2023 Hydrology Monitoring Project Report
Wetland Centre, Country of Grande Prairie, Alberta

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Executive summary

The purpose of this report is to outline activities conducted in 2023 as part of the Wetland Hydrology Monitoring Project (The Project). The Project supports the Wetland Centre by focusing efforts on two objectives: (1) Data collection and wetland training, and (2) Citizen science and public outreach. In 2023, the specific objectives were:

Objective 1, (1-1) of the Hydrology Monitoring Project was to install 3 water monitoring wells per wetland type; (1-2) collect initial baseline data to inform future training/demonstration projects; (1-3) record water level fluctuations with a data logger; (1-4) conduct bail tests to collect conductivity data.

Objective 2, Citizen science & public outreach: Continue organizing citizen science water level activities in a public friendly area near the already established trails where the public can learn more about the Wetland Centre, boreal wetlands, and the partners involved in the project, and (2-3) Partner with local groups to amplify and provide interactive applied science learning activities and communication materials.

Figure 1. A water level monitoring well at the Wetland Centre.

Infographic

2023 Hydrology Monitoring Summary

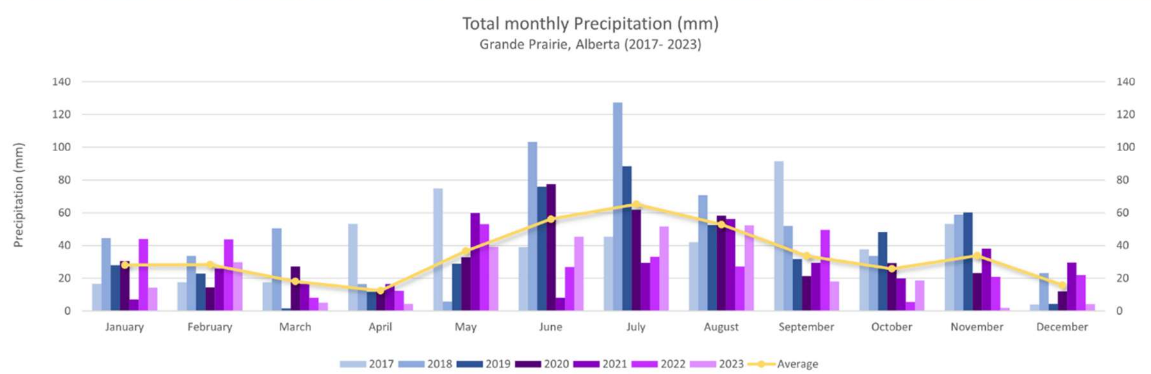
Boreal Wetland Centre

County of Grande Prairie, Alberta

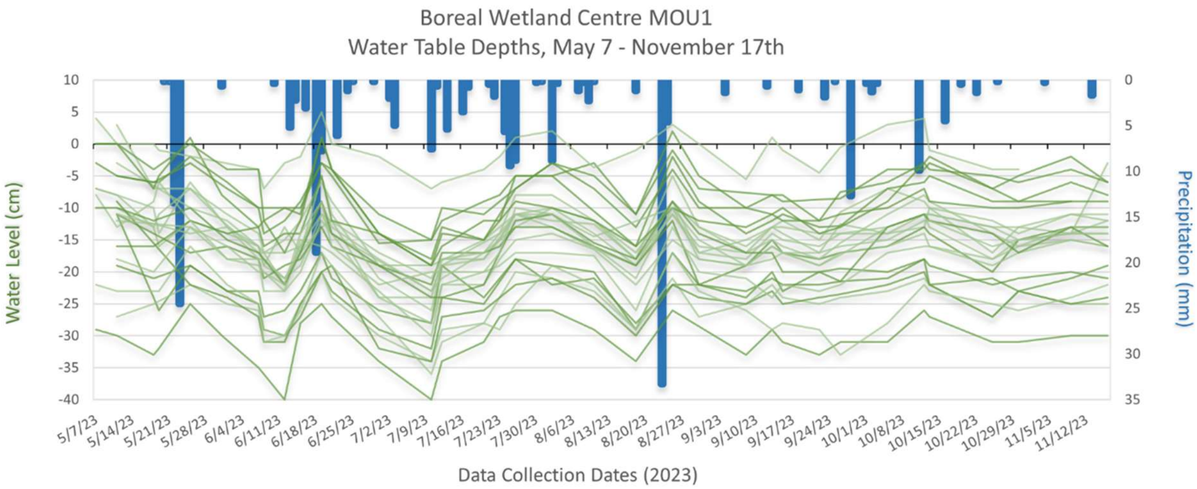
Goal: To improve our understanding of boreal wetland hydrology at the Wetland Centre by focusing efforts on data collection, wetlands training and public outreach.

Key outcomes:

- 33 Volunteer managed wells **+ 1 from 2022**
- 1,132 Volunteer collected data points **+ 764 from 2022**
- 3 Data loggers collecting continuous data **No Change**
- 3 new volunteers were trained to record water level data
- 1 Full-time summer student taking weekly measurements

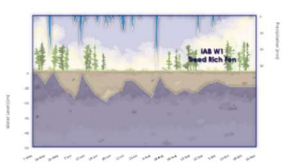


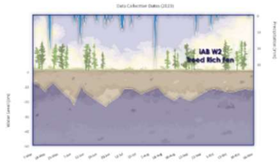
Overall, the Wetland Centre experienced near-average precipitation in spring and summer with water tables, with more responsive fluctuations during the active growing season. Fall and winter precipitation however, was well below average.

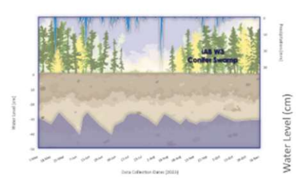


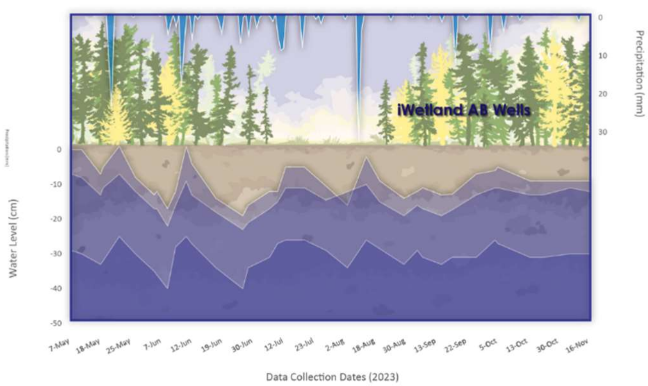
iWetland

iWetland is a collaboration between researchers and the public to collect wetland water level data. To date, there are three iWetland wells at the Wetland Centre. Visual graphs are developed to communicate wetland water table fluctuations throughout the season. iWetland is successful in data collection and knowledge sharing with the public.









Next Steps

The well network at the Wetland Centre will not be expanded in 2024. Instead efforts will focus on collecting more data from MOU2, and performing Bail Tests to better understand hydrologic conductivity at the site.

Key outcomes

- The total number of monitoring wells at the site is 33.
- 3 community members were trained and equipped this year to take weekly water level measurements.
    - Over 1,132 data points collected from May to December. This includes iWetland data.
- Bryson Richie practiced graphing the data in Excel, and Adobe Illustrator.
    - Transforming the iWetland data into visual graphs in photoshop was a powerful outreach tool. A previous intern (Jessie Lavallee-Whiffen) developed the methodology.
    - A graph showing water level measurements was made for each well. Some wells were additionally graphed to include precipitation data from a nearby weather station.
- 4 data loggers were deployed at the site, one barometric and 3 collection water level data.
- Over 3,500 trail camera photos at 4 different wetland forms were captured.
- The iWetland citizen science project was considered a success in data collection and knowledge sharing, though additional efforts in community outreach are recommended.

Site description

The Wetland Centre is located at Evergreen Park in the County of Grande Prairie, Alberta, in Canada's Boreal Plains ecozone. There are two locations that were used within Evergreen Park as part of the hydrology monitoring project: Evergreen Centre MOU (area 1) and the ELIS MOU (area 2) (Figure 2). The Evergreen Centre MOU has a parking lot at the trail head and established trails, making it an accessible area for visitors. The area 2 is further from the site entrance and requires a hike in with no established trails and was solely accessed by DUC staff and contractors.

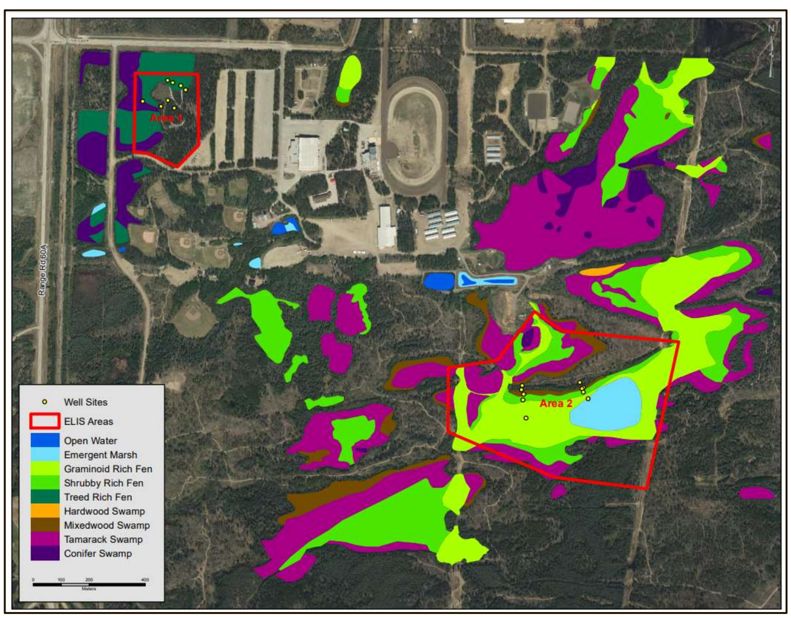


Figure 2. Map of the different wetlands and the two areas at the Wetland Centre. Note that 3 wells are not shown in area 1.

Area 1 and area 2 are composed of different wetland forms: Area 1 (Figure 3) by conifer swamps, treed rich fens, and an oil sands exploration (OSE) demonstration which is considered a shrubby rich fen (not shown on map). Further information on the OSE area can be found here. Area 2 (Figure 3) was originally mapped in 2018 with diverse wetlands including mixedwood swamp, tamarack swamp and shrubby rich fen (Figure 2), though multi-year flooded conditions has resulted in a shift towards graminoid species dominance.

Figure 3. Photos of Area 1 (left) and Area 2 (right).

Objective 1

Objective 1-1. Install 3 water monitoring wells per wetland type

As of October 2023, there are 33 wells across the site (Figure 2- *Note that 3 wells are not shown in area 1*): 24 in Area 1, and 9 in Area 2 (Table 2). See Appendix 1 for well construction/installation methodology. Well measurements were taken weekly to bi-weekly with the blow stick method for shallow water levels (Appendix 2) from May 7th to November 16th, 2023. The naming convention of the wells denote the wetland type (based on Figure 2), i.e. TF = treed fen. In area 1, the well number in said wetland type, i.e. TF W3 = the 3rd well installed in a treed fen. In area 2, the wells are split by transect 1 and transect 2, i.e. wells that start with T1 are in transect 1, and the numbers denote the position in the transect. Note that "Trans" is used for the 2 wells installed in upland-wetland transition areas.
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Area	Wetland type	Wells (installed/planned)
1	Swamp	3/3
1	Treed fen	16/3
1	Oil sands exploration (OSE)	5/3
2	Transition	2/3
2	Mixedwood swamp	3/3
2	Shrubby fen	2/3
2	Graminoid fen	1/3
2	Emergent marsh	1/3
2	Tamarack swamp	0/3
	Total	**33**

Table 1. Well instrumentation by wetland type in areas 1 and 2 as of November 2023.

Figure 4. Conditions in area 2. Background shows a green band of living conifers in the upland, mid photo shows the high willow and tamarack mortality, and foreground shows the strong encroachment of graminoids.

Challenges in Data Collection

As the project has developed, we have been more successful in achieving well installation and data collection goals in MOU1 than MOU2. Some of the barriers influencing the success of meeting these goals is related to access to specific wetland types. Many of the wetland types in MOU2 have not had wells installed, because it is more difficult to send volunteers to do data collection in MOU2 due to accessibility and safety concerns. There is often standing water, making wells hard to reach without proper gear (hip waders), and due to lack of trail infrastructure, we hesitate to send volunteers to check these wells alone. Therefore, while the wetland hydrology project has been successful in MOU1, it has not yet been successful in achieving Objective 1 in MOU2.

For 2024, there are currently no plans to install additional wells. Adding additional wells would increase work for our volunteers, and currently we do not have any specific project needs for additional wells at this moment, although there is a possibility of more well installation in future years.

Objective 1-2. Collect initial baseline data

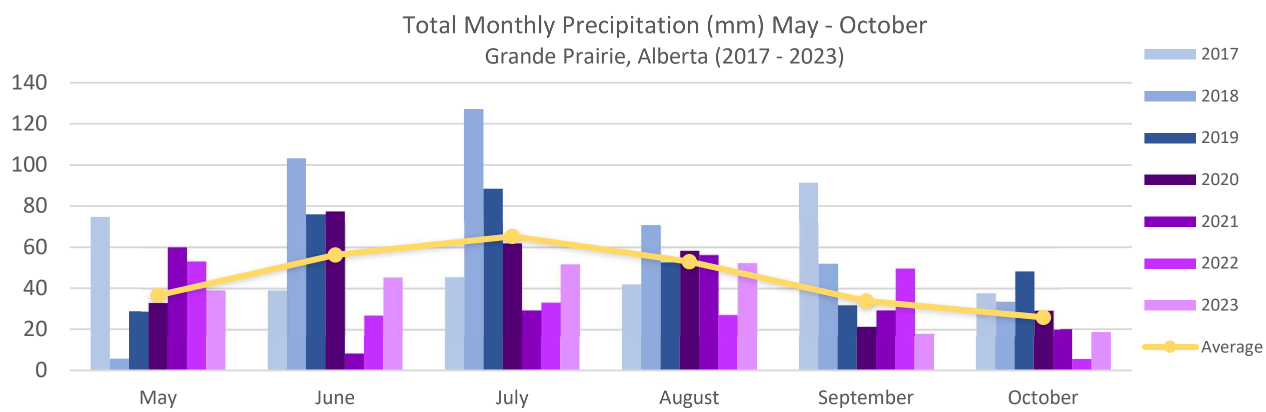
1-2-1. Meteorological conditions

Daily precipitation data (2017-2023) was downloaded from the Grande Prairie, Alberta, NAVCAN Weather Station (55°10'44.37"N 118°52'56.93"W), located approximately 11 km NW of the site. Although total rainfall was slightly higher than the previous year (187 in 2022, 223 in 2023), the study period received 34 mm less than the average rainfall from 2017-2023. (Table 3).

Year	Total Rainfall (mm)	Total Snowfall (cm)
2017	252	-
2018	374	220
2019	299	163
2020	266	147
2021	199	97
2022	187	178
2023	223	98
Average:	257	151

Table 2. Grand Prairie total rainfall over 7 years between the months of May-October 2017-2023, and total snowfall of each preceding winter from September-May.

Rainfall (Figure 5) received in May and August 2023 were near average compared to the previous 7 years. The driest months were September and October, receiving 18.0 mm and 18.6 mm respectively. June, July and August all saw increases in precipitation over 2022 (+18.4 mm, +18.6 mm, and +25.1 respectively), although June and July fell below the 7-year average for each month (-10.9 mm and -13.6 mm). Snowfall (Figure 6) from winter 2022-2023 was 53 cm below the 7 year average.



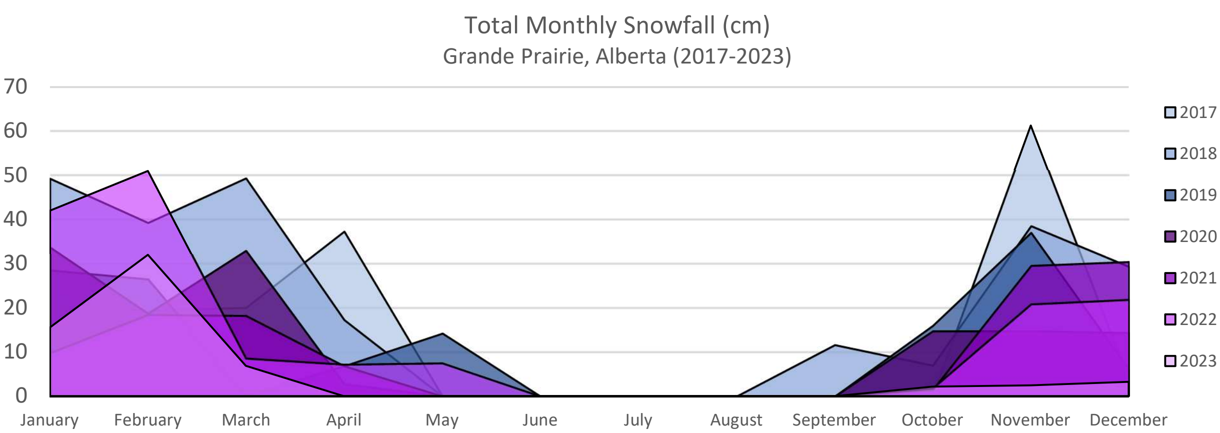


Figure 5 and 6. Comparisons of monthly precipitation in Grande Prairie over 7 years.

Overall precipitation in the 2023 study period was characterised by relatively frequent but low (<10 mm) rainfall events in May-July, maintaining moisture into late August (which had the largest rainfall event, 33.3 mm) and into Autumn. Because of this relative frequency, while overall precipitation was slightly below average, it was able to contribute to smaller but more frequent fluctuations in water table level when compared with to 2022. Water deficits are historically common occurrences in the Western Boreal Plains (Devito et al., 2012), and feedback mechanisms assist in maintaining ecological processes (Harris et al., 2020). However, studies have shown that the impacts of climate change will result in increased moisture deficits across the Boreal Plain ecozone (Price et al., 2013).

1-2-2. Water levels

The number of water level measurements taken over the study period ranged from 2 to 33 per well (Table 4). Less measurements were taken in area 2 for accessibility and volunteer safety concerns - data was only collected by DUC staff. There are two data loggers in area 2, one upland logger and one wetland logger to compensate for this data gap. Analyses on this area is not included in this year's report as one logger was left in the well over winter, and was not retrievable.

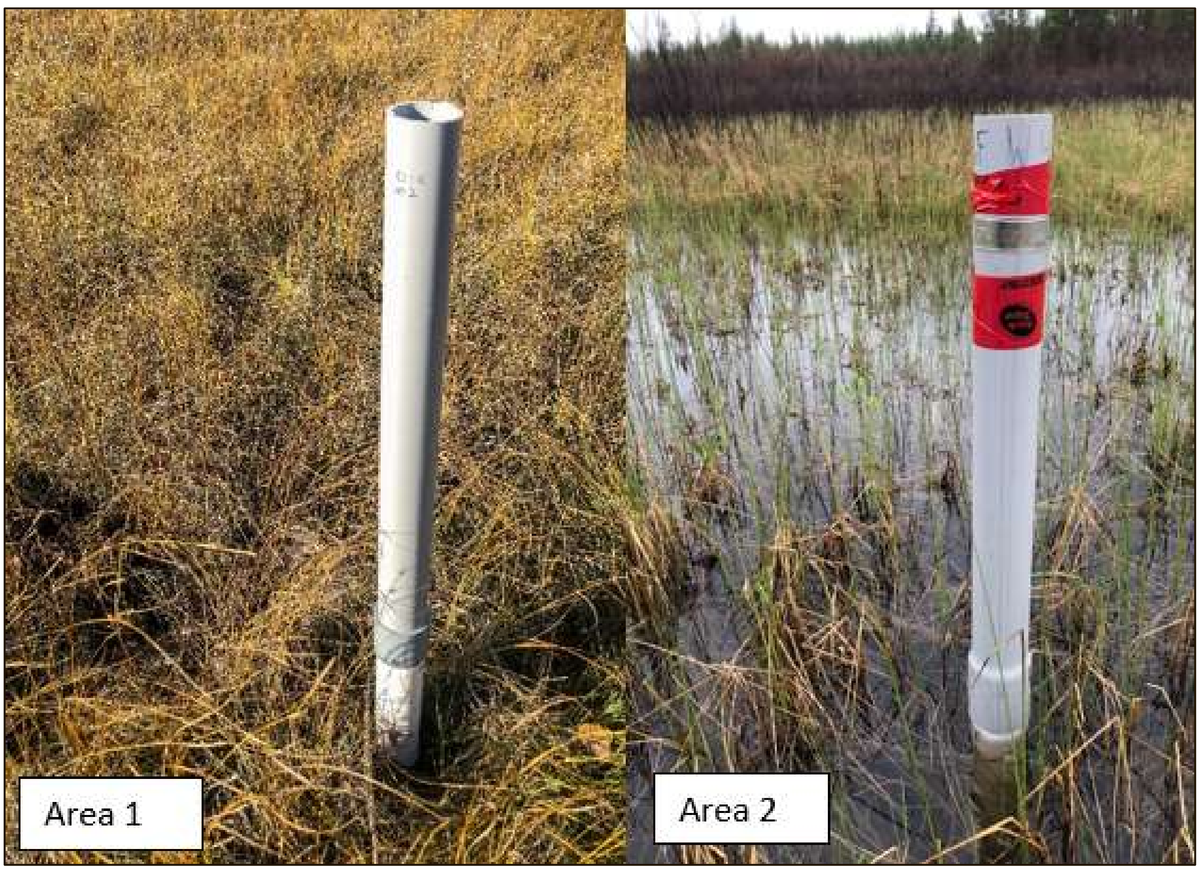


Figure 6

Figure 7. Visual comparison of water level conditions in area 1 and area 2. Left well is OSE W2 (Avg. wt -7 cm), and right well is T2 GF W4 (Avg. wt 26 cm).

Area 1

The average water level position in MOU1 was -17.4 cm (data not shown) and ranged from -83 cm (OSE UP) to 5 cm (OSE W3) (Table 4). Water table levels in Area 1 generally stayed below the ground surface with the exception of iAB W1, SW2 and OSE W3, each of which had water tables recorded above the ground surface either following spring melt or after rainfall near or above 10 mm (data not shown).

Area	Well ID	May		June		July		August		September		October		Average from May-Oct	
		WT	n	WT	n	WT	n	WT	n	WT	n	WT	n	WT	n
1	iAB W1	-2.7	6	-10.1	7	-12.8	5	-8.8	5	-12.6	5	-6.8	4	-9.0	32
1	iAB W2	-9.7	6	-16.0	7	-17.4	5	-13.0	5	-17.6	5	-12.2	5	-14.3	33
1	iAB W3	-29.7	6	-32.1	7	-31.6	5	-28.8	5	-31.3	5	-29.2	5	-30.5	33
1	HH T1 D1	-20.0	4	-25.8	8	-24.8	4	-23.0	5	-21.0	5	-20.8	5	-22.8	31
1	HH T1 D5	-12.8	4	-16.3	8	-17.6	5	-13.8	5	-15.2	5	-14.2	5	-15.1	32
1	HH T1 U1	-19.7	3	-23.3	8	-21.5	5	-21.2	5	-21.8	5	-20.2	5	-21.6	31
1	HH T1 U10	-24.7	3	-26.1	8	-27.0	5	-24.0	5	-24.0	5	-23.2	5	-24.9	31
1	HH T1 U5	-15.5	2	-25.3	8	-26.6	5	-24.2	5	-24.0	5	-22.8	5	-24.1	30
1	HH T2 D1	-6.5	2	-15.8	8	-16.4	5	-15.4	5	-14.3	5	-13.4	5	-14.7	30
1	HH T2 D5	-4.7	3	-9.6	8	-10.8	4	-7.3	5	-8.8	5	-4.6	5	-8.0	30
1	HH T2 U1	-3.7	3	-12.9	8	-14.5	5	-12.2	5	-12.6	5	-10.4	5	-11.7	31
1	HH T2 U10	-14.0	2	-17.5	8	-17.0	5	-16.3	5	-17.2	5	-15.6	5	-16.6	30
1	HH T2 U5	-12.5	2	-15.3	7	-16.2	5	-13.8	5	-13.8	5	-12.6	5	-14.3	29
1	OSE SW4	-17.0	3	-18.9	8	-21.4	5	-17.0	5	-17.8	5	-16.0	5	-18.1	31
1	OSE UP	-48.5	4	-61.5	8	-66.6	5	-49.0	5	-65.5	5	-57.8	5	-58.7	32
1	OSE W1	-9.0	5	-15.5	8	-16.8	4	-11.2	5	-16.2	5	-11.6	5	-13.5	32
1	OSE W2	-4.4	5	-8.6	8	-9.8	5	-5.0	5	-8.5	3	-5.4	5	-7.0	31
1	OSE W3	1.0	5	-1.9	7	-3.6	5	-1.0	5	-2.6	5	-0.4	5	-1.5	32
1	SW2	-1.0	4	-7.3	8	-12.8	5	-4.5	5	-11.8	5	-5.4	5	-7.4	32
1	SW3	-21.4	5	-24.6	8	-29.8	5	-22.0	5	-29.7	5	-24.8	5	-25.3	33
1	TF W1	-14.7	3	-12.8	8	-13.8	5	-12.0	5	-11.7	5	-9.2	5	-12.2	31
1	TF W2	-9.6	5	-20.3	8	-21.2	5	-18.5	5	-22.3	5	-17.0	5	-18.5	33
1	TF W3	-10.5	4	-16.4	8	-19.8	5	-13.8	5	-19.5	5	-13.4	5	-15.9	32
1	TF W4	-12.7	2	-17.4	8	-17.4	5	-15.3	5	-16.8	5	-14.0	5	-16.0	30
2	T1 EM W4	-	-	-8.5	1	-	-	59.0	1	-	-	-	-	14.0	2
2	T1 MS W2	-	-	5.0	1	-	-	7.0	1	-	-	-	-	5.7	2
2	T1 SF W3	-	-	10.0	1	-	-	14.0	1	-	-	-	-	11.3	2
2	T1 Trans W1	-	-	-30.0	1	-	-	-25.0	1	-	-	-	-	-28.3	2
2	T2 GF W4	-	-	27.0	1	-	-	26.0	1	-	-	-	-	26.7	2
2	T2 MS W2	-	-	15.0	1	-	-	23.0	1	-	-	-	-	17.7	2
2	T2 SF W3	-	-	10.0	1	-	-	10.0	1	-	-	-	-	10.0	2
2	T2 Trans W1	-	-	-47.0	1	-	-	-41.0	1	-	-	-	-	-45.0	2
2	T2 UP W0	-	-	-171.0	1	-	-	-135.0	1	-	-	-	-	-159.0	2

Table 3. Monthly water level averages (WT) in cm and number (n) of measurements taken at each well from May to October 2023.

Figure 8 shows water level measurements alongside daily precipitation data for the 24 wells located within MOU1. Throughout the 2023 growing season, there were four rain events which exceeded 10 mm, occurring in May, June August and September. Continuous rainfall between May 22 and 23 totaled 38mm. June 18 saw 19 mm with several days of rain above 5 mm before and after. The largest rain event occurred on August 23, reaching 33.3 mm. Finally, September 28 received 12.7 mm of rain. July also experienced the most consistent rainfall, with some recorded precipitation on 14 of 31 days, including 7 days with precipitation between 5.0 and 9.4 mm.

Throughout MOU1, water table level can be observed responding to rainfall in a few different ways. Higher volume but short-lived rainfall events as well as lower volume multi-day rainfall events both align consistently with increases in water level. Likewise, drawdown of the water table corresponds to periods with less rain. The rate of drawdown in July through mid-August appears to be slightly higher than from late August through October, despite the latter receiving significantly less rainfall. One of the main differences that could account for this is increased uptake of water during periods of active vegetative growth compared to late the latter half of the study period, characterized by greater vegetative cover and reduced growth rates transitioning into dormancy and senescence. Factors not fully accounted for include surface runoff and lateral groundwater recharge from surrounding areas.

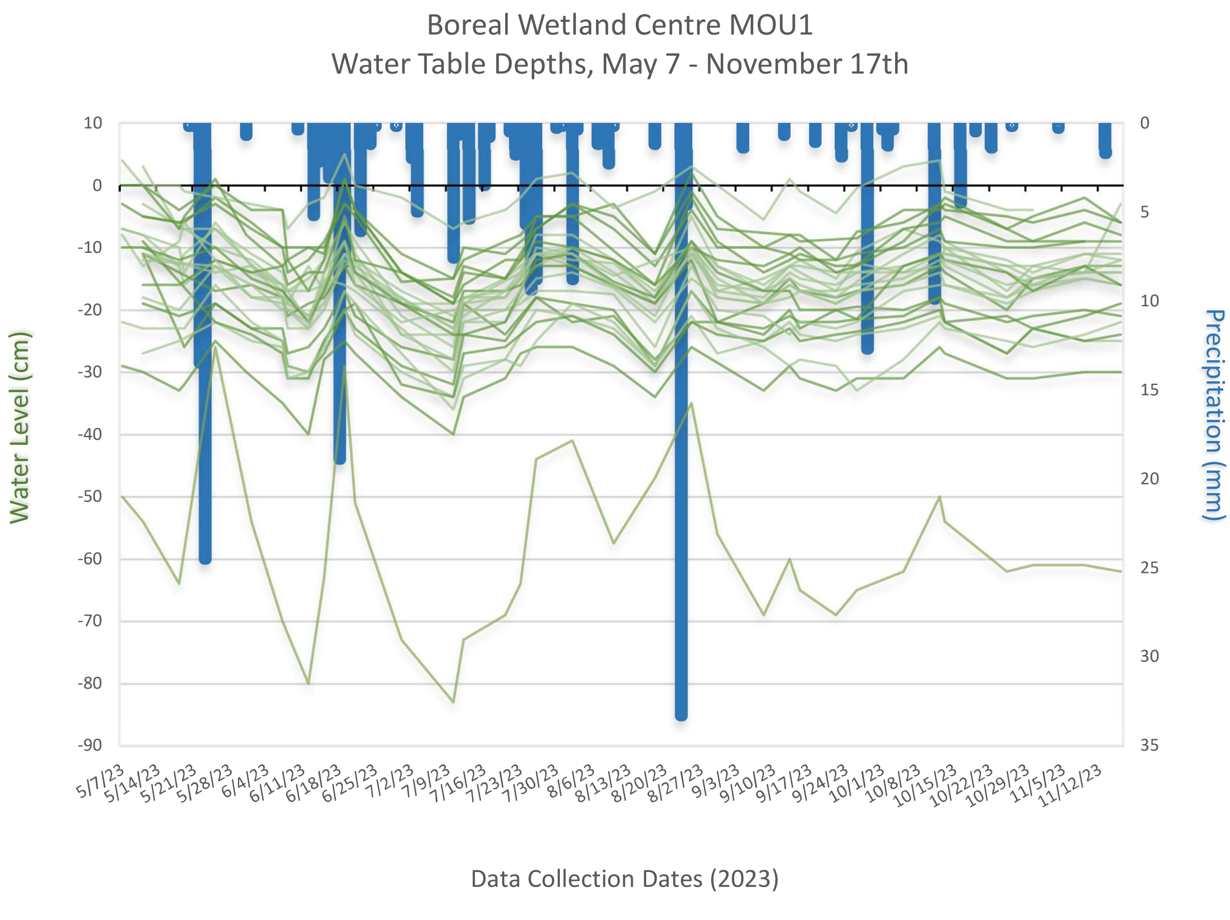


Figure 8. MOU1 water table position and precipitation, May 7 - November 17, 2023

Figure 9 shows water level measurements and daily precipitation data for the five wells located within the Oil Sands Exploration (OSE) site in Area 1. OSE W1, W2, and W3 are located on the reclaimed wellpad demonstration site, situated in a treed rich fen; OSE SW4 is in a conifer swamp; and OSE UP is located in an upland area. OSE W3 had the highest average water level in Area 1 (-1.5 cm), with 13 of 31 recorded dates with water at or above ground level. W1 had the lowest average level of the 3 wells on the pad (-13.5 cm), and the second highest variation in levels of the OSE wells. Interestingly, water levels for SW4 were closest to W1 despite it being located furthest away from SW4. This corresponds with a downward grade from the far end of the pad towards a shallow depression at the entrance, before transitioning back up into the natural treed fen followed by swamp then upland.

OSE UP1 is the only upland well currently installed, and thus has a significantly higher depth to water table than any other MOU1 well (avg. -58.7 mm), as well as by far the greatest variability. As a result, the responses to rainfall present in other wells appear more amplified in UP1, with more rapid increase and drawdown in the active growing season, followed by lower and more moderate fluctuations in late summer into fall. Added influences on the rate of these fluctuations could include elevation, soil permeability, surface runoff, and greater overall biomass.

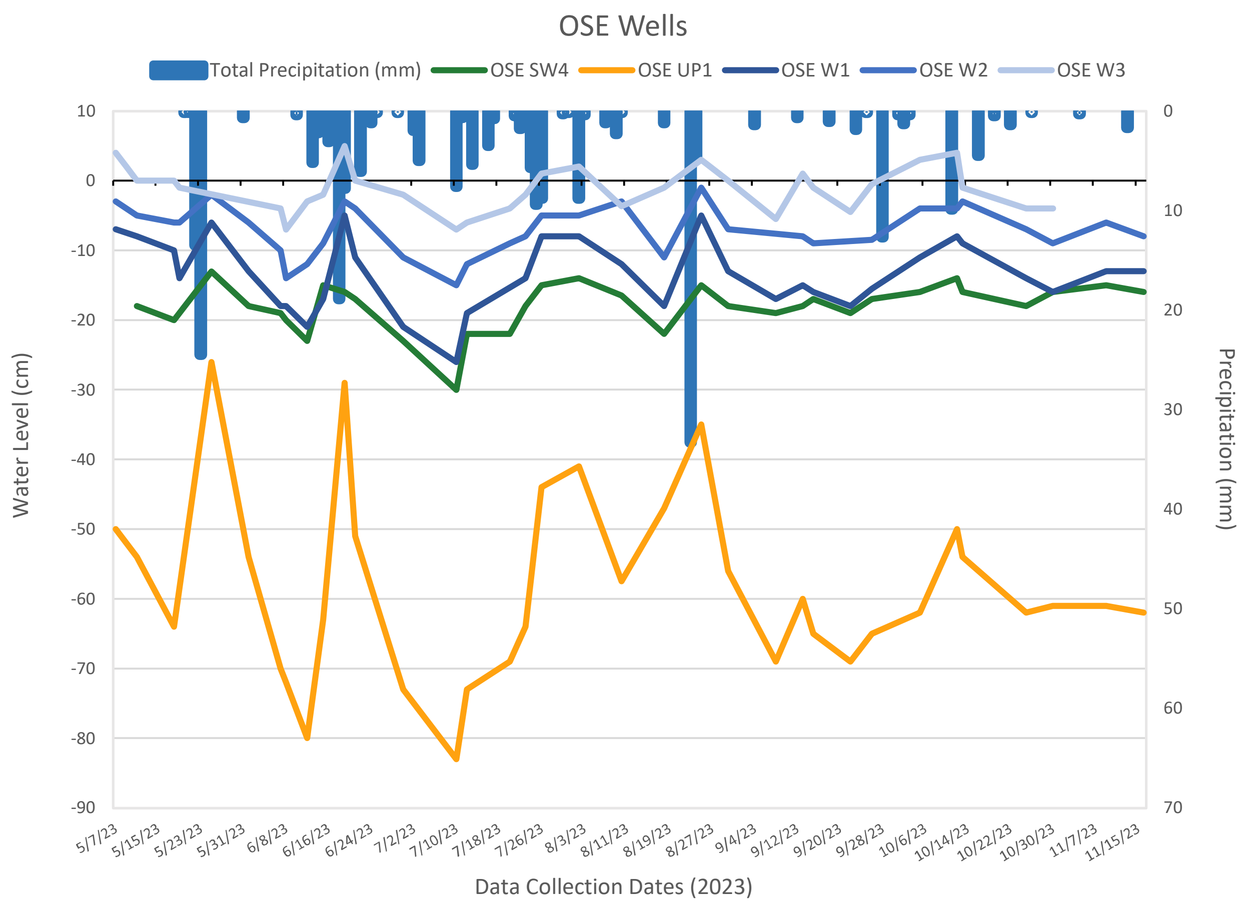


Figure 9. OSE transect water table position and precipitation, May 7 - November 17, 2023.

Figure 10 and water level measurements and precipitation data for the four wells situated within the treed fen. During the active growing season water levels were dynamic, dropping relatively quickly during any period without rainfall (particularly with TF W2), and raising back after rain events exceeding 10 mm. Similar to 2022, water table levels all increased and remained relatively stable following the largest rainfall event of 2023 on August 23, as vegetative growth slowed. The treed fen wells rates of uptake and drawdown were irregular, with water levels at one well periodically rising above and below another. This could be in part due to differences in lateral groundwater movement, as this set of wells are more scattered across Area 1 than others.

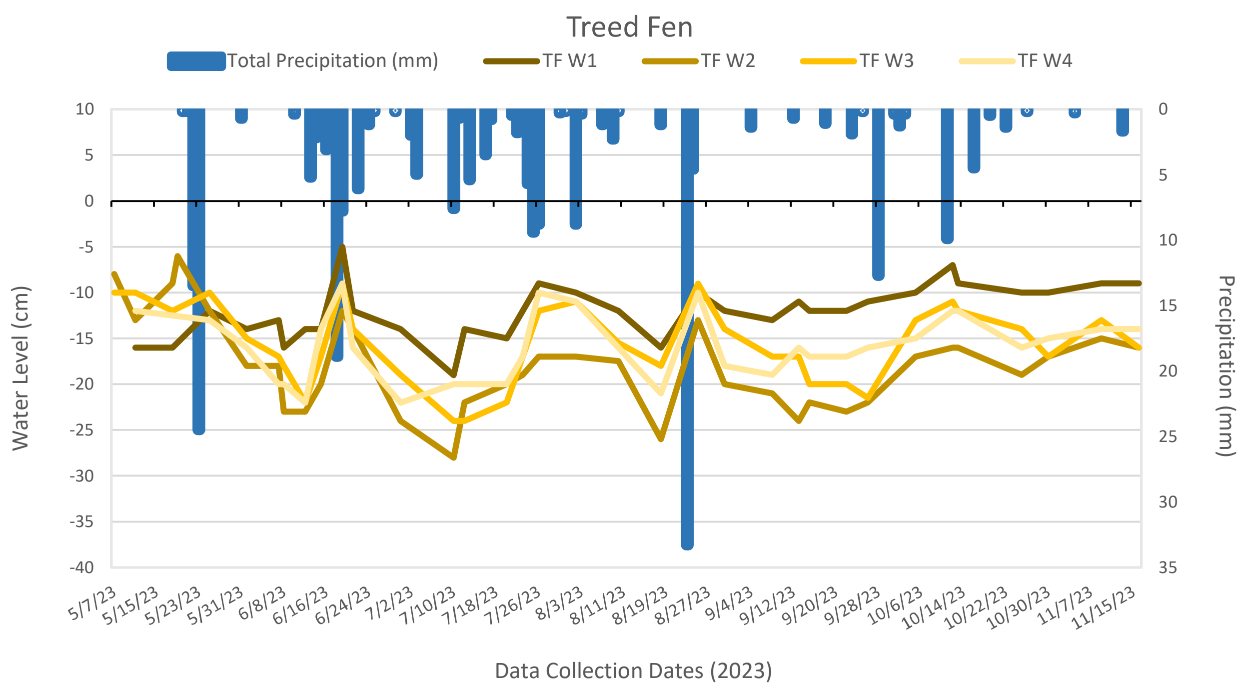


Figure 10. Treed Fen well water table positions and precipitation, May 7 - November 17, 2023.

Figure 11 shows water level measurements and precipitation data for Swamp wells 2 and 3. Both wells are relatively close together, and water levels fluctuate very similarly throughout the study period, but with a consistent difference of around 20mm between the two. This would likely owe to differences in microtopography, as water table is measured relative to the ground surface. Unlike many of the wells in MOU1, the conifer swamp wells didn't exhibit an immediate shift into more moderate fluctuations in late summer, possibly owing to continued consumption of water from trees before entering dormancy in fall.

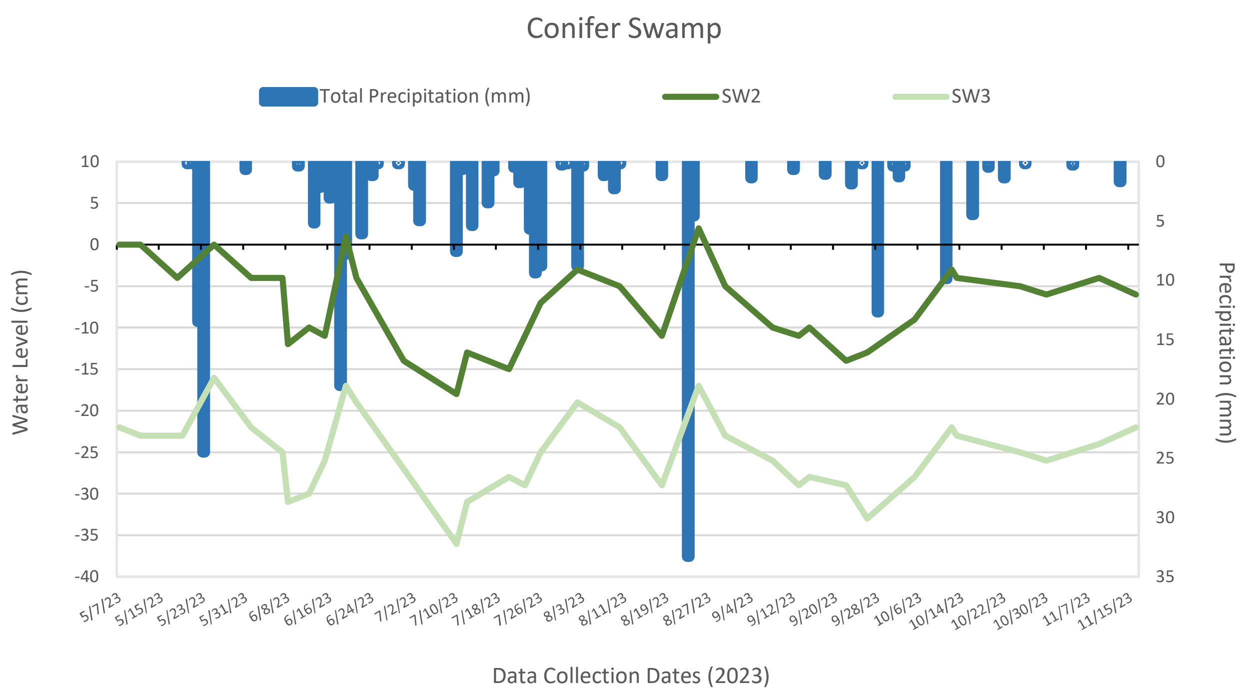


Figure 11. Swamp well water table positions and precipitation, May 7 - November 17, 2023.

Figure 12 illustrates water level measurements and precipitation data for the two hammerhead transects. The transects run perpendicular to a demonstrative corduroy road, which was installed in 2009. Wells are labelled either 'U' for Upstream or 'D' for downstream, along with their distance in metres from the road (ie. HH T2 U10 is on transect 2, and is 10 m upstream). 2023 is the second year that data was gathered from these wells.

One of the areas of interest for the hammerhead wells is to look for indications of the effects that the corduroy road may be having on water movement, and while cannot be certain of direct impacts from the water wells alone, the water levels of the two D1 wells in comparison to the others merit some attention. While the D5 wells consistently had the highest levels of their respective transects, the D1 wells would periodically fluctuate out of sync with the other wells, even occasionally dropping below the U10 wells, which were the lowest on average. This could indicate that the area immediately adjacent to the downstream side of the road may be effected, but these differences aren't enough to be conclusive. Further investigation to determine potential upstream and downstream effects could include vegetation surveys; water and soil sampling for electrical conductivity, pH and volumetric water content; and most importantly piezometer wells.

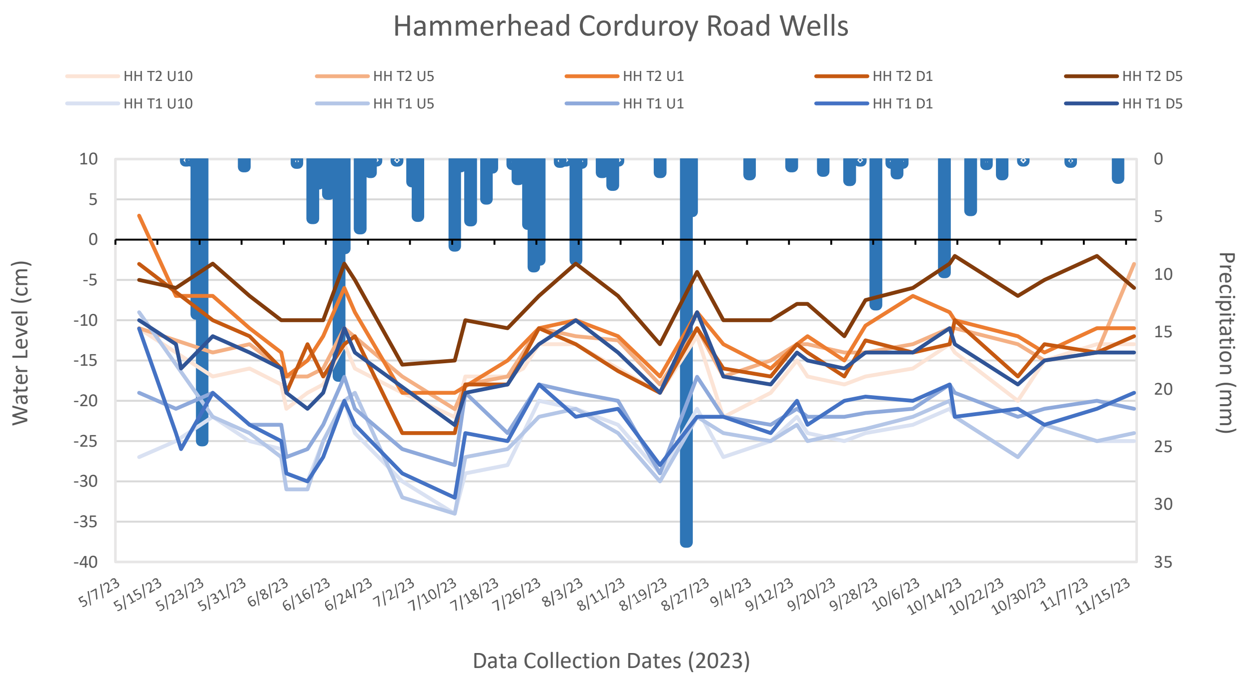


Figure 12. Corduroy Transects water table position and precipitation, May 7 - November 17, 2023

Wells in area 1 consistently had lower water levels than those in area 2 (Table 4), which is expected given that area 2 was consistently flooded through the study period.

Area 2

The average seasonal water level in area 2 was -1.74 cm (data not shown) and ranged from -48 cm (T2 Trans W1) to -171 cm (T2 UP W0) (Table 4); if we don't consider the transition wells, the lowest range would be -2 cm (T1 MS W2). The transition wells are not located in wetlands – they are in the upland-wetland transition area, elevated from the flooded wetland basin, and deeper water level values are expected. Figure 12 shows the water level positions of the nine wells in MOU2, Illustrating this discrepancy in water levels. *Note that the 0 cm measurement (grey line) = ground level*.

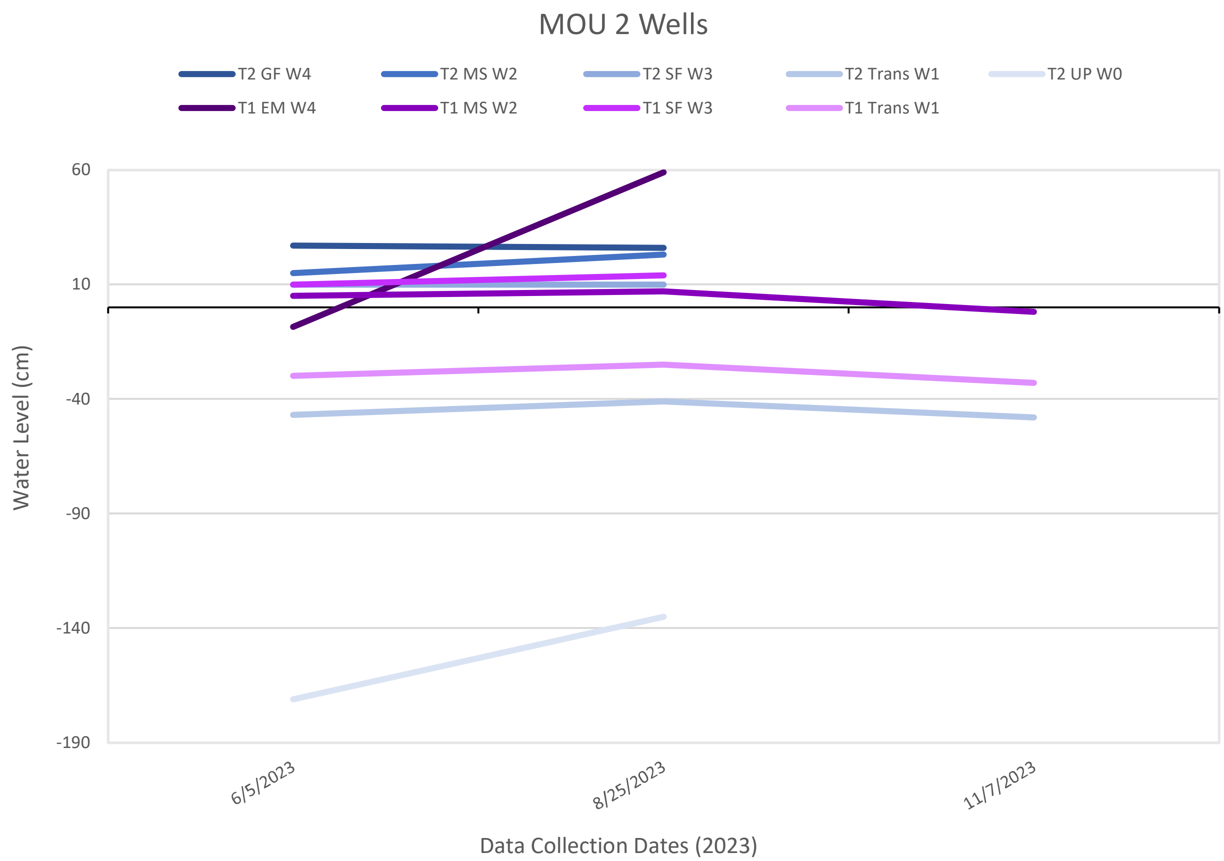


Figure 13. Water depth for MOU2 from June to November 2022.

1-2-3. Peat depths

There were no additional peat depth measurements taken in 2023.

Objective 1-3. Record water level fluctuations with data loggers

1-3-1. Data loggers

Figure 14. Barometric data logger (bottom center) attached to the outside of a well.

The data loggers were deployed June 8, 2023. The loggers are Onset® HOBO® U20L-04, a HOBO® waterproof shuttle with a coupler was used to launch and collect data, and HOBOware Pro was used for barometric compensation. Two were installed in area 1, and 2 in area 2. One of the loggers in area 1 was installed outside of a well for barometric compensation (Figure 13). The loggers were removed from the wells on November 16th, 2023.

Figure 14 shows that the corresponding manual measurements line up within an acceptable 5 cm of the logged data. Similar to the manual measurements, the rise in water level towards the ground surface corresponds with the largest seasonal precipitation event on August 22.

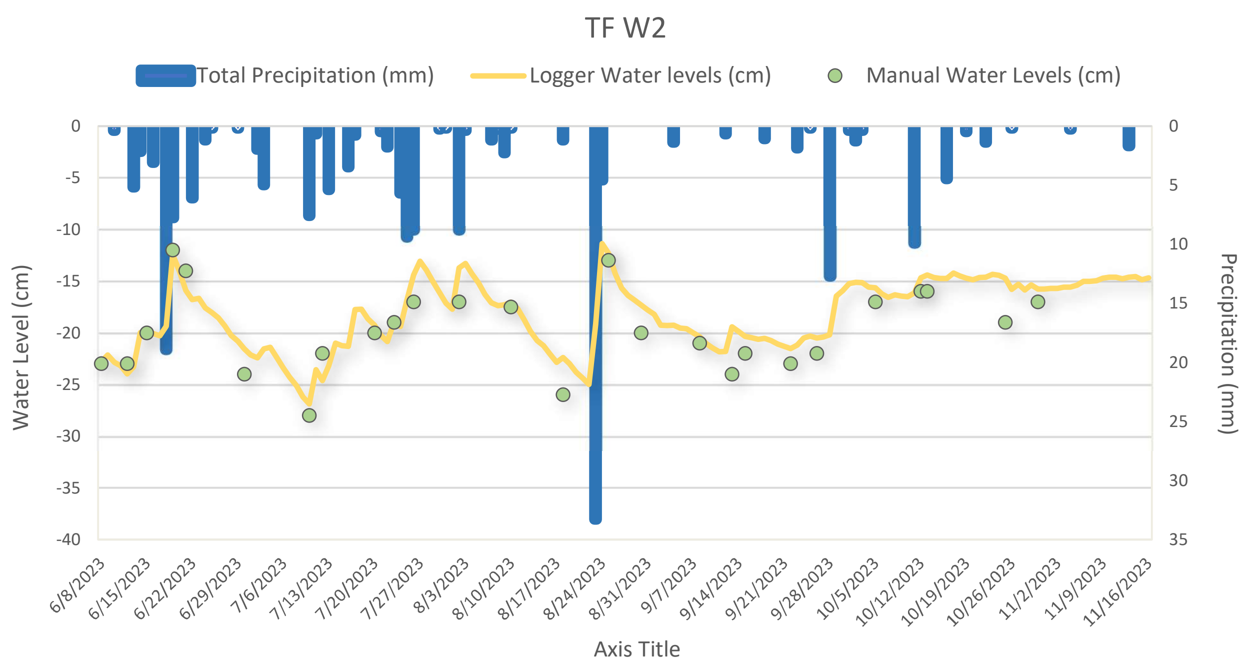


Figure 15. Logged data (yellow line), manually collected data (green dots), and precipitation (blue bars) from well TF W4 in a treed fen.

Figures 15 shows the water depth taken by the upland data logger in MOU2, in conjunction with the precipitation data. A similar trend is observed in the wells in area 2 as the wells in area 1, we see a general water table draw down and a response to rain events. The logger data provides a more complete picture of the water table during rain events and highlights how responsive and dynamic the water table in this region is. *NOTE: A second logger was installed in MOU2, but was unable to be removed before becoming trapped by early winter freeze.*

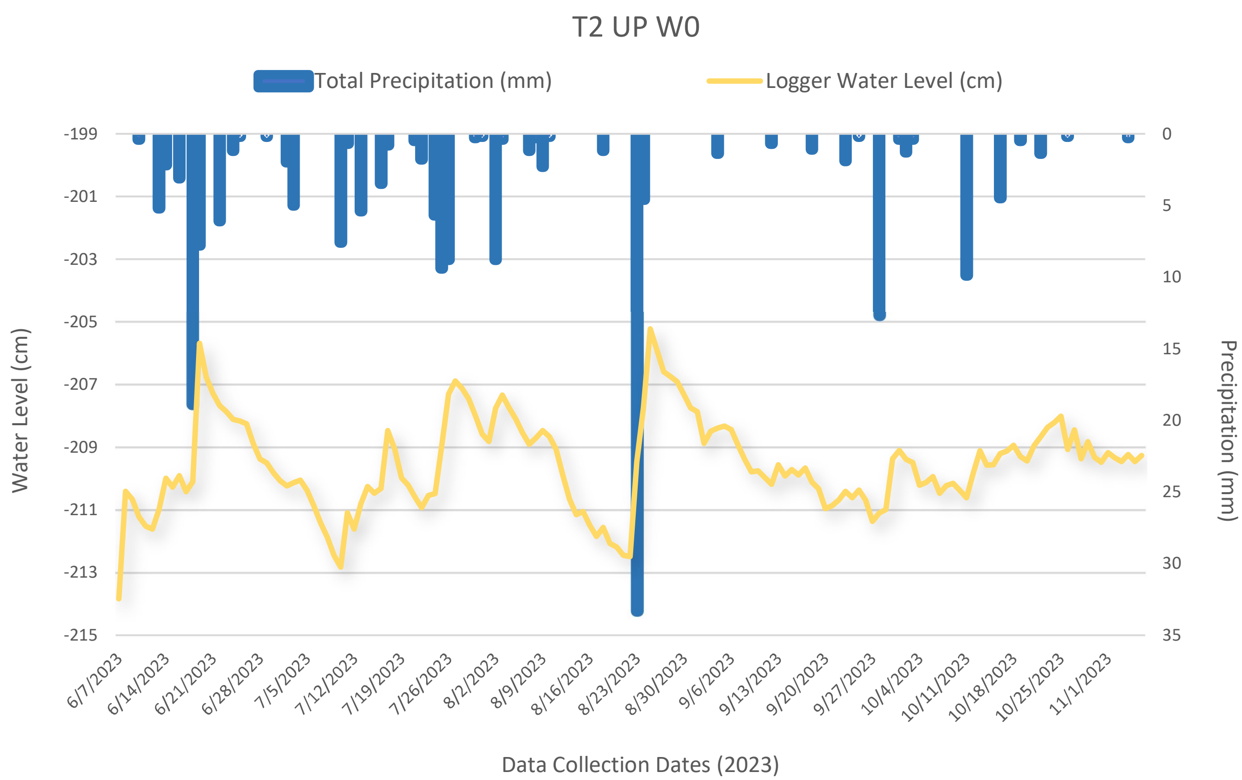


Figure 16. Logged data (Yellow line) and precipitation (blue bars) from well T2 UP W0 in an upland forest.

Objective 2: Public Outreach

Objective 2-1. Establish water level citizen science activities that can be used by the public and school groups

2023 marked the 3rd year of the iWetland project at the Wetland Centre. For background information, see the project webpage. For detailed instructions on creating iWetland wells, see Appendix 5. There are 3 iWetland wells located in area 1 at the Wetland Centre, and locations were chosen based on accessibility to the public, i.e. next to the trail network, and to capture the two different wetland forms present in area 1.

Figure 17. iWetland well (left) and signage (right).

Scatterplots were created in excel and imported to Adobe illustrator to create illustrative graphs (Fig. 18). Click here for the detailed tutorial. Overall, the iWetland citizen science project is considered successful in terms of data collection and volunteer engagement. The iWetland wells were part of the weekly data collected by volunteers. The design for the wells, created by Catherine and Scott Ketcheson in 2021, worked for simple volunteer data collection, and the calibration equations were easy to apply in Excel. The illustrative graphs, updated for 2023, were used on the project website and for social media communications. We received feedback that they are an easier way for the public to comprehend water level data.

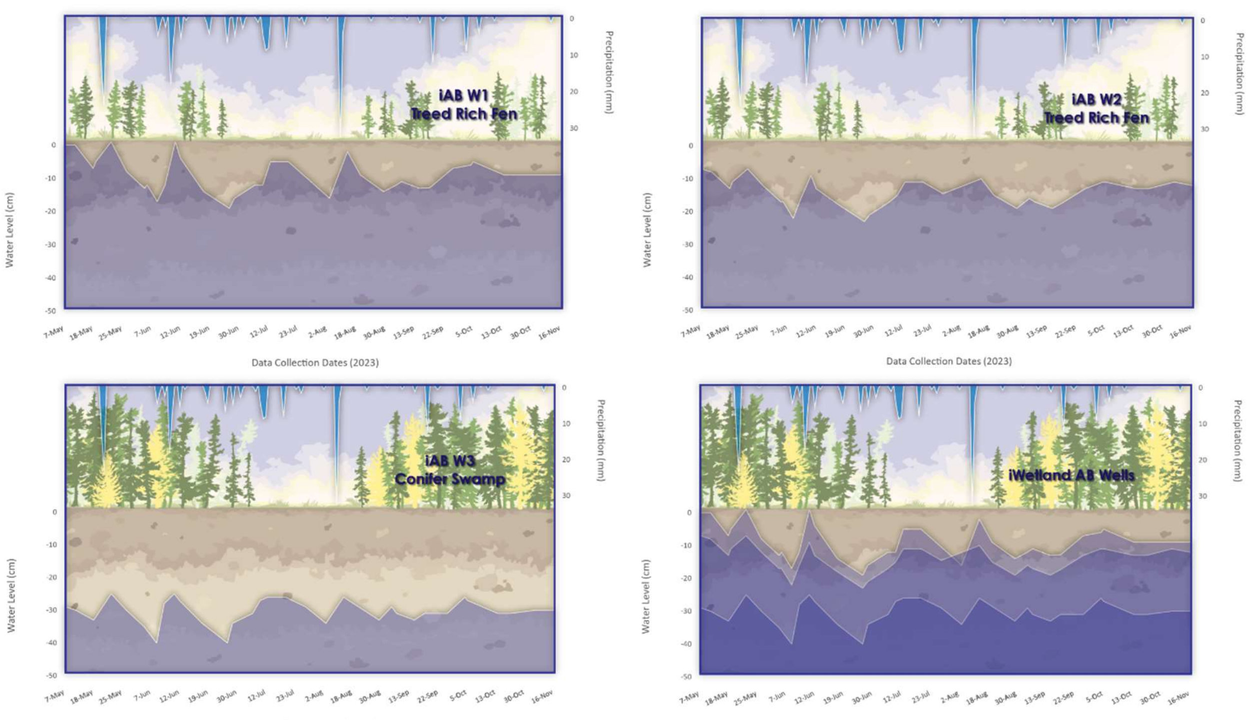


Figure 18. iWetland visual scatterplots were created as a public-friendly way to show water level position throughout the season.

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