from the site, including following a brief site visit undertaken by Dr. Worthington. There appears to be no direct evidence of karst, however I noted above that I have not yet observed the site. I would point out that some degree of enhanced solution along fractures in and near the MQEE area is apparent from the borehole logs with evidence of clay fines up to 9.07 mBGS in OW70D-20 (and also OW78D/S-20). In addition, several water-bearing fractures were noted in borehole OW70-08 (Appendix B).	General	Daryl W. Cowell	While no major karst features have been identified that could potentially impair the proposed MQEE, it is expected that some degree of enhanced solution along fractures occurs in all shallow dolostone deposits in humid environments. The karst studies by GHD and Dr. Worthington focused on whether the proposed mitigation measures could be successfully implemented for the MQEE. Our studies confirmed that they could and in fact, have been successfully used for the Existing Quarry since 2007. Although JART's comments are noted as December 2022, the peer review comments provided by Mr. Cowell are dated April 25, 2022. We note that subsequent to the preparation of this comment, Mr. Cowell was able to participate in a Site visit conducted on June 20, 2022.	
2.	Section 10.4 in the main report is titled "Cumulative Effects" however, this section is very brief and only speaks to the fact that there are "no known other forms of development identified in the immediate study area". There is no attempt to consider cumulative impacts on groundwater and wetlands associated with other quarries in the immediate area (main and north quarries; west and east cells). Section 1.1, page 2 of the report notes that detailed studies (including monitoring well data) have been underway for "more than 40 years". Cumulative effects resulting from at least the three adjacent quarries should be thoroughly evaluated.	General	Daryl W. Cowell	Refer to Response to Comment #1 in the Progressive and Final Rehabilitation Monitoring Study Matrix – repeated below for convenience. ***The GWRA describes the fact that the existing quarry has resulted in some dewatering influence in the bedrock aquifer and that this has likely had an impact on Wetland U1 and Wetland W36. The present conditions, both groundwater and wetland, are described in the GWRA (Section 6, particularly Section 6.8) and ecological conditions are also described in the NRIA & EIA.*** ***The potential effects of the Milton Quarry are known as they are represented by the existing conditions. These conditions are a result of the approved extraction conditions and the influence will not increase as the current quarry configuration and mitigation measures will prevent further alteration.*** ***The proposed MQEE will maintain or enhance the existing (approved) conditions and therefore there will not be any increase in cumulative effect of the MQEE addition to the Existing Quarry.***	

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				To be clear, the intent of a cumulative effects assessment is not to evaluate proposed conditions relative to a pre-development (natural) state but rather to evaluate the impact of the proposed development in combination with other developments that are already approved. In this area, there are no other land use developments in progress with accumulating negative effects to water resources.	
3.	*'The potential influence of the proposed quarry on the groundwater is bounded by existing hydrogeologic features (which are hereafter referred to as hydrogeologic boundaries). Therefore, the study area is defined by the limits of these boundaries, including the existing Milton Quarry cells to the north, west, and south. The Niagara Escarpment lies to the southeast the study area.'* The function of the hydrogeological boundaries that bound the potential influence of the proposed quarry should be described as well as how these boundaries will be maintained in the future.	Page 1, 2nd last paragraph – Section 1.1 Report Overview	Norbert M. Woerns	These hydrogeologic boundaries are described in the main body of the GWRA report. In summary: - the Milton Quarry cells are groundwater discharge controls as groundwater flow from the MQEE flows toward and discharges into these cells. The groundwater discharge function (relative to the MQEE) will persist under both dewatered and rehabilitation lake conditions. - The Niagara Escarpment is also a groundwater discharge feature. The groundwater levels and flow between the MQEE and the Niagara Escarpment will be maintained in the future by the mitigation and rehabilitation measures proposed for the MQEE. Therefore, there will not be any change in the function of these features as hydrogeologic boundaries; although the discharge flow to the other quarry cells will vary over time as the quarry lakes are filled. This flow is assessed in the impact assessment (GWRA Section 10).	
4.	*'Planning for efficient and sustainable use of water resources.'* What is meant by 'sustainable use'? Clarification is required.	Page 4, Section 1.2 Policy Context, 2nd paragraph, 9th bullet	Norbert M. Woerns	The sustainability of the use refers to the ability to continue to use the water resource for the intended purpose over the long term. In large part this involves assessing the potential future conditions to ensure there is sufficient water to operate the water management system as proposed. Extensive analyses have been conducted to demonstrate that the water supply is sustainable, including under potential future climate conditions. The assessment also includes ensuring suitable engineering, legal, and financial assurances are available. These aspects are addressed by the proposed mitigation system and associated approvals and legal agreements.	

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5.	In the discussion of seasonal groundwater fluctuations, it is not clear whether the discussion is in regard to the previously documented conditions for the existing quarry or for the MQEE? Examples of hydrographs showing the seasonal groundwater level fluctuations should be provided or referenced for the MQEE.	Page 5, Section 2.1, Overview, 5th paragraph	Norbert M. Woerns	The referenced section is a general overview of regional conditions. Refer to GRWA Section 6.3 where the groundwater elevations are discussed in detail along with accompanying hydrographs and groundwater contour maps.	
6.	Vertical fracture orientation is described. The significance of these fracture orientations with respect to groundwater movement should be discussed.	Page 7, Section 2.3.2 Bedrock, 5th paragraph	Norbert M. Woerns	The presence of vertical fractures is one of the lines of evidence considered in characterizing the Amabel Aquifer as a single hydrostratigraphic unit as they contribute to vertical interconnectedness of the rock mass. The orientation is provided for general knowledge in this regional overview but was not studied in detail and is not indicated to be a key factor in the overall horizontal direction of groundwater movement.	
7.	*'The Milton Quarry is not located within any designated Source Water Protection (SWP) areas (i.e., it is outside any Wellhead Protection Areas-WHPAs'* (page 10, 3rd paragraph), Surface drainage through the Dufferin Quarry property contributes to the maintenance of water supply for the Kelso wells indirectly through the Hilton Falls Reservoir Tributary and Kelso Reservoir. Dufferin Quarry provides 700,000m^3 of water to the Hilton Falls Reservoir Tributary which drains into the Kelso Reservoir. Since the MQEE is located within the Hilton Falls Reservoir Tributary drainage area, the potential therefore exists for the Dufferin Quarry to impact both the quantity and quality of the Kelso municipal water supply wells. This should be reflected in the ongoing water quantity and quality monitoring program for the Dufferin Quarry water resources.	Page 10, Section 2.5, Regional Hydrogeology Above the Escarpment (Source Water Protection), 3rd paragraph (Issues list item 1.1)	Norbert M. Woerns	The existing Milton Quarry approvals and legal agreements, to which Conservation Halton is a signatory, fully address the protection of water quantity and water quality necessary for the downstream system. The proposed MQEE does not alter these protections.	
8.	There should be a discussion of the inter-relationship between surface water and groundwater divides and the impact of changing groundwater divides may have on surface water features. Figure 2.8 shows groundwater elevation contours from which regional groundwater flow can be inferred. Interpreted flow directions are not shown on this figure. As noted on Figure 2.8, groundwater elevations *'are from MOE drilling records extracted for 2000 GWRA'.* An updated version of this figure should be included with recent on-site groundwater elevations to reflect current conditions and the extent of the current zone of influence of the existing quarry. Current groundwater elevation contours are provided for the MQEE area in Figures 6.1, 6.2, 6.3 and 6.4.	Page 11, Section 2.5 Regional Hydrogeology Above Escarpment, 1st paragraph (Issues list item 1.2)	Norbert M. Woerns	The proposed MQEE will not change groundwater divides. The proposed mitigation measures will support groundwater levels and hence maintain the existing groundwater flow patterns and divides. The groundwater surface water interactions in the MQEE area are described in detail in GWRA Section 6.8. The regional groundwater flow system shown on Figure 2.8 is provided to show the overall regional groundwater flow context. Since the derivation of the dataset, the groundwater flow directions and divides have not been influenced beyond the hydrogeologic boundaries for the Existing Quarry (i.e. the Sixth Line Tributary, North Quarry, Main Quarry, and Niagara Escarpment). Within these hydrogeologic boundaries the groundwater divides have been maintained by the Existing Quarry mitigation measures. Attachment	

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				A includes 3 figures from the Annual Monitoring Reports corresponding to the dates of Figures 6.1, 6.2, and 6.3 (i.e., April 2020, October 2020, and April 2021) referenced in the comment. These figures illustrate the overall groundwater flow regime is maintained within the hydrogeologic boundaries of the Existing Quarry. Updating of Figure 2.8 of the GWRA is not warranted and would only change in the local area within the Existing Quarry hydrogeologic boundaries where the remaining areas of Amabel Aquifer are supported by the mitigation measures. The groundwater flow conditions in the local area of interest are better reflected on the MQEE area maps (GWRA figures referenced in the comment) or the Existing Quarry figures from the 2021 Annual Water Monitoring Report (GHD, March 2022) which are included in Attachment A for convenience.	
9.	First paragraph on page 11 states that Figure 2.8 Regional Groundwater Flow Map presents bedrock groundwater map prior to extraction of the North Quarry, West Cell, or East Cell. Please clarify what season the map represents and/or if it represents minimum, maximum or average groundwater levels.	Section 2.5 Regional Hydrogeology Above Escarpment, page 11	CH	The map does not represent a specific season or groundwater level statistical condition. The groundwater contour elevations were generated from the MECP water well records database and thereby reflects reported water levels at the time of well installation over various years and seasons.	
10.	*'The study area plan was developed as presented on Figure 3.1.'* Figure 3.1 shows the North Quarry, West Cell and East Cell. Analysis focuses primarily on the MQEE with the majority of data from monitoring locations in and adjacent to MQEE. The focus of this GWRA is therefore on the MQEE and not on the broader study area shown on Figure 3.1.	Page 12, Section 3.1, Topography and Instrumentation, 1st paragraph.	Norbert M. Woerns	The comment is correct. The GWRA studies focused primarily on the area shown on Figure 3.3. Figure 3.1 shows the broad area surrounding the Existing Quarry areas and the proposed MQEE for general reference. Figure 3.2 zooms into the area surrounding the Milton North Quarry and Extension Lands, including field investigation locations. It is Figure 3.3 that illustrates the proposed MQEE area, associated focus area for GWRA study, and field investigation locations.	
11.	*"There are several historical surface water monitoring locations in the area of the proposed MQEE, including 2 locations in proximity to the south and southeast of the proposed MQEE extraction area (SG5 and SG6, respectively)."* Besides SG5 and SG6, what are the other historical surface water monitoring stations in the area of the MQEE, which would support the MQEE proposal?	Section 3.3, Surface Water Level Monitoring, page 13, 14	CH	These are the most relevant gauges. Other locations exist (e.g., SG7/DP7); however, access to many locations was lost in 2007. The supplemental monitoring network has been significantly expanded as part of the current application to ensure all immediately downgradient wetlands are suitably instrumented.	

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12.	*'Previous assessments have demonstrated the continued suitability of recharge water for mitigation and the proposed MQEE will not alter the water quality. Therefore, further assessment of the suitability of the recharge water for mitigation is not necessary and the assessment focusses herein on the baseline characteristics of water chemistry on the MQEE lands as requested by the Region of Halton.'* (Page 14 last paragraph and page 15, 1st paragraph) As noted above in Comment7 above, there is potential for Dufferin Milton Quarry specifically including MQEE to impact off-site downgradient surface water and groundwater resources. Water quality monitoring should therefore continue to be an integral part of the ongoing monitoring plan. In addition, periodic reassessments of the potential for dissolution of Amabel dolostone should be completed in the event of potential long term progressive changes in recharge water quality. See Comment 38.	Page 14, Section 3.5 Water Quality Data, last paragraph (Issues list item 1.4)	Norbert M. Woerns	The proposed water quality/chemistry monitoring program is suitable and sufficient. Monitoring of water quality is completed proactively as it is drawn from the Reservoir and prior to discharge, rather than downgradient at an unidentified receptor. Samples are also collected throughout the recharge system, including at 3 recharge wells spaced near, mid-distance, and distant from the Pumping Station. The quality of water in the reservoir and water being discharged through the recharge system is routinely monitored and evaluated. The results of these analyses are presented in the annual water monitoring reports and analyzed as part of the 5-Year AMP Reviews. The sampling program has been established for the WMS and is regulated under an Industrial Sewage Works Environmental Compliance Approval (ISW ECA# 6124-C42GL4). Any necessary adjustments to the sampling program associated with the MQEE will be determined in consultation with the MECP.	
13.	To understand groundwater and surface water interactions within wetlands it would be beneficial to understand thickness and composition of the underlying overburden. Is there any data available to shed some light on it, especially for wetlands U1, W36, W41, W46 and W56?	Section 4.2 Overburden, page 16	CH	The available information indicates that there is limited overburden under these wetlands and they are not isolated from groundwater effects. The proposed mitigation measures have demonstrated they are effective under similar conditions for the wetlands associated with the Existing Quarry, including Wetlands W5, W7, W8, and V2. Therefore, it was determined that intrusive investigations (e.g., borings) within the wetlands were not warranted.	
14.	Is there any evidence of erosion of bedrock associated with the proximity of the brow of the escarpment? Any halo effect close to MQEE?	Section 4.3.1 Amabel Formation, page 16, 17	CH	GHD is not aware of any evidence of bedrock erosion at the brow of the escarpment associated with extraction of the current approved Extension lands. To GHD's knowledge, this has not historically been a concern and evaluations of erosion at the brow of the escarpment have not been undertaken. The extraction limit of the MQEE is approximately the same distance from the brow of the escarpment as the current approved East Extension and sits at a distance of more than 1,000 m. Furthermore, the Niagara Escarpment Plan only requires a 200 metre setback from the brow.	

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15.	How was the Groundwater Recharge of 233 mm determined and is this for pre-quarry conditions? Clarification is required.	Page 20, Section 5.2.1 Climate Change Considerations, Last Paragraph Last Bullet Point	Norbert M. Woerns	Since at least 2004, groundwater recharge has been a calibration parameter typically ranging from 150-250 mm/yr. The most recent previous updates (e.g., Extension Pre-Extraction Update) employed a recharge rate of 200 mm/yr. As part of the 5-Year AMP Review (Appendix K), a thorough evaluation was undertaken including a full groundwater recharge assessment. A HEC-HMS model was developed for the watershed and infiltration was evaluated for climatic conditions including current (1980-2010), 2050's, and 2080's. Through this review the recharge rate for current conditions was adjusted slightly to 233 mm/yr. The values determined are considered representative for vegetated areas outside the excavation footprint and are applied for the evaluation of either pre-quarry, existing, or future conditions.	
16.	Three scenarios were assessed through a water budget analysis to address climate change scenarios. The first water budget scenario is based climate data for the area from Canadian Climate Normals period from 1981 to 2010 representing baseline observed long term average conditions. Two additional water budget scenarios were presented that represent potential future conditions in the latter part of the century representative of the 2050s and 2080s. Both scenarios assumed higher temperatures, higher precipitation, higher evapotranspiration and higher recharge. No scenario was assessed using decreased precipitation. This was explained as follows: *'short term variability (i.e., drought) is not a concern now or in the future due to the substantial body of water in storage at the site. In the event of severe water availability reduction, the lake filling process could be temporarily postponed, and water could be drawn from storage to sustain operation of the mitigation system'*. (Section 10.2.2.1, page 66, 3rd paragraph) This should be supported with a detailed analysis. Consideration should also be given to the downstream off-site water requirements under drier conditions.	Page 21, Section 5.2.1 and page 66 Section 10.2.2.1 Climate Change Considerations (Issues list item 1.5)	Norbert M. Woerns	A detailed analysis of conditions was completed and is documented in the 5-Year AMP Review (Appendix K). Climatic projections were derived for the middle (2041-2070) and end (2071-2100) of the 21st Century, using General Circulation Model (GCM) data calculated with Representative Concentration Pathways (RCP) 8.5 Scenario. It should be noted that while precipitation increases in these scenarios, so does the evapotranspiration. The net of these changes is reduced runoff, and an overall reduction in predicted water surplus for the site, as documented in Table 5.3 of the GWRA Appendix G (Water Budget Evaluations). Significant evaluation has already been undertaken and two sensitivity scenarios are presented with reduced water availability. Further reductions in water availability could be evaluated through arbitrary reductions in precipitation; however, such undefined and arbitrary scenarios would not appear to be of value.	
17.	This section states that in recent years there has not been any surface water runoff from the MQEE lands. This could be potentially explained by groundwater lowering due to extraction in the east cell and increased infiltration. Is there any historical surface water flow data for MQEE? Alternatively, is there any historical groundwater level data for MQEE, which compared to ground surface elevation could be used to either support infiltration or suggest rejected recharge and surface runoff?	Section 5.3 Hilton Falls Reservoir Tributary, page 23, 2nd last paragraph	CH	While surface runoff has not been observed to date, the climatic conditions in recent years has not been ideal for observation of runoff, with conditions being drier than typical. All data available on the MQEE property have been presented in the GWRA and evaluated to the extent possible. The historical data available are not sufficient to allow comparison to ground surface to suggest rejected recharge or surface runoff. Notably, both groundwater level data and	

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				surface water observations are absent from the central portion of the MQEE property (e.g., Wetland U1 and farmer's drainage channel) as the previous program focused on the surrounding natural resources which were identified as PSWs. The proposed mitigation measures will enhance conditions in Wetland U1 and Wetland W36 to suit ecological objectives for amphibian breeding. For more distant wetlands (e.g. Wetland W41) there is no indication of past influence from the Existing Quarry and the proposed mitigation measures will maintain the existing conditions. Further characterization of potential past conditions is not needed to achieve these objectives.	
18.	*'Based on observations by GHD and GEC, there has not been any surface water runoff from the MQEE lands in recent years (GEC observations commenced in early spring 2019 and GHD observations commenced in winter 2020).'* The relatively short observation period may not be representative of average surface water runoff conditions. Longer term on-site climate data should be considered to support these observations as well as the impact of the existing quarry operations on the MQEE site. Cross-sections on Figs 4.2 and 4.3 show lower groundwater levels adjacent to existing Phase 3 East Cell and Phase 1 North Quarry Cell. Lower groundwater levels suggest impacts from existing quarry operations extend beneath MQEE between 200 and 350m. The observed surface water conditions on MQEE appear to have most likely been influenced by existing quarry operations and represent impacted conditions. This suggests that the current mitigation measures have not prevented the decline in groundwater levels beneath MQEE from existing quarry operations. Clarification is required.	Page 23, Section 5.3 Hilton Falls Reservoir Tributary, 5th paragraph (Issues list item 1.6)	Norbert M. Woerns	Longer term on-Site climate data have been considered and descriptions of surface water conditions in spring 2019, 2020, and 2021 were provided with climatic context (see GWRA Section 6.8.1 for Wetland U1 and Section 6.8.2 for Wetland W36). The influence on surface runoff and groundwater conditions was acknowledged by GHD in the GWRA, "Wetland U1 is located approximately 580 m from the Main Quarry and 440 m from the North Quarry and is interpreted to be within the historic zone of influence of both the Main Quarry and the North Quarry. It is concluded that the Wetland U1 area may have experienced higher groundwater levels and a greater degree of groundwater support and interaction in the past." Trigger wells and targets have not been developed for the MQEE area immediately adjacent the North Quarry or southwest corner of the East Cell. In fact, the Existing Quarry analyses and approvals considered that there would be some drawdown of groundwater in the MQEE area. Recharge operations to date have been guided by Trigger Wells and by data available at distance including but not limited to BH65, BH66, and OW69-08. The water levels observed indicated that known water resources were protected and further mitigation efforts were not warranted. At this time, it is clear that the most effective approach to mitigation of Wetland U1 is by diffuse discharge, as incorporated in the proposed MQEE.	

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19.	States that tributary is labeled HS-1 on Figure 5-2, but that label is not on this figure. In general Figure 5-2 is difficult to read (e.g. HS-2), and labels are floating in space (e.g. W42, W40). Suggest this figure is clarified to be easier to read.	Section 5.3 Hilton Falls Reservoir Tributary	CH	The labels for HF-1 and HF-2 are behind the wetland layer and will be brought to the front in any future mapping. Labels for wetlands will also be reviewed, and leader lines added where necessary. For clarity, we have provided a revised version of Figure 5-2 in Attachment B.	
20.	States that the small drainage ditch from U1 to W36 likely had historic flow supported by a higher groundwater regime in the past. Will the flow be re-established as part of the management strategy for these wetlands?	Section 5.3 Hilton Falls Reservoir Tributary	CH	Re-establishment of flow in the discharge channel is not currently proposed as part of the mitigation. Flow from Wetland U1 through the drainage ditch to Wetland W36 would be redundant as direct mitigation through diffuse discharge is proposed within Wetland W36 itself.	
21.	There is reference to hazard land buffer requirements without stating what these requirements are. These should be identified.	Page 25, Section 5.5 Natural Hazard Lands, 3rd paragraph (Issues list item 1.7)	Norbert M. Woerns	The hazards and associated buffer zones were not developed by GHD and were provided by Conservation Halton. The hazards and their associated buffers are presented on GWRA Figure 5.5	
22.	Staff agrees with the statement that, given the type of the proposed development (i.e., aggregate extraction), karst topography may not be a hazard, however it can have an effect on potential natural features relying on karst topography in the hydrological sense. Mitigation measures should be proposed to deal with this potential karst.	Section 5.5 Natural Hazards, page 25, 26	CH	The mitigation measures proposed have been operating successfully for more than 15 years and no significant changes are anticipated for the MQEE, which represents a modest 15% increase in recharge operations. Additional contingency mitigation measures have been provided in Part II Section A.2.6 of the AMP Addendum including: • 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)	

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				• 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	
23.	The discussion of the groundwater flow system is lacking a discussion of the impact the existing quarry has had on the local and regional groundwater system. The discussion of groundwater flow through the Amabel is as follows; *'Groundwater flow in the Amabel Aquifer occurs primarily through the fractures and minor dissolution features in the bedrock. The Amabel is sufficiently well connected and generally lacks major bedding controls on groundwater flow such as may occur in the presence of marked changes in lithology.'* (Page 27, 2nd paragraph) A discussion is lacking of the impact of the predominant vertical fracture set, as described on page 7, 5th paragraph in section 2.3.2, on the groundwater flow pattern.	Page 27, Section 6.1 Site Hydrogeology – Overview, 2nd paragraph (Issues list item no 1.8)	Norbert M. Woerns	The influence of the existing quarry is limited as a result of the extensive mitigation measures employed, including the 8.5 km recharge well loop around the North Quarry and Extension areas. Potential influences to the south of the site are limited by the presence of the Main Quarry and termination of the aquifer at the escarpment. Influences north of the Main Quarry on the MQEE lands have been extensively documented and assessed to the extent possible with all available data. As discussed in Section 6.2 of the GWRA, the Amabel Aquifer behaves as a single hydrostratigraphic unit. In addition, GHD has successfully implemented groundwater flow modelling for the design of WMS components for more than 20 years. The model is based on effective porous media and, to date, assessment of local scale fracture flow (either horizontal or vertical) has not been necessary for determining groundwater flow patterns. Evaluations using effective porous media have been implemented successfully at the site and it is GHD's opinion further description, delineation, or discussion of the vertical fracture set would be of limited value to the project. As stated in response to Comment #6 above, the vertical fracture orientation is not indicated to be a key factor in the overall horizontal direction of groundwater movement. Furthermore, variability would be expected given the size of the site and observations in one area may not be directly transferrable to other areas. The discussion provided is intended to be regional context only, and not for the assessment of local flow patterns.	

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24.	Based on review of Figures 6.1 through 6.3 it appears that in areas not impacted by the quarry operation the seasonal groundwater fluctuations are between 1 and 2 metres, while in areas most likely impacted by the quarry operation it is between 2 and 7 metres. Groundwater levels under Wetlands U1 and W36 seem to fluctuate between 2 and 7 metres. The pre-extraction groundwater levels under wetlands U1 and W36 are unknown. Based on monitoring well OW78-20 located downstream of U1, the groundwater elevation in the spring of 2020 measured at elevation 336.92 masl, considering the lowest part of U1 has a ground surface elevation just below elevation 337.5 masl and the surface water level was measured at about elevation 337.7 masl, potentially, groundwater discharge was present in the spring of 2020 in U1. It should be noted that the groundwater elevation prior to extraction of the east cell in MW319A-10, OW3-80, OW-3-2-II and OW-3-3II was substantially higher and occasionally above elevation 340 masl, which suggests groundwater discharge conditions in U1 were present prior to the east cell extraction and the mitigation system in place for East Cell did not adequately mitigate the quarry impacts to U1. Was this understood as part of the previous application?	Section 6.3 Groundwater Elevations, page 28-30	CH	Seasonal fluctuation of groundwater levels is controlled by precipitation, overburden composition and thickness, and interactions with nearby surface water features. In the vicinity of OW70-08, on the south side of the East Cell, relatively thin high-permeability overburden exists. This combination allows for enhanced natural groundwater recharge within a topographically high area. These conditions resulted in Pre-Extension groundwater levels that fluctuated regularly by as much as 6 metres. In 2020, water levels at OW3-2-II, upgradient of Wetland U1 were above the base of the wetland; however, water levels at downgradient OW78D/S-20 were below. Given this dynamic, it is not possible to determine if groundwater discharge to the wetland occurred. The potential groundwater-surface water interaction and the potential influence on groundwater conditions was acknowledged by GHD in the GWRA: “Groundwater support [to Wetland U1] from the northeast may also occur during brief periods during high groundwater level conditions” [page 37] “Wetland U1 is located approximately 580 m from the Main Quarry and 440 m from the North Quarry and is interpreted to be within the historic zone of influence of both the Main Quarry and the North Quarry. It is concluded that the Wetland U1 area may have experienced higher groundwater levels and a greater degree of groundwater support and interaction in the past.” [page 38] Monitoring data from OW3-80, OW3-2, and OW3-3 end in 2007 when Dufferin lost monitoring access. Subsequently, the extraction limit of the North Quarry was advanced eastward in 2007, 2008, and 2009. It is not possible to determine if the influence on MQEE water levels resulted from Main Quarry/North Quarry extraction or advancement in the East Cell; however, nearby Wetland V2 was affected by the combined effect of Main Quarry/North Quarry extraction prior to 2009 and was noted to be drier than anticipated in 2000. It is reasonable to conclude that Wetland U1 would have been affected at the same time, or potentially earlier given closer proximity to the Main Quarry.	

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Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
				GHD also notes, the East Cell recharge system commenced seasonal operation in late 2010, and full-time operation in 2013. Extraction in the East Cell commenced with a sinking cut in 2015; however, groundwater drawdown was not evident in supplemental monitoring data until late 2017. During this period, the recharge system was operating in the absence of extraction related influence, and water levels were held higher than would have historically occurred. This is evident in water levels recorded at trigger wells around the East Cell, and was documented extensively in the 5-Year AMP Review. These elevated conditions may have temporarily raised water levels on the MQEE lands, allowing for some mitigation of Main Quarry/North Quarry related influence. Any contemporary decrease since 2017 could be the result of a return to a normal groundwater regime, as maintained by the WMS. As identified in response to Comment #18, above, prior assessments did not consider conditions in Wetland U1 as it had not been identified by the province and was not designated as a PSW. The Existing Quarry analyses and approvals considered that there would be some drawdown of groundwater in the MQEE area. Recharge operations to date have been guided by Trigger Wells and by data available at distance including but not limited to BH65, BH66, and OW69-08. The water levels observed indicated that known water resources were protected and further mitigation efforts were not warranted. At this time, it is clear that the most effective approach to mitigation of Wetland U1 is by diffuse discharge, as incorporated in the proposed MQEE.	
25.	*'Groundwater elevations fluctuate dramatically during the year based on seasonal effects except in some discharge areas where a relatively consistent surface water levels dampen these fluctuations (refer to Figure 6.4, 6.7, and 6.8).'* (Page 29, second last paragraph) For recently installed southern monitoring wells (OW78D/S-20, OW80-20, OW81-20, OW82-20) there are seasonal fluctuations in water levels of 5 to 7 metres. This compares to historical water level fluctuations of 2 to 3 metres in nearby monitors (OW69-08, BH 65, BH66). What are the possible causes and/or significance of this difference? Is the distance from an active quarry face a factor in the seasonal water level fluctuations? Long term monitor BH64, located near the existing main quarry shows seasonal water level fluctuations of between 6 to 7 metres. *'Some of the groundwater elevations in the northern group of monitoring wells exhibit an influence or control from the East Cell recharge system operation (e.g., OW71-08,*	Page 29, Section 6.3, Groundwater Elevations,2nd last paragraph (Issues list item 1.9)	Norbert M. Woerns	As discussed above in comment #24, seasonal fluctuation of groundwater levels is controlled by precipitation, overburden composition and thickness, and interactions with nearby surface water features. On the south side of the East Cell, relatively thin high-permeability overburden exists. This combination allows for enhanced natural groundwater recharge within a topographically high area. These conditions resulted in a natural groundwater mound and Pre-Extension groundwater levels that fluctuated regularly by as much as 6 metres. Conditions are similar across the MQEE as these areas are directly downgradient of this recharge area and	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
	BH71, OW79S/D-20) or East Cell dewatering (e.g., OW3-80).' (Page 29, last paragraph) The influence of the East Cell recharge system operation or the East Cell dewatering have on the groundwater levels as shown on the hydrographs requires some discussion and explanation. No hydrograph for OW71-08 and OW79D-20 are provided on Figures 6.7a and 6.7b showing the northern group of wells. The location of BH112, OW68-07 are well removed from MQEE and should be described as they do not appear on most figures except Fig. 3.1 and Fig. A.1.			groundwater mound. As noted above, proximity and interaction with surface water is known to dampen fluctuation observed in the groundwater flow system by providing both a drain from the system (groundwater discharge point) during high groundwater conditions, and acting as a source of water (in-system storage) during low or reducing groundwater conditions. Supplemental monitoring wells OW69-08, BH65, and BH66 are all directly adjacent wetlands, or in the case of BH66, located between larger features both upgradient and downgradient. While BH64 is located adjacent Wetland W36, this wetland is within the historic zone of influence of the Main Quarry/North Quarry, retains less water than Wetland W41, or W46, and would be expected to provide less dampening to the groundwater flow system. As shown on GWRA Figures 6.1 to 6.3, the BH64 area receives groundwater support from the high recharge area and groundwater mound south of the East Cell. Given upgradient seasonal fluctuations and reduced dampening, the variability is expected. With respect to the specific monitoring wells identified in the last paragraph of the comment: - OW71-08 is located north of the MQEE area, beyond W70-08 and BH71 which are included. Therefore, OW71-08 is considered redundant for the purpose of the hydrograph - OW79D-20 is not included as it is redundant to the purpose of the figure based on its water level being almost identical to OW79S-20 which is included (refer to comparison on GWRA Figure 6.6) - BH112 and OW68-07 are background wells and are included on the figures to provide a context of water level variations outside the potential area of influence of the Milton Quarry	
26.	*'There is no potential for groundwater use interference from the proposed MQEE... the closest private landowner with a water well is more than 1,200 metres from the MQEE'.* (Page 35, last 2 paragraphs). Figure 6.9 shows the location of the nearest wells above the escarpment since the Amabel Aquifer is the source of groundwater for supply wells above the escarpment. Below the escarpment and down-gradient of the existing Milton quarry and proposed MQEE are bedrock formations that, for the most part exhibit hydraulic characteristic of aquitards and are typically not considered groundwater sources of supply due to the lack of water and generally poor water quality. There is no discussion of existing down-gradient groundwater or surface water users below the escarpment and the impact the	Page 35, last 2 paragraphs, Section 6.6 Groundwater Use, (Issue list item 1.10)	Norbert M. Woerns	Typically, private water well assessments and any associated impacts would be considered within approximately 500 m of the extraction limit. The nearest water supplies are outside this range in a separate hydrogeologic unit. Given the distance and hydrogeologic separation, impacts would be highly unlikely, even in the absence of mitigation. Supplemental monitoring is underway that confirms no discernable drawdown has occurred south and east of the MQEE to date. Mitigation is proposed for the MQEE that would limit or	

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Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
	existing Milton Quarry may have had on possible down-gradient groundwater and surface water users and the possible impact the MQEE may have on these users			eliminate any drawdown from the proposed extension. The supplemental monitoring program has been bolstered to confirm this with numerous additional surface and groundwater (trigger wells and supplemental monitoring wells) monitoring locations. No impact is anticipated above or below the Escarpment, and no changes in water availability are anticipated for residences below the Escarpment.	
27.	The original chart provided by JART did not include a row #27. This blank row has been added for completeness to avoid potential future confusion.				
28.	The proposed quarry extension appears to be closer to the brow of the Niagara Escarpment than the previous applications. As it is likely bedrock closer to the escarpment brow is more karstic, fractured and permeable, has there been any testing done to characterize bedrock properties near the escarpment brow? Further, are there any contingencies proposed to ensure that the recharge system will be sufficient to maintain groundwater levels between the brow of the escarpment and the quarry? Mitigation measures should be proposed to deal with this potential karst.	Section 6.5, Karst Assessment, pages 34	CH	Significant testing has been undertaken historically on the MQEE property, and on the existing Extension lands in the form of WMS operations. Full-depth extraction has occurred immediately north and west, providing additional insight into rock quality and hydrogeologic conditions. Increased karstification has not been correlated with proximity to the escarpment to date; however, both the current and proposed extraction limit remain a significant distance from the brow of the escarpment. The extraction limit of the MQEE is approximately the same distance from the brow of the escarpment as the current approved East Extension and sits at a distance of more than 1,000 m. Furthermore, the Niagara Escarpment Plan only requires a 200 metre setback from the brow. No additional off-property testing has been undertaken downgradient of the site; however, mitigation measures and contingencies are proposed in the event karst is encountered. Additional contingency mitigation measures have been provided in Part II Section A.2.6 of the AMP Addendum as referenced in response to Comment #22 above.	
29.	*'Influence from quarry dewatering in the absence of mitigation has been observed at distances greater than 500 m in some areas depending upon hydrogeologic conditions.'* (Page 36, section 6.7 1st paragraph). Should provide illustrations of the extent of influence of the existing quarry with figures	Page 36, Section 6.7 Zone of Influence 1st paragraph	Norbert M. Woerns	The referenced statement refers to past observations based on historic quarry influences in the absence of mitigation. The figures provided in Attachment A and the maintenance of target water levels at Trigger Wells demonstrate the	

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Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
	showing groundwater elevation contours.	(Issues list item 1.12)		maintenance of groundwater levels relative to the hydrogeologic boundaries. The zone of influence for the Milton Quarry Extension with mitigation (comparable to the proposed MQEE) is limited to the immediate area within the recharge mitigation zone extending from the quarry excavation to the recharge/trigger well alignment. It is important to recognize that the zone of influence varies based on a variety of factors, including: local area hydrogeologic/permeability conditions, depth of quarry dewatering influence, climatic effects, and groundwater-surface water interactions. While some areas historically exhibited an influence greater than 500 metres, this is not the case in all areas.	
30.	Influence from quarry dewatering in the absence of mitigation has been observed at distances greater than 500 m. There is a number of wetlands within the MQEE zone of influence: U1, W36, W41, W46 (at least E and D) and W56. These wetlands should be instrumented with groundwater and surface water monitors to ensure no negative impacts and to confirm the effectiveness of the proposed mitigation.	Section 6.7, Quarry Zone of Influence, pages 36, 37	CH	Agreed. All of the wetlands identified in the comment are part of the water level and ecological monitoring programs detailed in the AMP Addendum. Each of these wetlands has one or more staff gauges included in the monitoring program and there are a network of monitoring wells to monitor groundwater levels relative to these wetlands. Refer to AMP Addendum Part I Figures 5 and 6 and Part II, Sections B and D for further details on monitoring. There is no indication from water level monitoring or ecological observations that the Existing Quarry dewatering has had an influence on Wetlands W41, W46, and W56. It is noted that within Wetland W46, the water level monitoring locations are within wetland pools W46a and W46b (not W46d and W46e) as they exhibit a longer hydroperiod and were identified by GEC to be the pools of interest within Wetland W46.	
31.	*'Examination of the available water level information reveals that the wetland had a short hydroperiod in 2020, drying out as early as late April and confirmed to be dry during field inspection on May 13, 2020.'* (Page 37, section 6.8.1, 2nd paragraph) It is not clear that there currently exist any mitigation measures for maintaining water level and hydroperiod in U1 from impacts of the existing quarry operations. Is this considered a normal hydroperiod for a wetland of this type? The short hydroperiod suggest altered conditions. Clarification is required. *'Wetland U1 is located approximately 580 m from the Main Quarry and 440 m from the North Quarry and is interpreted to be within the historic zone of influence of both the Main Quarry and the North Quarry. It is concluded that the Wetland U1 area may have experienced higher groundwater levels and a greater degree of groundwater support and interaction in the past. Such a past interaction with groundwater would help explain*	Page 37, Section 6.8.1, 2nd paragraph and page 38, 1st paragraph, Wetland U1 (Issues list item 1.13)	Norbert M. Woerns	Wetland U1 experienced particularly dry climate conditions in spring 2021 as well as 2020 and 2022. Aside from the climatic influences, GHD has identified that Wetland U1 has also been influenced by historic drawdown influences from the Existing Quarry. The proposed MQEE addresses the Wetland U1 situation by incorporating mitigation measures that will actually enhance the present/recent conditions in Wetland U1. The mitigation measures will maintain a desirable (ecologically beneficial) hydroperiod. The target levels for this "desirable" hydroperiod have been established in collaboration with GEC to optimize the future	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
	*the past excavation of the drainage ditch leading south away from the wetland pool as well as the ecological observations reported by GEC in the NETR/EIA". (*Page 38, 1st paragraph) To what extent will the impact of the existing quarry operations be considered in establishing Target water levels within Wetland U1?			ecological conditions within Wetland U1 with a focus on supporting successful amphibian breeding. The proposed target level will result in a significantly higher spring water level and a much longer hydroperiod in Wetland U1 relative to present/recent conditions.	
32.	*'Wetland W36 is located with the historic zone of influence of the Milton Quarry and the distance from the Main Quarry to the monitored area is 275 m and greater. It is expected therefore to have experienced higher groundwater levels and a greater degree of groundwater support and interaction in the past. Available long-term monitoring data such as at monitoring well MW4 (monitoring extends from 1990 to present at the MW4/4A/4B/4C series of proximal locations as included in Appendix D) at the edge of the Main Quarry to the west of Wetland W36 demonstrate the dewatering influence of the quarry development. The water level available at MW4 (installed in 1990) and BH64 (installed in 1999) indicate that the influence on groundwater support for Wetland W36 had occurred prior to 1999. Such a past interaction with groundwater would also help explain the now dry portion of the wetland and drainage pathway extending to the Main Quarry to the west.' (Page 39, 2nd paragraph)* In recognition of the influence of the Milton Quarry, enhancement of the water levels and hydroperiod in excess of current conditions are proposed. It is not clear whether the proposed mitigation measures will fully address the existing quarry impacts. Clarification is required.	Page 39, 2nd paragraph, Section 6.8.2, Wetland 36, (issues list item 1.14)	Norbert M. Woerns	The existing conditions reflect both natural conditions and the influence of the approved Existing Quarry. The proposed mitigation will enhance these existing conditions. The mitigation is designed to address the important ecological wetland functions identified in the NRA/EIA; in particularly amphibian breeding. As noted in response to Comment #2 of the Progressive and Final Rehabilitation Comments: "…it is neither the goal nor a reasonable requirement for the proposed MQEE to restore groundwater conditions to a pre-extraction state. Rather the goal of the mitigation and rehabilitation measures is to maintain or enhance water resources relative to their condition under current approved conditions. The proposed MQEE is appropriate to satisfy this goal."	
33.	Wetland W41 has perennial surface water present and is supported by a small spring near SG61. Based on a number of monitoring wells upstream of the wetland there are groundwater discharge conditions within the wetland. In the east side of the wetland there are potentially downward gradients based on BH66 groundwater levels. Flow out of W41 was observed in July and August of 2021. The groundwater level at monitoring well BH65 is clearly higher than the surface water level indicating groundwater discharge conditions within the wetland during more than half of the year, including winter, spring, summer, and into September. To ensure wetland hydroperiod is maintained trigger levels for W41 should be set and mitigation actions and/or measures proposed.	Section 6.8.3 Wetland 41 and Wetland 46, page 39, 40	CH	Refer to Response to Comment #12 from the AMP Comments – repeated below for convenience. ***The establishment of specific targets for the wetlands identified in the comment is not consistent with the mitigation and AMP approach. Water level targets are proposed where there is direct control over the associated water level using the mitigation measures – i.e. Wetland U1 and Wetland W36.*** ***The other wetlands described in the NETR & EIA are located at considerable distances from the proposed MQEE extraction area. There will be no changes to the surface catchments of these wetlands and any quarry dewatering influences during the interim period will be mitigated through the operation***	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
				of recharge wells per the AMP Addendum. The same approach to protecting wetlands is used for the existing Milton Quarry Extension. ***There is no direct control of these wetland water levels as the groundwater influence from the quarry side of the wetland is only one of the factors that can significantly influence the wetland water level. Other factors include: climate conditions (precipitation, snowpack, temperature, etc.), influences within the wetland (e.g. flow obstructions from beaver dams, tree fall, etc.), and any influence from other areas beyond the wetland. It is anticipated that groundwater conditions will be maintained passively under the rehabilitation condition, although future monitoring will determine if any seasonal operation of recharge wells will be necessary. This is all described in the AMP Addendum.*** ***Although there are no target levels proposed for these wetlands, there is comprehensive monitoring and evaluation of water levels in these wetlands as described in the AMP Addendum (Part II, Sections A.2.6, D.4.1, and D4.5). If warranted, further mitigation or rehabilitation adjustments would be implemented to protect these wetlands in accordance with the AMP Addendum.***	
34.	Monitoring well BH66, although useful is not representative of groundwater conditions for W41 nor W46. BH66 is located close to a 3 to 4 metre drop in ground surface at the bottom of which there is a series of wetlands. This drop is most likely responsible for lower groundwater levels in BH66. BH66 is also a considerable distance from wetlands W41 and W46. A groundwater monitor should be constructed on the upstream end of W41 and in the vicinity of W46 and incorporated into the monitoring program. To ensure wetland hydroperiod is maintained trigger levels for W46 should be set and mitigation actions and/or measures proposed.	Section 6.8.3 Wetland 41 and Wetland 46, page 40	CH	It is correct that BH66 is not in a suitable location for use as a Trigger Well. The AMP Addendum identifies that BH66 will be monitored as part of the Supplemental Monitoring network, not as a Trigger Well in the Performance Monitoring network. The AMP Addendum proposes Trigger wells on the upgradient (northwest) side of Wetland W41 and Wetland W46 as recommended in the comment. Figure 4 of the AMP Addendum identifies monitoring wells OW80-20, OW81-20, and OW83.21 as trigger wells (labelled “preliminary target monitoring locations” in the legend). In 2022 the proposed trigger well location network was optimized by the installation of two new monitoring wells (OW84-22 and OW85-22). With these additions, the trigger well network for the MQEE is now proposed to be comprised of monitoring wells (from north to south) OW79S-20, OW85-22, OW81-20, and OW84-22, as illustrated on AMP Addendum Figure 4Rev1 included in	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
				Attachment C, hereto. Monitoring wells OW80-20 and OW83-21 will be retained as Supplemental Monitoring wells, as shown on revised AMP Addendum Figure 5Rev1, also included in Attachment C.	
35.	Monitoring wells OW79-20, OW80-20 and OW69-08, although useful are not definitive to assess groundwater conditions at wetland W56. OW79-20 is some 150 metres upgradient of W56, OW80-20 is some 125 metres away and cross gradient and OW69-08 is on the downstream end of W56. Based on Figure 6.1 groundwater level drop under the wetland from the upstream end to the downstream end is at least 1 metre. A groundwater monitoring station adjacent to and on the upstream end of W56 should be installed and incorporated into the monitoring program. To ensure wetland hydroperiod is maintained trigger levels for W56 should be set and mitigation actions and/or measures proposed.	Section 6.8.4, Wetland 56, page 40, 41	CH	The basis of the mitigation measures and the Performance Monitoring program described in the AMP Addendum is to maintain the groundwater levels upgradient of potential water resources receptors such as Wetland W56. The program involves establishing target water levels at the upgradient trigger wells. Maintaining those water levels demonstrates that there is not a groundwater drawdown influence extending to features further downgradient. Beyond the trigger well location and beyond the wetland, other factors may influence the surface water or groundwater level. Other factors include: climate conditions (precipitation, snowpack, temperature, etc.), influences within the wetland (e.g. flow obstructions from beaver dams, tree fall, etc.), and any influence from other areas beyond the trigger well or wetland. It is not the intent of the mitigation measures to compensate for these influences that are unrelated to the quarry. Experiences had demonstrated this system of mitigation and monitoring to be effective and precautionary. Mitigation is achieved without needing a trigger of observable influence at the potential receptors. In fact, in order to be able to ensure a specified target level can be maintained by the mitigation measures, it is necessary to have the trigger wells in reasonable proximity to the recharge well alignment. Furthermore, groundwater monitoring wells immediately adjacent to surface water features have been found to be less effective monitoring tools as they tend to have a water level response that is buffered by the storage and/permeability associated with the surface water feature. Therefore, upgradient trigger well locations are preferred. The Supplemental Monitoring program includes groundwater level monitoring at additional locations, surface water level monitoring with the wetlands (including Wetland 56) and monitoring of	

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Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
				ecological conditions. These additional data are analyzed as required by the AMP Addendum to identify if there are any unforeseen changes and whether any modification of mitigation measures is warranted. Refer also to Response to Comment #12 from the AMP Comments – repeated above in response to Comment # 33 for convenience.	
36.	*'Within the MQEE area, the groundwater chemistry results demonstrate that the groundwater is somewhat independent of the groundwater recharge system, even in the area south of the East Cell recharge system where it would otherwise appear to be downgradient of the recharge system.'* (Page 43, 3rd paragraph) How is this difference in water chemistry taken into account with respect to dissolution of bedrock over time?	Page 43, 3rd paragraph, Section 7.1, Water Chemistry Overview,	Norbert M. Woerns	The evaluation of potential dissolution over time is based on the recharge water chemistry as the recharge water is the dominant component of water recirculating from the recharge alignment back to the quarry bodies. This is the principal dissolution consideration and the analyses by GHD and Dr. Worthington confirm there is no concern of enhanced dissolution due to the chemistry of the recharge water as well as the relatively slower dissolution rate of dolostone (versus limestone which is not part of the Amabel Formation). As stated in the GWRA, Section 7.4, page 46: "… the recharge water is super-saturated with respect to dolomite and would tend to promote the precipitation of dolomite, rather than dissolution." In general, the non-recharge groundwater is also quite 'hard' with little potential for dissolution of the dolostone bedrock.	
37.	There is a distinct difference in surface water quality in Wetland W41 between the upstream and downstream end at stations SG61 and SG6, respectively. A discussion of the results and the potential reason should be provided.	Section 7.3 Surface Water Chemistry, Page 44, 45	CH	SG61 and SG6 are located at opposite ends of Wetland W41 and are not upstream/downstream. Flow is toward the middle of the wetland (e.g., north from SG6 toward SG60, and south from SG61 to SG60). As a result, the discharge from Wetland W41 occurs from approximately the middle of the wetland, flowing south. Some variability in chemistry is anticipated in samples of natural waters. Three parameters demonstrated differences that persisted in both samples: sulfate, sodium, and chloride were greater at SG61 than at SG6; however, concentrations remain low and the difference is small in absolute terms.	

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Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
38.	*'The results of the geochemical modelling demonstrate that the recharge water is super-saturated with respect to dolomite and would tend to promote the precipitation of dolomite, rather than dissolution. The pH of the recirculation water, generally around 8.3, provides supporting evidence that the recirculation water is in equilibrium with the formation. Dolomite would not dissolve in the recharge water unless the pH drops below 7.5 (maintaining all other parameters the same).'* (Page 46, 2nd paragraph) The majority of recent groundwater and surface water samples have pH values below 7.5 as shown in Table 7.1 and 7.2 respectively. It is also not clear what impact this would have on the dissolution potential of recharge water. Clarification is required. *'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.'* (Page 8 section 2.3 Water Main Extension and Control Huts-AMP Addendum Part II, Section A, Interim Mitigation Measures and Rehabilitation) It is not clear what the potential for chemical change in the recharge water is, due to chemical precipitation as noted above in the recharge water system. It is also not clear whether this was considered in the chemical analysis of dissolution potential of the recharge system water. Clarification is required.	Page 46, 2nd paragraph, Section 7.4 Recharge Water Chemistry and Dissolution Potential, (Issue list item1.15)	Norbert M. Woerns	The source of lower pH water is precipitation, which is known to be slightly acidic (carbonic acid) due to dissolved atmospheric carbon dioxide. This phenomenon causes the natural dissolution of carbonate rocks. A full review and assessment of potential impacts associated with this natural occurrence was provided in Appendix E of the GWRA (and noted in Section 7.4 of the GWRA), and was found not to be a concern. The pH value of 7.5 is the point of equilibrium and pH values near this point indicate near-saturation. The dissolution potential of the waters encountered is low and, once mixed with recharge water, becomes non-existent. Recharge water is sampled at the Pumping Station as it enters the system, and then at 3 recharge wells spaced near, mid-distance, and distant from the Pumping Station. These water chemistry data collected over more than a decade of operations indicate that little or no change occurs to recharge water as it travels through the system, and these waters are indistinguishable from one another. This is visually demonstrated on Figure 5.25 of Appendix H of the 5-Year AMP Review. As the Extension has advanced, data have continued to indicate that the water chemistry in the WMS is stable. The MQEE represents a small addition to the WMS and will not alter the recharge water chemistry. Potential variability in recharge water chemistry due to mixing with groundwater was considered and was not identified as a concern (refer to GWRA Section 7.4).	
39.	*'The results from samples collected at the Reservoir Outfall (SW52B) have been used to represent the quarry-related and recharge water in the WMS. All available samples collected at SW52B through the end of 2020 were included in the assessment updating the analysis presented in the 5-Year AMP Review. These results were plotted to compare quarry water* *composition with samples collected from groundwater and surface water in the MQEE, and the results are presented on Figure 7.2.'* (Page 46, last paragraph and page 47, 1st paragraph) Figure 7.2 shows that the Reservoir Outfall water is chemically distinct from groundwater samples taken from East Extension Observation wells. The MQEE observation wells were sampled in 2021. It is not clear to what extent the observation wells on Figure 7.2 have been influenced by the existing WMS (Water Management System). The water	Page 46, last paragraph, and page 47, 2nd paragraph, Section 7.5 Water Chemistry Comparison (Issues list item 1.16)	Norbert M. Woerns	Major ions make up the largest portion of the dissolved solids in natural waters. It takes a large volume of water of one type (a particular ratio of major ions) mixing with another type to significantly change the ratio of the major ions in that water type; therefore, major ion ratios are useful in demonstrating if waters of different types are mixing. Figure 7.2 plots major ion ratios and demonstrates that the recharge water in the WMS has not mixed significantly with water in the MQEE. Samples from each system plot in two different portions of the central diamond with no samples scattered in between. Therefore, if groundwater near the observation wells has been influenced by water from the WMS, it is to a very small extent.	

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Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
	quality difference between the Reservoir Outfall (i.e., recharge water) and the MQEE groundwater quality in the MQEE observation wells is therefore uncertain. Clarification is required. *'Concentrations of the major ions in the WMS are similar to the range measured in the Cabot Head Shale Formation (Table 7.3 in the WRA; CRA, 2000), which indicates mixing of* *groundwater from the Amabel and the Cabot Head Formations (note: water in the quarry cells contacts the shaley beds in the Reynales and Cabot Head as a result of the mining disturbance of the bedrock immediately below the quarry floor).'* (Page 47, 2nd paragraph) The MQEE will be dewatered using a sump in the quarry excavation floor and that this sump will eventually extend into the underlying Cabot Head shales (Section 8.3.1, 3rd paragraph, page 49). The WRA CRA,2000 document referred to above was not provided for peer review comment. It is not clear to what extent the water quality from the Cabot Head shale will affect water quality in the recharge water system. Clarification is required.			The sump for the East Cell will continue to be used for the MQEE to the extent possible. Should another sump (or smaller satellite sump) be required, this small excavation would not be anticipated to significantly change the sites water chemistry, as has been shown through the installation and operation of similarly constructed sumps in the Main Quarry, North Quarry, and Extension Cells.	
40.	*'Infiltrating groundwater and precipitation water will be collected and diverted into the existing integrated WMS system and rehabilitation program for the Main Quarry, North Quarry, West Cell, and East Cell. Any excess water (i.e., not required for mitigation system storage or pumping) will be handled in an appropriate manner through the WMS to optimize the beneficial use of all available water.'* (Page 49, Section 8.3.1,2nd paragraph) It is not clear how excess water will be handled. Clarification is required.	Page 49, Section 8.3.1, 2nd paragraph, Quarry Dewatering.	Norbert M. Woerns	Excess water is handled in accordance with the AMP and the Water Management Agreement. The Water Management Agreement includes an explicit Hierarchy in Schedule 6. In practice, this hierarchy is implemented by CRH and CH through a collaborative dialogue respectful of the ongoing climate conditions and water management needs of CH and CRH. The existing provisions were established and approved by all agencies for the Existing Quarry and will be extended to include the MQEE.	
41.	The Dufferin Spill Response Plan referred to in the 3rd paragraph in this section was not provided for review.	Page 50, Section 8.5, 3rd paragraph, Fuel/Maintenance Management and Spill Response Plan (Issues list item 1.17)	Norbert M. Woerns	Dufferin's Spill Response procedure is an operational tool that CRH uses to assist in managing their obligations relative the Environmental Protection Act and the Ontario Water Resource Act. It was not understood that the details of this plan are within the review mandate for JART; however, the document has been provided within Attachment D.	
42.	*'The water resources that have been identified for protection or enhancement by the proposed MQEE mitigation measures, include:* *•Wetland U1 and Wetland W36* *•Wetlands east of the MQEE area, including: Wetland W41 and to a lesser extent, Wetlands W46 and W56* *•Other features beyond the above wetlands, including the HFRT and Speyside Tributary* (Page 51, 5th paragraph)	Page 51, 5th paragraph, Section 9.1 Water Resource Mitigation – Overview, (Issues list item 1.18)	Norbert M. Woerns	Wetlands W41, W46, W56, and other Speyside Wetlands will be protected by the groundwater recharge well system as described in response to Comment #35 (above) for Wetland W56. Maintaining the target groundwater level between these wetlands and the MQEE extraction area will prevent any negative impacts to these wetlands that might otherwise result from groundwater drawdown in the absence of mitigation. Extensive Supplemental Monitoring is also proposed to confirm that these wetlands are not experiencing any unanticipated impacts as a result of quarry	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
	Diffuse discharge of water into Wetland U1 and W36 is proposed utilizing the WMS along with recharge wells to maintain groundwater levels. It is not clear what other mitigation measures if any will be implemented for Wetland 41, W46, and 56. Neither target water levels nor hydroperiods have been established for these wetlands. Clarification is required.			dewatering. Refer to response to Comment #35 (above) for further discussion.	
43.	*'The primary mitigation design objectives include:* *•Maintaining the existing groundwater regime close to existing conditions during all critical* *periods for the natural features and organisms which are directly dependent on groundwater* *(Refer to NETR/EIA and AMP Addendum).* *•Optimizing the water depth and hydroperiod for Wetland U1 and the upper portion of Wetland W36 to enhance ecological conditions.* *•Maximizing the degree of "passivity" of the mitigation measures.* *•Ensuring 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 response program as described in the AMP Addendum.'* (Page 51. Last paragraph with bullets near bottom of page) 'Maintaining existing groundwater regime' suggests that existing quarry impacts have been approved and do not require mitigation beyond what has already been approved for the existing quarry operations. This should be confirmed. It is noted that wetlands U1 and W36 will be enhanced by optimizing water depth and hydroperiod. To what extent is enhancement required? Note that the NETR/EIA report was not included in this peer review. It is not clear what is meant by *'maximizing the degree of passivity of the mitigation measures.'* Clarification is required. What alternatives have been considered and how have they been demonstrated?	Page 51, Section 9.1 Water Resources Mitigation – Overview, last paragraph and bullets near bottom of page. (Issues list item 1.19)	Norbert M. Woerns	The existing conditions are a result of the approved Existing Quarry operations. The intent of the mitigation measures is not to restore groundwater conditions to a pre-development (natural) state but rather to evaluate the impact of the proposed development in combination with other developments that are already approved. As described in the GWRA and NETR/EIA, Wetlands U1 and W36 have been influenced by past aggregate extraction (e.g., Main Quarry, North Quarry) and their hydroperiods are now shorter as a result of previously approved extraction. Optimizing the hydroperiods of Wetlands U1 and W36 is an enhancement over existing conditions and will ensure suitable conditions for amphibian breeding and recruitment, as well as improving overall wetland conditions. The enhancements for Wetlands U1 and W36 are proposed by CRH as a contribution to achieving a net environmental gain and providing an overall benefit to the Endangered Jefferson Salamander and Unisexual Ambystoma. This will be achieved through the use of proven techniques that are readily implementable as part of the proposed MQEE. Refer also to the responses to other similar comments on existing conditions. For example Comments #32 and #33 above, and their corresponding references to AMP Comment #12 and Comment #2 on the Progressive & Final Rehabilitation Report for discussion in the context of cumulative effects. With respect to the mitigation alternatives evaluation, CRH, CRH's water and ecology consultants, and staff from all the agencies involved have conducted considerable evaluation of potential options for quarry development, both extraction and rehabilitation, in the local region of the Niagara Escarpment landscape. This has included more than 30 years of consultation and collaboration for the Milton Quarry and more than 15 years for the comparable Acton Quarry.	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
				The proposed mix of comprehensive integrated water management, groundwater recharge through wells, diffuse discharge to select wetlands, rehabilitation to lakes has been agreed as the quarry development approach that maximizes the benefits to water resources, including related ecological features in balance with minimizing the long-term active management requirements. The proposed MQEE involves only a modest extension of these measures and results in further enhancement of existing water resources conditions in the MQEE area.	
44.	*'Possible seasonal long-term (post-quarrying and lake filling) groundwater recharge system operation along the south and east perimeter of the MQEE consistent with the potential seasonal recharge approved for the East Cell.' (*Page 52,3rd paragraph,5th bullet) This suggests that seasonal long-term (post-quarrying and lake filling) groundwater recharge system may not be required. The decision-making process with specific procedures and requirements for terminating post-quarrying groundwater recharge operations should be clarified.	Page 52, Section 9.1 Water Resources Mitigation Overview, 3rd paragraph, 5th bullet	Norbert M. Woerns	The decision-making process with respect to the final extent of the long-term water management requirements is incorporated into the approved AMP and associated Site Plan and Legal Agreement conditions which have already been agreed to by the agencies. The final outcomes are subject to review by MNRF and associated agencies as part of the rehabilitation implementation. The Water Management Agreement provides CH with engineering review oversight of the final rehabilitation water management system as they will assume ownership of this system in the long-term.	
45.	*'once lake filling is complete under rehabilitation conditions, the overall groundwater recharge system will largely no longer be required as the lake system will provide the necessary groundwater support. Continued pond-to-pond transfers (pumping of water from the Reservoir to the East Cell Lake with gravity flow to the other lakes) are anticipated to be necessary to maintain the optimum lake levels.'* (Page 53, last paragraph) The above suggests reducing and/or phasing out of the recharge system. What is the anticipated time frame for this to occur? See comment 44 above.	Page 53, Section 9.1 Water Resources Mitigation – Overview, last paragraph (Issues list item 1.20)	Norbert M. Woerns	The recharge system operation will be transitioned to its final long-term condition, which may be "not required", during the lake filling period. As the lakes fill, the demand on the adjacent recharge system areas will diminish as the flow to wells and the number of operating wells will diminish accordingly, while still maintaining acceptable water levels. The filling of the West Cell has commenced in 2022 so the transition has been initiated; however, lake filling has not yet progressed to the level that any reduction in recharge system demand is evident.	
46.	This paragraph states that the groundwater recharge system will no longer be needed once lake filling is complete. Considering that the final MQEE lake elevation is 333.0 masl which is lower than at least seasonal groundwater levels, the downstream wetlands W41, W46 and W56 may be impacted. Water level targets for W41, W46 and W56 should be set and these mitigation measures should be left in place if needed post extraction. More details are needed to ensure protection of these features hydrologic functions.	Section 9.1 Overview, page 53, last paragraph	CH	The protection of all downgradient water resources will be considered in the determination of any long-term seasonal recharge requirements. The AMP requirements provide for suitable evaluation and protection and these protections are extended to the referenced wetlands through the AMP Addendum.	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
47.	*'Water quality will not be appreciably changed by quarry activities as evidenced by monitoring of existing quarry operations and mitigation conditions (as discussed in Section 7 and Section 10).'* From applied research findings from Blackport and Golder 2006, page 53 it is noted: *'Potential water quality impacts associated with changes to the physical system, as a result of aggregate extraction include:* • *A decrease in the contaminant attenuative ability when the soil layer and unsaturated zone is removed. This results in an increased potential for contaminants to enter and travel through the groundwater system from any surface source of contamination (e.g., surface runoff, future land uses)* • *Water quality changes downgradient of a post-extraction lake as a result of exposure of the water table to the atmosphere. These changes include changes in pH and dissolved oxygen that could impact nutrient and metal concentrations, locally down gradient of the post-extraction lake.* • *Thermal plumes from below water extraction and post-extraction ponds were typically very local. Depending on the hydrogeologic setting, the impact was typically less than 200 m.* • *Potential for an influx of poor-quality water from deeper geologic units, in quarrying operations where lower geologic units, of poor water quality, are breached during extraction operations.'* Comment should be provided on the above water quality considerations.	Page 54, Section 9.2, Surface Water, 4th paragraph.	Norbert M. Woerns	All of the generic aggregate site considerations identified in the comment have been considered in the evaluation for the proposed MQEE and are either not of concern or have adequate safeguards in place. There is no evidence of any unacceptable influences from the extensive operation and monitoring experience at Milton Quarry, nor is there any basis for future concern. In brief: • CRH trains their staff and conduct their operations in accordance with spill management and response plans. There is no evidence of aggregate operations impacting surrounding groundwater resources • The Milton Quarry Reservoir is one of the largest water bodies in Halton Region. The water in the Reservoir has been extensively monitored and evaluated for water quality/chemistry as described in the GWRA (Section 7) and the 5-Year AMP Review. The water quality is suitable for all downgradient groundwater and surface water receptors • Extensive thermal monitoring and analysis has been completed for the Existing Quarry and no concerns have been identified. Regardless, there are no aquatic habitats in the vicinity of the MQEE that are sensitive to the modest changes in thermal conditions that could potentially be caused by the quarry • The Amabel Aquifer is underlain by an extensive low permeability aquitard (the Cabot Head Shale) that will remain intact. There is no realistic potential for any water quality impacts as a result of induced seepage through the aquitard.	
48.	*'This existing WMS has been in place and successfully operating to protect water resources since 2007 as described in the 5-Year AMP Review and Annual Monitoring reports.'* [1] Blackport Hydrogeology Inc. and Golder Associates, 2006: Applied Research on Source Water Protection Issues in the Aggregate Industry Phase 1 Findings, November 2006, Prepared for The Ministry of Natural Resources, Natural Resources Management Division, Lands and Water Branch, P.O. Box 7000, 300 Water Street, Peterborough, Ontario, K9J 8M5. 164 p. The 5-Year AMP Review and the 2021 Annual Water Monitoring Report have shown that water levels have been maintained within the three wetlands adjacent to the East Cell. Groundwater levels do not appear to have been restored to pre-extraction levels with the WMS It is however noted that groundwater levels have been maintained above target water levels set for trigger wells.	Page 55, Section 9.3 Interim recharge Mitigation Measures, last paragraph.	Norbert M. Woerns	The mitigation objectives are to maintain target water levels in the three identified wetlands and in groundwater at the designated trigger well locations. The comment correctly notes that these objectives have been met. As noted in response to Comment #32 above (and in response to other comments), it is neither the goal nor a reasonable requirement for the Existing Quarry, or the proposed MQEE, mitigation and rehabilitation measures to restore groundwater conditions to a pre-extraction state. Rather the goal of the mitigation and rehabilitation measures is to maintain or enhance water resources relative to their condition under current approved conditions. The proposed MQEE is appropriate to satisfy this goal."	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
49.	*'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.'* (Page 57, 2nd paragraph) It is recognized that Wetland 36 is located within the historic zone of influence of the Milton Quarry. (See comment 32, issues list item 1.14 above) Enhancements are proposed for Wetland 36 with the seasonal addition of water with diffuse discharges to 2 pool areas in the upper portion of the wetland. The question remains whether this is sufficient for the restoration of the lower portion of wetland 36 considering the impact of the existing Milton Quarry. Clarification is required.	Page 57, 2nd paragraph), Section 9.3.1 Diffuse Discharge into Wetland U1 and Wetland W36, (Issues list item 1.21)	Norbert M. Woerns	The proposed mitigation for Wetland W36 may provide some enhancement to its existing water-related condition (hydroperiod and water depth) in the western portion of the wetland; however the purpose of the mitigation is not to restore all of Wetland W36 to its historic condition (in fact part of it was physically removed by the Main Quarry). The mitigation is focused on what is most ecologically advantageous and practically achievable; that is the enhancement of the two upstream wetland pools to provide suitable conditions to support successful amphibian breeding functions as described in the NETR/EIA.	
50.	*'From a water resource perspective, the objective of the rehabilitation plan is to create an end use that is protective of, or enhances, the existing water resource and ecological features with the minimum active management or engineering works necessary to achieve this objective. To best satisfy this objective, the existing Milton Quarry rehabilitation plan includes allowing portions of the North Quarry, West Cell, and East Cell to be filled with water to create three separate lakes. These three lakes will provide passive support to the surrounding groundwater recharge system, minimizing the need for any active (pumped) recharge in the long term.'* (Page 59, Section 9.4, 2nd paragraph) It is not clear how long the active pumping of water will be required after quarry closure and the amount of water estimated to be pumped. See comments 44 and 45. Clarification is required.	Page 59, Section 9.4, 2nd paragraph, Quarry Rehabilitation , (Issues list item 1.22)	Norbert M. Woerns	Active pumping and water management is required in the long-term based on the current approval for the Existing Quarry. The proposed MQEE does not materially change these requirements. With respect to the groundwater recharge system operation, at a minimum operation will be required until lake filling is complete. The total recharge flow and the number of active recharge wells at any given time will decrease over the lake filling period, subject to the lake filling progression and climate variability. The calculated lake filling timelines and a conservatively (high) estimate of potential long-term recharge requirements are presented in Section 10.3.3.2 and Tables 10.2 and 10.3 of the GWRA.	
51.	*'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.' (*Page 59, 3rd paragraph) This suggests precipitation of carbonate and water quality change during transmission of recharge water to recharge wells. What impact would this have on pH and dissolution potential of recharge water?	Page 59, 3rd paragraph, Section 9.3.3, Water Main Extension and Control Huts	Norbert M. Woerns	Precipitates are identified as a potential source of particulate matter; however, the amount of actual precipitate formation is minimal. This is confirmed by water chemistry data collected at different points within the system. Recharge water is sampled at the Pumping Station as it enters the system, and then at 3 recharge wells spaced near, mid-distance, and distant from the Pumping Station. These water chemistry data collected over more than a decade of operations indicate that little or no change occurs to recharge water as it travels through the system, and these waters are indistinguishable from one another. This is visually demonstrated	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
				on Figure 5.25 of Appendix H of the 5-Year AMP Review. Given that no apparent change in water chemistry occurs as water travels through the WMS, no impact would be expected on the dissolution potential of recharge water.	
52.	It is said that after the lake filling is complete, the three lakes will provide passive support to the surrounding groundwater recharge system, minimizing the need for any active (pumped) recharge in the long term. Can the system be scaled back and stay operational with reduced pumping or possibly periods of no pumping and withstand winter freezing conditions? What sections of the recharge system will be left in place in the long term?	Section 9.4 Quarry Rehabilitation, page 59	CH	Yes, the water management system has been designed to accommodate frozen conditions similar to municipal water infrastructure. In the long term, the water management system will be transferred to CH and decisions about long-term conditions will reside with CH. The long-term operations will include use of much of the system, although at reduced flows and duration.	
53.	*'The lake will include exposed quarry wall areas, particularly in the southeast portion of the extraction area that will serve to support the existing groundwater levels in this area that support the surrounding wetlands.'* Depending upon the local groundwater flow direction and final lake levels, exposed vertical quarry walls, after rehabilitation and lake filling, may contribute to loss of groundwater through seepage into the quarry. In general, it would be advisable to restrict groundwater movement from adjacent areas into the quarry. Therefore, exposed quarry walls, after final rehabilitation, should be minimized. Measures to reduce the loss of groundwater through seepage into the rehabilitated quarry should be undertaken to assist in the restoration of groundwater levels in adjacent areas.	Page 59, Section 9.4, Quarry Rehabilitation, 3rd paragraph.	Norbert M. Woerns	The rehabilitation plans optimize the conditions to create a variety of habitat and the sections of exposed quarry wall areas contribute to passive support of groundwater levels to the south, while limiting the overall fill importation requirements. Overall, GHD understands that the rehabilitated landform is supported from the natural environment review and the Niagara Escarpment Plan also supports the use of exposed quarry walls in the rehabilitation plan.	
54.	*'Maintaining the three lakes at controlled elevations (through pumping and gravity flows) will allow the passive mitigation of water resources associated with the Sixth Line Tributary system, private water supply wells, and the western wetland by maintaining the lakes at a higher elevation than these water resources. This control requires seasonal pumping to the East Cell Lake and controlled gravity overflow cascading to the West Cell and then the North Quarry. Any excess water in the North Quarry will be pumped back to the Main Quarry.'* Why the need to pump excess water in the North Quarry to the Main Quarry? Clarification is required.	Page 60, Section 9.4.1, 2nd paragraph, Background on Existing Approved Rehabilitation	Norbert M. Woerns	The Existing Quarry design and approvals include the ability to pump water back from the North Quarry to the Main Quarry for two purposes: - Retaining water to be able to optimize ultimate beneficial use of the water - To manage the North Quarry lake level There is no gravity outfall from the North Quarry other than an emergency overflow to Sixth Line Tributary that is being incorporated into the rehabilitation design. Therefore, the long-term plan includes the continued use of pumping (as seasonally necessary) to transfer surplus water from the North Quarry to the Main Quarry Reservoir.	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
55.	*'The created East Cell/MQEE lake will have an elevation of approximately 333 m AMSL.'* (Page 61, 2nd paragraph) What feasible actions or mitigation alternatives such as those outlined in Section 9.5 have been considered for implementation to increase the created East Cell/MQEE lake level such that active pumping in the long term after termination of quarry operations, will not be required for protection of adjacent wetlands?	Page 61, Section 9.4.2, MQEE Rehabilitation, 2nd paragraph, (Issues list item 1.24)	Norbert M. Woerns	The East Cell lake level of 333 m AMSL is based on the optimum level for passive mitigation of groundwater levels to the North, along Sixth Line Tributary. The maintenance of desired conditions in other adjacent wetlands is straight-forward under these conditions. This rehabilitation plan is approved and it is not proposed to revise the overall Milton Quarry rehabilitation plan as part of the relatively minor addition of the MQEE area. The proposed MQEE is compatible with the existing approved plans.	
56.	Additional groundwater monitors, thresholds and appropriate contingency actions and/or mitigation measures should be proposed for Wetlands W41, W46 and W56. Please see comments on Sections 6.8.3 and 6.8.4.	Section 9.5 Response Action and Contingency Mitigation Measures, page 61, 62	CH	These wetlands are fully protected by the monitoring and mitigation measures as described in the AMP Addendum and in response to other comments. Refer to responses to previous comments – such as Comment #30, #33 (AMP Comment #12), #34, #35, and #42 above.	
57.	*'The effect of the proposed extraction on runoff to Wetlands U1 and W36 would likely be negligible; however, enhancement is proposed for these features so mitigation measures have been included. Therefore, there is not anticipated to be any negative effect on surface water flow from the proposed MQEE.'* (Page 64 1st paragraph) What is the rationale for enhancement measures of the wetlands if impacts to runoff are considered to be negligible? Clarification is required.	Page 64, 1st paragraph, Section 10.2.1, Surface Water Flow (Runoff), (Issues list item 1.26)	Norbert M. Woerns	Wetlands U1 and W36 are identified to have been influenced by Existing Quarry dewatering effect – i.e. by groundwater influences. Therefore, it is proposed to enhance the existing conditions in these wetlands. Refer to responses to previous comments – such as Comment #21, #32, and #43 above.	
58.	The first paragraph states "there is not anticipated to be any negative effect on surface water flow from the proposed MQEE". Please comment if the required annual discharge of 700,000 m^3 into HFRT is to supplement all of the pre-extraction runoff or just baseflow from the HFRT catchment affected by the quarry?	Section 10.2.1 Surface Water Flow (Runoff), page 64, 1st paragraph	CH	The required 700,000 m3/year of discharge to HFRT is greater than the historic baseflow which was the basis of the original agreement between Dufferin and CH (CH Permit No. 0377 issued April 24, 1989). The larger value of 700,000 m3/year is the result of extensive further consultation between CRH and CH and represents the amount of water they both agreed to commit to as part of the Water Management Agreement. MNRF and MECP supported this value and issued the LRIA and ORA approvals in recognition of the decision by CRH and CH.	
59.	The summary table shows under dry quarry floor and rehabilitation quarry as open water there is no infiltration assumed. In other words, no leakage is assumed through the bottom of the quarry. Water Budget analysis Appendix G Section 3.4.2 Vertical Leakage (page 9) assumes leakage of between 4.7 mm/yr. (quarry floor) to 9.5 m/yr (lakes and wetlands). How were these leakage rates determined what are the vertical hydraulic gradients from below the quarry floor? Clarification is required.	Page 65, Section 10.2.2 Surface Water Balance, Water Balance Summary Table	Norbert M. Woerns	The rates were determined as a component of the original WRA: "The vertical leakage rate from quarry ponds was estimated 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 calculated based on a hydraulic conductivity of 10-7 cm/s for the lower competent Cabot Head Shale, a vertical anisotropy ratio of 10 (Kh/Kv), and vertical gradients of 1.5 and 3.0 for the dry	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
		(Untitled)		quarry floor and rehabilitated lake areas, respectively" [WRA, May 2000, Appendix E, Section 3.4.6] The leakage rates have been confirmed appropriate through numerous updates and analyses since 2000, including a substantial assessment in the 5-Year AMP Review, and update for the GWRA.	
60.	The water balance summary table on page 65 is very generic and does not account for exfiltration and infiltration in and out of the various rehabilitated ponds. Please comment on what the net effect would be relative to the existing conditions including these flows?	Section 10.2.2 Surface Water Balance, page 64, 65	CH	The details of the water balance analyses are presented in the water budget report included as Appendix G to the GWRA; however, these analyses are complex and are not ideal for all readers. The inset table was provided as a simple (generic) illustration of approximate water availability to the watershed over the life the proposed extension. The full analysis presented in Appendix G of the GWRA is consistent with the 5-Year AMP Review Water Budget Analyses, previously reviewed by the agencies.	
61.	*'The evaluation presented above is based on parameters estimated for the Canadian Climate Normals (CCN) period from 1981 to 2010 and is representative of baseline (observed long-term average) conditions. As discussed in Section 5.2.1, assessment was undertaken for the evaluation of changing climate conditions. Two additional climate change scenarios were evaluated that represent potential future conditions representative of the 2050s and 2080s. The parameters applied are representative of a 30-year average (similar to the CCN values) centered on the years identified and are representative of future long-term average conditions.* *The key differences between the current climate scenario and the most distant scenario evaluated (2080's) are an estimated increase in precipitation of 137 mm/year, an increase in evapotranspiration of 82 mm/year, and an increase in lake evaporation of 176 mm/yr.'* Due to uncertainties with regard to future climatic conditions, climate change scenarios should include a scenario with a decrease in precipitation from Canadian Climate Normals. See Comment 16 (Issues list item 1.5) above.	Page 66, first paragraph in Section 10.2.2.1 Impact on Climate Change and page 67, 1st and second paragraphs (Issues list item 1.27)	Norbert M. Woerns	Refer to response to Comment #16 above.	
62.	*'It is noted that short-term variability (e.g., drought) is not a concern now or in the future due to the substantial volume of water in storage at the Site. In the event of severe water availability reduction, the lake filling process could be temporarily postponed, and water could be drawn from storage to sustain operation of the mitigation system. Once rehabilitation is complete, the Reservoir will continue to function as a substantial buffer for the system and provide lake top-up as required.'* Data/calculations to demonstrate that severe drought conditions would not result in adverse down gradient impacts and the required 700,000 m3/yr discharge to the Hilton Falls Reservoir Tributary should be provided. See comment 65 below. What would the downstream impacts be under the various scenarios and what mitigative	Page 66, 3rd paragraph, Section 10.2.2.1, Impact on Climate Change.	Norbert M. Woerns	This matter was addressed to the satisfaction of all agencies, including CH in particular, as part of the Existing Quarry approvals and legal agreements. The past 15 years of operations confirm there are sufficient water storage volumes and protections in place. The proposed MQEE does not materially affect the existing approved situation. The rehabilitation lakes include conservatively large freeboard allowances as have been/will be subject to engineering review by CH in	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
	measures would be required to offset impacts. Do the lakes have sufficient capacity to accommodate major storm events?			accordance with the Water Management Agreement.	
63.	*'Groundwater and surface water regimes will be appropriately maintained as part of the proposed implementation of the AMP Addendum for the MQEE. There are no anticipated negative effects on water resources. The water resources of concern are the wetlands to the south and east of the proposed MQEE extraction area. These water resources will be maintained or enhanced by the proposed mitigation, rehabilitation, and monitoring measures described in Section 9 and the AMP. There are no water supply wells that have the potential to be influenced by the proposed MQEE.'* (Page 66 section 10.3.1 2nd paragraph) It is not clear that the proposed maintenance or enhancement of the water resources will adequately address the existing quarry impacts on the groundwater system. Clarification is required as to how the existing quarry impacts on the groundwater system will be addressed by the proposed mitigation measures. There is no discussion on the potential for impacts on downgradient seeps and springs along the Escarpment. Previous comments pertain to upgradient private wells although there is no reference to possible downgradient water users. Also see Comments 31 and 32 above (Issues list items 1.13 and 1.14 respectively). Clarification is required.	Page 66, Section 10.3.1, 2nd paragraph, Overview – Groundwater Assessment, (Issues list item 1.28)	Norbert M. Woerns	Refer to responses to Comments #31 and #32 above.	
64.	*'The current approved existing quarry extraction and rehabilitation conditions are used as the basis for comparison of proposed future conditions with the MQEE. For the hydrogeologic simulations, this condition is represented using the calibrated model, modified to account for approved full extraction and/or rehabilitation with required mitigation and to reflect long-term average climate conditions.'* This appears to be a reasonable approach for purposes of determining the impact of the MQEE during quarry excavation. It however does not take into consideration the adequacy of the proposed rehabilitated state of the MQEE with respect to the existing quarry impact. It should be noted that the approved rehabilitated state of the existing quarry was beyond the scope of this peer review.	Page 68, 3rd paragraph, Section 10.3.3 Hydrogeologic Assessment	Norbert M. Woerns	The impact assessment for rehabilitation conditions is based on comparison to the approved Existing Quarry rehabilitation conditions. The Existing Quarry rehabilitation conditions are approved and hence do not require review. Refer to response to Comment #32 above.	
65.	*'Under the existing approved quarry conditions, the calculated available annual water volume within the quarry for storage or discharge/mitigation under existing quarry active extraction conditions is 1,311,804 m3. The calculated available annual water volume within the quarry for storage or discharge/mitigation under existing quarry approved rehabilitation conditions is 788,473 m3. The decrease in water availability between the active extraction and rehabilitation scenarios is attributed to the change in land type and associated increase in evapotranspiration, as discussed in the context of the proposed MQEE area in Section 10.2.'* (Page 68, 5th paragraph) As stated above, active annual water volume within the quarry for storage or discharge (i.e., annual surplus) is 1,311,804 m3 for the approved quarry. It is assumed that this includes the Main Quarry, North Quarry, West Cell and East Cell. It is noted that the	Page 68, 5th paragraph, Section 10.3.3, Hydrogeologic Assessment.	Norbert M. Woerns	Refer to response to Comment #62 above.	

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Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
	reservoir in the Main Quarry has a total capacity of 5.5 million m3. (Page 55, section 9.3, 3rd paragraph ,1st bullet). The rehabilitated main quarry reservoir appears to have sufficient storage volume to supply the Hilton Falls Reservoir Tributary for a number of years. Table 10.2, Predictive Site Water Budget indicates that the WMS pumps 5,180,453m3/yr under interim extraction conditions without considering the MQEE. The water budget schematic, Figure 3.1, from Appendix G, Water Budget Assessment, indicates that 95% of the pumped water is recirculated back into the quarry. The recirculated pumped water from the WMS appears to be included as groundwater inflow on Table 10.2. The amount of groundwater inflow available to the approved quarry from external areas is therefore significantly smaller than the total groundwater inflow indicated on Table 10.2. The amount of annual surplus water from the approved quarry is expected to be much smaller than indicated on Table 10.2. This reinforces the need to consider drought conditions in the climate change scenarios. Clarification is required. See Comment 61 (Issues list item 1.27) and Comment 62 above.				
66.	*'The simulated hydrogeologic conditions shown on Figure 10.1 demonstrate that the proposed mitigation of water resources during the interim period will generally maintain or raise groundwater levels in the vicinity of the proposed MQEE area.' (Page 69, second paragraph)* Figure 10.1 shows that groundwater levels are augmented and slightly increased beyond the recharge wells. Between the recharge wells and the MQEE excavation groundwater levels are shown to decrease up to about 10m beneath Wetland U1. This indicates that groundwater levels are not maintained between the recharge wells and the quarry excavation. Clarification is required of the above statement.	Page 69, 2nd paragraph, Section 10.3.3.1 Interim Conditions – Groundwater Assessment (Issues list item 1.29)	Norbert M. Woerns	The intent of the referenced statement (Page 69, second paragraph) is to state that groundwater elevations are generally maintained or raised in the vicinity of the proposed MQEE area beyond the recharge wells. It is expected that groundwater elevations will decrease between the MQEE excavation and the groundwater recharge wells.	
67.	*'There are no areas influencing water resources where the groundwater level is not maintained (decreases are shown with negative (purple) contour lines) or raised under these representative simulation conditions.'* (Page 69, 4th paragraph) This statement is unclear and requires clarification.	Page 69, 4th paragraph, Section 10.3.3.1 Interim Conditions – Groundwater Assessment (Issues list item 1.29)	Norbert M. Woerns	This statement is intended to convey that the groundwater elevations are maintained or increased beyond the recharge well locations. Therefore, all water resources located beyond the recharge wells are not impacted. The one wetland located in an area of groundwater drawdown is Wetland U1 which will be enhanced by diffuse discharge.	
68.	*'The total annual available water inflow to the quarry for the proposed full extraction condition with the MQEE is simulated to be 7,369,573 m3. _ _ _ There is clearly sufficient water available to provide the proposed mitigation and enhancement for water resources associated with the MQEE area and the existing quarry'.* Water from recharge wells and diffuse flow to wetlands via the WMS appears to be recirculated back into the quarry and included in the groundwater inflow quantities as suggested by Figure 3.1 Appendix G. The available water to the quarry from external sources on an annual basis appears to be significantly lower than indicated in Table 10.2 Clarification is required. See Comment 65.	Page 70, 2nd paragraph, Section 10.3.3.1, Interim Conditions, (Groundwater Assessment, Predictive Site Water Budget, Table 10.2 Groundwater Inflow).	Norbert M. Woerns	It is correct that the groundwater inflow values in Table 10.2 include the recirculating portion of the recharge flow as those flows are represented in the groundwater model. Under extraction conditions, this recirculating flow is larger than the 'external' groundwater inflow. These facts are accounted for in the water budget calculations.	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
69.	*'As per the existing approved Milton Quarry Extension, if monitoring indicates the final lake level is high enough to support the eastern wetlands and sufficient seasonal fluctuations in water levels occur, the groundwater recharge system operation will be discontinued. Due to the variability and uncertainty inherent in the hydrogeologic system, this cannot be definitively established at this time. Therefore, the proposed MQEE may require extension or modification of the potential seasonal recharge system operation approved for the East Cell and has been allowed for in the proposed MQEE rehabilitation plans.'* What decisioning process is in place to determine when recharge system and diffuse discharge can be terminated? It is not clear who makes that decision and what criteria will be used to make that decision. Clarification is required.	Page 70, Section 10.3.3.2, 3rd paragraph, Rehabilitation Conditions.	Norbert M. Woerns	Refer to response to Comment #44 above for explanation of the decision-making process regarding the long-term water management measures.	
70.	Considering the time required for lake filling and given that the proposed final lake levels are lower than the groundwater levels in the area, there is a potential for impacts to W41, W46 and W56. As such, the groundwater recharge system would need to be left in place to ensure that requested target levels for W41, W46 and W56 are maintained and until it can be demonstrated through monitoring that the recharge system is not necessary to maintain them. The above needs to be addressed in updates to the AMP.	Page 70, Section 10.3.3.2, 3rd paragraph, Rehabilitation Conditions.	CH	The need to consider the potential need for long-term groundwater recharge system operation is an existing AMP requirement that also extends to the proposed MQEE. Refer to AMP Addendum Part I, Section 3.2 and Section 3.3 as well as Part II, Section E.3.4.	
71.	Considering, lake filling may take several years to establish after quarry rehabilitation, similarly to previous comments, who would be responsible for the groundwater recharge system in terms of assessment, decision making, etc.? This needs to be addressed in updates to the AMP.	Page 70, Section 10.3.3.2, 3rd paragraph, Rehabilitation Conditions.	CH	The ARA Licence holder is fully responsible during the extraction and lake filling periods until the transfer to CH. This is specified in the AMP Addendum (refer to Part I Section 2, 3, and 4).	
72.	The climate change scenarios assumed increase in precipitation but did not consider the possibility of decreasing precipitation. Justification for this is required with detailed analysis. See Comment 16 (Issues list item 1.5), Comment 61 (Issues list item 1.27), Comment 62 and Comment 65.	Page 72, Section 10.3.3.3.3 – Assessment of lake filling time and impact of Climate Change, 6th paragraph (Issues list	Norbert M. Woerns	Refer to response to Comment #61 above.	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
		item 1.30)			
73.	See Comment 38 (Issues list items 1.15) and Comment 39 (Issues list item 1.16).	Page 73, Section 10.3.4 Water Quality, (Issues list item 1.31)	Norbert M. Woerns	Refer to responses to Comments #38 and #39 above.	
74.	*'The Milton Quarry and the proposed MQEE are located outside of all Wellhead Protection Areas (WHPAs), as presented on Figure 2.7'.* (Page 74, Section 10.3.5,1st paragraph) This area is also recognized as an area of Significant Groundwater Recharge. (SGRA) and is also designated as a Highly Vulnerable Aquifer (HVA). The report concludes that *'The overall groundwater recharge will be maintained or enhanced in the SGRA as part of the MQEE'*. (Page 74, section 10.3.5,2nd paragraph.) This is attributed to the recharge system which *'is operated to maintain groundwater levels that are at, or above target water levels at trigger wells*. (Page 74, section 10.3.5, 2nd paragraph). There is no discussion regarding the possible reduction or termination of the recharge system or portions of the recharge system under post rehabilitation conditions and the impact this may have on groundwater recharge. Details are lacking to support the above noted conclusion. The extraction of bedrock as part of MQEE will expose the underlying aquifer including the bottom of the quarry as well as the quarry walls. A detailed discussion is lacking with respect to the possible change in vulnerability of the Amabel Aquifer within the MQEE area between existing conditions and proposed post rehabilitation conditions. A discussion of measures proposed to reduce the vulnerability of the aquifer und post rehabilitation conditions should be included. See Comment 7 (Issues list item 1.1) and Comment 47 above.	Page 74, Section 10.3.5, 1st paragraph, Source Water Protection Considerations, (Issues list item 1.32)	Norbert M. Woerns	The rehabilitation scenario assessment includes passive support for areas adjacent to the North Quarry, West Cell, and north side of the East Cell, with operation of recharge wells along the east side of the East Cell and adjacent the MQEE. Significant discussion of this scenario is provided, including Section 10.3.3.2 of the GWRA that provides a full impact assessment for groundwater. The impact assessment contains the evaluation of rehabilitation conditions as proposed, including all details necessary to determine changes in groundwater availability. No reductions in groundwater levels or availability are proposed relative to approved conditions. With respect to potential contamination of groundwater, the proposed extraction does not change the aquifer vulnerability under Source Water Protection evaluations as it is already classified as Highly Vulnerable due to the natural hydrogeologic conditions. The MQEE, in fact the entire Milton Quarry is outside of any Source Water Wellhead Protection Areas (WHPAs) as described in the GWRA (Section 6.6 and Section 10.3.5). Furthermore, CRH trains their staff and conduct their operations in accordance with spill management and response plans. There is no evidence of aggregate operations impacting surrounding groundwater resources. Furthermore, under both active extraction and rehabilitation conditions, the direction of groundwater flow at the extraction limit is generally inward. In both	

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				active extraction and rehabilitation scenarios, recharge mounds are created by either recharge wells or wetland diffuse discharges, generating small gradients toward the excavation. A limited amount of discharge would be expected to occur from the south end of the MQEE; however, groundwater in this area reports to the Main Quarry.	
75.	*'The water resources characterization and impact assessments presented in this report have considered the potential for cumulative effects that may arise from the development of the proposed MQEE. The proposed MQEE has been designed and evaluated in manner that is fully integrated with the existing quarry. The AMP/AMP Addendum and its mitigation, monitoring, and response actions directly ensure the protection or enhancement of features and functions related to water resources in the vicinity of Milton Quarry and the proposed MQEE. There are no known other forms of development identified in the immediate study area (refer to the Planning Summary Report,) that would contribute to a significant cumulative effect on water resources in the area of Milton Quarry.*' (Page 74 last paragraph, page 75,1st paragraph The existing groundwater impacts of the Dufferin Quarry have been combined with those anticipated from the MQEE as shown in Figure 10.1 and 10.2. Impacts from the existing Dufferin Quarry have not been identified separately from those anticipated from the MQEE. It is not clear whether the trigger levels will acknowledge the existing impacts of the existing approved Dufferin Quarry. See Comment 18 (Issues list item 1.6).	Page 74, last paragraph and page 75, 1st paragraph, Section 10.4 Cumulative Effects, (Issues list item 1.33)	Norbert M. Woerns	Refer to response to Comment #32 above. Maintaining the target water levels for trigger wells will maintain the groundwater levels and protect water resources beyond the alignment of the trigger wells.	
76.	Some of the groundwater elevation data is reported as depths rather than as elevations (masl), which makes understanding and comparison of the dataset difficult. Recommend updating this section to include the groundwater data as elevations in meters above sea level.	Appendix D, Table D.1, page 27 onward	CH	Groundwater elevations are reported wherever possible; however, some domestic wells do not have a surveyed reference elevation. In these instances, the depth to water was reported rather than the elevation. If reproduced, the table header will be adjusted to reflect that these measurements are depths (m) and not elevations (masl).	
77.	Monitoring for surface water and wetlands is only for 2 years (2020/2021). Does this period contain the full range of conditions? (Wet, dry and normal year?). Several of the surface water observations state that they were dry but have observed water in the past.	Multiple Sections	CH	While some new monitoring locations are only available commencing in 2020, extensive historical data (some spanning more than 4 decades) is available at some locations and all available data was used in the MQEE analysis. The data represents the years in which it was collected. The climatic context of the data is discussed in the GWRA report, particularly where the time period is only recent. Monitoring continues and an updated data set will be provided in the Pre-Extraction Report as identified in the AMP Addendum.	

	JART Comments (December, 2022)	Reference	Source of Comment	Applicant Response (January 2023)	JART Response
Report/Date: Geology and Water Resources Assessment Report December **2021**			**Author: GHD**		
78.	General note for all drawings: Labels for wetlands and other natural features are sometimes 'floating' and not clearly associated with an individual feature (example W37, W38, W39) or are missing altogether. Please ensure figures are easy to read and that labels clearly indicate the feature.	Geology and Water Resources Assessment Report	CH	Noted.	
79.	Dufferin proposes as part of the MQEE to artificially maintain water levels in Wetland U1. Since there has been no traditional surface water assessment (hydrology) using design events nor any hydraulic evaluation of the outlet channel, it is suggested that these investigations be completed to inform the planning and management of the feature. It is suggested that this be conducted as a form of sensitivity analysis to ensure there are no risks of flooding or erosion. A worst case analysis is considered appropriate which uses detailed topography/bathymetry of the wetland and channel extended to W36. Dufferin proposes as part of the MQEE to artificially maintain water levels in Wetland U1 through the WMS which relies on injection wells and target wells to provide water to features of significance. As noted, since there has been no traditional surface water assessment (hydrology) for Wetland U1 using design events or severe recorded events nor any hydraulic evaluation of the outlet channel from this feature, it is suggested that these investigations be completed as a further test and complement to work completed to-date. It is suggested that this work could further inform the planning and management of the feature in terms of water levels over multi-seasons including severe storms. It is suggested that this be conducted as a form of sensitivity analysis to ensure there are no risks of flooding or erosion in the downstream lands which could be exacerbated by artificial filling of the wetland. A worst-case analysis is considered appropriate which uses detailed topography/bathymetry of the wetland and channel properties extended to Wetland W36.		Ron Scheckenberger	The proposed MQEE mitigation for Wetland U1 will not result in an increase of potential risk of downstream flooding. In order to illustrate this fact, as requested an evaluation of storm runoff for "worst-case" conditions has been provided in Attachment E and described below. Wetland U1 has a maximum depth of approximately 0.5 m and depression storage within the feature is minimal relative to the catchment size. Total storage in the wetland is approximately 600 m^3 at the discharge elevation of 338.09 masl, and only 400 m^3 at the proposed maximum target elevation of 338.00 masl. As a result, the maximum potential reduction of wetland storage during operating conditions is 400 m^3. For this analysis the Rational Method was employed to estimate total runoff for a 100-Year/12-Hour storm event. Land use was considered and runoff coefficients were used corresponding to both the land types and return period of the event (100-Year). The runoff coefficients used are 0.41 for pasture/range, and 0.39 for woodland areas. The runoff calculation was completed for current approved and proposed MQEE conditions to assess the potential impact of reduced storage in Wetland U1. Under current conditions, total runoff is anticipated to be approximately 4,400 m^3. Given potential maximum storage of 600 m^3 in Wetland U1, the net release to the discharge channel would be 3,800 m^3. For proposed MQEE conditions, the total runoff is estimated to be 2,600 m^3. Given storage of 200 m^3 (storage between 338.00 and 338.09 masl), the total runoff release is estimated to be 2,400 m^3. – approximately 63% of the current potential release. This simple analysis demonstrates that under future proposed conditions the channel would be	

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				expected to experience a reduced discharge volume in a “worst-case” scenario. This is consistent with GHD’s understanding and would be expected since the catchment for Wetland U1 is reduced by approximately 40% for proposed MQEE conditions. Flooding and potential erosion during a significant (e.g., 100-Year) event are not a concern as the Wetland U1 discharge channel reports to Wetland W36, and ultimately to the Main Quarry, both of which are capable of conveying the potential water volumes which would be lower than under historic/current conditions as demonstrated above.	

Attachments:

Attachment A: Groundwater Contour Maps from Annual Monitoring Reports: April 2020, October 2020, April 2021. As referenced in response to Comment #8.
Attachment B: GWRA Figure 5.2, revised as Figure 5.2rev1 to show labels for HF-1 and HF-2 as referenced in response to Comment #19.
Attachment C: AMP Addendum Figure 4 and 5, revised as Figure 4rev1 and Figure 5rev1 to show updated trigger well locations as referenced in response to Comment #34.
Attachment D: CRH Spill Response Procedure as referenced in response to Comment #41.
Attachment E: Supporting Material for Illustrative Worst-Case Storm Runoff Calculation for Wetland U1 as referenced in response to Comment #79.

Attachments

Attachment A

Groundwater Elevation Contour Plots

0 100 200 300m

PHASE 2 (WEST CELL)

PHASE 3 (EAST CELL)

PHASE 1 (NORTH QUARRY CELL)

NORTH QUARRY

ROCK PILLAR

RAMP

HILTON FALLS (Side Trail)

BRUCE TRAIL (Side Trail)

SIXTH LINE TRIBUTARY

SPEYSIDE TRIBUTARY

FIRST LINE (UNOPENED ROAD ALLOWANCE)

RECHARGE BASIN STATION

DYKE C

LEGEND

- WATER ELEVATION MONITORING LOCATION
- 324 GROUNDWATER CONTOUR (m AMSL)
- PROPERTY LINE
- LICENSED LIMIT OF EXTRACTION
- MUNICIPAL BOUNDARY
- DUFFERIN OWNED BUFFER
- DUFFERIN OWNED LICENSED
- DUFFERIN LEASED
- WETLAND IDENTIFIED AS PROVINCIALLY SIGNIFICANT
- WATERMAIN (AS-BUILT/EXISTING)
- MAIN QUARRY LIMITS DECEMBER 2008
- EXTRACTION LIMITS - LOWER BENCH DECEMBER 2020
- EXTRACTION LIMITS - UPPER BENCH DECEMBER 2020
- EXTRACTION LIMITS - FLOOR BENCH DECEMBER 2020

NOTE:
THE NORTH QUARRY AND EXTENSION PORTIONS OF THE GROUNDWATER RECHARGE WELL SYSTEM WERE OPERATING AT THIS TIME.

Dufferin Aggregates

GHD

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
BOUNDARY INFORMATION COMPILED FROM SURVEYS AND SKETCHES PREPARED BY FRED G. CUNNINGHAM, ONTARIO LANDS SURVEYORS, MILTON, ONTARIO, DECEMBER 2,1997.

figure 5.35

GROUNDWATER CONTOURS - APRIL 2020
NORTH QUARRY AND EXTENSION
MILTON QUARRY
Region of Halton, Ontario

N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(166)\10978(166)GN-WA009.DWG Plot Date: MAR 18, 2021

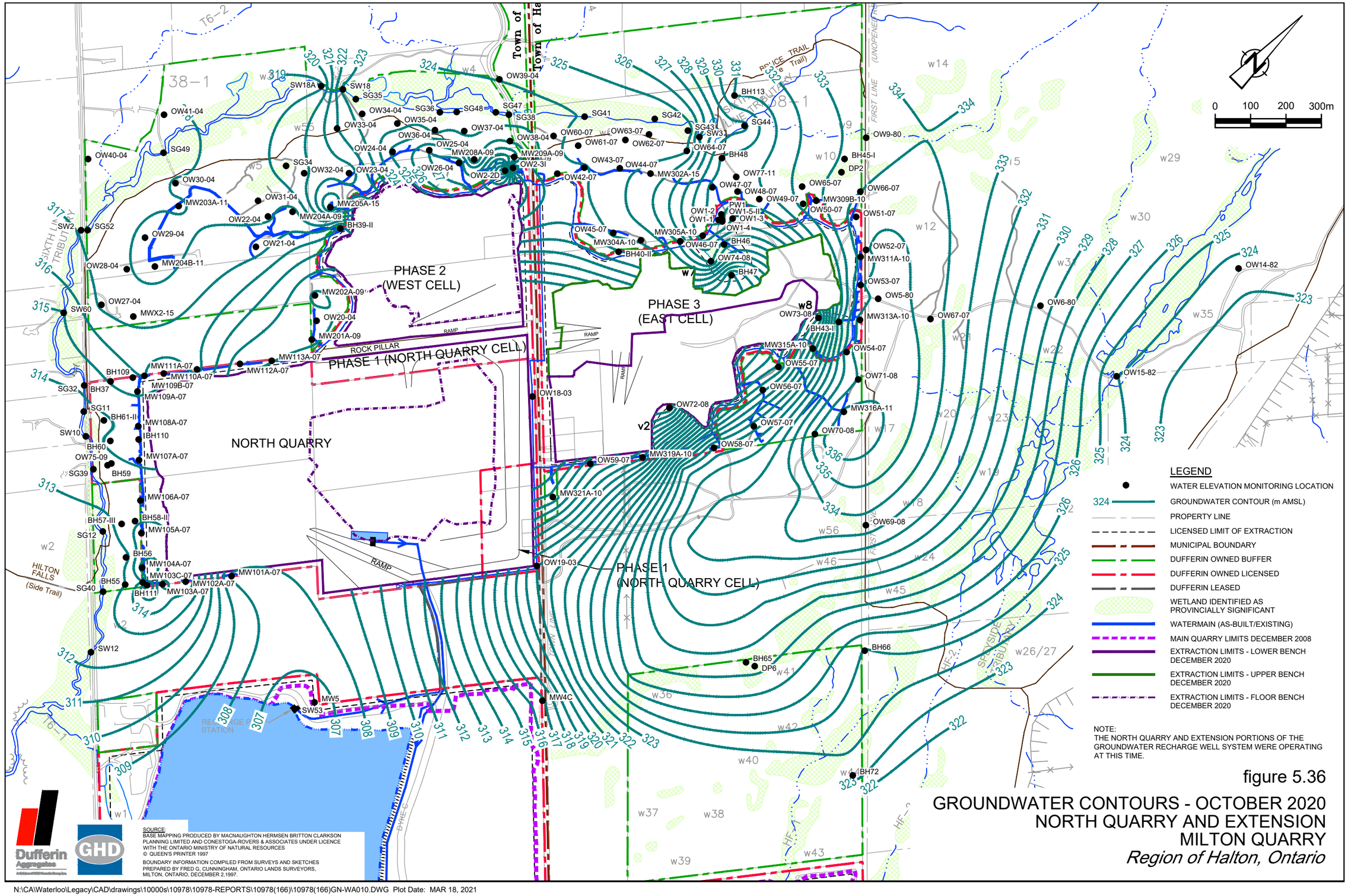


figure 5.36

GROUNDWATER CONTOURS - OCTOBER 2020
NORTH QUARRY AND EXTENSION
MILTON QUARRY

Region of Halton, Ontario

N:\CA\Waterloo\Legacy\CAD\drawings\10000s\10978\10978-REPORTS\10978(166)\10978(166)GN-WA010.DWG Plot Date: MAR 18, 2021

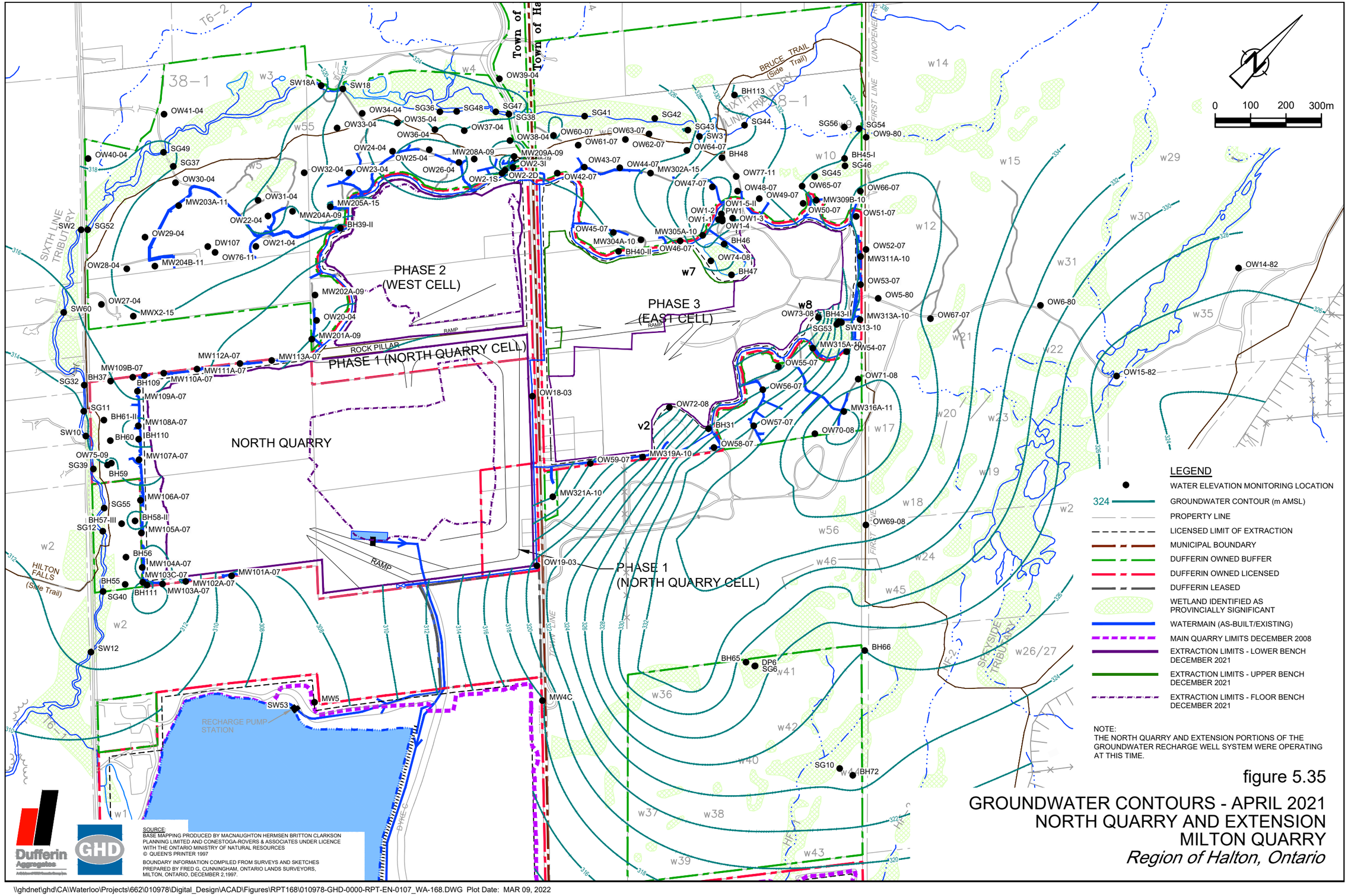


figure 5.35

GROUNDWATER CONTOURS - APRIL 2021
NORTH QUARRY AND EXTENSION
MILTON QUARRY

Region of Halton, Ontario

\\ghdnet\ghd\CA\Waterloo\Projects\662\010978\Digital_Design\ACAD\Figures\RPT168\010978-GHD-0000-RPT-EN-0107_WA-168.DWG Plot Date: MAR 09, 2022

Attachment B

GWRA Figure 5.2Rev1

EAST CELL

NORTH QUARRY

EAST EXTENSION

MAIN QUARRY

TOWN LINE

DRAINAGE CHANNEL HIGH POINT (338.09)

SW47 SW38D SW5-80A SW5-80B

IN1-07

DW111 DW112 DW113 DW113A DW114 DW115 DW116 DW116A DW117 DW118 DW118A DW119 DW119A DW120 DW120A DW121

OW18-03 OW19-03 OW2-80 OW59-07 OW72-08 OW55-07 OW56-07 OW57-07 OW58-07 OW71-08 OW70-08 OW69-08 OW79S-20 OW79D-20 OW78S-20 OW78D-20 OW80-20 OW81-20 OW83-21 OW82-20 OW1-80 OW3-80 OW3-1-I OW3-1-II OW3-1-III OW3-2-III OW3-2-I OW3-3-II OW3-3-III OW3-3-I OW10-80 OW11-80 OW4-80 OW3-2-II OW15-82

MW319A-10 MW321A-10 MW316A-11 MW4B MW4A MW4C MW4

BH31 BH42 BH1-80A BH6-60 BH36 BH35 BH33 BH12-I BH12-II C1-I C1-III C1-II BH64 BH65 BH66 BH67 BH68 BH71 BH72 BH4-60 BH5-60 BH2-60

Barn Well TW1-80

SW319-10 SW4-80A SW4-81B SW4-81C SWDP4 SWDP6 DP4 DP6 DP7 DP8

SG31A SG31 SG5 SG6 SG7 SG10 SG18 SG57 SG58 SG59 SG60 SG61 SG62 SG63 SG64 SG65 SG66

CUL_N CUL_S SW6-81

w17 w18 w19 w20 w23 w24 w25 w26/27 w36 w37 w38 w40 w41 w42 w44 w45 w46a w46b w46c w46d w46e w46f w56

u1

HF-1 HF-2

BRUCE TRAIL (Posted Joint Trail)

328 330 332 334 336 338 340 342 344 346 348 350 322 324 326 320 288

LEGEND

CATCHMENT DIVIDE

SUB-CATCHMENT DIVIDE

0 50 100 150m

Coordinate System: UTM17m NAD27

GHD

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

SITE SURFACE WATER DRAINAGE

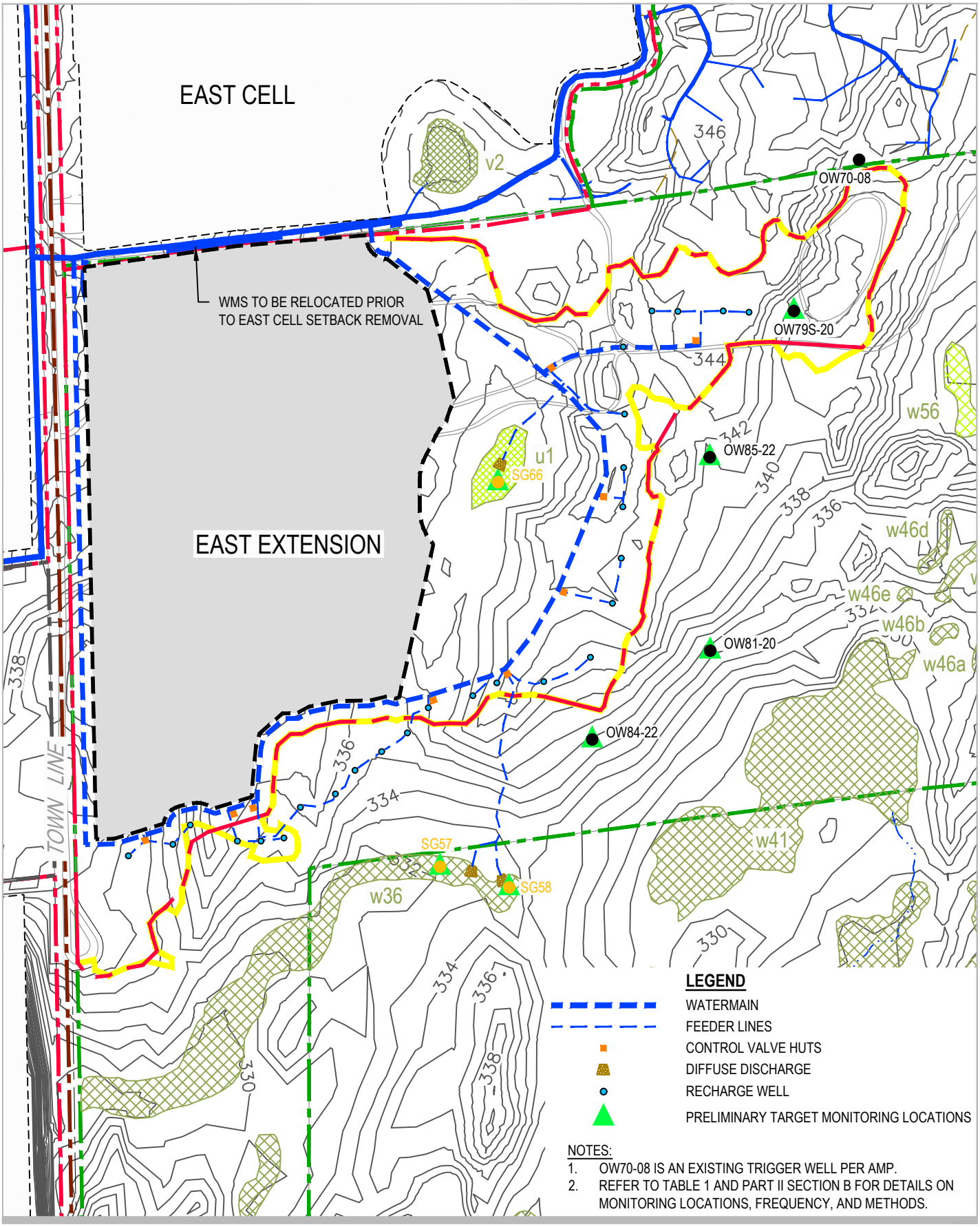
Project No. **10978-200**
Date **January 2023**

FIGURE 5.2 REV 1

Filename: \\ghdnet\ghd\CA\Waterloo\Projects\662\010978\Digital_Design\ACAD\Figures\LTR025\010978-GHD-00-00-LTR-EN-D104_WA-025.dwg
Plot Date: 25 January 2023 4:14 PM

Attachment C

AMP Addendum Figure 4Rev1 and Figure 5Rev1



0 50 100 150m

1:5000

Coordinate System: UTM17m NAD27

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

Project No. **10978**
Date **January 2023**

PRELIMINARY PERFORMANCE TARGET MONITORING LOCATIONS

FIGURE 4 REV 1

Filename: \\ghdnet\ghd\CA\Waterloo\Projects\662\010978\Digital_Design\ACAD\Figures\LTR025\010978-GHD-00-00-LTR-EN-D101_WA-025.dwg
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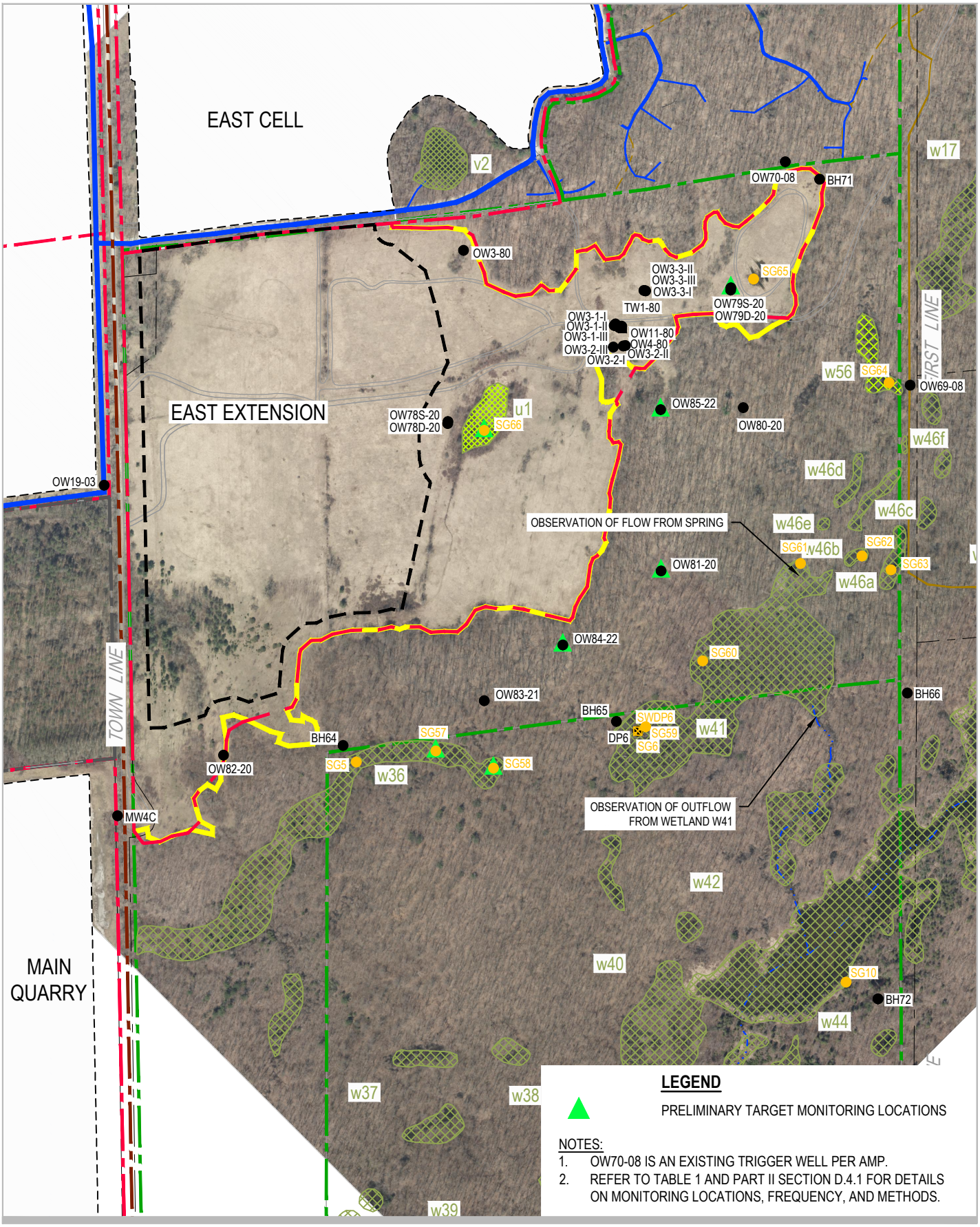

0 60 120 180m

Coordinate System: UTM17m NAD27

CRH MILTON QUARRY EAST EXTENSION
REGION OF HALTON, ONTARIO

SUPPLEMENTAL WATER LEVEL MONITORING LOCATIONS

Project No. **10978**
Date **January 2023**

FIGURE 5 REV 1

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Plot Date: 25 January 2023 4:15 PM

Image: 2019 Halton Region Orthoimagery from First Base Solutions.

Attachment D

CRH Spill Response Procedure

1.0 PURPOSE:

To protect human health and safety, prevent or mitigate adverse environmental impacts, and ensure that Dufferin Aggregate (DFA) and Dufferin Concrete (DC)/Ontario Redimix (ORM) sites properly manage spills and follow consistent reporting procedures. To enable better tracking of the causes of spills and facilitate the implementation of improved control measures.

2.0 SCOPE:

This Work Instruction (WI) outlines response actions for potential spills of any size at all DFA and DC/ORM facilities. The WI details spill response procedures that will minimize potential health and safety hazards, environmental damage, and clean-up efforts.

3.0 DEFINITIONS:

Adverse Impact: the impairment of the quality of the natural environment, injury or damage to property, plant or animal life, harm or material discomfort to any person, loss of enjoyment of the normal use of property or interference with the normal conduct of business.

Containment: an impervious structure preventing a liquid or material from entering the natural environment

Corrective Action: action to eliminate the cause of a detected non conformity

Natural Environment: air, land and water, or any combination or part thereof

Non – conformity: failure to conform to regulatory requirements, accepted environmental standards, and/or the operating standards established by a company.

Non Reportable Spill: a spill that needs to be reported internally only

Reportable Spill: a spill that must be reported to the Ministry of the Environment & Climate Change (MOECC) Spills Action Centre (SAC)

Spill: a discharge of any substance (liquid, powder or solid) into the natural environment (air, land or water) from a structure, vehicle or other container that is abnormal in quality or quantity.

Subject Waste: hazardous or liquid industrial waste as defined by O. Reg. 347 (Ex: waste oil, waste antifreeze)

4.0 RESPONSIBILITY:

All employees at all DFA and DC/ORM sites are responsible for implementing the procedures of spill response described in this WI.

The Manager at each site is responsible for ensuring that the WI is implemented.

The Environment Department is responsible for revising and reviewing the WI.

The Manager, Environment is responsible for authorizing the WI.

5.0 WORK INSTRUCTION:

5.1 Preparedness

5.1.1 Preparation for the possibility of a spill or release of any product at DFA and DC/ORM sites is the key to minimizing impact to the natural environment, employee health and safety, and private property.

5.1.2 Spills can occur at anytime:

- During transportation to or from sites;
- While loading or un-loading products on site and during delivery;
- Leaks from storage containers or piping;
- From third parties working on site; and,
- During regular handling of products.

5.1.3 To be prepared for any spill incident, there are universal product spill kits located at every DFA and DC/ORM site. The spill kits shall be:

- Accessible in areas where activities that pose a risk may occur, with the locations documented in the Site Emergency Response Plan (DFA) or Site Specific Contingency Plan (DC/ORM). Consideration should be given to service vehicles being fitted with compact mobile spill kits.
- Stored in a drum or sealed container, and hold the appropriate materials for the products used in the area, such as:
    - A list of contents;
    - Chemical resistant gloves;
    - Absorbent pillows, pads and socks;
    - Plastic bags, sheets or tarps and ties;
    - Drain covers (for maintenance shops); and,
    - Goggles and/or safety glasses.

5.1.4 Being prepared for a spill includes awareness and understanding of the site specific conditions in which you work, including:

- The locations of the nearest water bodies (creeks, rivers, ditches, catch basins, floor drains and manholes);
- Refer to Site Emergency Response Plan (DFA) or Site Specific Contingency Plan (DC/ORM) for a map of all surrounding environmental receptors (water bodies, residential dwellings, commercial zones, etc.)
- Knowledge and awareness of the products that could be released;
- Location of the on-site spill kit(s) and how to use the equipment in the kits;

- Locations of Material Safety Data Sheets (MSDS) for all products on site;
- Location of centralized list of hazardous chemicals identified in the EMS;
- Correct reporting procedures for all levels of spills and environmental releases; and,
- Location of the nearest hospital, fire station and police station.

5.1.5 In order to comply with environmental legislation, it is essential that a facility respond quickly and appropriately to a spill, taking all necessary measures to minimize the impact of the spill or release. Response activities include:

- Internal and external notification;
- Situation assessment (**see Section 5.3 for spill categories**), and;
- Incident specific procedures

5.1.6. The site manager or designee shall ensure that:

- Best management practices are applied to all activities that may result in a spill, such as fuel transfer from storage tanks, vehicle operation, storage of chemical products, handling of subject or hazardous waste and handling of concentrated dust suppressants;
- Third parties handling a regulated substance have a spills management plan and spill kits, or are supervised by trained employees; and,
- MSDS for products used on site (gasoline, diesel, solvents, admixtures, etc.) are available

5.2 Response

The guiding principal of spill response is safety: always know what product you are dealing with, and always use the appropriate personal protective equipment (PPE). If there is uncertainty regarding what the product is, or what PPE is required, refer to the instructions stated on the MSDS, or report the spill and wait for instructions. After assessing the situation for potential hazards (such as fire, explosion, general safety, etc) ***the following response shall be taken for all levels of spills <u>if it is safe to do so</u>:***

5.2.1 <u>Any DFA or DC/ORM employee noticing a spill shall:</u>

- Cease all activities that are fire hazards. Small work areas shall be evacuated immediately as per Health and Safety Procedures until the supervisor is contacted;
- Immediately eliminate the source of the spill (i.e. plug leak, turn off valve, or shut off source);
- If possible, contain the spill and block path to drains or surface water by using the materials provided in the Spill Kits, and begin the cleanup procedure;
- Cease all pumping or gravity discharge of water in the affected area (DFA);
- Communicate to supervisors/managers:
  - Substance spilled, approximate quantity, location and time
  - Status of containment, self contained or free flowing
- Assist the supervisor in completing the Incident Investigation Report (XA.05.B08.FR.01)

5.2.2 <u>The most senior employee at the time of the incident shall</u>:

- Identify the spill category (see section 5.3);
- Notify all applicable parties as per section 5.3.2

- Supervise the containment and cleanup of the spill (unless a supervisor/manager has arrived to assume this responsibility);
- Report all spills in accordance with site specific permits (i.e. submission of a written report to the MOECC District Manager if it is required under the site Environmental Compliance Approvals). Contact the CRH Canada Environment Department for assistance.
- Contact an Emergency Response Contractor (listed in Appendix A) if cleanup cannot be performed by site staff. Request documentation of spill cleanup and removal of impacted material from site.
- Prepare the Incident Investigation Report for the spill and submit to the CRH Canada Environment Department; and,
- Ensure all cleanup materials are appropriately accounted for and disposed of, and the Spill Kit is restocked accordingly.

5.3 Spills Classification and Notification

For additional information on classifying spills as either reportable or non-reportable, refer to the MOECC Spill Reporting Requirements Flowchart, in Appendix B.

5.3.1 REPORTABLE Spills

A Reportable Spill is an accidental or intentional release of any product, liquid or otherwise, that can possibly cause harm to life, property or the natural environment. A spill is considered REPORTABLE if one or more of the following occurs:

- The release of any product **greater than 100L** into the natural environment;
- The release of any quantity of a product that **enters or has the potential to enter any waters either directly or through drainage structures** (eg: catch basin, floor drain, or direct to a watercourse or DFA settling pond);
- Any **fire** on or off site that requires external assistance to control;
- The release or discharge of any quantity from a **stationary source** that enters the natural environment;
- The release or discharge of any product from a vehicle/mobile equipment when greater than 100L spills outside of an engineered containment structure;
- The release or discharge of any quantity of an **unknown product or** any product of **unknown quantity,** or;
- The release of **subject waste in any quantity** into the natural environment

5.3.2 Notification for REPORTABLE Spills

If a reportable spill occurs on or offsite, DFA and DC/ORM employees are responsible for ensuring that it is ***immediately*** communicated to the following parties:

- **Site Manager and/or Supervisor**
- **Environment Department**
- **MOECC Spills Action Centre (SAC) at 1-800-268-6060**
- **Local Municipality (if applicable)**

All employees must be prepared to contact the MOECC SAC in the event of a reportable spill should any of the above listed parties be unavailable. Once personnel have reported a Reportable Spill, they are

considered the supervisor of the situation and shall remain on-site until an alternative representative arrives to take over the situation.

The DFA or DC/ORM employee responsible for contacting the SAC shall provide the following information:

- Report what you know about the spill including:
    - The name or type of product
    - The quantity of the product released
    - Weather conditions
    - Response measures and status of containment
- Ask the MOECC SAC representative for the Incident Reference Number
- If initial information provided to SAC changes significantly then updated information must be reported as soon as possible under the given circumstances.

5.3.3 Non-Reportable Spills

A non-reportable spill is an accidental or intentional release of any product, liquid or otherwise, that is not likely to cause immediate harm to life, property or the natural environment. A spill is considered NON-REPORTABLE if one or more of the following occurs:

- The off-site release of concrete that does not have the potential to enter a watercourse (as defined in section 5.3.1);
- The on-site release of cement powder from a delivery tanker, silo or dust collection equipment, that does not result in any amount of cement powder migration off-site; or,
- The release of any product on-site that is contained in an engineered containment structure that does not have the potential to affect any watercourse either directly or through drainage structures

Notification for NON-REPORTABLE Spills

All employees must be prepared to coordinate the spill response until the appropriate personnel arrive on site, and follow the response outlined in Section 5.2 of this procedure. Employees shall take all necessary measures to minimize harm to life, property and the natural environment, provided it is safe to do so.

For any level of spill an Incident Investigation Form must be filled out and sent into the CRH Canada Environmental Department within 24 hours of the incident.

5.4 AFTER INCIDENT PROCEDURES

5.4.1 The Site Manager and Manager, Environment is responsible for determining when the spill cleanup is complete, and retaining all documentation and pictures to confirm that cleanup was properly completed, including documentation of the waste removal and disposal.

- For spills to water, the spill cleanup is considered complete when no traces of the spill can be detected. The MOECC may recommend that a water quality analysis be completed by a Canadian Association for Environmental Analytical Laboratories (CAEAL) accredited laboratory to confirm that the water quality complies with MOECC criteria.

5.4.2 Once the spill response and clean-up have been completed, a review will be done to assess the actions undertaken and recorded on the Incident Investigation Report.

5.4.3 The review will be scaled to the severity of the incident, and should be completed by all those involved in the incident, including but not limited to the following personnel:

- Individual reporting the spill
- Site Supervisor and Manager
- Manager, Environment

5.4.4 All reports and MOECC correspondence will be kept on-file in a central location for the duration of the life of the site where the Spill Response occurred.

5.4.5 Disposal of all spilled material and any materials used for the cleanup will be done in accordance with the Hazardous Waste Management Work Instruction.

6.0 COMMUNICATIONS:

The CRH Canada Environment Department is responsible for communicating this procedure to the appropriate personnel.

7.0 TRAINING REQUIREMENTS:

Plant teams at all DFA and DC/ORM sites must be trained on this WI by the CRH Canada Environment Department.

Plant and site teams are responsible to communicate the requirements of this WI and the associated Environment Talk when issued.

8.0 RELATED DOCUMENTATION:

These documents shall not be destroyed until as directed by the Documents Management Procedure (XA.08.101):

XA.05.B08.FR.01 Incident Investigation Report
XA.03.105 Hazardous Waste Management
Site Specific Contingency Plan (DC/ORM)
Site Specific Emergency Response Plan (DFA)
Site Specific Spill Plans (any related plans required by site specific approvals)

9.0 REVISIONS:

List of document changes made:			
Date	**Revision #**	**Revision**	**Revised by**
Dec 21, 2010	1	General cleanup and change of staff titles. Addition of reference to training material in Section 9.0. Document # revised as per XA.08.103.	JD
Mar & Apr 2012	2	Changed “SOP” to “WI”, additions to “Records”, “Related Documents” and “References” sections, added wording into section 5.1.2. Updated Appendix A. Added reference to Documents Management Procedure.	BT/JD
Aug 5, 2014	3	General cleanup and change of staff. Minor changes throughout sections 5.2 & 5.3 to consolidate and provide clarification.	MT
Nov 27, 2015	4	Additional wording to Section 5.3.3 regarding on-site cement spills	MT
Feb 12, 2016	5	Updated references for company name change to CRH.	EL

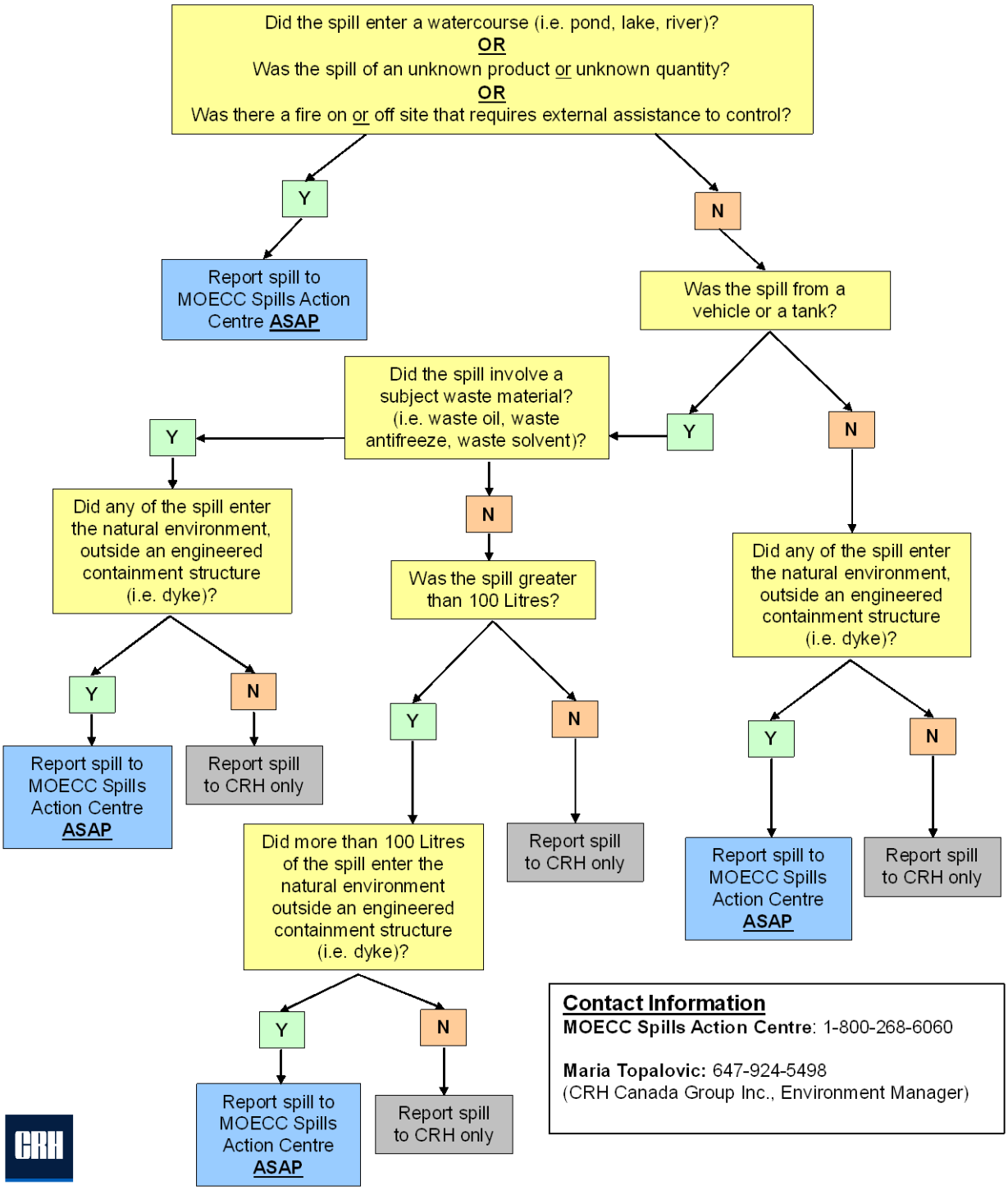
APPENDIX A: EMERGENCY RESPONSE CONTRACTOR LIST

The following contractors are registered with BROWZ and therefore approved by CRH Canada to assist sites in spill response.

Company Name	**Location**	**Phone #**	**Services**
A&G the Road Cleaners	Toronto	905.857.5756	Sweeping, vacuum sweeping, and flushing
Centennial Sweeping	Toronto (Weston)	416-741-4141	Sweeping & flushing, equipment rentals
Safety-Kleen Canada Inc.	Ancaster Brampton Breslau London Oshawa	905-648-3270 905-840-0118 1-800-265-2792 519-685-3040 905-579-3221	Contaminated haulage & disposal, spill response
Smits Tank Maintenance	Oakville	905-845-6820	Wet/dry vac truck, pressure wash, confined space, spill response, hazardous waste disposal
Veolia Environmental Services	Hamilton Division (spills): General services:	905-547-5661 1-800-461-3267	Wet/dry vac truck, pressure wash, hazardous waste disposal, spill response
Aevitas Inc. (Tesla)	Ayr Division	1-519-740-1333 1-800-324-8997	Wet/dry vac truck, pressure wash, hazardous waste disposal, spill response

APPENDIX B: SPILL REPORTING REQUIREMENTS FLOWCHART

SPILL REPORTING REQUIREMENTS



Attachment E

Supporting Material for Illustrative Worst-Case Storm Runoff Calculation for Wetland U1

Table E.1

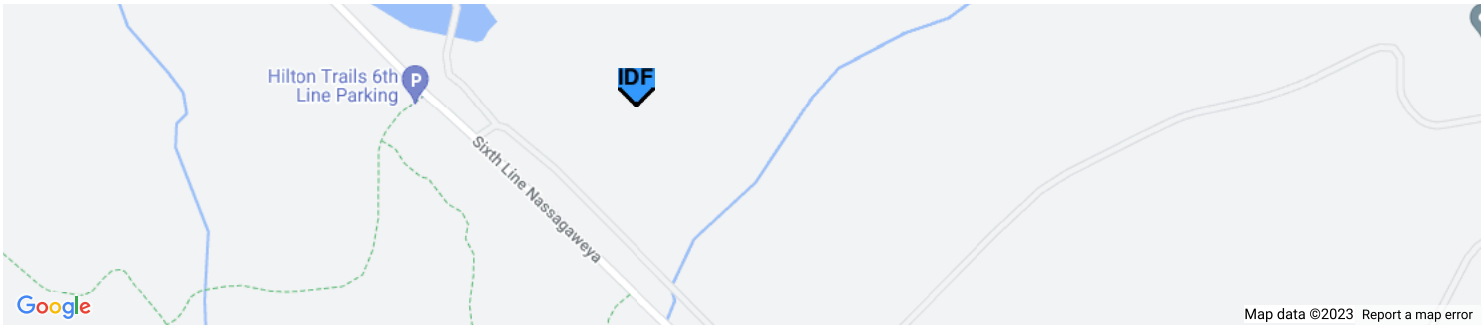
Worst-Case Storm Runoff Calculation for Wetland U1
Milton Quarry East Extension
Region of Halton, Ontario

	Current Approved Condition	Proposed MQEE Condition
Catchment Area - Meadow (ha)	8.4	4.2
Catchment Area - Woodland (ha)	2.1	2.1
Runoff Coefficient - Meadow (%)	41%	41%
Runoff Coefficient - Woodland (%)	39%	39%
100-Year/12-Hour Total Precipitation	102.9	102.9
Total Runoff Generated (m^3)	4400	2600
Wetland U1 Storage Capacity (m^3)	600	200
Net Discharge to Channel (m^3)	**3800**	**2400**

Active coordinate

43° 32' 15" N, 79° 58' 14" W (43.537500,-79.970833)

Retrieved: Tue, 24 Jan 2023 18:13:07 GMT



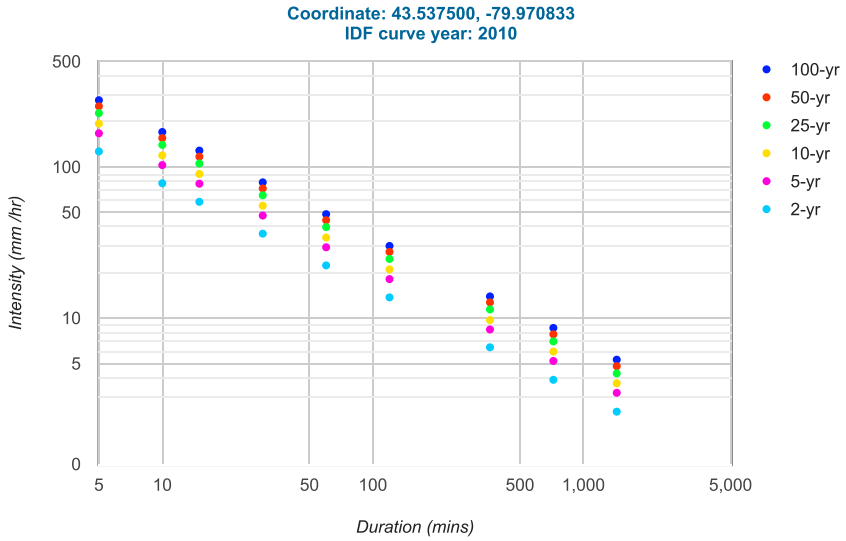
Location summary

These are the locations in the selection.

IDF Curve: 43° 32' 15" N, 79° 58' 14" W (43.537500,-79.970833)

Results

An IDF curve was found.



Coefficient summary

IDF Curve: 43° 32' 15" N, 79° 58' 14" W (43.537500,-79.970833)

Retrieved: Tue, 24 Jan 2023 18:13:07 GMT

Data year: 2010
IDF curve year: 2010

Return period	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
A	22.3	29.4	34.1	40.0	44.4	48.7
B	-0.699	-0.699	-0.699	-0.699	-0.699	-0.699

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	126.7	78.0	58.8	36.2	22.3	13.7	6.4	3.9	2.4
5-yr	167.0	102.9	77.5	47.7	29.4	18.1	8.4	5.2	3.2
10-yr	193.7	119.3	89.9	55.4	34.1	21.0	9.7	6.0	3.7
25-yr	227.2	140.0	105.4	64.9	40.0	24.6	11.4	7.0	4.3
50-yr	252.2	155.3	117.0	72.1	44.4	27.4	12.7	7.8	4.8
100-yr	276.6	170.4	128.3	79.1	48.7	30.0	13.9	8.6	5.3

Rainfall depth (mm)

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	10.6	13.0	14.7	18.1	22.3	27.5	38.2	47.1	58.0
5-yr	13.9	17.1	19.4	23.9	29.4	36.2	50.4	62.1	76.5
10-yr	16.1	19.9	22.5	27.7	34.1	42.0	58.5	72.0	88.8
25-yr	18.9	23.3	26.4	32.5	40.0	49.3	68.6	84.5	104.1
50-yr	21.0	25.9	29.3	36.0	44.4	54.7	76.1	93.8	115.6
100-yr	23.1	28.4	32.1	39.5	48.7	60.0	83.5	102.9	126.8

Terms of Use

Applied Hydrology
Ven Te Chow, David R. Maidment, Larry W. Mays
McGraw-Hill, Inc., Toronto, 1988
588 pages

TABLE 15.1.1
Runoff coefficients for use in the rational method

	Return Period (years)						
Character of surface	**2**	**5**	**10**	**25**	**50**	**100**	**500**
Developed							
Asphaltic	0.73	0.77	0.81	0.86	0.90	0.95	1.00
Concrete/roof	0.75	0.80	0.83	0.88	0.92	0.97	1.00
Grass areas (lawns, parks, etc.)							
Poor condition (grass cover less than 50% of the area)							
Flat, 0–2%	0.32	0.34	0.37	0.40	0.44	0.47	0.58
Average, 2–7%	0.37	0.40	0.43	0.46	0.49	0.53	0.61
Steep, over 7%	0.40	0.43	0.45	0.49	0.52	0.55	0.62
Fair condition (grass cover on 50% to 75% of the area)							
Flat, 0–2%	0.25	0.28	0.30	0.34	0.37	0.41	0.53
Average, 2–7%	0.33	0.36	0.38	0.42	0.45	0.49	0.58
Steep, over 7%	0.37	0.40	0.42	0.46	0.49	0.53	0.60
Good condition (grass cover larger than 75% of the area)							
Flat, 0–2%	0.21	0.23	0.25	0.29	0.32	0.36	0.49
Average, 2–7%	0.29	0.32	0.35	0.39	0.42	0.46	0.56
Steep, over 7%	0.34	0.37	0.40	0.44	0.47	0.51	0.58
Undeveloped							
Cultivated Land							
Flat, 0–2%	0.31	0.34	0.36	0.40	0.43	0.47	0.57
Average, 2–7%	0.35	0.38	0.41	0.44	0.48	0.51	0.60
Steep, over 7%	0.39	0.42	0.44	0.48	0.51	0.54	0.61
Pasture/Range							
Flat, 0–2%	0.25	0.28	0.30	0.34	0.37	0.41	0.53
Average, 2–7%	0.33	0.36	0.38	0.42	0.45	0.49	0.58
Steep, over 7%	0.37	0.40	0.42	0.46	0.49	0.53	0.60
Forest/Woodlands							
Flat, 0–2%	0.22	0.25	0.28	0.31	0.35	0.39	0.48
Average, 2–7%	0.31	0.34	0.36	0.40	0.43	0.47	0.56
Steep, over 7%	0.35	0.39	0.41	0.45	0.48	0.52	0.58