November 25, 2008 EBA File: E22101512

Lac Ste Anne Community Group
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Attention: Ms. Patricia Fish
Chairperson

**Subject: Work Plan for Groundwater Interference Assessment
Centred On LSD 06-055-01 W5M (Lac Ste Anne County)
Near Onoway, Alberta**

EBA Engineering Consultants Ltd. (EBA) is pleased to provide this work plan to the Lac Ste Anne Community Group related to a property centred on LSD 06-055-01 W5M (NW, NE and SW), currently the subject of proposed commercial aggregate extraction activity, located north of Hwy. 37 and east of Secondary Hwy. 777, approximately midway between Matchayaw Lake and Onoway, Alberta.

The proposed commercial aggregate extraction is understood not to involve excavation to depths below the prevailing uppermost water table.

1.0 STUDY OBJECTIVES

The requested objective is to provide the Lac Ste Anne Community Group (LSACG) with a means to determine if domestic and livestock water wells close to the proposed aggregate extraction activities are at risk from well interference effects. Water well interference refers to those changes in water quantity or quality, or both, that deviate from historical ranges. The interference effects are therefore water quantity or quality changes that are superimposed onto the natural range of seasonal and annual fluctuation.

Some of the main potential problems that can arise when well interference causes a decline in the non-pumping (static) water level include:

- Increased water lift and pumping costs to well owners
- Decreased well storage, potentially affecting the viability of lower-yielding wells to produce sufficient water for peak period use
- A reduction in water quality from the greater contribution of deeper aquifer water, potentially causing natural mineralization to increase (iron, manganese, chlorides, sulphates, etc.), possibly necessitating water treatment to meet water use standards.

A second requested objective is the provision of a means to assess potential changes to the groundwater contribution to the Sturgeon River, applicable to the river reach adjacent to the proposed aggregate extraction. This reach of the Sturgeon River is probably fish

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bearing, therefore, a reduction in groundwater contribution, either from interception before it enters the river or from groundwater direction reversal induced by high rates of abstraction, is needed to rule out significant stream depletion at periods of lowest annual stream flow, i.e., typically in late summer.

2.0 REGULATORY FRAMEWORK

Water resources in Alberta are administered by Alberta Environment and are protected by legislation under the Water Act which supports the conservation and management of water including its allocation. Under the Water Act, aquifers are considered to be water bodies and regulatory authorization is required for groundwater diversion from an aquifer.

Applications for commercial activities involving groundwater abstraction are regulated under the Water Act, similar to country residential subdivisions in terms of protecting provincial groundwater resources.

3.0 SCOPE OF WORK

The following sub-sections outline a scope of work to meet the objectives of assessing the potential for interference on water wells in proximity to the proposed aggregate extraction and for assessing groundwater contribution to the Sturgeon River.

The information collected and type of interpretation is similar to that required for evaluation of a groundwater diversion application under the Water Act, i.e., new water well applications for commercial or country residential water use, although the following scope emphasizes the identification of potential aquifer overuse and resultant groundwater interference.

The following seven tasks outline a sequence of study to meet these objectives.

3.1 TASK 1 - DESKTOP INFORMATION REVIEW

This task will characterize the local hydrogeological setting of the subject property and local area. A compilation and review of public records that relate to the subject property will be conducted to identify local physiographic features and respective hydrostratigraphic units used by the local water wells.

Generally the following information is searched and compiled for the subject property and surrounding area:

- Aerial photographs - compilation of historical photos, often 1920s to present, to identify areas of surface water and changes in land use
- Map information - NTS maps for: topography, surficial (drift) geology, bedrock topography, hydrochemistry, hydrogeology, aggregate surveys

- Hydrogeology reports - Alberta Geological Survey, Alberta Research Council
- Water well records - Groundwater Information Centre (GIC) database of water well records centred on the proposed groundwater diversion, within a specified search radius, often 1.6 km (1 mile).

At the end of Task 1, a preliminary evaluation will be made using the compiled information to develop a conceptual understanding of the subject site and local area in terms of local aquifers and aquitards (groundwater flow barriers) that may be present.

3.2 TASK 2 – CONCEPTUAL MODEL DEVELOPMENT

A conceptual model will be developed to assess the local aquifer(s) ability to meet the needs of all existing groundwater users and those of the proposed aggregate washing activities. To this end, an initial aquifer interpretation will be conducted by developing geologic and hydrogeolopgic cross-sections through the subject property and surrounding area to show aquifers and aquicludes.

Contingent on the water well records level of detail, an initial interpretation of aquifer yield will be conducted by calculating well specific capacities and apparent aquifer transmissivities (using "book value" aquifer storage values), from the two-hour pumping test records reported on water well records.

An initial determination of the upper limit of groundwater abstraction for the subject site will be undertaken after a review of precipitation data from 30-year climate normal records, to assess the total annual precipitation recharge to the subject property. This represents the upper limit for groundwater abstraction that can be sustained solely from precipitation recharge, i.e., from precipitation onto subject property alone without taking groundwater from outside the property lines.

If sufficient groundwater monitoring records are available, water table information will be shown on site cross-sections to evaluate if a shallow water table or perched water table is present, which would necessitate de-watering to maintain a dry excavation base for equipment to operate during proposed aggregate extraction activities.

At the end of Task 2, an updated work plan will be prepared that summarizes the findings of Tasks 1 and 2. Subsequent tasks may also be refined in terms of work scope and schedule.

3.3 TASK 3 – FIELD AND WATER WELL VERIFICATION SURVEY

A water well and surface water field verification survey will be conducted to verify the public records obtained in Task 1, involving the following:

- Water well verification
  - Non-pumping (static) water levels

  - Well yield and time for recovery after peak period use
  - Water quality treatment equipment, if used
- Surface water features verification
  - Location and description of features including: streams, dug-outs, ponds, etc.

It would be prudent during Task 3 to collect well water samples for analytical laboratory testing of water quality parameters. These results will be compared to water quality standards applicable to domestic use and for livestock watering, according to each respective water well use.

These laboratory results will therefore form an initial water quality database that can be updated so that a benchmark of water quality is established for each local water well, representing a "pre-construction" type record for well owners.

3.4 TASK 4 – DRAWDOWN TEST

The two-hour pumping tests conducted by water well drillers is too short to evaluate long-term sustainable well yield, i.e., provides a short-term yield only. Groundwater diversion applicants are therefore required to verify that the land can support the proposed water use without degrading or interfering with existing groundwater users adjacent to the property by conducting long-term drawdown testing.

The objective of a drawdown test is to pump from the local aquifer(s) on a subject property so that groundwater movement is induced around the well to simulate long-term pumping. The testing should be conducted on the subject property and the pumping effects measured as changes in the static (non-pumping) water levels in nearby observation wells.

It is unknown at the present time whether a suitable abstraction well or sufficient observation wells exist for Task 4 to be fully conducted as described. If not already present, therefore, this task will require the construction of an abstraction well and suitable observation wells, using a qualified water well contractor.

If fully implemented, the outcome of Task 4 will be an assessment of the hydraulic radius-of-influence that an abstraction well is capable of inducing at different pumping rates.

Drawdown testing data typically enables the following interpretations to be made:

- Optimal abstraction rate for long-term (20-year) operation
- Projected distance to zero drawdown, to evaluate maximum interference distances
- Identification of hydraulic boundaries, whether recharge (river) or barriers to groundwater movement
- Identification of hydraulic connectivity between abstraction and observation wells.

The latter is generally more pronounced in the case of fractured bedrock aquifers. During Task 4, it would be prudent to monitor the non-pumping (static) water levels in nearby water wells that are considered to be potentially at risk from interference, to identify direct hydraulic connectivity via fractured bedrock, if present.

The distance to which aquifer drawdown effects can be assessed is a function of the duration of the drawdown testing, i.e., a longer testing time will be needed if the local wells are several hundred metres from the abstraction well. To fully assess the potential for long-term interference to local wells therefore and to identify if Sturgeon River water is intercepted, a minimum of one week is suggested as the drawdown test duration, i.e., a one-week duration pumping test.

3.5 TASK 5 – GROUNDWATER MODELLING

In situations where the local geology is complex, either from the presence of multiple aquifers in use by the local water wells, or complex in terms of three-dimensional spatial relationships, groundwater modelling can be used to simulate an abstraction well at the subject property and predict the change it may have on local groundwater conditions, in terms of flow direction and water levels over the long-term.

Groundwater modelling can also assist in simulating groundwater conditions and predicting long-term changes that may occur to surface waterbodies as a result of groundwater abstraction, such as the groundwater contribution to the nearby Sturgeon River.

The level of effort to develop groundwater models can be substantial and therefore wherever possible, analytical solutions to the groundwater flow equation are often used (Microsoft Excel). In the case of complex hydrogeology, a numerical model is generally required (e.g., U.S. Geological Survey MODFLOW) to represent the three-dimensional aspects of the hydrogeology, groundwater boundaries, water levels within multiple aquifers, etc.

At present the degree of hydrogeological complexity for the subject property and local area is unknown. Task 5 will be refined therefore according to the findings of Tasks 1 to 4, inclusive.

3.6 TASK 6 – SURFACE WATER ASSESSMENT

Given the proximity of the Sturgeon River to the subject property (on the order of several hundred metres), Task 6 has been included in order to assess potential stream depletion that might result from the reduction of groundwater contribution for the nearby river reach, i.e., west and south of the subject property.

Sturgeon River hydrographic stations would be identified (Environment Canada) up- and down-stream, from which river flow and level information will be reviewed and the seasonal and annual river flows assessed for this reach of the Sturgeon River. The

contribution to the river made by groundwater from the subject property will be evaluated using analytical solutions (Microsoft Excel) and possibly by numerical modelling, if warranted (as part of Task 5).

Further surface water field studies would be recommended in the event that the groundwater contribution to the Sturgeon River was predicted to decrease by more than 10% within the zone-of-influence by groundwater from the subject property, or the predicted stream depletion was greater than 5% of 7Q20 flow, defined as the lowest seven-day average flow based on a 20-year return interval (Ontario MOE, 2008).

3.7 TASK 7 – INTERFERENCE ASSESSMENT

This task would combine the findings of the previous tasks to develop a tabulated summary of existing local water wells and their respective potential for interference from commercial-scale abstraction at the subject property. Recommendations would also be provided regarding possible mitigation measures to alleviate any significant interference effects, if warranted.

An overall assessment of surface water interference would also be provided as well as any recommendations for further fieldwork in the event that the degree of predicted interference exceeded the groundwater contribution "trigger" values defined in Task 6.

Task 7 will conclude with the preparation of a full report that describes the work conducted, methods used and study findings, together with appropriate recommendations for mitigation or prevention of interference effects to local groundwater users.

4.0 PRELIMINARY SCHEDULES

Tasks 1 to 4, inclusive are typically conducted within a two-month timescale, during non-winter months.

Task 4 is contingent on the presence of a suitable abstraction well located on the subject property and the presence of suitable observation wells at distances and groundwater intake depths to monitor the drawdown testing. In the event that new wells are needed to conduct Task 4, they are typically planned and constructed to ultimately become groundwater wells for use on the subject property. Any new wells would require a separate work plan and coordination with a qualified water well driller, requiring a time period on the order of several months to implement as the process is generally dictated by contractor availability.

The level of effort required for Task 6 can range significantly depending on the amount and quality of hydrogeological data that is available and the local conditions being simulated. This task may therefore require a more flexible timing, on the order of one to two months in the event that a three-dimensional model is required to be constructed, calibrated and checked for parameter sensitivity.

Task 7 would typically be completed within a one-month period.

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5.0 CLOSURE

We trust that this work plan meets your present requirements for assessing potential water well interference effects for the Lac Ste Anne Community Group. If you should have any questions or would like clarification regarding any parts of this work plan, please do not hesitate to contact the undersigned.

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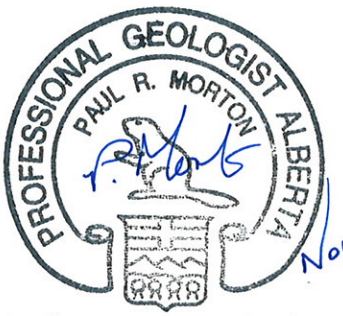

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Attachments: Appendix A: Environmental Report – General Conditions

APPENDIX

APPENDIX A ENVIRONMENTAL REPORT - GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

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