GOLDER

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Suki Sekhon
CRS Group of Companies
Unit 730-475 West Georgia
Vancouver, BC V6B 4M9

INFORMATION REVIEW FOR HYDROGEOLOGICAL COMPONENTS OF EXISTING GROUNDWATER MODEL, TWIN LAKES RESORT, TWIN LAKES, BC

Mr. Sekhon,

CRS Group of Companies (CRS Group) have requested that Golder Associates Ltd. (Golder) provide comment with respect to the potential impact on the hydrogeological regime from an additional 40 RV sites at the Twin Lakes Golf Resort (TLGR) development in Twin Lakes, BC. The additional 40 RV sites are in addition to 50 new homes and 39 existing RV sites that were initially proposed for the Phase 1 development and evaluated in Golder's 2016 hydrogeological assessment report[1]. It is inferred that the additional 40 RV sites will form part of the Phase 1 development at the TLGR.

For this assessment, Golder developed a scope of work to update the existing numerical groundwater flow model for the Twin Lakes study area (Proposal 1114930112-008-P-Rev0; dated 3 July 2020). The scope of work included an initial review of annual precipitation data and long-term groundwater and surface water levels from 2011 to 2020 to assess water level trends for the study area; followed by an update to the existing numerical groundwater flow model. If the initial information review found that annual precipitation rates and water levels for the study area generally remained unchanged or increased since 2011, and correspondingly, that the baseline aquifer saturated thickness of 20 m ± 1.2 m (as used in Golder, 2016) has been met or exceeded, then the numerical groundwater flow model developed for the study area could be used in its existing state, with no additional refinement of recharge (input) source parameters, model calibration or sensitivity analysis. Golder would then update the existing model, taking into account the future domestic water usage values to reflect the additional 40 RV sites at the TLGR (for a total of 50 homes and 79 RV sites); the model would be rerun to evaluate groundwater and surface water conditions for selected future scenarios. If the initial information review found that significant reductions have occurred in annual precipitation rates and water levels for the study area since 2011, the numerical groundwater flow model developed for the study area would be revised prior to rerunning of the model.

[1] Golder report entitled "*Hydrogeological Assessment, Groundwater Availability Study, Proposed Residential Development (Phase 1), Twin Lakes, BC*" dated 26 January 2016 (Golder 2016).

Golder Associates Ltd.
590 McKay Avenue, Suite 300, Kelowna, British Columbia, V1Y 5A8, Canada
T: +1 250 860 8424 F: +1 250 860 9874

This technical memorandum summarizes the results of a review of annual precipitation rates from the nearest climate station to the study area (Summerland CS) and long-term groundwater and surface water levels for the study area since 2011, and provides a recommendation on whether the existing numerical groundwater flow model can be rerun using updated future domestic water usage values to reflect the additional 40 RV sites at the TLGR, or whether the model would need to be revised prior to rerunning of the model.

Separate to the information review summary, and as requested by CRS Group, this technical memorandum also includes a comment with respect to whether the proposed future domestic groundwater usage rate applied in Golder (2016) for the Phase 1 development at TLGR (i.e., 50 new homes and 39 existing RV sites) can supply either the original proposed 50 homes and 39 existing RV sites, or a combination of RV sites and homes.

Information Review

Groundwater levels at the water wells monitored by Golder (Domestic Lake Lot Well [WTN 102070], TLGR Domestic Well [WTN 58491] and Old Highway Well [WTN 19387]) and at the two Ministry of Environment Observation Wells (404 and 403) exhibited an overall increasing trend between January 2011 and May 2020 (Figure 1). Closer observation of the groundwater levels shows that there is an upward (increasing) trend in groundwater levels between January 2011 and circa May 2018, followed by a slight downward (decreasing) trend between circa May 2018 and May 2020. Surface water level trends in Horn Lake, Twin Lake and Trout Lake were consistent with the groundwater level trends (Figure 1). Based on a review of total precipitation data for the Summerland CS climate station between 2010 and 2020, the increase in groundwater levels and surface water levels between 2011 and 2018 and the decrease in groundwater levels and surface water levels between 2018 and 2020 is inferred to correspond to changes in total precipitation in the region of the study area.

Non-pumping groundwater levels measured between May 2018 and May 2020 were generally greater than the groundwater levels measured at the water wells between early 2011 (when the long-term monitoring program at the Twin Lakes study area began) and May 2018; and were up to approximately 1.3 m greater than the May 2013 groundwater levels that were used to calibrate the numerical groundwater flow model (see Figure 1 and the attached water level summary table).

Surface water levels recorded in Twin Lake between November 2018 and May 2020 appear to be lower than in previous years, based on the difference in elevation between Twin Lake and Observation Well 404 (located immediately south of Twin Lake). The elevation difference between Twin Lake and Observation Well 404 was approximately 0.6 m to 0.8 m greater between November 2018 and May 2020 compared to the elevation difference in the years prior to November 2018 (Figure 1). The levels appear to be demonstrating another influence not observed in groundwater level trends nor in Horn Lake and Trout Lake level trends. The cause of the lower levels in Twin Lake, and correspondingly, the elevation difference between Twin Lake and Observation Well 404 is not known at this time, and although speculative, may be due to pumping activities in Twin Lake, reduced overland flow between Horn Lake and Twin Lake, or other changes in surface water use from Twin Lake. Nonetheless, it does not change the conceptual hydrogeological model developed in Golder (2016) for the study area.

Conclusions

Update to Numerical Groundwater Flow Model

Groundwater level trends and surface water level trends observed between January 2011 and May 2020 are consistent with the conceptual hydrogeological model developed for the study area in Golder (2016), and the baseline aquifer saturated thickness of 20 m ± 1.2 m is therefore considered to be valid with respect to the current (May 2020) groundwater conditions.

Based on the initial information review, no additional refinement of recharge (input) source parameters, model calibration or sensitivity analysis is required at this time. The numerical groundwater flow model developed for the study area can therefore be updated for the additional 40 RV sites (only) and then rerun to evaluate groundwater and surface water conditions for selected future scenarios. It is noted that for the model rerun, the remaining groundwater usage rates (including withdrawals and returns) for current and future existing irrigation wells and domestic wells at the TLGR, current and future existing domestic wells surrounding Twin Lake, and future agricultural withdrawals, as presented in Golder (2016) and used in the existing numerical groundwater flow model, will remain the same. Should these groundwater usage rates require updating, this will be considered a separate scope of work and will be addressed through a scope change request to CSR Group. It is further noted that no changes will be made to the existing conceptual hydrogeological model for the study area, or to the existing groundwater model layers, grid spacing, extents, or boundary conditions.

Future Groundwater Usage

The proposed future domestic groundwater usage rate applied in Golder (2016) for the Phase 1 development at TLGR was for 50 new homes and 39 existing RV sites, and as long as the groundwater usage rate remains the same as the rate assessed in Golder (2016), groundwater may be used to supply the proposed 50 new homes and 39 existing RV sites, or a combination of RV sites and homes. The long-term (10+ years) groundwater and surface water levels observed in the study area support the opinion made in Golder (2016) that the projected future groundwater usage at the proposed Phase I development at the TLGR is sustainable at the proposed net withdrawal rate.

Limitations

This letter was prepared for the exclusive use of CRS Group of Companies (CRS). Any use which a third party makes of this letter, or any reliance on or decisions to be made based on it are the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this letter.

The letter, which includes all attachments, is based on data and information collected during the desktop assessment conducted by Golder personnel and upon third party information provided by CRS. The letter provides a level of assurance commensurate with the level of study. The letter is based solely on the site conditions described in this letter, and upon the third-party information provided to us by CRS, as referenced in the letter.

In evaluating the site, Golder has relied in good faith on information provided to us. We accept no responsibility for any deficiency, misstatements or inaccuracies contained in this letter as a result of omissions, misinterpretations or fraudulent acts of the persons or agencies interviewed.

This desktop assessment was performed according to current professional standards and practices in the environmental field. If new information is discovered during future work, including excavations, borings or other activities or studies, Golder should be requested to re-evaluate the conclusions of this letter, and to provide amendments as required.

Closure

We trust that this technical memorandum provides you with the information you require at this time. Should you require additional information or have any questions, please contact the undersigned at your convenience.

Yours truly,

Golder Associates Ltd.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
ATHANASOPOULOS
35943
21/20

Pana Athanasopoulos, MSc, PGeo
Associate, Senior Hydrogeologist

Jacqueline Foley, MSc, GeoL
Associate, Senior Hydrogeologist

PA/JF/lih

Attachments: Water Levels

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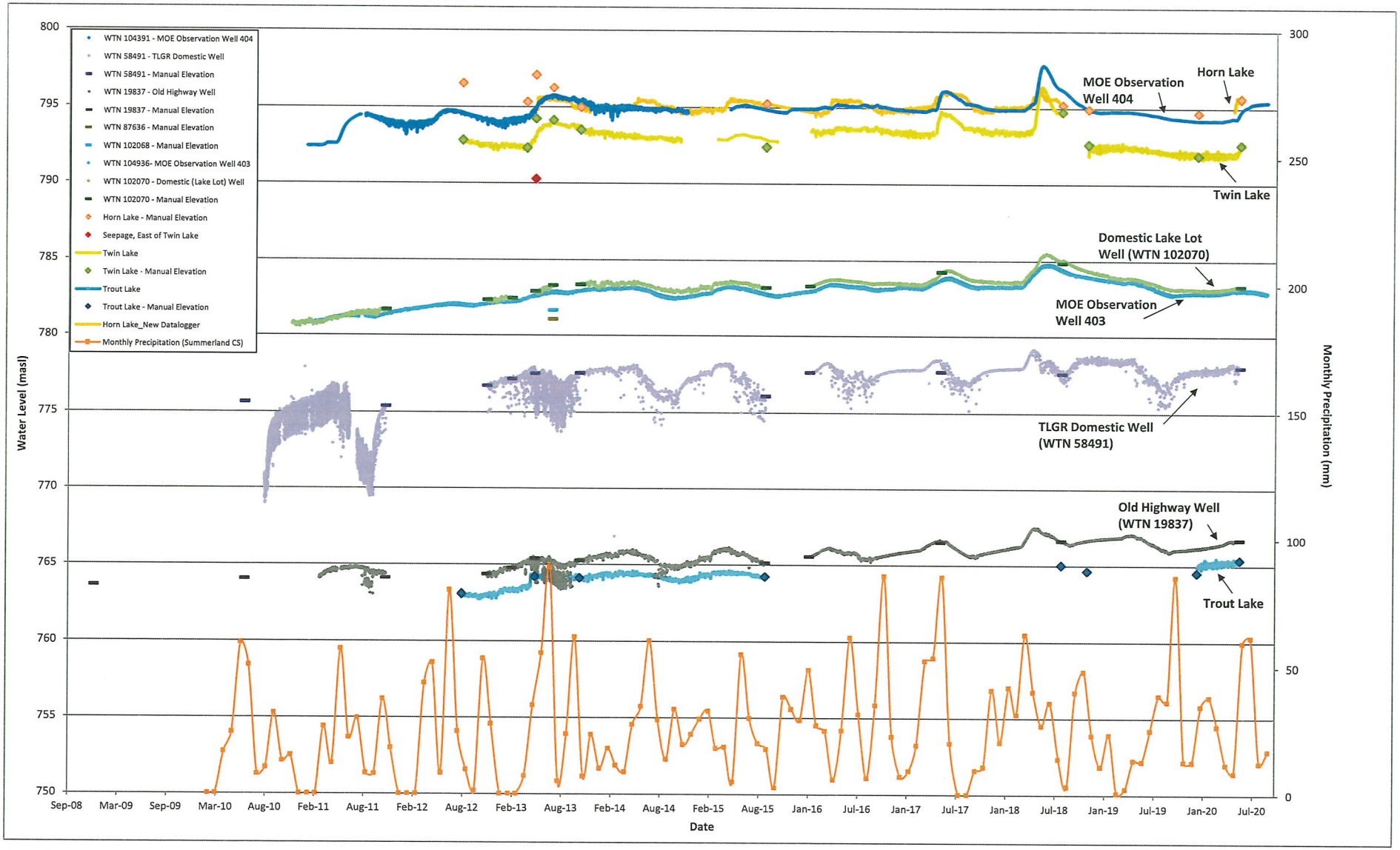
Groundwater and Surface Water Elevations within the Twin Lakes Area



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Final charts_with may 2020 data.xlsx

Golder Associates Ltd.

Summary of Manual and Surveyed Water Levels
Groundwater Availability Study,
Twin Lakes, BC

		Horn Lake	Turtle Pond	Twin Lake	Seepage, East of Twin Lake	Observation Well (WTN 102070)	Observation Well (WTN 102068)	Domestic Well (WTN 87636)	Domestic Well (WTN 58491); by Irrigation Well	Old Highway Well (WTN 19837)	Trout Lake	Yellow Lake
Northing		5465435	5466510	5467166/5466703/5466331	5466325 (Apr); 5466326 (May)	5467465	5467527	5467625	5468345	5469055	5469462	5469004
Easting		300667	301509	302224/301619/301809	302524 (Apr); 302400 (May)	302237	302284	302314	302257	302292	302566	300861
Ground Surface Elevation (masl)						802.36	812.96	817.56	780.83	775.48		
Height of Pipe Above Ground Surface (m)						0.48	0.60	0.6	0.47	0.11		
Top of Well Pipe Elevation (masl)						802.84	813.56	818.16	781.30	775.6		
Depth to Bottom of Well (masl)						759.98	765.09	760.02	758.32	744.69		
	Date											
Depth to Water (mbtop) -groundwater wells	30-Oct-08											
	12-Dec-08									12.00		
	14-Jun-10								5.67	11.56		
	10-Nov-11					21.16			5.93	11.50		
	13-Nov-12					20.51			4.60	11.24		
	11-Feb-13					20.40			4.15	10.83		
	06-May-13					19.94			3.77	10.21		
	09-Jul-13					19.54	31.90	37.09				
	17-Oct-13					19.48			3.74	10.34		
	25-Aug-15					19.65			5.23	10.47		
	01-Feb-16					19.54			3.66	10.04		
	25-May-17					18.60			3.60	9.10		
	09-Aug-18					17.99				8.98		
	10-Aug-18								3.71			
	12-Nov-18											
	16-Dec-19											
	20-May-20					19.52			3.30	8.92		
Water Elevation (masl)	30-Oct-08											
	12-Dec-08									763.59		
	14-Jun-10								775.63	764.03		
	10-Nov-11					781.68			775.37	764.09		
	14-Aug-12	796.51	796.37	792.75							763.05	745.61
	11-Oct-12											
	13-Nov-12					782.33			776.70	764.35		
	11-Feb-13					782.44			777.15	764.76		
	04-Apr-13	795.31		792.27	789.40							
	06-May-13	797.07		794.18	790.26	782.91			777.53	765.38	764.17	
	09-Jul-13	796.22		794.09		783.30	781.66	781.07				
	17-Oct-13	794.97		793.44		783.36			777.56	765.25	764.08	
	25-Aug-15	795.25		792.36		783.19			776.07	765.13	764.22	
	01-Feb-16					783.30			777.64	765.56		
	25-May-17					784.25			777.70	766.49		
	09-Aug-18	795.20		794.75		784.86				766.62	765.01	
	10-Aug-18								777.59			
	12-Nov-18	794.92		792.58							764.63	
	16-Dec-19	794.67		791.86							764.51	
	20-May-20	795.63		792.56		783.32			778.00	766.67	765.36	