



File: 38050-03/ HONGYANG BOTTLING PLANT

August 6, 2019

To: Murray Allison, RFT, Water Stewardship Officer
Thompson Rivers Natural Resource District
Via email to Murray.Allison@gov.bc.ca

From: David Thomson, P.Geo., Regional Hydrogeologist
Ministry of Forests, Lands, Natural Resource Operations & Rural Development
South Area Groundwater Science, Vernon, BC.

Re: Review of Materials submitted in support of Application 20005985

This technical memo is in response to ongoing communication related to a meeting held at the offices of EHD Consulting in Kamloops in Fall 2018 to clarify expectations of the Province of BC with respect to deficiencies in the original application. In response, two reports (Hy-Geo, 2018 and 2019a) and a short memoranda (LHC, 2018b) were submitted. In April 2019, you asked for additional clarification regarding recharge estimates, and one more short summary (Hy-Geo, 2019b) and a short memoranda (LHC, 2019) were supplied. Subsequently you asked me to review the materials surrounding recharge estimates and statements regarding the sustainability of the withdrawal, which required additional clarification with both Qualified Professionals (QPs). In the end, both QPs agree with each other's assessments.

Previously, your primary concerns included aquifer confinement, surface water connectivity, pumping test, absence of basic background hydrologic data, connection to Cutoff Valley Creek, and recharge.

Aquifer Confinement

LHC originally assessed that the aquifer was in a confined state and the wells drilled for this investigation were an anomaly. Hy-Geo's (2019a) supplemental report indicates the aquifer is largely in an unconfined state. I agree with the Hy-Geo opinion as it represents an up-to-date assessment of the 2007 Ministry of Environment mapping, using additional well records not

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available in 2007. LHC (2019) now also appear to concur the aquifer is unconfined. Hy-Geo's usage of the WTF method of estimating recharge is applicable to unconfined aquifers.

Surface Water Connectivity

Hy-Geo (2018) acknowledge probable connectivity between the applicant's well and Duck Lake. The suggested mitigation of pumping well water into Duck Lake, should the pumping well induce lake water to flow toward the well, requires further investigation to implement, owing to Duck Lake being "2 to 3 times more mineralized (e.g. TDS) than samples from the CHZ wells." Two potential areas of concern related to the connectivity are as follows:

- Water quality changes in Duck Lake resulting from this proposed mitigation may impact vegetation or aquatic life habituated to the relatively high degree of mineralization. Other subject matter experts could be consulted about this.
- Section 58 of the *Water Sustainability Act*, under the subject of "Well Operation", may be triggered if water from Duck Lake were to migrate to the aquifer as a result of well operation, and cause "a significant adverse impact on the quality of water".

Both of the above considerations would need to be assessed relative to the actual potential loss from the lake, rather than the order-of-magnitude estimates currently received. Additional monitoring is recommended at the end of this letter, between the pumping well and the lake, to be able to assess this.

The report also provides evidence that Salt Lake is likely not impacting the aquifer water quality.

Pumping Test

The original pumping test (LHC, 2016) was not strictly compliant with our requirements but nonetheless the late time response appears to represent stabilized drawdown for analysis. That analysis provides an estimate of transmissivity, which is critical to Hy-Geo's estimation of recharge and sustainability of the withdrawal. Implementation of monitoring conditions should mitigate uncertainty surrounding the pumping test analysis, should a license be granted.

Absence of Data

The initial report was lacking much required information, and that has been remedied with subsequent reports, primarily those by Hy-Geo (2018 and 2019a).

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Connection to Cutoff Creek

Hy-Geo demonstrates through water quality analysis there seems to be no discernible flow from the aquifer to Cutoff Creek. Although the cross-section shows an artesian flowing well near the creek, the creek itself is indicated to be isolated from the aquifer by till.

Recharge

Two methods were used by Hy-Geo to estimate recharge to the aquifer. Recharge was estimated by Hy-Geo using the WTF method to be 25.2 to 100.8 US gpm, and estimated to be much higher using a water budget. The difference between these two estimates is attributed to the highly transmissive aquifer causing a muted response in water level rise, which the WTF method is dependent on. Put another way, the estimation of recharge from water levels is biased low, due to the speed at which groundwater moves through the aquifer.

One key assumption of the applicability of the WTF method is that the observation well hydrograph depicts only natural fluctuations (ie, no pumping). A critical dependency of the recharge estimations derived from the water budget method are the reliance on the value of transmissivity estimated by LHC. Again, monitoring conditions should address uncertainties.

While the WTF method does not distinguish recharge sources, water quality comparisons and well information substantiate that bedrock inflow may constitute a significant contribution to aquifer recharge. The water type of the unconsolidated aquifer at the production well and the bedrock well (WPID 38346) are similar, although there is a ~two-fold difference in total dissolved solids (TDS). TDS ranges from ~800-1200 mg/L in the unconsolidated aquifer, excepting the Ministry observation well, while the bedrock well reported 2390 mg/L. Surface water as represented by Gainor Lake and Cutoff Valley Creek ranged from 287-425 mg/L. Salt Lake has a TDS ranging from 109,000 to 232,000 mg/L, while Duck Lake reports 2470-2650 mg/L TDS.

The measured TDS in the unconsolidated aquifer may represent vertical mixing of the two sources of recharge, with surface runoff and infiltration dominant over bedrock recharge. Allowing for the fact that most of the well samples are from the south end of the aquifer, the percentage of bedrock recharge may be yet lower (meaning more recharge comes from other sources).

LHC (2019) provide a table relating the estimated recharge to total groundwater demand from the aquifer. Hy-Geo concurred with the estimates.

Sustainability

LHC (2019) state that the withdrawal is estimated to range between 6.4% and 24.7% of recharge in a given month, and that the estimate is on the low end of range provided by Hy-Geo. Hy-Geo makes a more concise statement that "it is considered that there is sufficient

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groundwater available on an annual basis to support CHZ well production in the range of 80 to 200 US gpm.” The reports provided to date appear to substantiate this evaluation.

Summary

The SDM concerns regarding area hydrogeology for this application, as I understand them, have been addressed by the LHC and Hy-Geo reports with a reasonable effort, given the uncertainties inherent in hydrogeology. That being said, there still remains some uncertainty regarding impacts to water quality in the aquifer as a function of well operation, which is acknowledged by Hy-Geo. As such Section 58 the *Water Sustainability Act* may come to bear on operation of the well. Further, Section 16 provides the decision maker the ability to request a proposal for mitigation of the effects, and/or impose terms and conditions related to those effects. Monitoring and mitigation measures are recommended by myself and the Qualified Professionals.

Recommendations

Monitoring conditions recommended by Hy-Geo address some of the remaining uncertainties, in particular the concern about the production well inducing flow from Duck Lake to the production well. Hy-Geo suggest bedrock recharge may contribute significantly to the CHZ production well flow, and while this may be the case, the hydraulic connection remains a concern generally to SDMs. Further to this, I suggest installing LTC (level-temperature-conductivity) dataloggers in the production well and in a new or existing monitoring well that:

- Is situated between Duck Lake and the production well but closer to Duck Lake;
- Has a very similar length of screen as the production well; and,
- Is situated at an elevation anticipated to intercept water that would migrate from Duck Lake to the production well; accompanying calculations and projections should be made available on request.

Prior to operating the production well, the natural range of variability in relevant water quality parameters – specifically conductivity and conservative solutes such as chloride and possibly others – should be determined. The Qualified Professional should have experience with statistical analysis of water quality results to best assess natural variability and discern anomalies from trends.

Based on that assessment the Qualified Professional will:

- design a monitoring and mitigation plan that at a minimum should include water quality sampling for laboratory analysis based on “trigger” parameters and values;
- determine numerical values for conductivity, chloride and other indicator parameters at the monitoring well or wells that would trigger the mitigation to begin; that mitigation may include resampling or checking values but ultimately should dictate a reduction or cessation of pumping in the absence of information supportive of recirculating water;

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- report to FLNRORD any triggering of the mitigation plan within one week of the event; and,
- Report findings on a regular basis (minimum yearly).

Water quality samples taken from the monitoring well(s), and production well by the applicant as part of routine operation for water bottling should be uploaded to the province's Environmental Monitoring System (EMS). The monthly analytical suite should include major ions as well as dissolved metals, at a minimum.

The potential for mitigating impacts to Duck Lake by recirculating pumped water into the lake, and the utility or potential impacts of doing so, is a complex issue that will require additional consideration and likely study as noted earlier. The monitoring and mitigation plan would not be required, if the SDM is not concerned about the probable hydraulic connection between the production well and Duck Lake.

Signed,



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Regional Hydrogeologist

Ministry of Forests, Lands, Natural Resource Operations & Rural Development

South Area Groundwater Science,

Vernon, British Columbia.

Cc: Skye Thomson, Section Head, South Area Groundwater Science (via email).

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