INTERA ENGINEERING LTD.
1 Raymond Street, Suite 200
Ottawa, ON K1R 1A2
Tel: (613) 232-2525
Fax: (613) 232-7149

May 31, 2008

Ref. No.: 04-233-4

Friends of the Rural Communities and Environment (FORCE)
c/o Lawson Park Ltd.,
P.O. Box 15, R.R. #1
Freelton, Ontario L0R 1K0

Attention: Graham Flint, Chair, FORCE

Re: Review of MOE Draft PPTW and Supporting Documentation, St. Marys Flamborough Quarry Site, City of Hamilton

Dear Mr. Flint,

Please accept this letter as INTERA Engineering Ltd. report on hydrogeologic review of the Ontario Ministry of Environment draft Permit To Take Water (PTTW) and supporting documentation for the proposed Groundwater Recirculation System (GRS) pumping tests at the St Marys Cement Inc. (Canada) property. The St Marys Cement property is the site of a proposed Quarry is to be developed in the Amabel Formation dolostone to depths of about 36 to 40 m in Part of Lot 1, and Lots 2 and 3, Concession 11, geographic Township of East Flamborough, now the City of Hamilton.

The draft PTTW was posted on the Environmental Registry by MOE on May 7, 2008 following release of a hydrogeological work plan for the proposed GRS testing prepared by Gartner Lee Limited (GLL) on March 25, 2008. The GLL hydrogeological work plan described the proposed sequence and recent results of activities undertaken to further characterize the Amabel Formation dolostone aquifer and to undertake the pilot scale testing of the GRS. The GRS is proposed to mitigate Quarry-induced drawdowns in the bedrock aquifer and impacts to local surface water ecological features.

This review letter is follow-up to series of hydrogeological review letters I have prepared for this site since March, 2005. I have previously reviewed the following five major hydrogeological documents and sets of documents:

- *Final Hydrogeological Work Plan,* prepared by GLL in March, 2008;
- *Final Draft – Hydrogeological Work Plan,* prepared by GLL in August, 2007;
- *Revised Work Plan for the Evaluation of Groundwater Recirculation System* prepared by GLL in September 2006;
- *Draft Three-Volume Hydrogeological Level 2 Report* prepared by GLL in June, 2005; and
- *Preliminary Hydrogeological Assessment Repor*t, prepared by GLL in August, 2004.

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The last two of these earlier reports were prepared for Lowndes Holdings Corporation, former site owners. I previously provided hydrogeological review comments on these five earlier sets of reports in correspondence with you dated April 30, 2008, November 19, 2007, November 26, 2006, November 11, 2005 and March 28, 2005, respectively.

This report was prepared by Kenneth G. Raven, P.Eng., P.Geo., Principal and Senior Hydrogeologist of INTERA Engineering Ltd. This report reviews the MOE draft PTTW and supporting documentation provided by you via e-mail on May 9, 2008.

This letter is organized by the following four sections:

1. Primary Documents Reviewed
2. Hydrogeologic Review and Concerns
3. Conclusions

1. PRIMARY DOCUMENTS REVIEWED

The following two primary documents were the focus of this review:

- *Draft Permit to Take Water, Pumping Test Bedrock Wells TW14, TW15 and TW16, St Marys Cement Inc. (Canada), Reference Number, 4455-6U9MKG,* Posted by Ontario Ministry of the Environment to Environmental Registry, May 7, 2008.

- *Review of Application for Permit to Take Water, Pumping Tests Bedrock Wells TW14, TW15 and TW16, Reference Number, 4455-6U9MKG,* Report prepared by Nova Hydrogeology Inc. (Dr. Kent Novakowski) for Ontario Ministry of the Environment, West Central Region, May 5, 2008.

2. HYDROGEOLOGIC REVIEW COMMENTS

Based on my review of the primary documents outlined in Section 1 and in consideration of previous reports prepared for this site as listed in my earlier review letters, I offer the following comments and identify the following hydrogeologic issues and concerns for the Nova Hydrogeology review and the MOE Draft PTTW.

2.1 Nova Hydrogeology Review

1. The Nova Hydrogeology review provides an in-depth theoretical assessment of the hydrogeological work undertaken to support the PTTW application in order to get to a final opinion on whether the proposed GRS groundwater triggers will be protective of off-site groundwater users. Dr. Novakowski completed some independent analyses of the range of possible drawdowns for the proposed first GRS pumping test using simple analytical well models that demonstrate the potential for off-site well impacts and the importance of vertical leakage in limiting drawdown. These independent analyses were completed with two simple analytical expressions for pumping from a well considering well bore storage (Papadopolus and Cooper) and vertical

leakage (Moench) models. These models are simplified expressions that are useful for scoping calculations and to investigate effects of considering different processes on well drawdown. They should be used as a precursor to more advanced and more realistic 3-D models such as the GLL MODFLOW model. The Nova Hydrogeology review correctly identifies the lack of discussion around the choice of storativity used in the GLL predictive MODFLOW modeling of the drawdown to be created by the GRS pilot pumping tests, which increases the uncertainty about these drawdown predictions.

2. Although the Nova Hydrogeology review points out the need to consider well bore storage on the resultant analyses of pumping tests for determination of accurate hydraulic properties, I am of the opinion that well bore storage will not be an important factor in analyzing pumping tests at this site because of the very high transmissivities and flowrates involved. Similarly he stresses the need to use packer-isolated hydraulic testing methods over hydrophysical and open-hole pumping tests to more accurately determine the distribution of hydraulic properties in the rock mass of the site.

3. With the minor exceptions outlined above and some below, I am in general agreement with the majority of the Nova Hydrogeology review. Although he believes that the proposed GRS groundwater triggers are sufficiently conservative to be protective of off-site groundwater users, he puts on the table several issues concerning the quality of the hydrogeologic characterization work and the reliability of the predictions of both Quarry and GRS drawdowns and potential for off-site impact. Several of these concerns (e.g., poorly constructed monitoring wells that do not intersect permeable intervals and hence underestimate pumping test drawdowns, undue reliance on the questionable results of the earlier 72 and 168 hr pumping tests in predicting GRS pumping test drawdowns and on-site well trigger levels, poor vertical connections in the bedrock that will limit GRS trench performance, etc) have previously been conveyed to you, in my earlier review letters.

4. The Nova Hydrogeology review states that it would not be necessary for the GRS pilot test to achieve the full depth Quarry drawdowns to obtain meaningful data on hydrogeolgic behaviour of the groundwater system that are representative of full depth Quarry drawdown conditions. He states that a pumping test of 3 m drawdown would achieve the same result as a pumping test of 30 m drawdown.

   I disagree with this statement. In my opinion it is always better to have the pumping test run for as long as possible at the maximum pumping rate such that it creates as closely as possible the expected full depth Quarry drawdown in the three pumping wells. The main reason why one should pump as long and as hard as possible and try to simulate full depth Quarry drawdown is that such pumping creates a more realistic set of hydraulic conditions that more accurately assesses the vertical leakage capacity of the overlying bedrock units. As Dr. Novakowski shows, vertical leakage is a critically important parameter that can limit the propagation of drawdown away from the pumping well. However such vertical leakage is a transient process with a finite volume of water that can be released over time. At some point in time after the start of pumping, the water available for vertical leakage will be exhausted (or severely depleted) and the drawdown cone will significantly increase in radial extent and amount to that representative of long-term full depth Quarry drawdown. Since this is the objective of the first GRS pumping test, one should try as hard as possible to achieve it. In my opinion, it is much more likely that drawdowns representative of depleted vertical leakage/recharge and long-term full depth Quarry drawdown will be observed with a pumping test of 30 m drawdown than of 3 m drawdown given the time limits on the pumping tests (6 to 8 days).

5. Since the purpose of the first GRS pumping test is to provide a set of drawdown conditions against which the subsequent GRS mitigation measures can be assessed, it is important that the drawdown conditions are as accurate and as representative as possible of full depth Quarry

conditions, given the acknowledged limitations of pumping wells to represent a quarry face. Shorter duration pumping tests of limited drawdown are not the preferred way of conducting the pilot scale GRS testing to meet the objectives of the GRS pumping tests.

6. The Nova Hydrogeology review suggests reconfiguring the pumping tests to allow for easier interpretation of the tests for determination of aquifer hydraulic properties using relevant and appropriate conceptual and analytical models of the wells and bedrock system at the Quarry site and surrounding area. While this course of action may yield better and more easily interpreted estimates of aquifer properties, it would unnecessarily complicate and compromise the ability of the pumping tests to meet their intended objectives, namely to try and create full depth Quarry drawdowns.

7. The single most important conclusion of the Nova Hydrogeology review, is that the first pumping test will not be able to simulate the effects of full Quarry drawdown due to radial flow effects and the turbulent head losses that will occur when one tries to pump the wells at the rates necessary to achieve something that approximates full Quarry drawdown. This conclusion is important because it clearly indicates that Dr. Novakowski is of the opinion that the GRS pilot test will be a poor surrogate for full Quarry drawdown conditions. I am in agreement with Dr. Novakowski on this important issue.

2.2 Draft MOE PTTW

1. Based on the reduced draft PTTW limits on pumping rates for the pilot scale GRS, it is clear that the MOE is trying to balance potential for off-site impact against the objectives of the GRS pumping tests. However, with a combined pumping limit of 3000 m^3/day for all three wells (TW-14, TW-15 and TW-16) and the issue of turbulent head losses in the wells noted earlier, there is no guarantee that the GRS pumping tests will achieve targeted drawdowns.

2. The draft PPTW does not prohibit completion of the proposed pumping tests in summer months. Since this GRS pilot test is intended to assess future impact to the groundwater system and groundwater users, running the tests in the summer would be the most appropriate and conservative time to do so, when groundwater recharge rates and vertical leakage are expected to be minimal. Running these tests in October or November, would be less than ideal as groundwater recharge rates and vertical leakage will be much greater than in the summer months due to decreased evapotranspiration.

3. The draft PTTW does not explicitly require the continuous measurement of flowrates and cumulative flowrates to the recirculation trench, although this monitoring is outlined in the GLL *Final Hydrogeological Work Plan* (pg. 19). As continuous monitoring of recirculation flowrates is an essential need of the GRS pilot testing it should be included, preferably in Section 4.1.2 of the draft PTTW.

4. The maximum daily groundwater pumping rates of 3000 and 4500 m^3/day allowed for in the draft PTTW still appear to represent a significant percentage (i.e., 57 and 85%) of the Stantec calculated 7Q20 low flows in Mountsberg Creek, suggesting that groundwater loading to the Creek could be significant under summer conditions of low flow. Such loading may pose a threat to fisheries within Mounstberg Creek, which are known to be spawning habitat for brown trout and brook trout. The daily testing of discharge water quality as required under Section 4.12 of the PTTW and the field monitoring of surface water quality parameters of pH, temperature, dissolved oxygen, conductivity and turbidity as required under Section 4.14 will be critically important in providing warning of any adverse surface water quality impacts.

5. In terms of access to important monitoring information, the draft PTTW (Section 4.10) requires the on-site monitoring well data be made publicly available on a daily basis and that as per Section 4.17 all other surface water and groundwater monitoring data required under the PTTW be included in reports to be prepared within 30 days of the completion of each phase of the testing program and submitted to the Director. Although not specifically listed in the reporting requirements of Section 4.17, it would be preferred that the water quality monitoring data required under Sections 4.12 (GRS pumping wells daily groundwater sampling) and Section 4.1.4 (daily surface water field indicator parameters of pH, temperature, dissolved oxygen, conductivity and turbidity) be included in the reporting requirements of Section 4.17.

3. CONCLUSIONS

The Nova Hydrogeology review, prepared in support of MOE review of the PTTW application for the proposed DGR pilot testing, outlines several hydrogeologic concerns that confirm my earlier opinion on the great difficulty and potential hazards of undertaking meaningful pilot scale GRS and of application of the results of pilot scale GRS to a full Quarry scale.

The key hydrogeological concerns for this undertaking include:

1. The short-term pilot scale GRS pumping tests will be a poor surrogate for full Quarry drawdown and hence will not provide data representative of the effects of full Quarry drawdown - one of the stated objectives of the proposed GRS pumping tests that in my opinion should be pursued.

2. The proposed pilot scale GRS test, even if it could achieve representative full Quarry drawdown, will only provide information on the practicality and performance of the GRS over a very short term time frame and only for the immediate vicinity of the pilot scale GRS test area.

3. Given that GRS is an unproven mitigation technology for the conditions of the Quarry site (freezing winter weather, extremely heterogeneous fractured carbonate bedrock aquifer), and the potential long-term concerns associated with GRS system performance (physical, chemical and biological well/trench plugging, dissolution and creation of preferential flow paths, winter operations causing freezing of groundwater discharge on Quarry faces limiting supply of reinjection water to the GRS, etc.), the results of the pilot scale GRS will not be representative of long-term full scale operation of a GRS at the Quarry.

4. All of the hydrogeologic concerns and issues that were expressed in my April 30, 2008, November 19, 2007, November 26, 2006, November 11, 2005 and March 28, 2005 letters to you remain for the proposed GRS pilot test and full scale implementation of GRS at the proposed St Marys Cement East Flamborough Quarry.

Review of the draft MOE PTTW identifies the need for two enhancements:

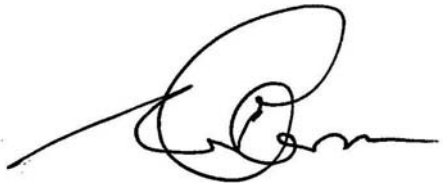
1. Inclusion of the requirement to continuously monitor groundwater recirculation rates to the recirculation trench as part of the monitoring requirements of Section 4.1.2 of the draft PTTW.

2. Water quality monitoring data required under Sections 4.12 (GRS pumping wells daily

groundwater sampling) and Section 4.1.4 (daily surface water field indicator parameters of pH, temperature, dissolved oxygen, conductivity and turbidity) should be included in the reporting requirements of Section 4.17.

Respectfully submitted,

Intera Engineering Ltd.



Kenneth Raven, P.Eng., P.Geo.
Principal

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