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November 11, 2011

St. Marys Cement Inc. (Canada)
55 Industrial Avenue,
Toronto, ON

Attn: Melanie Horton, Lands Manager

Re: Hydrogeological Assessment, for Above and Below-Water Extraction, Hillsburgh Pit, Town of Hillsburgh
St. Marys Cement Inc. (Canada)
Cambium File: 1900-001

Dear Ms. Horton,

Cambium Environmental Ltd. is pleased to present our hydrogeological assessment for the proposed licence amendment and extension of your Hillsburgh Pit. The report assesses the potential change in the hydrogeological conditions as a result of aggregate extraction above the water table in the proposed extensions lands, and below the water table extraction within the existing licenced area.

If you have any questions, please do not hesitate to call myself at (705) 742-7900, ext. 203.

Best regards,

Cambium Environmental Inc.

Kevin Warner, M.Sc., P.Geo (Ltd)
Senior Project Manager

KDW/kdw

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Hydrogeological Assessment, Hillsburgh Pit Extension and Amendment

prepared for

ST. MARYS CEMENT INC. (CANADA)

Reference No.: 1900-001

November 11, 2011

Cambium Environmental Inc.

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EXECUTIVE SUMMARY

CBM Aggregates, a division of St. Marys Cement (Canada) Inc. (St. Marys CBM) currently operates a sand and gravel pit licenced for above-water extraction of aggregate material, just northwest of the settlement of Hillsburgh, within the Town of Erin. St. Marys CBM proposes to amend a portion of the existing licence to allow for extraction below the water table. Furthermore, two small parcels of land, adjacent to, but not within the licence area, are proposed to be licenced for extraction below-water (Phase 1 & 2). A large land parcel to the west is also proposed to be licenced for aggregate extraction above the water table (Phase 3 & 4).

The hydrogeological assessment required to be undertaken according to the Aggregate Resources Act included the background review of geological and hydrogeological references and the assessment of available on-site information such as borehole logs, groundwater measurements, and groundwater quality results. The background review also indicated the presence of two municipal water supply wells located 2 km south of the pit, within the settlement of Hillsburgh. A portion of the existing pit and proposed extension lands lay within the Well Head Protection Area for the supply wells.

Assessment of the proposed pit extension and deepening included basic modeling of the calculated drawdown in the water table as a result of extraction of aggregate material below the water table. A water balance was also calculated for the proposed changes at the site to determine if the proposed pit extension and deepening would impact groundwater resources.

The hydrogeological assessment found that the proposed changes will not adversely impact groundwater resources in the area. Specifically, surrounding water wells and the municipal supply wells, most of which draw their water from the underlying bedrock aquifer, will not be impacted by above and below water aggregates extraction at the Hillsburgh Pit as the extraction will be limited to the overburden sand and gravel deposits and not into the underlying bedrock. Any wells completed in the shallow overburden aquifer will not be impacted by the proposed below water extraction at the Site. Furthermore, no dewatering activities are proposed at the site, with below water extraction being undertaken using free-draining excavation or drag-line.

There are no adverse impacts to water quality anticipated for the site as a result of the proposed extraction. Sand and gravel extractions do not utilize any chemical compounds which may impact the surrounding water quality resources. The only risk to water quality is the use of heavy machinery at the site (fuel, oil and lubricants). With regulated safe handling of these products, no impacts to the surrounding water quality is anticipated.

Aggregate extraction operations are a permitted use within designated wellhead protection zones, as proscribed in the Wellington Official Plan, as aggregate extraction does not pose a threat to drinking water resources.

CAMBIUM ENVIRONMENTAL INC.

Kevin Warner, M.Sc., P.Geo (Ltd).
Senior Project Manager

KDW/kdw

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1.0 INTRODUCTION

CBM Aggregates, a division of St. Marys Cement (Canada) Inc. (St. Marys CBM hereafter) owns and operates a sand and gravel pit (Hillsburgh Pit, licence #15343), located northwest of the settlement of Hillsburgh, on Wellington Road 24, in the Town of Erin (see Figure 1). St. Marys CBM is submitting an application for a Category 3, Class "A" "above-water extraction" licence under the Aggregate Resources Act for the proposed extension lands (Phase 3 and 4), located west of the existing pit, to be licenced for above-water extraction (Figure 2). Also, an application for an amendment to their existing Site Plans will be submitted for a portion of their existing above-water licence to allow for "below-water extraction" within the existing pit licence. There are two small portions of land east (Phase 1) and north (Phase 2) of the existing licence, which are not licenced, and will require a Category 1, Class "A" "below-water extraction" licence. Please refer to the MHBC Planning report (MHBC Planning, 2011) for which land parcels are included for below-water or above-water extraction. Cambium Environmental Inc. (Cambium) was retained by St. Marys CBM to prepare the hydrogeological assessment for the licence applications and Site Plan amendment.

The existing licence area for the Hillsburgh Pit is 50 ha, with 11.2 ha to be amended for below-water extraction and the remaining 38.8 ha to remain as above-water extraction. The proposed extension lands consist of a total 62 ha, of which 51.3 ha will be licenced for extraction above-water and 10.3 ha licenced for below-water extraction. Only the southwest corner of the property (Phase 1), and a portion of the woodlot north of the existing pit (Phase 2), will be a new below-water licence. In total, the pit will encompass a licence area of 112 ha, with an above-water extraction area of 82 ha and 12 ha for below-water extraction.

1.1 SCOPE OF WORK

1.1.1 AGGREGATE RESOURCE ACT REQUIREMENTS

For new licence applications, as well as licence amendments for below water extraction, the *Aggregate Resources* of *Ontario Provincial Standards* (Ministry of Natural Resources, 1997) detail the following requirements for the hydrogeological assessment of pits where extraction is to occur below the water table:

> *Hydrogeological Level 1: Preliminary hydrogeologic evaluation to determine the final extraction elevation relative to the established groundwater table; and the potential for adverse effects to groundwater and surface water resources and their uses.*
>
> *Hydrogeological Level 2: Where the results of Level 1 have identified a potential for adverse effects of the operation on groundwater and surface water resources and their uses, an impact assessment is required to determine the significance of the effect and feasibility of mitigation. The assessment should address the potential effects of the operation on the following features if located within the zone of influence for extraction below the established groundwater table, where applicable.*

A technical report must be prepared by a person with appropriate training and/or experience in hydrogeology to include the following items:

a) water wells;

b) springs;

c) groundwater aquifers;

d) surface water courses and bodies;

e) discharge to surface water;

f) proposed water diversion, storage and drainage facilities on site;

g) methodology;

h) description of the physical setting, including local geology, hydrogeology, and surface water systems;

i) water budget;

j) impact assessment;

k) mitigation measures including trigger mechanisms;

I) contingency plan;

m) monitoring plan; and

n) technical support data in the form of tables, graphs and figures, usually appended to the report.

This report first addresses the Hydrogeological Level 1 and Level 2 requirements of the Provincial Standards, as above. Items a) thru i) are found in the Level 1 screening, Section 4.0. Items k) to m) are contained in the Level 2 Assessment, Section 5.0. Item n) is found throughout the report and appendices. The *"final extraction elevation relative to the established groundwater table"* has been determined using available geological and hydrogeological data.

1.1.2 WELLINGTON COUNTY OFFICIAL PLAN

Wellington County has identified Well Head Protection Areas (WHPAs) in section 4.9.5 of its Official Plan (Wellington County, 2008). The policies ensure that only permitted uses can be established within Well Head Protection Area. Schedule B2 of the Wellington County OP identifies the Well Head Protection Area for the two municipal supply wells located within the settlement of Hillsburgh, in the Town of Erin. A portion of the existing Hillsburgh Pit lies within the Well Head Protection Area. A portion of the proposed extension area is also located within the WHPA. The areas of the Hillsburgh Pit and proposed extension lands which are located in the WHPA, are located in Well Head Protection Area Zone 3, with a time of travel for groundwater of 2 to 25 years. Considering that the pit is located at the furthest extent of the WHPA, it is assumed that the time of travel from the pit to the supply wells would be closer to the 25 year time of travel. Furthermore, the municipal wells are completed in the underlying bedrock formations, well below the proposed final floor depth of the pit.

Aggregate extraction is deemed a Category C land use risk, according to section 4.9.5.1 and 4.9.5.8 of the Official Plan, as they have not been identified as a significant threat to drinking water resources. All new Category C uses may be permitted in the WHPA, subject to completing a risk assessment or hydrogeological analysis to the satisfaction of the County and local municipality.

According to the Wellington County OP, Table 11, a Category C land use (aggregate extraction) located within a Well Head Protection Area Zone 3, is subject to a Level III assessment. The hydrogeological assessment will identify the existing groundwater quality and local hydrogeological setting, the nature of any predicted adverse impacts, the ability to eliminate or effectively mitigate these impacts and the measures that will be taken to achieve this. Specifically, a Level III assessment (Table 12) requires the inclusion of the following:

a) a review of available well records and geotechnical reports from adjacent wells to assess the potential risk to the municipal aquifer;

b) disclosure report of risk activities including chemical uses, quantities, types, storage, handling, disposal, etc. and classification (Category B or C) of each activity;

c) complete an assessment of potential risks to local aquifers; and

d) disclosure report of the management programs associated with the use of chemicals at the site.

The above Level III assessment requirements are included in this report, while the assessment specifically for the municipal wells is detailed in section 5.1.3.

1.2 ASSUMPTIONS REGARDING THE PIT DESIGN AND OPERATIONS

St. Marys CBM has provided the following assumptions regarding the proposed Site Plans for below-water extraction:

a) The minimum setbacks are as shown on Figure 3 and the Site Plans.

b) The excavation will proceed below the water table by excavator or dragline forming a pit pond. Any excess water draining from the excavated aggregate material will drain back into the pit pond. The pit will not be de-watered.

c) The aggregate extraction is proposed at a maximum rate of 1,000,000 tonnes per year from the site.

d) No other water diversion, storage, or drainage facilities are involved in the pit operation, and there will be no direct discharge to surface water.

e) Aggregate will be stockpiled to drain prior to removal from the site.

f) Completed side slopes above water will be no steeper than 3:1 (horizontal: vertical). These will be progressively rehabilitated as the operation permits. Below-water slopes will be no steeper than 2:1.

g) Fuel may be stored on-site at the existing Hillsburgh Pit within the stockpiling and processing area. There will be no fuel storage within the extension lands (see Operational Plan, Site Plans, 2011). A spill response plan is in place for the Hillsburgh Pit and spill response kits located at the site. A copy of St. Marys CBM's Spill Response Plan for the Hillsburgh Pit is appended to this report (see Appendix A).

2.0 METHODOLOGY

A review of available data for the site and the surrounding area was conducted for this Level 1 assessment. This included a review of the current Site Plans, Ministry of the Environment (MOE) water well records, aerial photographs, and existing mapping and reports pertaining to the geology and aggregate resources of the area. The reference section at the end of this report lists all of the materials that were used in the review.

The MOE water well records are presented on Figure 2 and a summary of the well records are contained in Appendix B.

An aggregate resource inventory was previously conducted by Jagger Hims Ltd., (Jagger Hims, 2005). Thirteen boreholes were drilled on the site in September 2005, of which, three were installed with groundwater monitors. All of the boreholes encountered sand and gravel deposits, with a higher content of finer material (silt) at depth.

The borehole locations are shown on Figure 3, and the borehole logs and monitor details are located in Appendix C. A geologic cross-section is shown on Figure 4.

In late 2006, Gartner Lee Ltd. installed two groundwater monitors, located on the southeastern portion of the site. GLL-1 was drilled to a depth of 29.87 m and GLL-2 to a depth of 17.06 m. Both test holes encountered variable layers of sand and gravel, silt, and clay. Each borehole was equipped with a 51 mm PVC groundwater monitor. Groundwater levels have been monitored on a seasonal basis to obtain baseline data. GLL-1 has consistently been dry during the monitoring events and was likely not installed deep enough to encounter the water table.

Groundwater level measurements were collected from the four on-site monitors. The water level elevations are presented on Table 2.

One water quality sample was taken from GLL-1 on March 25, 2011 by Cambium staff and sent to SGS Canada Inc., an accredited laboratory in Lakefield, Ontario for analysis. The monitoring well was purged of three well volumes prior to collecting a sample. Previously, two on-site monitoring wells (BH5-5 and GLL-1) were sampled for water quality on July 5, 2007 by Gartner Lee Ltd. Water quality results from both monitoring events are presented on Table 3 and the laboratory certificates of analysis are located in Appendix D.

3.0 PHYSICAL SETTING

3.1 LOCATION AND LAND USES

The Hillsburgh Pit is located northwest of the settlement of Hillsburgh, and is bounded by Eighth Line to the northeast and Wellington County Road 24 to the southwest (see Figure 1 and Figure 2). The land on all sides of the property is used for agricultural purposes and includes several hedgerows and small woodlots. The property directly to the southeast along County Road 24 contains a large automobile repair shop. The southeastern portion of the property is currently licensed for sand and gravel extraction and is operational.

3.2 TOPOGRAPHY

In general, the local topography is relatively flat with about 10m of relief throughout the site. To the south of the site the topography changes more drastically, with a steeper decline in elevation towards the settlement of Hillsburgh.

3.3 SURFACE WATER DRAINAGE

There are no surface water drainage courses on or within 120 m of the proposed below-water extraction limit, minimum distance criteria required by the Aggregate Resources Act. The terrain at the site is hummocky. Due to the permeable nature of the surficial materials on site, much of the available precipitation infiltrates into the subsurface to the groundwater system. In the extension lands, overland flows will likely be limited to periods of frozen ground conditions or intense rainfall events, with approximately 95% of precipitation infiltrating into the ground as groundwater recharge or lost back to the atmosphere through evapotranspiration. The excavation of the pit within the extension lands would internalize any overland flows which may occur during the above conditions, into infiltration and groundwater recharge.

Within the existing pit excavation, overland flows would be internalized already, with 100% of precipitation infiltrating to groundwater groundwater recharge or lost back to the atmosphere through evaporation.

3.4 GEOLOGY AND AGGREGATE RESOURCES

Published geological mapping indicates that the surficial geology consists of undifferentiated ice-contact stratified drift (Barnett, 1991). This depositional setting exists north of the settlement of Hillsburgh to the south toward the historical Township of Erin boundary.

A subsurface materials investigation was carried out on the Hillsburgh Pit and Hillsburgh extension property by Jagger Hims Limited in September 2005. An array of 13 boreholes was drilled on the properties owned by St. Marys CBM and an analysis of the borehole logs led to several conclusions (see Figure 3 and Appendix B). The

materials of significance that were encountered on the property included: gravelly sand, sand and sand/silt. A majority of the gravelly sand is located on the southeast end of the property and a significant portion of this is located below the water table. Smaller pockets of gravelly sand exist throughout the property. Sand also exists near surface at the north and northwest portions of the property. The silt/sand exists throughout the property with a majority of it being below the sand on the north and northwest portions of the property. As stated by Jagger Hims (Jagger Himms Ltd, 2005), the gravelly sand has the most potential for making commercial products such as concrete stone. The sand materials have various possible uses, depending on their grain size such as plant feed, brick sand, and septic sand. The silt/sand have limited uses, one of which is fill material.

3.5 HYDROGEOLOGY AND WATER WELL USE

The hydrogeology of this site is characterized by a shallow, unconfined aquifer (water table) that occurs beneath the entire site. The water table slopes to the southeast, ranging in elevation from 469 to 452 mASL (Figure 3). Currently all extraction activity is above this elevation. There is a deeper aquifer system in the underlying bedrock formations that is unaffected by the pit operations.

There are 26 records of water wells within 500 m of the site. The well locations have been plotted on Figure 2 and the MOE well records are summarized in Appendix C. The following details include the depth of these wells and the geologic unit they are installed in:

- 6700743 - Well depth 51.2 m. Bedrock aquifer.
- 6700744 - Well depth 54.9 m. Bedrock aquifer. Within proposed licence area.
- 6700745 - Well depth 66.5 m. Bedrock aquifer.
- 6700773 - Well depth 73.2 m. Bedrock aquifer.
- 6703169 - Well depth 50.3 m. Bedrock aquifer.
- 6703203 - Well depth 86.9 m. Bedrock aquifer.
- 6704723 - Well depth 109.7 m. Bedrock aquifer.
- 6705633 - Well depth 47.2 m. Bedrock aquifer.
- 6708361 - Well depth 86.9 m. Bedrock aquifer.
- 6708813 - Well depth 83.8 m. Bedrock aquifer.
- 6709534 - Well depth 97.5 m. Bedrock aquifer.
- 6709547 - Well depth 57.9.m. Bedrock aquifer.
- 6709550 - Well depth 54.9 m. Bedrock aquifer.

- 6709887 - Well depth 54.9 m. Bedrock aquifer.
- 6710229 - Well depth 77.7 m. Bedrock aquifer.
- 6712152 - Well depth 86.9 m. Bedrock aquifer.
- 6712153 - Well depth 57.9 m. Bedrock aquifer.
- 6714145 - Well depth 52.4 m. Bedrock aquifer.
- 6714613 - Well depth 60.1 m. Bedrock aquifer
- 6715081 - Well depth 85.0 m. Bedrock aquifer.
- 6715401 - Well depth 61.0 m. Bedrock aquifer.
- 6715605 - Boreholes and Monitoring Wells by Jagger Himms. Within proposed licence area.
- 7039989 - Well depth 17.1 m. GLL-2 Monitoring Well. Within proposed licence area.
- 7039990 - Well depth 29.9 m. GLL-1 Monitoring Well. Within proposed licence area.
- 7048576 - Well depth 61.0 m. Bedrock aquifer.
- 7118021 - Well depth 60.5 m. Bedrock aquifer.

The MOE well records suggest that a sandy silt diamicton blankets the bedrock in the area. Three of the well records are for the monitoring wells completed on the site. All of the remaining 23 wells draw water from aquifers within the limestone bedrock.

There are two municipal supply wells (H2 and H3) in Hillsburgh, located within the boundaries of the town, approximately 2 km southeast of the Hillsburgh Pit (see Figure 5). Supply well H3 replaced H1, which is no longer in use. The municipal supply wells are well documented with wellhead protection assessment reports prepared by Golder Associates Ltd. and the Credit Valley Conservation Authority, both depicting the Hillsburgh Pit within the well capture area of these supply wells (Credit Valley Conservation Authority, 2010) (Golder Associates, 2006). Both of the municipal water supply wells are completed into the deep bedrock aquifer (Guelph-Amabel formation), approximately 50 to 60 m in depth (see Figure 6).

3.6 WATER QUALITY

Two on-site monitors (BH05-5 and GLL-1) were sampled for general water chemistry in 2007 and GLL-1 was resampled in 2011. The results are presented on Table 3 and the Laboratory Certificates of Analysis are included in Appendix D. Monitor BH05-5 is located upgradient of the existing Hillsburgh Pit and monitor GLL-1 is located downgradient.

Monitor GLL-1 exceeded the Ontario Drinking Water Standards (ODWS) for nitrate and aluminum in 2007 and only nitrate in 2011. GLL-1 is located near agricultural fields and the nitrate exceedance is likely related to the surrounding agricultural practices. Nitrate is also elevated in BH05-5 in 2007, although within the ODWS limit. Neither nitrates nor aluminum are related to aggregate extraction operations. The elevated nitrates are likely the result of surrounding agricultural practices. It is unknown what was attributed to the exceedance of aluminum in 2007 at GLL-1, however, aluminum was below the ODWS limit in 2011. Neither nitrates nor aluminum are typically associated with extraction operations at aggregate pits, therefore these exceedances are not related to the existing operations not would be expected to change as a result of the proposed above water expansion or below water excavation.

Petroleum hydrocarbons (BTEX) were also analyzed in 2011. All parameters were within the ODWS criteria and under detection limit.

3.7 EXISTING PERMITTED WATER USAGE

The Hillsburgh Pit is currently permitted to take water (PTTW #8216-84XLZB) for use in the aggregate washing plant located at the site. Water is taken from a small pond excavated into the water table and recirculated through a series of settlement ponds for reuse in the aggregate washing plant. This closed-loop water system is commonly used in the aggregate industry to recycle wash water. As such, typically 90% of the water taken from the aquifer is reused through this process, with no impacts on surrounding water resources. As such, and considering that the water taking is an existing use in the area and is already permitted by the Ministry of the Environment, the rate of water taking has not been considered in this hydrogeological assessment.

4.0 HYDROGEOLOGICAL LEVEL 1 ASSESSMENT

4.1 GROUNDWATER TABLE AND FINAL EXTRACTION ELEVATION

In 2010, the groundwater table at the site ranged from an elevation of 468.82 metres above sea level (mASL) (BH05-5) at the northwest portion of the licence area down to 453.85 mASL (GLL-1) at the downgradient boundary (November, 2010). The measured high water table in November, 2010, was the highest observed since 2006 (see Table 2). According to the water level monitoring data, the water table fluctuated by 0.66 m in the northern portion of the proposed licence (BH05-6) and 0.43 m in the south-eastern portion of the site (GLL-1), in 2010. Water level fluctuations up to about 1 m are typical in a sand and gravel unconfined aquifer system.

The geological boreholes by Jagger Hims Ltd. have identified that the aggregate deposit is variable across the site. In the existing pit licence area there is suitable material for below water extraction to a depth of approximately 15 m below the water table. The suitable material for aggregate products is found only above the water table within the proposed extension lands (Part B) adjacent the existing pit area. The water table slopes to the southeast, therefore the pit floor will follow this slope at 1.5 m above the seasonally high water table mark. The final extraction elevation within the pit pond is established at a maximum depth of 440 mASL in the existing licence area (below water resources). The pond elevation has been calculated to be 454 mASL, but will vary seasonally depending on the water table position. The pit floor in the above-water extraction areas will remain a minimum of 1.5 m above the water table position. Both the water table and the base elevation of the pit are illustrated on Figure 3 and Figure 4 and the Site Plans.

4.2 POTENTIAL FOR ADVERSE EFFECTS ON GROUNDWATER AND SURFACE WATER RESOURCES AND USES

The checklist introduced in Section 1.1.1, is used below to identify whether or not extraction operations at the Hillsburgh Pit and extension lands, above and below the water table, have any potential for groundwater or surface water impacts and, if so, which issues require further evaluation as part of a Level 2 Hydrogeological Assessment (see section 5.0).

4.2.1 WATER WELLS

The water wells within 500 m of the existing and proposed licence boundaries were inventoried by plotting MOE water well records (see Appendix C). There are 26 residential water wells within 500 m of the pit and extension lands. All of the water wells within the vicinity of the Hillsburgh Pit and extension lands draw their water supply from a deeper bedrock groundwater source rather than the shallow unconfined aquifer in which the below-water extraction will be occurring. Well depth ranged between 47.2 and 109.7 m below ground surface (BGS), averaging 69.5 m BGS. All of the wells in the MOE well records are completed in the bedrock.

There are two residences located east of the site, which may have wells completed into the shallow aquifer. Field reconnaissance of these residences identified a large diameter well casing at one of the residences, while the well at the other residence could not be located. Neither home owner was at the property during the well survey to provide information regarding their supply well. As a precaution, it is assumed that both residences are have shallow wells completed into the shallow overburden for this study until confirmed otherwise.

Above water table extraction operations do not excavate into the water table, therefore, will not impact water levels in the vicinity of the proposed extension areas (Phases 3 & 4) northwest of the existing pit, as there will be no below water extraction in this area. Below water extraction does remove material from below the water table, thereby creates a localized drawdown effect in the vicinity of the extraction area. Below water extraction is proposed within the existing pit area and in a small portion of Phases 1 & 2 of the extension lands. Experience with other pits operating below-water by free-draining excavation methods typically shows that there are no effects on off-site water wells. As mentioned above, all of the drilled wells identified in the MOE well records draw their water supply from the deeper bedrock aquifer systems and not from the shallow unconfined aquifer where the aggregate extraction will occur. The two municipal supply wells located in the settlement of Hillsburgh are also completed into the underlying bedrock aquifer. As these wells draw their water from deeper groundwater resources, these deeper wells will not be influenced by the proposed aggregate extraction operations.

The two assumed shallow wells located east of the site, the closest of which is approximately 400 m from the Site, may be influenced by the below water extraction operations and will be used for the assessment criteria in a detailed Level 2 impact assessment.

Pit operations typically do not involve the use, storage, or handling of significant quantities of potential contaminants, other than machine fuels/lubricants and occasional dust suppressant chemicals. If these are handled with normal, reasonable precaution (according to the regulations) then the risk of groundwater contamination in the shallow unconfined aquifer is very low. St. Marys CBM has already implemented a Spill Response Plan for its Hillsburgh Pit (Appendix A). Drilled wells identified within 500 m of the site, as well as the two municipal supply wells in the settlement of Hillsburgh, draw their water from the deeper bedrock aquifer systems that are protected from the shallow aquifer by less permeable silt deposits, therefore the risk to these wells is very low. Although the two assumed shallow wells located east of the property are completed into the same aquifer system, there is a low risk of contamination in these private water wells due to the numerous regulated precautions impletemented at the site concerning fuel handling practices.

4.2.2 SPRINGS

There are no springs identified within 500 m of the proposed licence boundary. The water table ranges from 17.3 to 29.6 m below ground surface, so there is no potential for groundwater springs to occur on-site and thus no impacts to any such feature.

4.2.3 GROUNDWATER AQUIFERS

Two groundwater aquifer systems have been identified according to MOE water well records and borehole investigations; a shallow unconfined aquifer in overburden deposits, and a deeper bedrock aquifer in the underlying limestone deposits.

The on-site geologic drilling program identified a shallow unconfined aquifer within the sand and gravel deposits to a depth between 18 to 30 m BGS. A less permeable silt unit underlies the shallow aquifer. Groundwater flow is to the southeast, with a difference in the water table elevation of approximately 15 m across the site. There is a seasonal difference in the water table elevations of up to 4 m in the area where below-water extraction is proposed. Above the water table extraction is proposed in the northwestern extension area (Phases 3 & 4). Since there will be no excavation into the water table in the extension area, there is no mechanism to effect groundwater water levels in this area, therefore a more detailed Level 2 impact assessment is not required.

In the proposed below-water extraction area (existing pit and in a small portion of Phases 1 & 2), the gravel pit will be extracted by free-draining excavation methods and will not be dewatered. In this area, the removal of aggregate below the water table and the creation of a pit pond have the potential to lower groundwater levels in the area and therefore warrants a more detailed Level 2 impact assessment.

The underlying limestone formations contain an aquifer system within the fractured bedrock. There is no proposed extraction within the bedrock deposits; therefore, there is no potential for impacts to the deep bedrock aquifer for adjacent water wells within 500 m.

Hillsburgh has two municipal water supply wells within the boundaries of the town (H2 and H3). A recent wellhead protection study (Credit Valley Conservation Authority, 2010) (Golder Associates, 2006) has shown that a portion of the existing Hillsburgh pit and extension lands are within the well capture area of these supply wells; therefore, this issue warrants a more detailed Level 2 impact assessment.

4.2.4 SURFACE WATER COURSES AND BODIES

There are no surface water drainage courses on-site or within the 120 m of the site boundaries that will require any physical alterations of any natural surface water features. The closest tributary is located approximately 1 km southeast of the site and well outside any influence of the gravel pit, therefore a Level 2 impact assessment is not required.

4.2.5 DISCHARGE TO SURFACE WATER

There are no proposed discharges to surface water at this site nor is there any groundwater discharge to surface water within 500 m of the proposed extraction area. Therefore, a Level 2 impact assessment is not required.

Recent studies on the effects of below-water extraction operations on water temperature indicated that groundwater temperature increases by 0.25 C in the vicinity of an open pond and equilibrates within 50 to 100 m of the open pond (Ostrander, 1998). There are no surface water features within this distance from the proposed pit pond, so there is little potential for any effect on baseflow temperatures in surface water. Therefore a Level 2 impact assessment is not required.

4.2.6 PROPOSED WATER DIVERSION, STORAGE AND DRAINAGE FACILITIES ON SITE

Below-water extraction operations will create a pit pond, approximately 15 m in depth. Groundwater will replace the void of removed aggregate, thereby increasing the storage capacity of water on the site. Pit ponds act as groundwater reservoirs, which regulate and extend the baseflow period, especially during drought conditions. No other diversion, storage or drainage of water for the site is proposed.

4.2.7 WATER BUDGET

Under the existing conditions, as a conservative estimate, only about 5% of the precipitation that falls on the extension lands will runoff as overland flow from the site (mainly during frozen ground conditions or periods of excessive rainfall) based on the permeable nature of the soils, the vegetation cover, and the topography. All of the precipitation that falls on the existing pit area will infiltrate to groundwater as the existing excavation will prevent any overland flow from leaving the site. Therefore, a significant portion of the surplus[1] water from both the existing pit area and the extension lands will infiltrate through the soils to become groundwater.

The proposed changes could alter the water balance. In the extension lands where aggregate extraction is proposed to be above the water table, the excavation of the pit will prevent any overland flow from leaving the site. Furthermore, during extraction, the vegetation cover will be removed, thereby lowering the rate at which water is lost from the site through evapotranspiration, allowing for more water to infiltrate into the ground. Therefore, there would be a net increase in groundwater recharge within the extension lands where above water extraction occurs.

When aggregate material is extracted from below the water table, thereby creating a pond, a number of changes may take place in the overall water balance. All precipitation that falls within the pond area will directly recharge the pit pond. There will be no surface water runoff in the pit area. However, evaporation off the pond surface could occur at a higher rate than the rate of evapotranspiration in areas that are vegetated, which could create a deficit to groundwater levels. This deficit in the water budget warrants a more detailed Level 2 assessment.

[1] *surplus water is the difference between the total precipitation and evapotranspiration*

4.3 LEVEL 1 HYDROGEOLOGY ASSESSMENT CONCLUSIONS

Table 1 Hydrogeological Level 1 Assessment Conclusions

Level 1 Checklist	Assessment of Potential Impacts	Need for Level 2 Assessment?
Water wells	Potential impact to shallow aquifer wells (two assumed shallow wells located east of the pit). No impacts to deeper groundwater resources. The surrounding drilled water wells draw water from the deeper bedrock aquifer, below the elevation where below water extraction in the shallow aquifer is taking place.	Assess potential drawdown on assumed shallow wells.
Springs	There are no springs on or adjacent the site. The closest surface water feature where a spring could occur is located approximately 1 km southeast of the site. Therefore, no direct impacts to springs as a result of the proposed excavation.	Not Required
Groundwater aquifers	Below-water extraction of material results in the potential for impacts to the shallow aquifer. Minor water table effects could occur immediately adjacent the pit in the shallow aquifer, which could lead to impacts in unidentified wells completed in the shallow aquifer or springs or seepage areas in the closest surface water features (approximately 1 km to the southeast). No impact to bedrock aquifer. Extraction is in the overburden material and above the deep bedrock aquifer, therefore no impacts will occur. A portion of the site is located within the well capture area of the municipal supply wells for Hillsburgh, therefore further assessment is required.	Assess the impact that below-water extraction will have on the shallow aquifer. Assess if there is any impact on the municipal supply wells.
Surface water courses and bodies	No direct impact to surface water features as there are no surface water courses or bodies what will be altered or removed within 1 km of the site. Potential for changes in groundwater flow to nearby surface water features will be assessed in "Groundwater Aquifers".	Not Required.
Discharge to surface water	No impact. There is no discharge of water to surface water proposed. There are no springs within 500m of the site. Water temperature equilibrates within 50-100m of the extraction pond. There are no surface water features within this distance which may be affected by baseflow warming.	Not Required
Water diversion, storage or drainage	No impacts. Creation of a pit pond will increase water storage on-site. There is no other proposed diversion, storage or drainage of water on the site.	Not Required
Water budget	The above-water extraction in the extension lands and below-water extraction in the existing pit area result in the potential for impacts to shallow aquifer. Creation of a pit pond will increase evaporation from the pond area and may alter the water budget.	Assess the degree of change in the water budget.

The Level 1 Hydrogeological Assessment, summarized above, has identified a few potential impacts on shallow groundwater resources that could result from below-water extraction at the Hillsburgh Pit (Phase 1 & 2). No impacts to groundwater or surface water resources were identified for the northwestern extension area (Phase 3 & 4) where above water table extraction is proposed. A Level 2 Hydrogeological Assessment is recommended to

specifically predict the degree of water table fluctuations in the immediate vicinity of the proposed pit pond for the potential to affect water levels in the shallow aquifer and assess any potential impact to the municipal supply wells in Hillsburgh as a portion of the Hillsburgh Pit and extension lands lie within the well capture area for these wells.

5.0 LEVEL 2 HYDROGEOLOGICAL ASSESSMENT

5.1 IMPACT ASSESSMENT

As noted above, this Level 2 Hydrogeological Assessment specifically addresses the potential for impacts to groundwater levels in the shallow aquifer as a result of the removal of aggregate below the water table and increased evaporation as a result of the creation of a pit pond. The closest surface water feature (wetlands, streams, etc.) that may be connected or utilize the shallow aquifer is located approximately 1 km southeast of the site.

According to current MOE water well records, all the water wells within 500 m of the proposed pit pond are completed within the bedrock aquifer; therefore, there are no water well users which utilize the shallow overburden aquifer within 500 m of the proposed below water extraction area. There are two residences located east of the proposed pond area which do not have MOE well records associated with them. The closest of the two residences is 400 m from the put. Previous attempts to interview the residence owner have been unsuccessful. Although the closest residence to the east may have a deep drilled well which is common throughout the area, the distance of this residence (400 m) will be arbitrarily used in the distance drawdown calculations described in the section below.

A portion of the Hillsburgh Pit and extension lands do lay within the well capture area for the municipal water supply wells. Although the supply wells draw water from the deeper bedrock aquifer, the Level 2 assessment will address the potential to impact these wells.

5.1.1 PREDICTED WATER TABLE DRAWDOWN IN THE SHALLOW AQUIFER

The effects of the aggregate extraction on the water table are expected to be minor and localized. Since the pit will be excavated by free-draining extraction methods from below the water rather than by de-watering, major groundwater drawdown will not occur. The only three potential mechanisms for groundwater impacts that are normally associated with the free-draining excavation method are:

a) the "levelling[2]" of the water table can occur where large or elongate ponds, parallel to groundwater flow, are created in an area where the natural groundwater elevation varies;

b) the removal of solid particles from below the water table means that groundwater must flow in to fill the void, resulting in the “equivalent” of a one-time groundwater withdrawal from the water table by placing this volume of water in storage in the pit pond; and

[2] “Levelling” – is the flattening of the pond surface to the same water elevation, in areas where there the water table is sloped along a hydraulic gradient

c) evaporation occurs from the surface of the pond that is created by the extraction.

There is a 4 m difference between water levels at the upgradient and downgradient sides of the proposed pit pond. Excavation of the pit pond would result in the "levelling" of the pond surface (i.e. same water elevation throughout the pit pond) compared to the surrounding water table. Theoretically, water levels at the upgradient (northwestern) margin of below-water extraction area would decrease by about 2 m and this change would result in a localized water table drawdown effect to the northwest. Conversely, the water table elevation could theoretically rise by up to 2 m adjacent the downgradient (southeast) margin of the below-water extraction area. This increase will tend to offset or mitigate any potential drawdown effects on the downgradient side that may be associated with the pit operation, as discussed below. Considering that the water table is not close to the ground surface (18 to 21 m below ground surface), there is no potential for flooding issues to the southeast of the pit pond as a result of the water table rising at the margin of the pit pond. Although there will be a 2 m drawdown in the water table in the upgradient vicinity of the margin of the pit pond (to the northwest) as a result of the pit pond levelling, this drawdown effect is localized near the margins of the pit pond. Furthermore, there are no water wells or surface water features which are connected to the shallow aquifer system near the upgradient margins of the pit pond that may be impacted. Water wells in this vicinity are deep wells completed into the underlying bedrock aquifer. There are no surface water features within 1 km of the site. The Phase 3 & 4 extension lands which are restricted to above-water extraction are also located upgradient of the pit pond, therefore the upgradient levelling effects from the below water extraction will be localized within the existing pit licence area with no off-site impacts.

Experience at other below-water aggregate operations suggests that in practice the remaining two mechanisms for potential groundwater impacts are usually minor effects. The aggregate removal effect is a temporary impact that only occurs while the pit is being extracted. Over time, additional precipitation in the pit, and groundwater recharge in the surrounding areas, will offset this effect. Furthermore, as the pond in the pit grows larger, a "reservoir" of water is created and the effects of removing solid particles from below the water table are diminished.

The evaporative losses are a long-term effect, since the ponds will exist during the operation and following rehabilitation. Evaporative losses are controlled by the pond area and become greater as the ponds grow (opposite to the effects of aggregate removal noted above), although these losses are generally minor and do not generate negative impacts.

Several calculations were carried out in order to confirm that the effect of below-water aggregate removal and pond evaporation were not significant at this site. Three scenarios were examined:

Case 1: Early in the below-water extraction operation when the evaporation would be low (a small pond), but the aggregate removal effects could be greater.

Case 2: Late in the operation when the evaporation losses could also be greater due to a large pond surface.

Case 3: Upon completion of extraction where the final pond area is at its maximum extend and when evaporation losses from the pond surface would be the greatest.

In all cases, the "worst case" assumptions of a hot, dry mid-summer week with no precipitation and a maximum rate of evaporation, plus a high rate of aggregate extraction of 4,082 tonnes per day all from below water for Case 1 and 2 were examined. The calculations are detailed in Appendix E.

In the first case, when the below-water excavation starts and a small pond is formed, the calculations show that after 5 days, the water table will be drawn down by less than 0.09 m (9 cm) within the excavation itself. According to the MOE water well records, there are no private wells in the shallow aquifer, however, there are two assumed shallow wells, the closest of which is 400 m east of the site. This residence likely has a deep drilled well as is common in the area, however the distance to this residence has been used in our distance drawdown analysis as the residence may have a well completed into the shallow aquifer. The closest residence is approximately 400 m from the pond edge, where a drawdown of 0.013 m (1 cm) would occur after five days of below water extraction (assuming that the well was completed in the shallow aquifer).

In the second case, near the end of the operating life of the pit when a large pond has been formed, the calculations show the drawdown at the excavation (in the pond) after 5 days to only be about 0.046 m (5 cm). At the closest private well (if it was completed in the shallow aquifer), a drawdown of 0.021 m (2 cm) is predicted, which is again insignificant. In the third case, when extraction is complete and only a large pond remains, evaporative losses in the pond and at the closest well are predicted to result in a water table drawdown of only 0.013 m (1 cm) and 0.006 m (1 cm), respectively, after 5 days.

The calculations confirm what would be expected, and what is usually experienced in these types of operations, that the effects on the groundwater table are mostly confined to the immediate area of the pit excavation, and that they are minor off-site, even under worst case conditions of hot, dry weather and a high rate of extraction.

5.1.2 WATER BUDGET

A water budget was prepared to compare current conditions to site conditions upon completion of extraction when a large pond remains (i.e., maximum evaporation rates). Details of this calculation are presented in Appendix F.

Under current conditions, only about 5% of the precipitation that falls on the site, outside of the existing pit area, will runoff based on the permeable nature of the soils, the vegetation cover, and the topography. All precipitation within the existing pit area will directly infiltrate to groundwater. Therefore, a significant portion of the surplus water for the site will infiltrate through the soils to become groundwater.

When the site is extracted and the pond is formed, a number of potential changes take place in the overall water balance. All precipitation that falls on the pond will be retained there. All precipitation that falls on other areas of the site will infiltrate into the subsurface as there will be no surface water runoff leaving the site. However, evaporation off the pond surface occurs and would result in a calculated net loss in groundwater recharge of 507 cubic metres per year (m^3/yr) to the sub-watershed once the pit pond is fully developed or about 0.1 % of the annual groundwater recharge for the site. There would be a loss in overland runoff of 11,253 m^3/yr which represents an equivalent loss of 0.36 L/s; however, this loss would only occur during runoff events where ground conditions are frozen or during large precipitation events.

The proposed formation of a pit pond and extension of the pit area will result in very minor changes to the water balance according to the above calculations. There will be an insignificant change to groundwater generated at the site, with a decrease of 0.1%. There are no areas for groundwater discharge (springs or streams) close to the site which may be affected by this change. The biggest change in the water balance is in the internalization of overland runoff which will be captured within the pit area, which would be a very minor in any event. Considering that this runoff would only migrate off-site during large precipitation events or during periods when the ground is frozen (i.e., spring melt), typically when there would be a large amount of runoff generated in the area, this loss would not be considered detrimental or a significant impact.

5.1.3 MUNICIPAL WATER SUPPLY WELLS

There are two municipal water supply wells in the boundaries of Hillsburgh. A recent study by Golder Associates had delineated the well capture area of these two wells (see Figure 5). This well capture area includes a portion of the Hillsburgh Pit, namely where the below water extraction is proposed. Below water extraction in the existing pit floor would not change the extent that the aquifer is vulnerable, as the extraction would be occurring within the upper unconfined aquifer system. Furthermore, the municipal supply wells are completed in the underlying bedrock aquifer.

The municipal supply wells are located approximately 2 km southeast of the Hillsburgh Pit. Both supply wells are completed into the bedrock aquifer and are not connected to the overburden aquifer (Figure 6). According to the MOE well records, there is a substantial silt/till deposit that occurs between the Hillsburgh Pit and the supply wells. The municipal supply wells take water from a deeper hydrostatic unit than the shallow aquifer system where below water extraction is proposed. As such, water resources in these deep municipal wells will not be affected by below water extraction.

Aggregate extraction is an acceptable use in wellhead protection areas as aggregate extraction is not classified as a significant threat to drinking water supplies. Aggregate extraction operations are categorized as a Moderate risk activity (Category C, lowest level of risk assessment) in the Wellington County Official Plan. Moderate risk activities are defined where only small quantities of liquids are involved and appropriate engineering measures

and management practices are applied. As outlined in Section 4.2.1, pit operations typically do not involve the use, storage, or handling of significant quantities of potential contaminants, other than machine fuels/lubricants and occasional dust suppressant chemicals. If these are handled with normal, reasonable precaution (according to the regulations) then the risk of groundwater contamination is very low. St. Marys CBM has already implemented a Spill Response Plan for its Hillsburgh pit (Appendix A). Any bulk fuel and oil storage and dispensing facilities shall not be conducted within any excavation area and must include secondary containment and spill prevention measures, as required by the Wellington Official Plan and the Technical Safety and Standards Act (TSSA). No fuel storage is proposed in any Phase of the extension lands (Note 1.2.13, Operational Plan).

5.2 MITIGATION MEASURES INCLUDING SPILLS CONTINGENCY PLAN AND MONITORING

5.2.1 SPILLS CONTINGENCY PLAN

A Prescribed Condition for a Class "A" Pit Below Water is the implementation of a Spills Contingency Plan. Please refer to Appendix A for the Spills Contingency Plan.

5.2.2 MONITORING PLAN

On-site groundwater monitors BH05-5, BH05-6, and GLL-1 should be monitored at the site to monitor water table fluctuations. Pond levels and groundwater levels should be monitored monthly and submitted to the MNR annually in a summary report.

Considering that the below-water extraction area is located within the established WHPA for the municipal supply wells, groundwater quality should be monitored annually, preferably during the autumn months, from the downgradient monitoring well (GLL-1) for generally water chemistry and BTEX (suggested parameter list is found in Table 3).

An annual summary report shall be prepared and submitted to the Ministry of Natural Resources by March 31st of the following year. Summary reports are to contain water level data corresponding to groundwater levels, and the water quality monitoring data, as described above.

6.0 CONCLUSIONS

Based on the analysis presented in the previous section, we conclude that below-water extraction at the Hillsburgh Pit would have only minor effects on the groundwater table in the area immediately surrounding to the pit. There will be no impacts to local water wells or closest natural water resources (i.e. no impacts to nearby streams, springs, wetlands or fisheries) in the vicinity of the Site as a result of below water extraction at the Hillsburgh Pit. Furthermore, it is our opinion that the operations at Hillsburgh Pit will not impact the quantity or quality of water supplying the municipal wells in the settlement of Hillsburgh.

7.0 RECOMMENDATIONS

There is already a groundwater monitoring program established for the site as part of its MOE Permit To Take Water. Therefore the following monitoring program is recommended for the site:

- The on-site groundwater monitors should be monitored monthly during periods when below-water extraction occurs.
- A qualified hydrogeologist should review the monitoring results annually, to confirm that there are no unexpected impacts in the water table.
- Groundwater quality should be monitored annually, preferably during the autumn months, from the downgradient monitoring well (GLL-1) for generally water chemistry and BTEX (suggested parameter list is found in Table 3).
- A summary report should be submitted to the MNR and MOE annually by March 31st of the following year.
- The proposed Site Plans prepared by MHBC Planning have been reviewed by Cambium staff. We are satisfied that the technical information and recommendations contained within this report are adequately captured within the Site Plan notes.

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GLOSSARY OF TERMS

ABBREVIATIONS

RFP	Request For Proposal	**µS**	microSiemens
MOE	Ontario Ministry of the Environment	**ODWS**	Ontario Drinking Water Standards
MNR	Ontario Ministry of Natural Resources	**PWQO**	Provincial Water Quality Objectives
PCofA	Provisional Certificate Of Approval	**TOC**	Total Organic Carbon
EPA	Environmental Protection Act	**VOC**	Volatile Organic Compounds
EAA	Environmental Assessment Act	**BTU**	British Thermal Unit
MW	monitor well	**°C**	temperature in degrees Celsius
masl	metres above sea level	**N/A**	not available
kg	kilogram	**%**	percent
mm	millimetres	**cfm**	cubic feet per minute
m	metres	**ppmdv**	part per million by dry volume
km	kilometres	**ppmv**	part per million by volume
ha	hectare	**ppm**	part per million
m^3	cubic metres	**min**	minimum
m^2	square metres	**max**	maximum
mg/l	milligrams per litre		

UNITS OF MEASUREMENT AND CONVERSIONS

Length

1 metre (m)	=	3.28 feet
1 millimetre (mm)	=	0.039 inches
1 kilometre (km)	=	0.621 miles

Area

1 hectare (ha)	=	2.47 acres
1 square metre (m^2)	=	10.76 square feet

Volume

1 cubic metre(m^3)	=	35.29 cubic feet
1 litre(L)	=	0.220 gallons

Mass

1 metric ton (tonne)	=	1.10 Imperial tons
1 kilogram (kg)	=	2.20 lbs
pound (lb)	=	453.6 g
gram (g)	=	---
milligrams (mg)	=	1×10^{-3} g
microgram (µg)	=	1×10^{-6} g
nanogram (ng)	=	1×10^{-9} g
kilogram (kg)	=	1000 g
pictogram (pg)	=	1×10^{12} g
metric tonne (t)	=	1000 kg

Appended Figures

Appended Tables

Appendix A

Spills Response Plan for Hillsburgh Pit

Appendix B

MOE Water Well Records Summary

Appendix C

Borehole Logs and Monitor Details

Appendix D
Water Quality Results

Appendix E

Groundwater Drawdown Calculations

Appendix F
Water Budget

Appendix G

Resumes