

File: 1508141

January 20, 2022

Crystal Mountain Society  
Galiano Island BC V0N 1P0

**Re: Groundwater Level Monitoring, Crystal Mountain Retreat Centre, Observation Well WID 23229 and Central Well WID 23227, Galiano Island**

**Monitoring Installation**

As requested, arrangements were initially made to install a datalogger in the Central Well WID 23227 on September 17, 2021. Due to a blockage of pump wiring near the top of the well it was not possible to safely install the instrument in WID 23227. It was subsequently decided to install the datalogger in Observation Well WID 23229. A sounding tube was eventually installed in the Central Well WID 23227 later that month to enable a datalogger installation.

*Observation Well WID 23229*

A Diver™ datalogger Serial No. DG945 was installed in the above well on September 17, 2021 by Hy-Geo Consulting. Well WID 23229 is a 6 inch (15.24 cm) diameter bedrock well, that was drilled in 1994 to a depth of 183 feet (55.78 m) and completed in grey sandstone. The recording interval was set at 10 minutes to detect any water level variations from neighbouring pumping wells and tidal effects. The corrected water level in the well at 9:50 am on September 17, 2021 was 18.460 m below ground. A second Diver™ datalogger Serial No. DF612 was also set near the well to record variations in barometric pressure at the same recording interval of 10 minutes synchronized with datalogger Serial No. DG945.

On January 3, 2022 the above dataloggers were retrieved by Keith Erickson at 11:35 am and delivered to Hy-Geo Consulting on January 4 for downloading, data analysis and interpretation. The corrected water level in the well at 11:30 am on January 3, 2022 was 14.773 m below ground.

*Central Well WID 23227*

A Diver™ datalogger Serial No. A4482 was installed in the above well on October 7, 2021

by Hy-Geo Consulting. This is a 6 inch (15.24 cm) diameter bedrock well, that was drilled in 1994 to a depth of 125 feet (38.10 m) and completed in shaley and grey sandstone. It is the prime production well for the facility and is equipped with a pump. The recording interval was set at 10 minutes to detect any water level variations from neighbouring pumping wells and tidal effects. The corrected water level in the well at 8:00 am on October 7, 2021 was 12.248 m below ground. The Diver™ datalogger Serial No. DF612 on site was utilized to record variations in barometric pressure at the same recording interval of 10 minutes synchronized with datalogger Serial No. A4482.

On January 3, 2022 datalogger Serial No. A4482 was retrieved by Keith Erickson at 11:15 am and delivered to Hy-Geo Consulting on January 4 for downloading, data analysis and interpretation. The corrected water level in the well at 11:10 am on January 3, 2022 was 8.956 m below ground.

### Precipitation Data 2021-22

With the absence of a current climate station on Galiano Island, the Mayne Island climate station may be considered representative of the general longer-term (monthly) precipitation patterns on Galiano Island (Government of Canada, 2022a). The most recent (2021-22) precipitation data for the region is available for climate station 1015638 on North Pender Island (Government of Canada, 2022b).

Precipitation in 2021 as observed at climate station 1015638 on North Pender Island was well below normal from February to August as shown in Table 1.

Table 1. Monthly 2021 precipitation data for North Pender climate station (Climate ID.1015638) compared to 1981-2010 normals for Mayne Island.

Month	Precipitation in 2021 (mm)	Monthly Precipitation Normal (mm)	Percent of Normal	Cumulative Percent of Normal
January	134.1	129.9	103.2	103.2
February	63	87.7	71.8	90.6
March	15	75.4	19.9	72.4
April	17.4	55.3	31.5	65.9
May	22.4	44	50.9	64.2
June	23.9	36.9	64.8	64.3
July	0	21.2	0	61.2
August	10.6	23.8	44.5	60.4
September	66.0	28	235.7	70.2
October	91.8	79.9	114.9	76.3
November	252.1	135.4	186.2	97.0
December	93.3	124.5	74.9	93.8
Total:	789.6	842		

Data from Government of Canada (2022a and 2022b).

Heavy rains beginning in September through November resulted in above normal monthly precipitation. Overall precipitation in 2021 of 789.6 mm was 93.8 percent of the annual normal (842 mm) for Mayne Island.

## **Monitoring Results**

### *Observation Well WID 23229, September 17, 2021 to January 3, 2022*

Given the frequent recording interval of 10 minutes chosen for the monitoring project, a large dataset of over 15,560 water level readings was generated for the above period. A separate hydrograph for this period was prepared to process the large data set and precipitation data was subsequently plotted on a separate graph for comparative purposes.

Figure 1 shows the water level below ground in Well WID 23229 from September 17 to January 3, 2022 compared with precipitation data from the North Pender Island climate station (Climate ID.1015638). Water level data shown has been corrected for barometric effects. The raw data for the September 17 to January 3, 2022 monitoring period is provided in Excel<sup>®</sup> spreadsheet titled "Crystal Mtn Obs Well September to Jan2022.csv".

The hydrograph in Figure 1 shows water levels relatively static in September and then rising steadily about 3.7 m through October to late December. Individual rain events do not appear evident in the water level hydrograph. Water levels in the well likely respond to the cumulative effects of the fall rainfall events.

Figure 2 in more detail, shows the water level fluctuations and trend in Observation well WID 23229 from September 30 to October 7, 2021 compared with predicted tidal fluctuations. There is a good visual correlation between the rising water levels and daily tidal fluctuations. The effect of the tidal fluctuation on the water level in the well is only about 5 cm. This relationship in well WID 23229 was reported previously (Kohut, 2015).

### *Central Well WID 23227, October 7, 2021 to January 3, 2022*

Given the frequent recording interval of 10 minutes chosen for the monitoring project, a large dataset of over 12,600 water level readings was generated for the above period. A separate hydrograph for this period was prepared to process the large data set and precipitation data was subsequently plotted on a separate graph for comparative purposes.

Figure 3 shows the water level below ground in Well WID 23227 from October 7, 2021 to January 3, 2022 compared with precipitation data from the North Pender Island climate station (Climate ID.1015638). Water level data shown has been corrected for barometric effects. The raw data for the October 7, 2021 to January 3, 2022 monitoring period is provided in Excel<sup>®</sup> spreadsheet titled "Crystal Mtn Central Well October to Jan2022.csv".

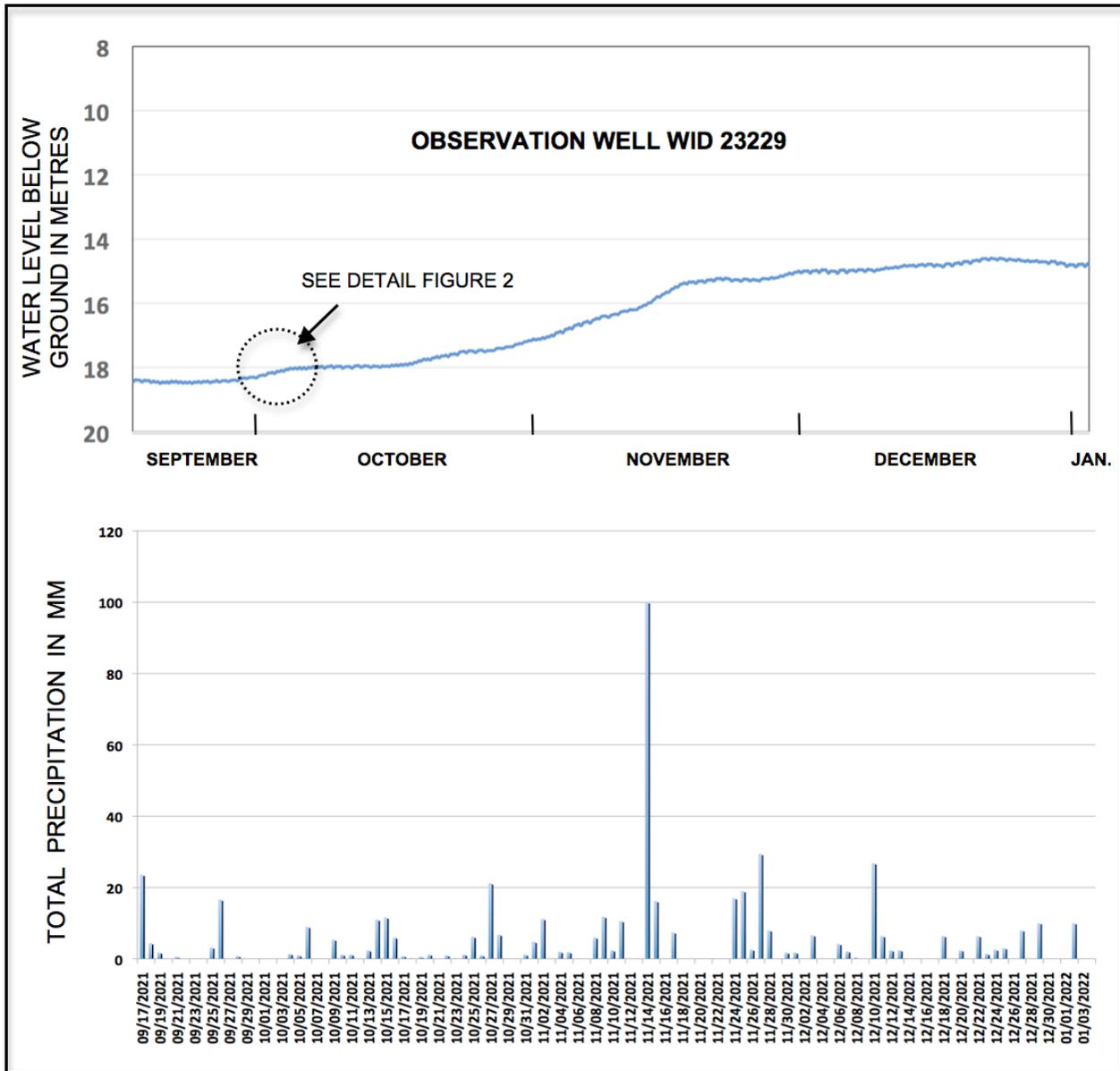


Figure 1. Water level below ground in Observation Well WID 23229 from September 17 to January 3, 2022 compared with precipitation data from North Pender Island climate station (Climate ID.1015638).

The hydrograph in Figure 3 for the Central well shows a very similar long-term trend with the water levels in the Observation well with water levels rising steadily about 3.5 m through October to late December. Individual rain events do not appear evident in the water level hydrograph. Water levels in the well likely respond to the cumulative effects of the fall rainfall events.

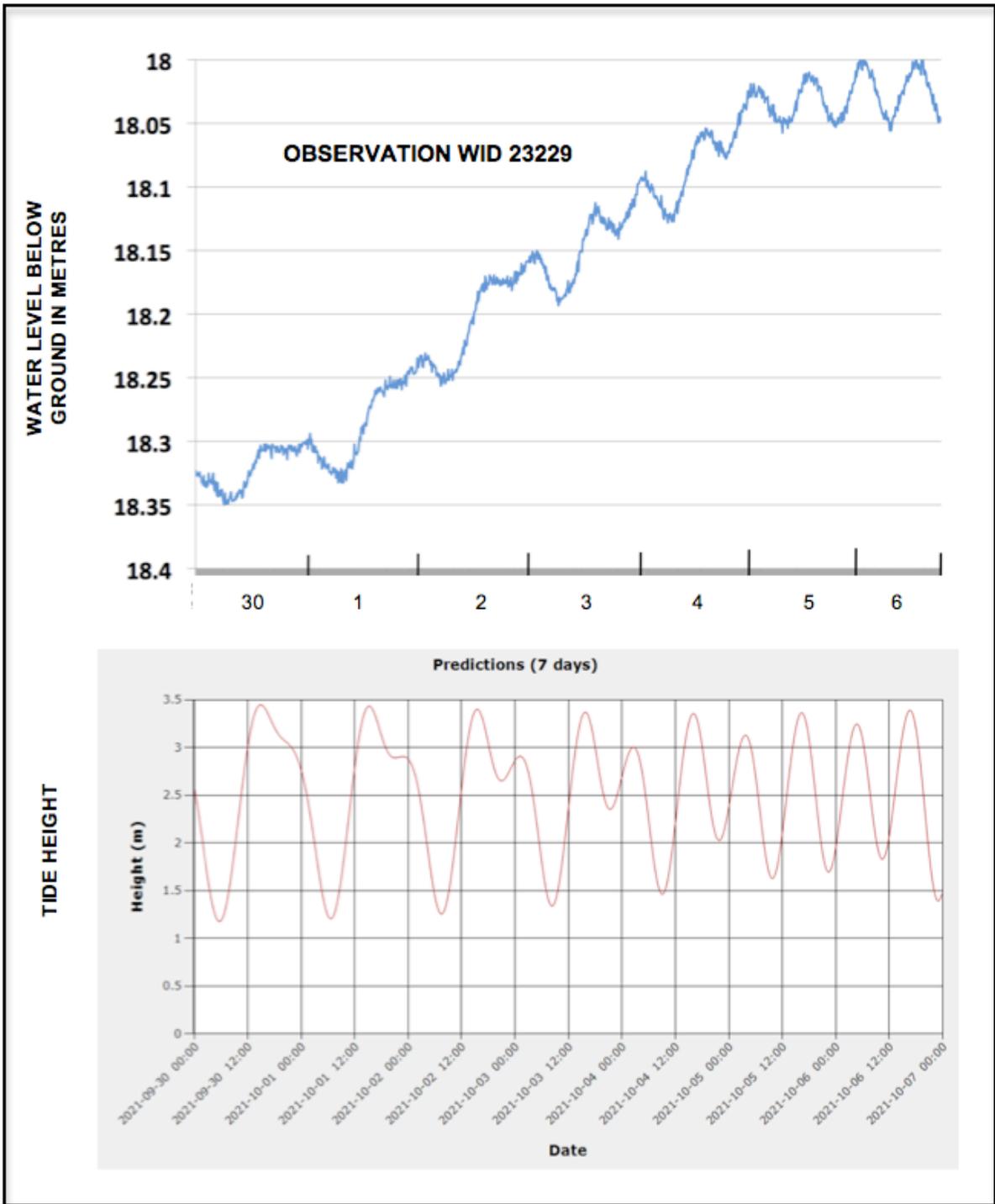


Figure 2. Comparison of water level fluctuations in Observation Well WID 23299 from September 30 to October 7, 2021 with predicted tidal fluctuations at Montague Harbour. Tidal graph adapted from Government of Canada, 2022c.

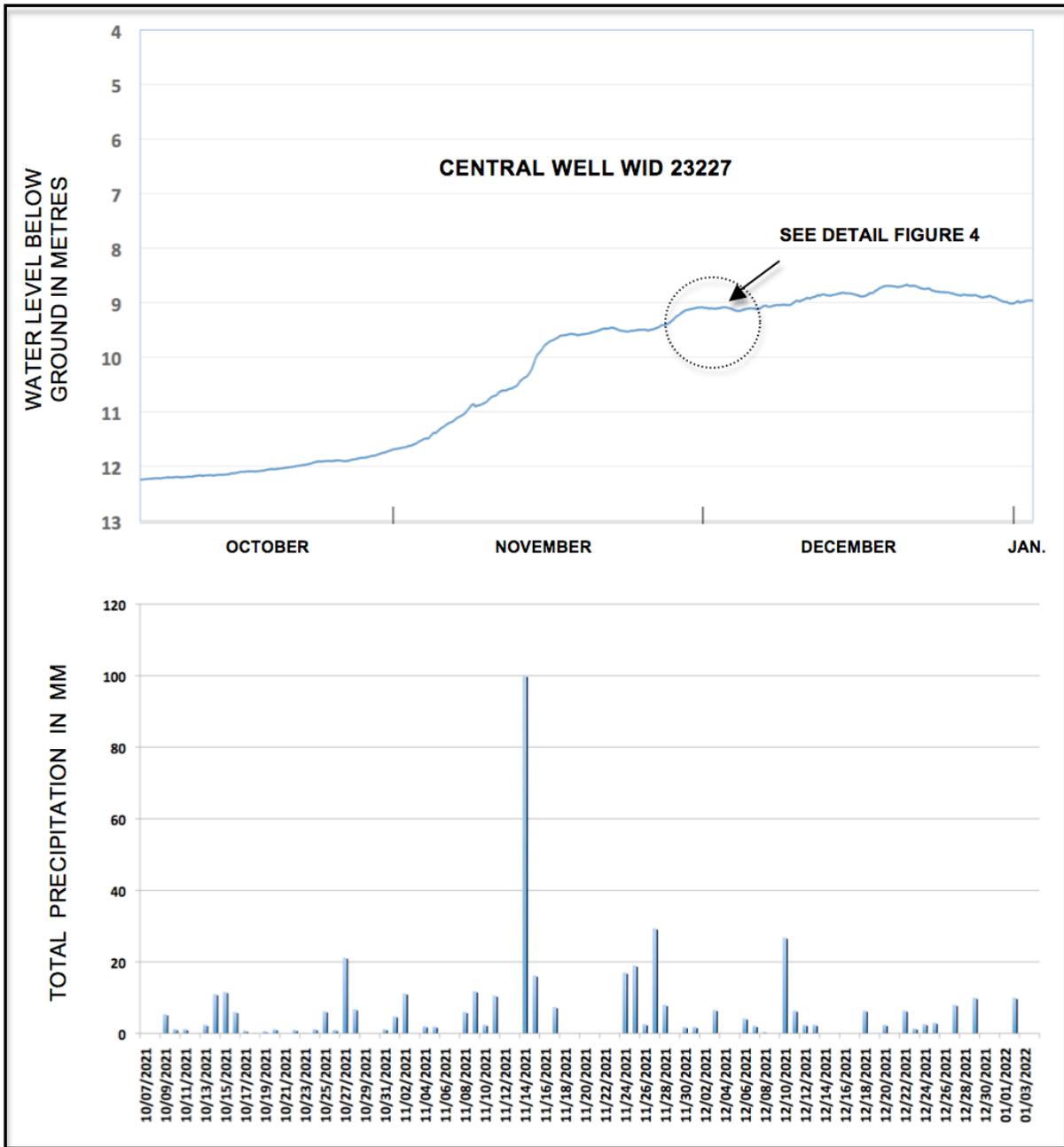


Figure 3. Water level below ground in Central Well WID 23227 from October 7 to January 3, 2022 compared with precipitation data from North Pender Island climate station (Climate ID.1015638).

Figure 4 in more detail, shows the water level fluctuations and trend in the Central well from November 30 to December 7, 2021 compared with predicted tidal fluctuations for the same period. There appears to be some periodic fluctuations ranging from 4 to 8 cm in the water levels although they do not correspond to any tidal influence. The cyclic nature of these fluctuations may reflect minor effects of pumping from neighbouring wells in the region.

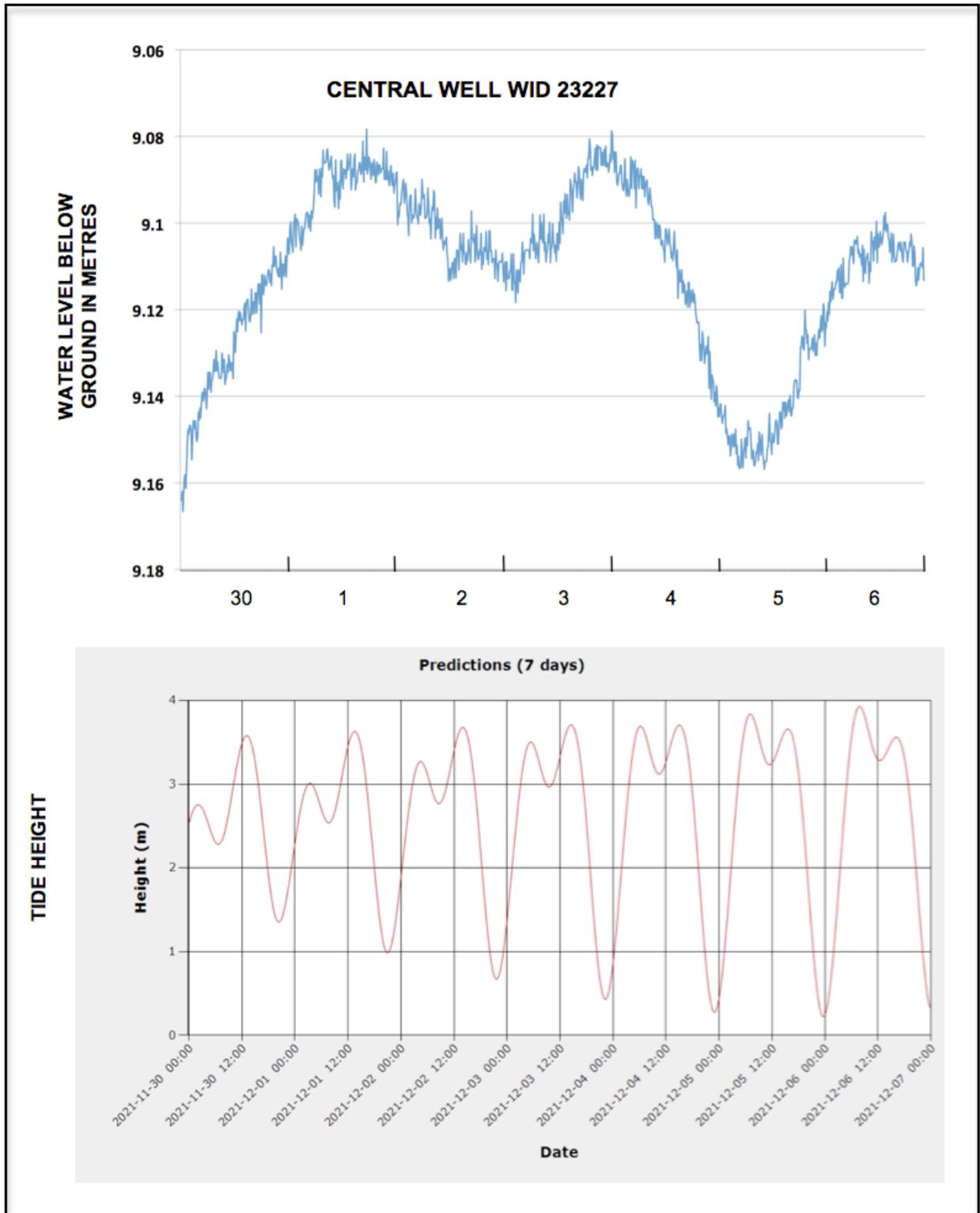


Figure 4. Comparison of water level fluctuations in Central Well WID 23227 from November 30 to December 7, 2021 with predicted tidal fluctuations at Montague Harbour. Tidal graph adapted from Government of Canada, 2022c.

The overall, non-pumping behaviour of the water level in Observation Well WID 23229 and the Central Well WID 23227 during the September 2021 to January 2022 monitoring period is consistent with previous monitoring observed at this site (Kohut, 2015). The monitoring results obtained above are also consistent with the observations, assumptions and results reported on the pumping test carried out on the Central Well WID 23227 in 2015 (Kohut, 2015).

## Conclusions

Based on the water level monitoring conducted on Observation Well WID 23229 and the Central Well WID 23227 between September 2021 and January 3, 2022, the following conclusions can be made:

1. Water levels in both wells behaved in a similar fashion rising approximately 3.5 m during the monitoring period in response to the cumulative effects of fall and early winter rains. Individual precipitation events do not appear evident in the water level hydrographs.
2. Water levels in Observation Well WID 23229 showed periodic tidal effects of about 5 cm.
3. On close examination, water levels in the Central Well WID 23227 showed periodic variations with fluctuations ranging from 4 to 8 cm. These did not correspond to any tidal influence. The cyclic nature of these fluctuations may reflect minor effects of pumping from neighbouring wells in the region.
4. The monitoring results obtained are consistent with the observations, assumptions and results reported on the pumping test carried out on the Central Well WID 23227 in 2015.

Respectfully submitted:

*A.P. Kohut*  
*Jan 20/22*

A circular professional seal for Alan P. Kohut, a Professional Engineer in the Province of British Columbia. The seal contains the text: "PROFESSIONAL PROVINCE OF BRITISH COLUMBIA ENGINEER" around the perimeter, and "A. P. KOHUT #10194" in the center.

Alan P. Kohut, PEng  
Senior Hydrogeologist

Hy-Geo Consulting  
Permit to Practice Number: 1001034

## References

Government of Canada. 2022a. *Canadian Climate Normals*. 1981-2010 Climate Normals & Averages. Internet website [http://climate.weather.gc.ca/climate\\_normals/index\\_e.html](http://climate.weather.gc.ca/climate_normals/index_e.html)

Government of Canada. 2022b. *Historical Climate Data*. Internet website <http://climate.weather.gc.ca/>

Government of Canada. 2022c. *7 Days Tidal Predictions*. Fisheries and Oceans Canada. Internet website <https://www.tides.gc.ca/eng/station?type=0&date=2021%2F07%2F29&sid=7420&tz=PST&pres=0>

Kohut, A.P. 2015. *Groundwater Assessment Report For Crystal Mountain Retreat Centre, Galiano Island*. Report prepared of Crystal Mountain Society. Hy-Geo Consulting, Victoria, British Columbia.