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File: 1809191

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EHD Engineering Ltd
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Attention: Ian Chadwick, P. Eng

Re: Assessments of Potential Recharge of Aquifer 0921 at Clinton, British Columbia

Further to Murray Allison's request for clarification on the recharge estimates discussed in my report of December 5, 2018 I have prepared the attached summary and comments regarding the recharge rates that have been estimated.

Determining Groundwater Recharge

Groundwater recharge or rates of groundwater replenishment with time are especially difficult to quantify with a high degree of certainty since recharge cannot be measured directly. Healy (2010) describes several methods that can be utilized to estimate recharge including, for example: water-budget methods, stream flow hydrograph analysis methods, the water-table fluctuation method, unsaturated zone studies and groundwater tracer studies. Sources of potential recharge to an unconfined aquifer for example, may include: direct infiltration of a portion of the precipitation falling on an aquifer, infiltration of surface water flows from upland areas adjacent to an aquifer and flows across an aquifer, and inflows from adjoining aquifers. The significance of each of these potential components may vary for any particular aquifer.

In the case of the Aquifer 0921, topographic and stream flow drainage conditions surrounding the aquifer indicate infiltration from surface water flows likely provides a significant source of recharge to the aquifer. If total inflows are relatively balanced with groundwater outflows from the aquifer, then annual water table fluctuations in the aquifer may be relatively small in amplitude. This seems to be the case for the observation well data available that varies over a range of < 1 m. Hydrochemical data from wells in the southern portion of the aquifer indicates that groundwater discharging from adjacent bedrock formations (Mountain Block Recharge) is also contributing recharge to the aquifer.

Recharge Estimates

Kohut (2018) estimated the surface water inflow, recharge component, to be 1,430,000 m^3/year for a normal year and 900,000 m^3/year for a dry year. These inflow values, however, are regarded as very conservative since additional sources of recharge are also known to exist, such as direct infiltration of precipitation, groundwater inflow from adjacent bedrock aquifers (Mountain Block Recharge) and a northerly groundwater inflow component from a presently unmapped, unconsolidated aquifer occupying the Three Mile Lake Valley at the south end of Aquifer 0921. These latter components of recharge have not been individually estimated by Kohut (2018).

Kohut (2018) estimated outflow from the aquifer to range from 2,970,000 to 11,000,000 m^3/year based on a Darcy analysis, including a range of various aquifer widths and hydraulic gradients. These outflow estimates would reflect all sources of recharge including Mountain Block Recharge. As similar total inflow and outflow values are anticipated based on the recorded observation well data, the minimum outflow value of 2,970,000 m^3/year is likely a conservative indication of the magnitude of annual recharge to the aquifer.

Closure

This report was prepared in accordance with generally accepted engineering, hydro-geological and consulting practices. It is intended for the prime use of CHZ International Investment Inc., and EHD Engineering Ltd. This report is based on data and information available to the author from various sources at the time of its preparation and the findings of this report may therefore be subject to revision. Data and information supplied by others has not been independently confirmed or verified to be correct or accurate in all cases. Any errors, omissions or issues requiring clarification should be brought to the attention of the author. The author and Hy-Geo Consulting accepts no responsibility for damages suffered by any third party as a result of any unauthorized use of this report.

Respectfully submitted,

Alan P. Kohut PEng
Principal and Senior Hydrogeologist

HY-GEO CONSULTING

References

Healy, R.W. 2010. *Estimating Groundwater Recharge*. Cambridge University Press. Cambridge, United Kingdom. ISBN 978-0-521-86396-4.

Kohut, A. P. 2018. *Assessments of Potential Recharge and Hydrochemical Characteristics of Aquifer 0921 at Clinton, British Columbia.* Report prepared for CHZ International Investment Inc., File 1809191, Hy-Geo Consulting, Victoria, British Columbia.