
MEMORANDUM

TO: Ian Chadwick, EHD Engineering Ltd.

E-MAIL: ehdconsulting@shaw.ca

FROM: Dennis Lowen LHC Project: 1818

DATE: April 23, 2019

RE: Updated Aquifer Recharge Estimates for Clinton Bottling Plant Well (Well ID #39845), Clinton, B.C.

OF PAGES: 3

Message:

Following up from questions posed by Murray Allison (FLNR, Kamloops) in his April 5, 2019 e-mail we have revisited our Aquifer Recharge estimates. In consultation with A. Kohut (Hy-Geo Consulting) and utilized the methodology of Barroso et al (Elk Ridge, 2019) we have refined our aquifer recharge estimates. We have employed climate data and aquifer water level monitoring (1978 - 2017) to produce monthly and annual recharge volumes. The recharge volumes have been compared to projected demand (including the subject well) as requested. Please see Attachment 1, Table 1 for a summary of recharge estimates for Aquifer 0921, Clinton, BC.

Table 1 - Assumptions and Notes

1. The bottling plant demand will be 864 m³/d for 365 days per year for an annual demand of 316,224 m³.
2. The LHC estimate for MBR has been reduced in consultation with A. Kohut. Average MBR is set at 3% of precipitation. MBR varies seasonally from 2 to 4% with 2% in winter months and 4% in warmer months.
3. The Village of Clinton has one well which is not in use therefore, no demand is attributed to that well. Clinton uses surface water sources for the village water supply. The sources are located northeast of the Village and outside of the Aquifer 0921 footprint.
4. There are 15 mapped wells in the aquifer however, the number of wells was estimated according to the number of private land parcels (50) over the aquifer. All the wells are domestic with annual average demand of 2m³/d each. Demand is assumed to vary seasonally with June - August demand three times that of the remainder of the year.
5. The methodology for the recharge and demand estimates follow the methodology in; FLNR Report Re: Water Licence Application Elk Ridge Estates, Paldi ATS 257935, March 26, 2019.
6. Mountain Block Recharge (MBR) is estimated to be the main component of the total recharge. This is common due to the mountainous terrain in BC. Numerous studies can be cited with a similar conclusion.
7. Irrigation return flow (surface waters used to irrigate farmland some of which infiltrates to the groundwater table) may contribute to recharge, but it is not considered due to a lack of data.
8. The climate data used is sourced from the iMap BC, EAUBC-Rivers database.
9. There is a time lag in recharging the aquifer (Weaver, 2005) evidenced by the monitoring well record. From the time of the freshest (snow melt) in mid-February the groundwater level peaks in mid-May indicating a 3-month time lag. This is to be expected for the aquifer which is mostly confined. We account for the time lag in our monthly recharge estimates.
10. A. Kohut (2019) has estimated recharge to the aquifer from upslope surface drainage as; 900,000 m³/year in a dry year and 1,430,000 in a wet year. We used the dry year estimate in Table 1 to be conservative. The drainage flow is seasonal with insignificant flows in winter. The seasonal variation is accounted for in the monthly recharge estimates.

Conclusions

Kohut (2019) has estimated outflow from the aquifer to range from 2,970,000 to 11,000,000 m³/year based on Darcy Groundwater Flow Analysis. Aquifer recharge and outflow must balance. Our recharge estimate of 3,489,168 m³/year is within the calculated outflow range (low end of range) and is considered conservative.

There is enough recharge to balance the projected aquifer demand. Demand as percent of recharge varies from 6.4 to 24.7% on a monthly basis. Annually demand is 10.1% of recharge. This is a sustainable scenario.

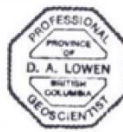
If you have any questions or require any further information, please contact the undersigned by e-mail: dl@lowenhc.ca or phone: 250 595 0624.

Best regards,

LOWEN HYDROGEOLOGY CONSULTING LTD.



Dennis A. Lowen, P. Eng. P. Geo
DL/hr



Date: April 23, 2019



References:

iMapBC, *EAUBC-Rivers*, Ministry of Environment and Climate Change Strategy, Knowledge Management, Feature Code: WI25511200, Cut-off Creek Valley, Contact - Dave McEwan, database created on 2014-12-11, last updated 2018-07-13.

Barroso, S. et al. *Technical Review*, File: 58000/WA/ATS 257935, Elk Ridge Estates, FLNR, March 26, 2019.

Kohut, A., Hy-Geo Consulting letter to EHD Engineering Ltd., Assessment of Potential Recharge of Aquifer 0921 at Clinton, BC., April 17, 2019.

Attachment 1

Memo: April 23, 2019
Updated Aquifer Recharge Estimates for Clinton Bottling Plant Well (Well ID #39845), Clinton, B.C.

Table 1

Climate Data Summary (EAUBC), and Estimated Recharge Compared to Total Groundwater Demand. - Aquifer 921, Clinton, B.C.														
Climate Inputs	Units	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Mean Temperature	°C	-7.9	-5.5	-1.8	2.3	6.3	10.5	13.2	13.2	8.9	3.6	-3.6	-7.6	2.7
Total Precipitation	mm.	40.9	25.6	24.4	25	37.3	47.2	47	41.4	37.2	28.1	33.3	44.2	431.6
Recharge	Area (m ²)	m ³ /month												m ³ /yr
R-Leak (10% of precip. over aq 921 footprint) m ³ /d	4,100,000	16,769	10,496	10,004	10,250	15,293	19,352	19,270	16,974	15,252	11,521	13,653	18,122	176,956
R-MBR (3% of precip. over MBR area)	186,300,000	152,393	95,386	136,372	186,300	277,960	351,734	350,244	231,385	207,911	157,051	124,076	164,689	2,412,212
Surface water inflow (small upland creeks)	15,700,00	0	0	0	128,571	128,571	128,571	128,571	128,571	128,571	128,571	0	0	900,000
	Totals	169,162	105,882	146,376	325,121	421,824	499,658	498,085	376,930	351,734	297,143	137,729	182,811	3,489,168
Groundwater Demand		m ³ /month												m ³ /yr
Domestic (50 parcels)	2 m ³ /d/each	2,000	2,000	2,000	2,000	2,000	6,000	6,000	6,000	2,000	2,000	2,000	2,000	36,000
Waterworks and Irrigation	Nil	0	0	0	0	0	0	0	0	0	0	0	0	0
Bottling Plant Well	864 m ³ /d	26,784	24,192	26,784	25,920	26,784	25,920	26,784	26,784	25,920	26,784	25,920	26,784	315,360
	Totals	28,784	26,192	28,784	27,920	28,784	31,920	32,784	32,784	27,920	28,784	27,920	28,784	351,360
Demands vs. Recharge (%)		17.0	24.7	19.7	8.6	6.8	6.4	6.6	8.7	7.9	9.7	20.3	15.7	10.1