July 30, 2007 EBA File: 1740149

Tamerlane Ventures Inc.
441 Peace Portal Drive
Blaine, WA 98230
USA

Attention: Mr. David Swisher
Vice President/Senior Project Manager

Dear Mr. Swisher:

Re: Evaluation of Deep Well Disposal, R-190 Mineral Deposit Site Near Hay, River, Northwest Territories

INTRODUCTION

Further to your request from Tamerlane Ventures Inc. (Tamerlane) to EBA Engineering Consultants Ltd. (EBA), we present here our evaluation of proposed disposal of process water by deep well injection at the R-190 site, near Hay River, NWT.

As a follow-up to the Technical Sessions held July 17-18, 2007 in Hay River, we understand that the following are the objectives for this evaluation:

1. Assess hydraulic feasibility of injecting process water at the following rates into the Presquile aquifer:
   a) 55 m^3/hr (equal to 1,320 m^3/d or 243 USgpm)
   b) 550 m^3/hr (equal to 13,200 m^3/d or 2,425 USgpm)
   c) 2,000 m^3/hr (equal to 48,000 m^3/d or 8,813 USgpm)
2. Determine to what extent mounding would occur for 1a, 1b and 1c above.
3. Provide an opinion on the fate of ammonia at low concentrations (about 1 to 2 mg/L) as a constituent of process water injected into the Presquile aquifer.

This letter contains all of the information, calculations and results for this evaluation.

Sources of information used for this evaluation are as follows:

- Developers Assessment Report Pine Point Pilot Project. April, 2007.
- Desktop Evaluation of Natural Groundwater Flow Velocities – Pine Point Mine Ground Freezing Project. EBA, September 2006.

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- Hydrogeology of R190 Mineralized Region, Great Slave Reef Project, Westmin Resources Limited. Report to Westmin Resources Ltd. by Stevenson International Groundwater Consultants Ltd., November, 1983.
- R-190 Aquifer Test Analysis and Preliminary Dewatering Design. Report to Westmin Resources Ltd. by Brown, Erdman & Associates Ltd., Project 80-190, February, 1981.

Limited reference was also made to these documents:

- A Study of the Great Slave Reef Pine Point Mines Aquifer, Based on Analyses of Selected Pine Point Mines Pumping Test Data. Report to Westmin Resources Ltd. by Stevenson International Groundwater Consultants Ltd., March, 1984.
- Investigation of Regional Geohydrology South of Great Slave Lake. Draft report prepared by U. Weyer, lead author, National Hydraulics Research Institute, 1984.

PROJECT UNDERSTANDING

We understand the following key points relating to this assignment:

- Bedrock geology underlying the R-190 site consists of Devonian-age reef carbonate rocks that dip gently to the west and are gently folded along east-west and northeast-southwest axes.
- The Presquile geologic unit consists of severely fractured, vuggy and karstic coarse-grained dolomite, occurring from 122 to 183 m (400 to 600 feet) depth below ground surface (61 m or 200 feet thick) at the R-190 site.
- The Presquile unit constitutes a productive karst aquifer, with high transmissivity (9,300 to 10,600 m^2/d) and storativity around 0.0001 to 0.0007. The aquifer is confined above by the Amco Shale and Watt Mountain formation, and below by the Pine Point Formation. Detailed aquifer test analysis shows evidence of hydraulic barrier boundary conditions at distances of 4 to 11 km from the R-190 site. The full extent and location of these barrier features is not well documented (in the sources available for this evaluation). Drawdown cones developed during these pumping tests showed a marked anisotropy with a strong east-west preferred alignment.
- Static water level for an open borehole penetrating to the Presquile aquifer measured at the start of a long-term pumping test in November 1980 was 27 m (88.6 ft) below ground surface.
- Process water would originate from dewatering water pumped largely from the Presquile aquifer.

OBJECTIVE 1 - FEASIBILITY OF INJECTING PROCESS WATER

In theory, the hydraulic behaviour of an injection well should be a mirror image of a pumping supply well. Instead of a drawdown cone forming (as around a supply well), a buildup cone or cone of recharge will form above the static water surface (potentiometric surface) of a water well. A highly productive aquifer is typically a highly receptive unit for injection, if steps are taken for proper water handling, well design and sustainable operation. In practice, recharge rates for a given well are lower than the pumping supply rates. This is due to the clogging effect of particulates, air bubbles, mineral precipitation or biological fouling as the injected water passes into the formation.

To facilitate sustainable injection rates, designers typically use large diameter wells and longer well screen lengths than typically used for screened water supply wells or the longest possible open borehole intervals to lessen maintenance. It is also advisable to thoroughly remove air bubbles and particulates (through filtering). If needed, based on detailed geochemical assessment of the mixing effects of the injection water with the natural groundwater, the injection water may need treatment before injection. A detailed geochemical mixing analysis of process water and natural groundwater in the Presquile aquifer is beyond the scope of this study, but we highly recommend this be done as part of system design.

The Presquile aquifer has historically produced large yields during long-term pumping tests, and in general we consider it hydraulically as a good candidate for process water injection. Stevenson (1983) reported that this unit contributed 97% of the total flow of 639 m^3/hr (2,345 igpm) during a 23-day pumping test in November, 1980 at R-190. Yet this substantial hydraulic stress did not create a large drawdown (maximum drawdown was <10% of available drawdown). The specific capacity (the amount of well yield for a given unit of drawdown) after 1,000 minutes of pumping at that test well was very high (148 m^3/hr per metre of drawdown).

The maximum injection flow rate for gravity-driven injection into an aquifer can be calculated. For a confined aquifer with water being recharged into a well completely open to the aquifer (such as envisioned here for injection into the Presquile aquifer), the maximum injection flow rate is given by the following equation (Driscoll, 1986, p.771):

$$Q = Kb\,(h_w - H_o) / \, 0.366\log(r_o / r_w)$$

where,

Q = injection flow rate (m^3/day), under gravity conditions

K = hydraulic conductivity (m/day)

b = aquifer thickness (m)

h_w = head above the bottom of aquifer while recharging (m)

H_o = static head above the bottom of aquifer with no pumping (m)

r_o = radius of influence (m)
r_w = radium of injection well (m)

Flowrates over this calculated value might be possible, but would need over-pressuring of the injection wellhead and piping system. Using a radius of influence (r_o) equal to the distance to the nearest barrier boundary (4 km), a well radius of 203 mm (8 inches for a 16 inch diameter well), the aquifer geometry and a Kb value (equal to transmissivity) of 10,000 m^2/d , the maximum calculated flow rate is:

Q = 10,000 m^2/d (183 m – 156 m)/ 0.366 log (4,000 m/0.2 m) = 171,519 m^3/d (7,146 m^3/hr)

This calculated value is not very sensitive to values of r_o or r_w since they are within a log function. For example, if the same calculation is done with r_o = 11,000 m (for a barrier boundary 11 km away) and a 24 inch diameter well (r_w = 0.3 m), the injection flow rate is 161,625 m^3/d (6,734 m^3/hr).

These calculations indicate that the Presquile aquifer would easily accept injection flow rates under gravity-driven conditions for all three of the predicted potential injection flow rates (55, 550 and 2,000 m^3/hr).

OBJECTIVE 2 – MOUNDING HEIGHT

There will be mounding of the natural water surface (potentiometric surface for the confined Presquile aquifer) around an injection well, where the water level in the formation rises higher than the static water level.

The theoretical build-up in the aquifer (mounding height) can be calculated by reworking the equation above.

$$\text{Mounding height} = h_w - H_o = Q \times 0.366 \log(r_o/r_w)/ Kb$$

For the initial calculation parameters given above, the mounding heights for the various proposed injection rates would be:

For an injection rate of 55 m^3/hr:

$$\text{Mounding height} = 1{,}320\ m^3/d \times 0.366 \log(4{,}000\ m/ 0.2\ m)/ 10{,}000\ m^2/d = \underline{0.21\ m}$$

For an injection rate of 550 m^3/hr, the mounding would be 2.1 m and

For injection rate of 2,000 m^3/day, the mounding would be 7.6 m.

The actual build-up inside a given well casing would be function of aquifer properties, plus the well diameter, static water level (depth below ground level which equals the limit of available build-up for a given well) and the well loss. Well loss in this context means that the water level of the build-up (cone of recharge) outside the well is lower than the water level in the well casing, and that only part of the rise in pumping water level in the casing (build-up head) is used to inject water into the formation. Well loss occurs due to head loss from injection water travelling down the well casing to the injection interval, and to head loss as the water turns to enter the formation (possibly locally under turbulent conditions). If there is a well screen or perforated casing at the injection interval, there would also be head losses as the water passes through the screen. Due to well loss, the pumping water level inside an injection well casing will always be higher than the actual mounding of the water (potentiometric) surface outside of the well casing.

As the specific wells for injection have not yet been designed, it is not possible now to predict the actual build-up in those wells. However, since there is 27 m of available build-up (depth to water potentiometric surface at R-190) and the maximum calculated build-up is only up to 7.6 m, there should be ample available build-up for gravity-driven injection into the Presquile aquifer even for wells with substantial well loss.

OBJECTIVE 3 – FATE OF AMMONIA

Ammonia as a chemical species (present as ammonium ion NH_4^+) is reactive and will typically readily oxidize through geochemical processes to nitrate compounds or be adsorbed on soil and rock surfaces down-gradient from the injection point. The actual behaviour of ammonium in the process water that is injected into the Presquile aquifer would require detailed geochemical analysis (e.g., using a mixing model like PHREEQC) to account for the differences in water pH, temperature, dissolved oxygen content and the ammonium concentration, which is beyond the scope of this work. In general, the low concentrations anticipated for the ammonium (1-2 mg/L), the deep injection depths (122 to 183 m below ground surface), the relatively large surface area for adsorption on the severely fractured dolomite aquifer, and the long travel distance to any receptors or surface water bodies (kilometres) suggests that ammonium would be readily retarded (reacted or adsorbed) in the subsurface.

We trust this evaluation is satisfactory for your current needs. If you have any questions, please contact the undersigned at your convenience.

Yours truly,
EBA Engineering Consultants Ltd.

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