Appendix D

Frequently Asked Questions

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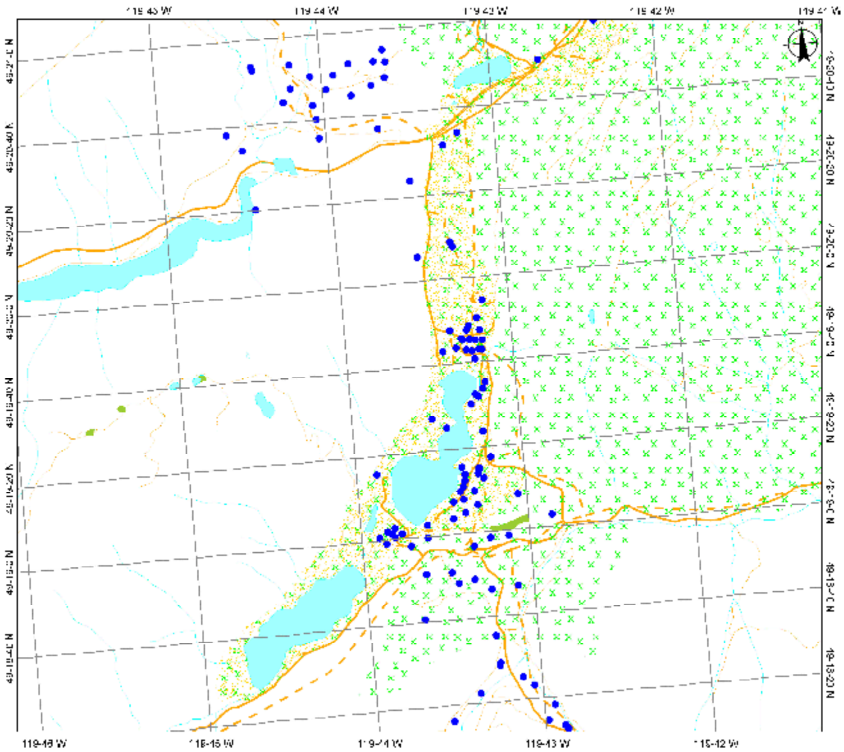
Frequently Asked Questions Regarding the Twin Lake Aquifer. These questions were provided to Summit in the RDOS Request for Proposals. Our opinion on the most reasonable answers to these questions are provided below. Refer to the main body of the report for substantiating data, interpretations, and findings.

1. Why is Twin (Lower Nipit) Lake so low? Why is Twin (Lower Nipit) Lake level so much lower than the other lakes in the Twin Lake aquifer?

To answer these questions, we must consider the following factors:

- Twin (Lower Nipit or Lower Twin) Lake has a smaller surface catchment than Horn (Upper Nipit or Upper Twin) Lake. Approximately 75% of the catchment drains to Horn Lake. Twin Lake therefore depends on inputs (both surface and ground) originating higher in the basin. Because the two lakes are not connected at the surface, their respective water levels will respond differently to stresses such as groundwater extraction and reduced precipitation.
- Twin Lake is low because it is not receiving sufficient input from surface flow and groundwater flow. The lake's water balance is not stable.
- In recent years, there have probably been insufficient periods of time when the level of the Horn Lake has been high enough to drive significant surface flow through the dam and connecting channel to the Lower Twin Lake. This is believed to be primarily due to climatic factors, however, it is possible that alteration to the approach channel upstream of the Horn dam has prevented some exchange of water between Horn Lake and Twin Lake, and also leaves the Turtle Pond without enough water.
- Twin Lake is surrounded by water wells, whereas Horn Lake is not (see **Map** below), and extracting groundwater has the same potential long-term effect as taking water directly out of the lake with a domestic license. This observation was made as long ago as 1966 by Ministry staff, again in 1981 (Van Der Kamp) and finally in the current study.
- The area's most significant groundwater pumping occurs downgradient of the Lower Lake (at the golf course). Such pumping can be expected to create a capture zone that extends in an upgradient (southerly) direction, and any effects on surface water from the capture zone (i.e. depressed groundwater levels) would be felt more at Twin Lake than at Horn. Based on the characterized geometric and hydraulic properties of the aquifer, the long-term average pumping rate of 200 to 250 US gpm centred under the golf course likely creates a cone of depression that extends under Twin Lake (see **FIGURE** below).
- In summary, Twin Lake is low because it is losing more water to evaporation and subsurface seepage than it is receiving by surface inflow, direct precipitation, and subsurface groundwater inflow from the connected aquifer.



Map showing relative density of wells around Twin and Horn Lakes
(source: B.C. Water Resources Atlas)

2. What changes might have occurred to account for the reduction to Twin (Lower Nipit) Lake Levels (has water been rerouted, dammed, additional pumping at the Golf Course made an impact?)

Ground and air surveys are recommended to determine if the approach channel upstream of the Horn Lake dam outlet needs to be deepened. We note that the channel is “unimproved” i.e. gravel-lined, and as such is difficult to maintain. During discussion with the Steve Rowe of the MoE it was stated that there is no requirement to maintain the channel to a specific elevation (Pers. Com. Rowe S. 2010). However, it makes sense that the channel should be maintained at a level that allows the dam to store and release water. Such a level would be approximately the same as the pipe invert. Our site visit found no information suggesting that flow in Horn Creek above Horn Lake has been diverted.

The golf course provided some estimates of groundwater use; however, they do not meter their groundwater wells and the estimates of past and future groundwater use provided by their consultant range between 350 and 1,000 US gpm. Our evaluation determined that the lower-bound estimate of golf course groundwater use for both irrigation and domestic purposes consumes a significant percentage of the natural groundwater flow through the aquifer, and that some early signs of groundwater decline are evident. As noted above, groundwater pumping near Twin Lake, as well as at the golf course, could be contributing to the decline of Twin Lake levels.

3. How much development can be supported in the future? And if water is being overused then by how much?

Dr. Garth Van Der Kamp of Waterloo University observed almost 30 years ago that the Twin Lakes surface water-groundwater system was probably over-allocated, or at the very least was approaching its sustainable capacity. He recommended more monitoring of surface water and groundwater levels and usage, which unfortunately has not been implemented. However, we have better tools and models available today than existed in the 1970s and 1980s that can partially – but not completely – make up for the lack of actual water data.

The answer to this question depends on which future scenario is assumed. If for example, we take into account future climate models, assume groundwater will be pumped by owners of existing agricultural and residential properties that do not currently have wells, and also assume that existing users continue pumping groundwater at similar rates they have in the past, we believe that the sustainable capacity of the aquifer system has already been reached. This is based on our opinion that somewhere between 30 and 50% of the natural groundwater flow is captured by pumping on a long-term average annual basis. This is a high percentage relative to other developed aquifers in the basin. For example, Golder Associates conducted a similar sustainability analysis of the aquifers in the rural Joe Rich area of RDCO east of Kelowna (2008) and found that existing well pumping accounted for 10 to 20% of the flow in the unconsolidated aquifer, further noting that even this amount of pumping might not be sustainable given groundwater's role in sustaining baseflows in area creeks. .

Since there is no allocation system for groundwater in B.C. at the present time, making land use decisions that allow for more groundwater to be used runs the risk of preventing existing permitted uses of land (including agriculture) from accessing the resource in the future – especially during relatively dry climate cycles. In our opinion, land use planning and development decisions should be made based on the assumption of dry climate cycles and not depend on infrequent and unpredictable wet cycles to make up for any shortfalls.

As noted in our report, the study area comprises a groundwater recharge zone. This means in general there is a downward vertical hydraulic gradient. Under such conditions, deeper wells will typically have lower water levels than shallow wells. As groundwater levels decline, the owners of shallow wells may feel the effects first; but in this recharge area setting, well deepening may not be a solution as it is likely to accelerate the decline in deep well water levels. There is not a complete record of groundwater levels spanning several years, although nearby wells such as BC MoE observation well 282 in Meyers Flat show long-term cyclical effects of climate. Although our study was conducted in a fairly dry year (2009) we note that current groundwater levels appear to be on the order of one to three metres below recent historical levels. If we assume an average aquifer saturated thickness of 20 metres, this suggests a 5 to 15% decline. This may or may not be significant, depending on whether water levels continue to fall, or if a wet cycle allows for more recharge and results in less water demand.

The indication of a small decline in groundwater levels is based on a limited data set and one of our key recommendations (carrying forward the 1981 recommendations of Van Der Kamp) is to implement long-term groundwater level monitoring in the Twin Lake Aquifer as soon as possible. This is a priority shared by the B.C. Ministry of Environment (O. Ivanov, pers. comm. 2009). We note that a one to three-metre decline represents a significant volume of groundwater removed from storage ($2.53X10^5$ m^3 to $5.75X10^5$ m^3 or $6.7X10^7$ US gal to $1.5X10^8$ US gal) removed from aquifer storage between Horn Lake and Highway 3A. This decline in water level is likely due to a combination of reduced recharge (climate) and increased use (pumping).

4. Is Horn Lake at a natural level or has it been dammed above? And what had been permitted in their licenses?

We found no evidence of a dam above Horn Lake in our site visit. The level of Horn Lake varies annually in response to the seasonal patterns of runoff, precipitation and temperature. There is no record of systematic lake level measurements available upon which to make a quantitative assessment of Horn Lake. At the time of our site visit in early December 2009, it appeared that the lake level was below the invert of the pipe that passes through the dam, and the sluice gate was open, indicating that the dam was not storing water. License No. C62298 allows for the Horn lake dam to store water between October 1 and June 15 (License No. F51116, see Appendix G for a copy of the license) each year, after which any remaining stored water must be released and may be used according to the conditions of License Nos.F54114, C52034 and C52997. None of the licenses **require** that the dam store water – this is only possible if the level of Horn Lake rises high enough for the dam to function as an impoundment structure. To our knowledge, there are no surveyed benchmarks that make an objective assessment possible as to the exact elevation of Horn Lake that constitutes storing water at the dam.

Based on photos provided to Summit and our site visit, it appears that the approach channel is not quite the same as it has been in the past (as evidenced by photo dated November 2005 compared to our December 2009 photos – see below). A small amount of sediment sloughing or possibly infill seems to have occurred, and could hold back lake water ahead of the dam, but only at levels that would be marginal in terms of driving flow through the pipe (this needs to be confirmed with a detailed survey). Based on our field observations, a lake level of approximately 3 ft (90 cm) above the pipe would submerge the entire channel in its current configuration (Photo D1), and therefore, it is our opinion that the dam can function to store and release water at higher Horn Lake levels; but the dam's ability to store water at lower (marginally useful) lake levels may be constrained.

Photo D1. Protective wooden structure around sluice gate inlet.

Photo D2 Horn Lake channel, November 2005
Note dam in background (red line)
Photo provided by RDOS

Photo D3. Horn Lake Channel, as seen during December 9 2009 site visit
Note dam in background (red line)

References

Rowe, Steve. 2010. Personal communication on February 26, 2010 during phone conversation with Douglas Geller (Summit). Water Stewardship Officer, B.C. Ministry of Environment.

Appendix E

Pertinent Documents

(1973 Botham, et. el. 1981a and b Van der Kamp,

1996 Hare, 1994 EBA) on CD ROM attached

Appendix F

GWBAT Spreadsheets on CDROM Attached

Appendix G

Copy of Water Licence F5116 on CD ROM attached