TRIP REPORT

State of Alaska
Department of Fish and Game

Field Date: April 14, 2023

Location: **Fort Knox Mine – Water Supply Reservoir (WSR)**

Objective: Late Winter Water Quality Monitoring of WSR

Participants: Chad Bear and Kieren Vasquez

Weather: 30°F, sunny, melting snow, 0 MPH wind, 2’ of snow on WSR, no overflow.

Access: State trucks and two snowmobiles

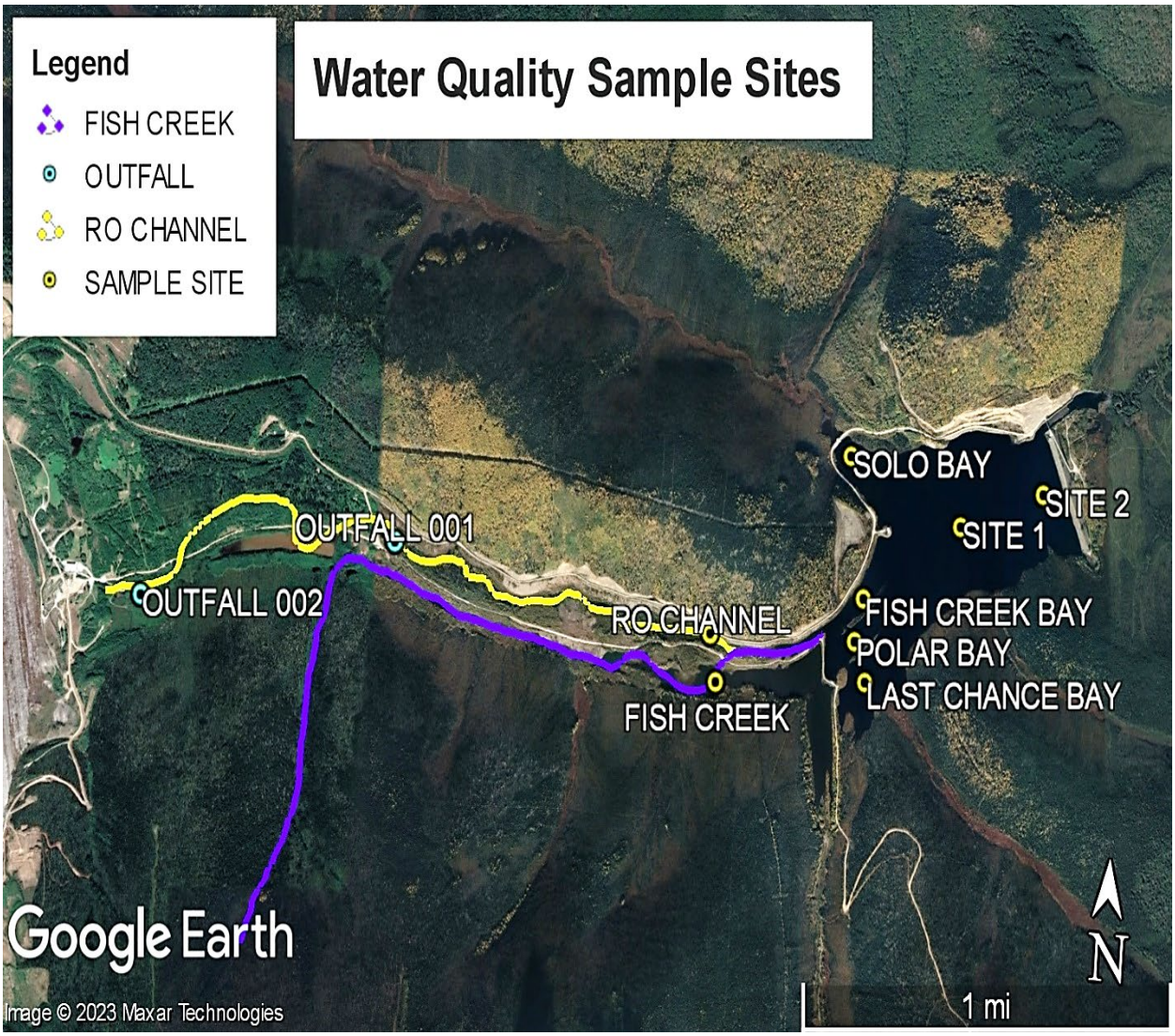

Figure 1. Fort Knox Water Supply Reservoir water quality sample sites, April 14, 2023.

Chad Bear and Kieren Vasquez drove to Fort Knox on April 14, 2023, to collect winter water quality data from the Fort Knox Water Supply Reservoir (WSR) and deploy two Hobo temperature loggers into Fish Creek and North Fork Fish Creek (Figure 1). Ice thickness on the WSR was slightly less than one meter. There was six inches of slushy overflow beneath two feet of snow. Overflow water may have influenced water quality at the one-meter depth sample, but not the remainder of the water column readings. The majority of Fish Creek was frozen over. Ice appeared soft and thin near the Pond F outlet, but very little flowing water was visible. The water temperature of Fish Creek at Pond F was 0.01°C and the outlet channel was completely frozen over except for one access hole (Figure 2). The RO Channel near the confluence with Fish Creek was also frozen and did not have a flowing channel. The RO Channel water temperature was 1.66°C taken at open water near Pond AB (Figure 3).

Figure 2. Fish Creek at Pond F outlet, April 14, 2023.

Figure 3. RO Channel near Pond AB, April 14, 2023.

WSR water temperatures recorded in 2023 ranged from 0.1°C to 4.2°C (Figure 4). The minimum temperature of 0.1°C was recorded in both Fish Creek Bay and Polar Bay, just below the ice surface. The maximum temperature of 4.2°C was recorded in Site 2 at 16 m depth, just above the reservoir bottom. Temperature at all six sample sites increased with water depth. The average water temperature profiles are the warmest recorded at Site 1, Site 2, and Polar Bay (Figure 5). Solo Bay, Fish Creek Bay, Solo Bay, and Last Chance Bay were like previous years. With the reduced and steady RO water discharge during the winter of 2022/23, water in the WSR was highly stratified when compared to the years with higher RO water discharge (Figure 4).

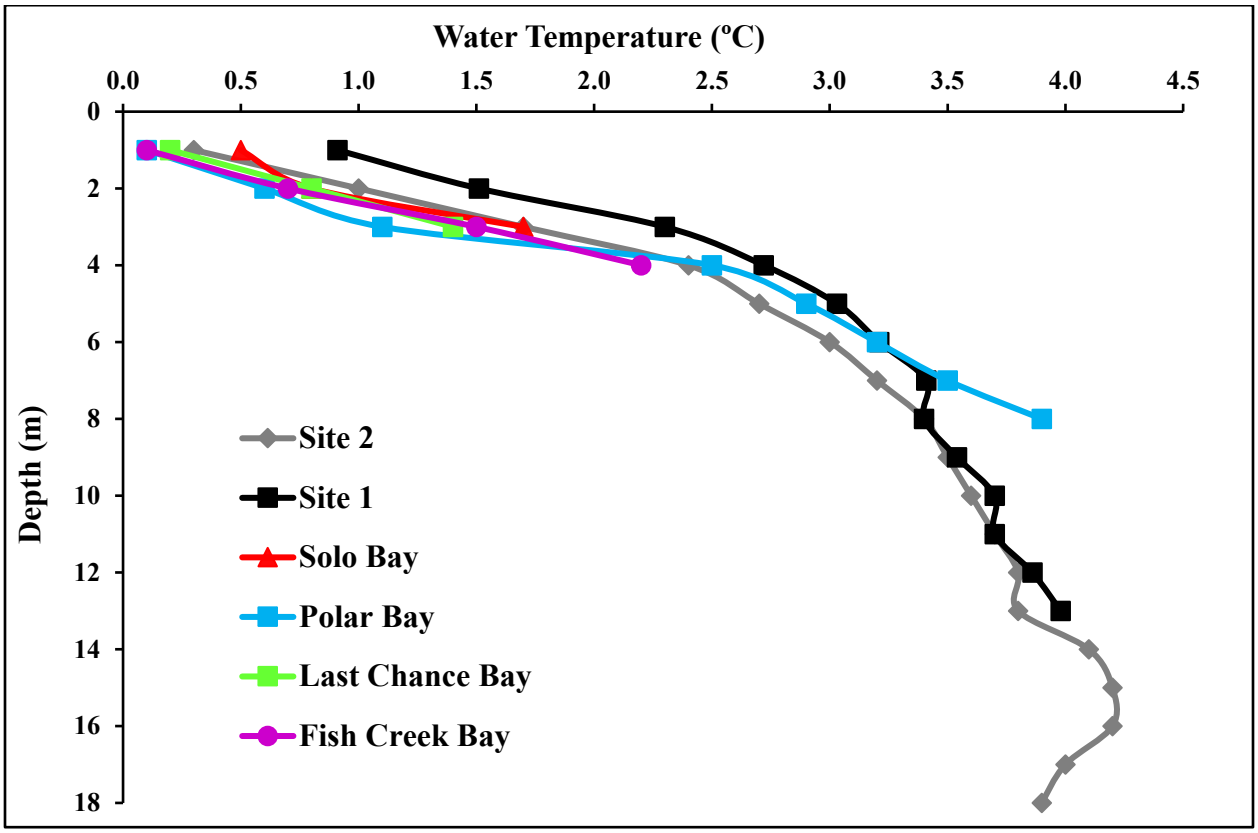

Figure 4. Fort Knox WSR water temperature profiles, April 14, 2023.

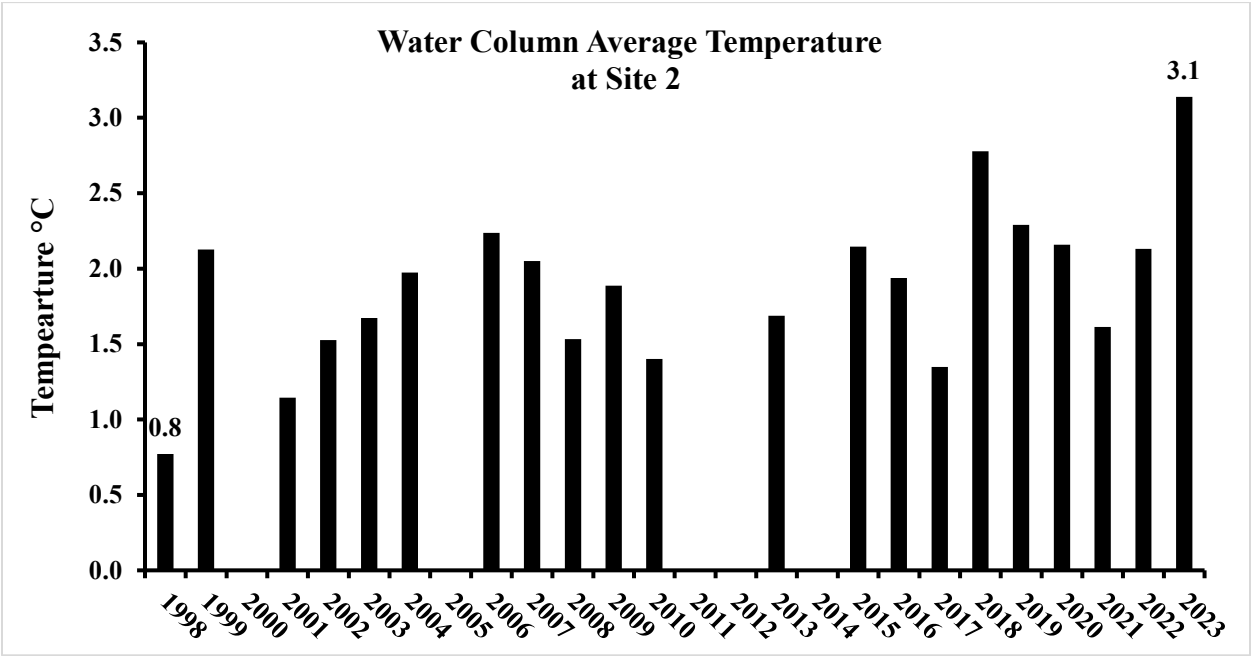

Figure 5. WSR Site 2 annual water column average temperature.

Dissolved oxygen (DO) is essential for the survival of fish, aquatic invertebrates, and aquatic plants. In 2023, Fish Creek Bay had the highest recorded dissolved oxygen (DO) at 11.80 mg/L followed by Polar Bay Bay at 11.20 mg/L (Figure 6). These maximums are higher than years prior to 2015 and are likely a result of RO water discharge that began in March 2015. Fish Creek Bay had the highest water column average DO concentration (7.75 mg/L) for the eighth year in a row followed by Solo Bay at 7.73 mg/L. At all WSR samples sites the DO was relatively high in the upper 8 m of the water column, but then dropped rapidly to near 0 mg/L below the 8 m depth.

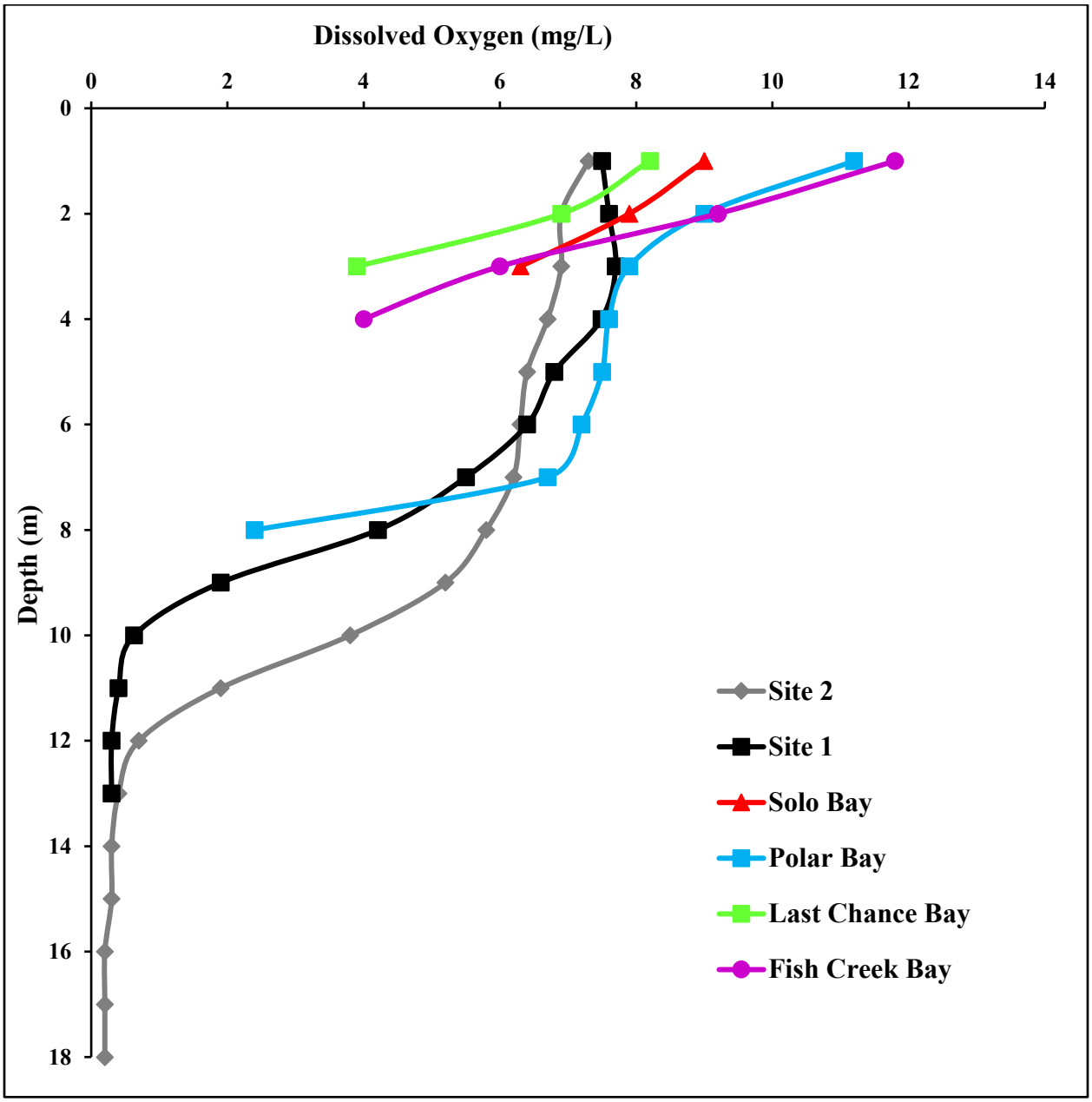

Figure 6. Fort Knox WSR dissolved oxygen (DO) (mg/L) profiles, April 14, 2023.

Temperature specific dissolved oxygen percent saturation DO (%) values were stratified between the surface and bottom in 2023 (Figure 7). WSR water was not well mixed (Figure 8). DO (%) showed the same stratification at 8 m as DO (mg/L). DO become anoxic in the reservoir below 10 m. With reduced discharged RO water entering the WSR from Fish Creek during winter of 2022/23 DO was lower than 2022.

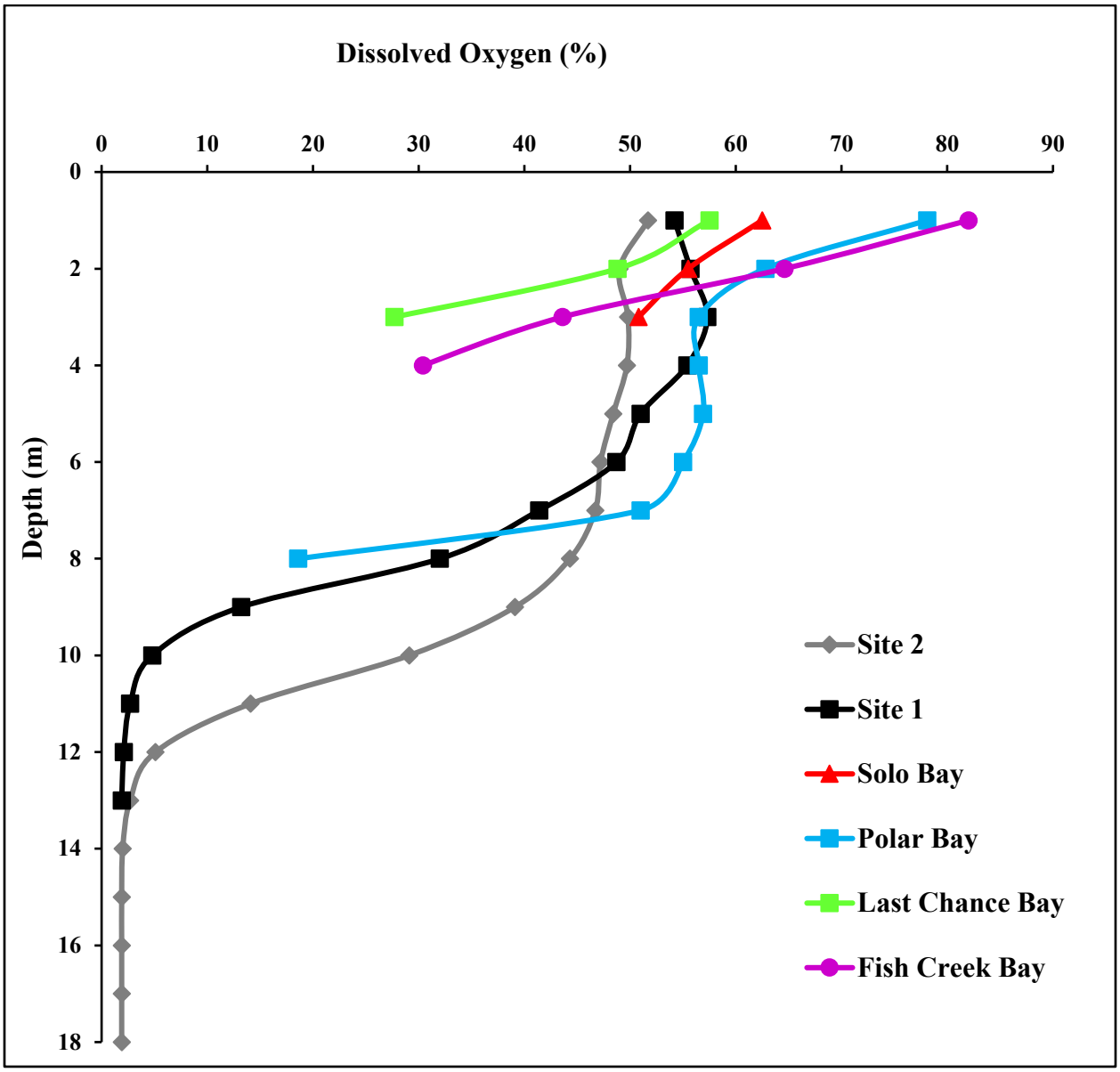

Figure 7. Fort Knox WSR dissolved oxygen (% saturation) profiles, April 14, 2023.

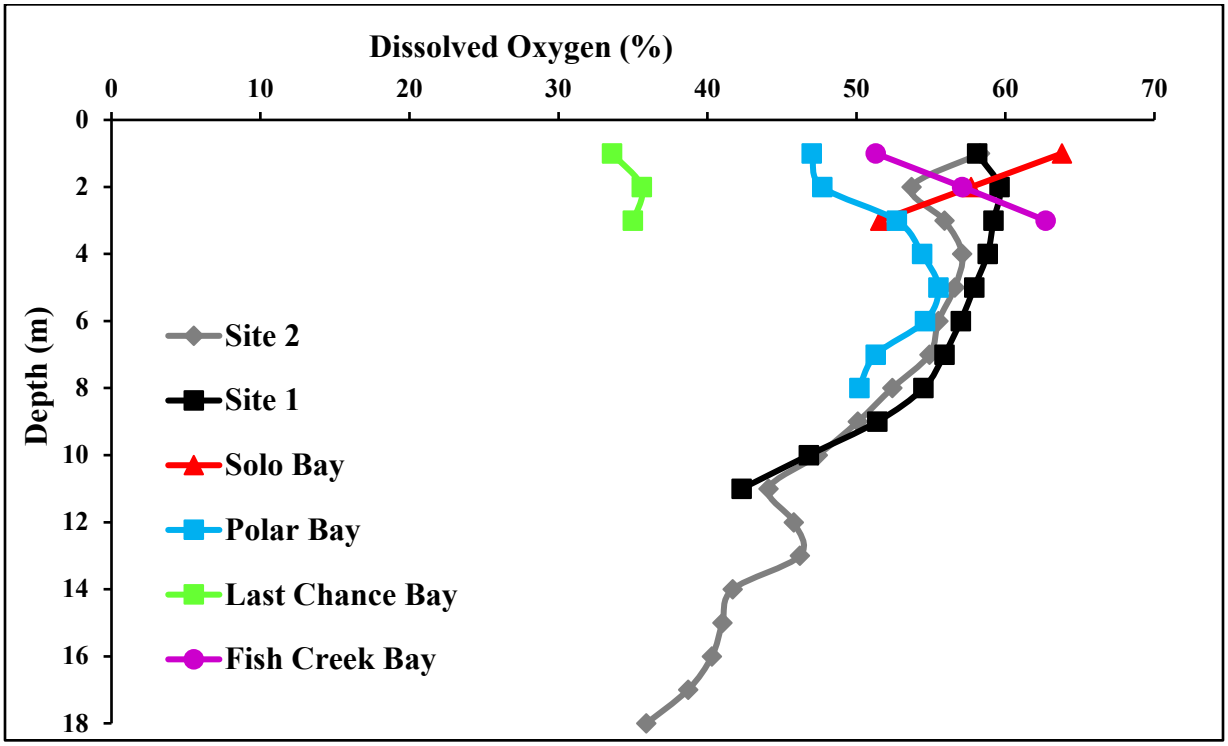

Figure 8. Fort Knox WSR dissolved oxygen (% saturation) profiles, April 14, 2022.

In 2023 the winter water column average dissolved oxygen DO (mg/L) recorded at Site 2 was above the Pre-RO average, but below the Post-RO average (Figure 9). This is likely a result of the reduced RO water entering the Fish Creek drainage and WSR in 2022/23.

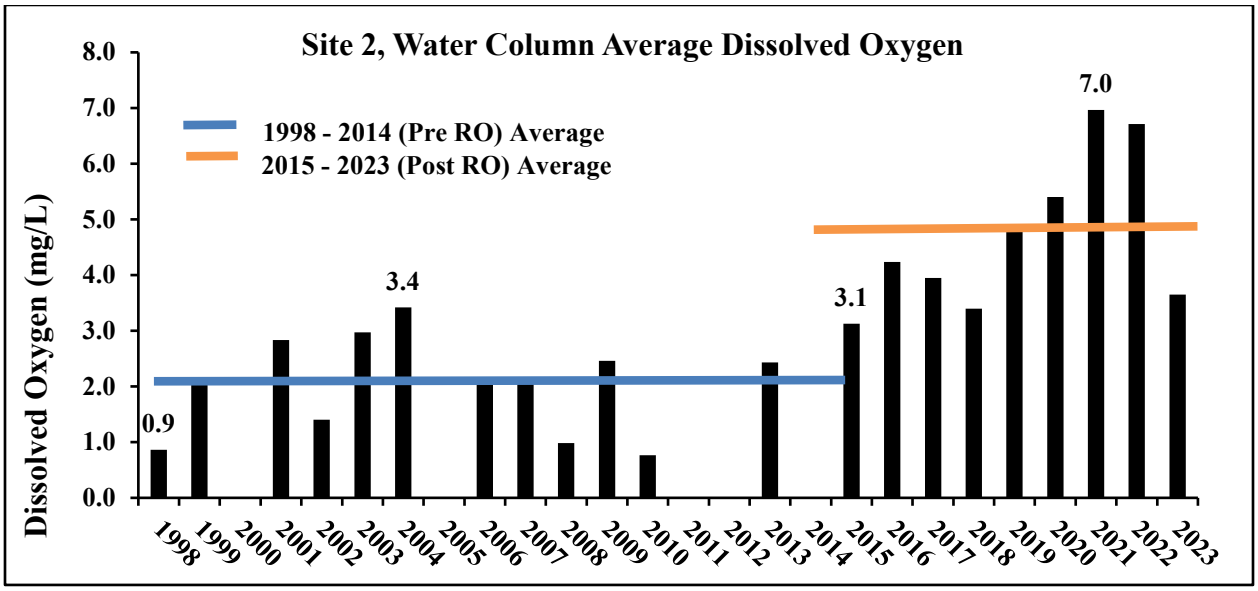

Figure 9. Average water column dissolved oxygen (mg/L) at Site 2, 1998 – 2023.

The pH of water has many effects on the plants, invertebrates, and fish, and has the potential to affect reproduction, recruitment, growth rates, and general health of fish. The WSR water pH in 2023 was relatively similar but had a wider range of values compared to prior years. The pH ranged from 6.3 at Solo Bay near the surface to 7.2 in Polar Bay near the surface (Figure 10). Most WSR pH readings met the ADEC standard for aquatic life, which includes freshwater fish such as Arctic grayling and burbot, of 6.5 to 8.5, with Solo Bay and Site 2 recording pH reading slightly lower than this standard in 2023.

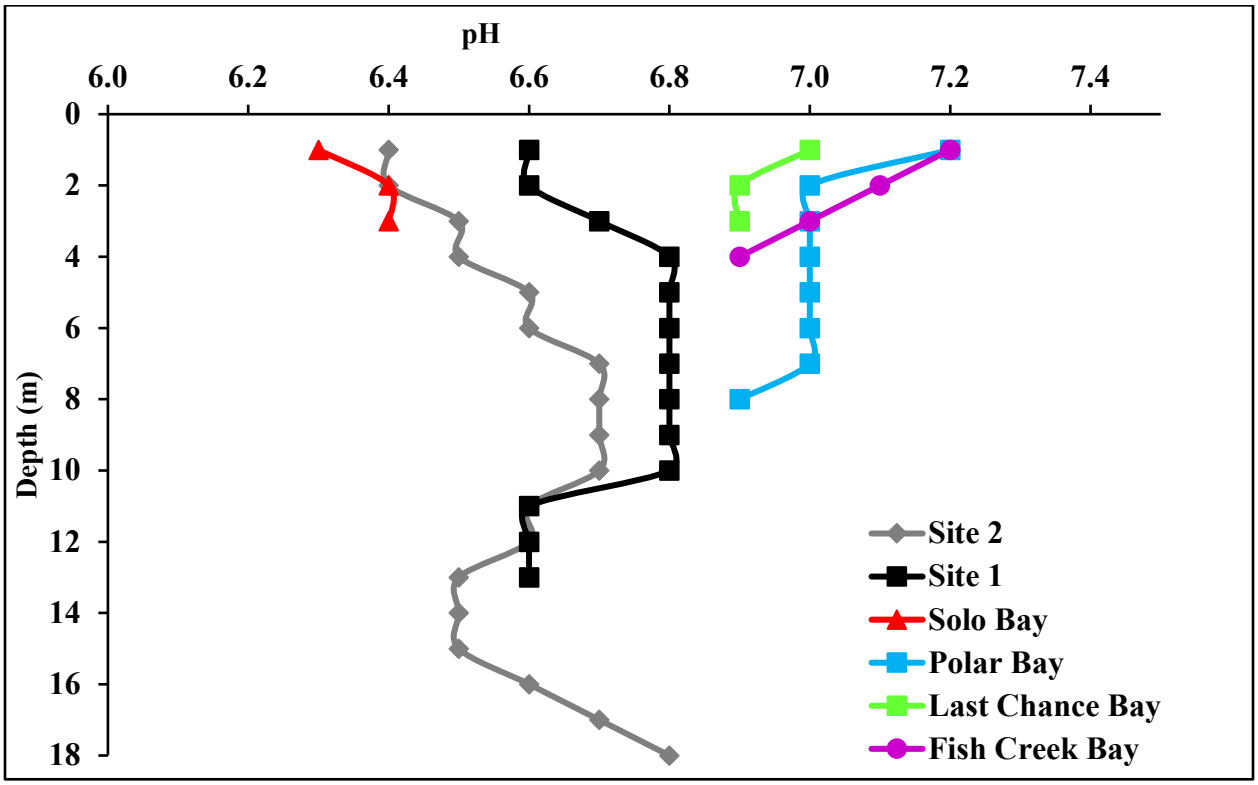

Figure 10. Fort Knox WSR water column pH profiles, April 14, 2023.

Specific conductance is the measure of how well water can conduct an electrical current and increases with increasing amounts and mobility of positively or negatively charged ions and can be used as an indicator of water quality. Specific conductance was similar among all six sites (Figure 11). Values generally increase with water depth as minerals sink from the surface and settle near the bottom. The one-meter reading, just below the ice surface, may be influenced by melt water mixing with WSR water while drilling the test hole. The 2023 WSR conductance values ranged between 107.1 and 399.2 µS/cm with most of the water column reading near 200 µS/cm. This is lower when compared to 2022 where most of the water column reading were near 400 µS/cm. The 2023 Site 2 water column average specific conductance was 255.7 compared to the 2022 average of 427.2 µS/cm, the highest ever recorded (Figure 12). Higher values indicate an increase in dissolved solids such as chloride, nitrate, phosphate, sodium, magnesium, calcium, and iron.

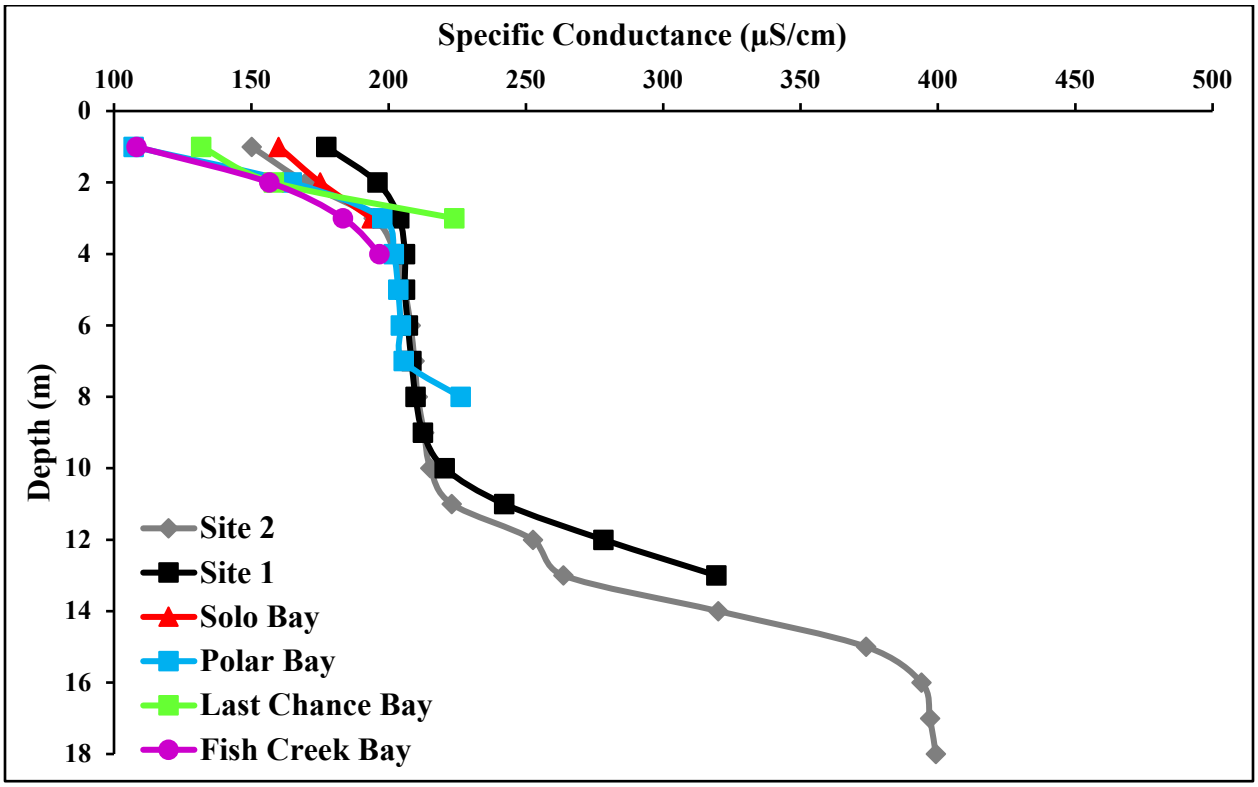

Figure 11. Fort Knox WSR specific conductivity (µS/cm) profiles, April 14, 2023.

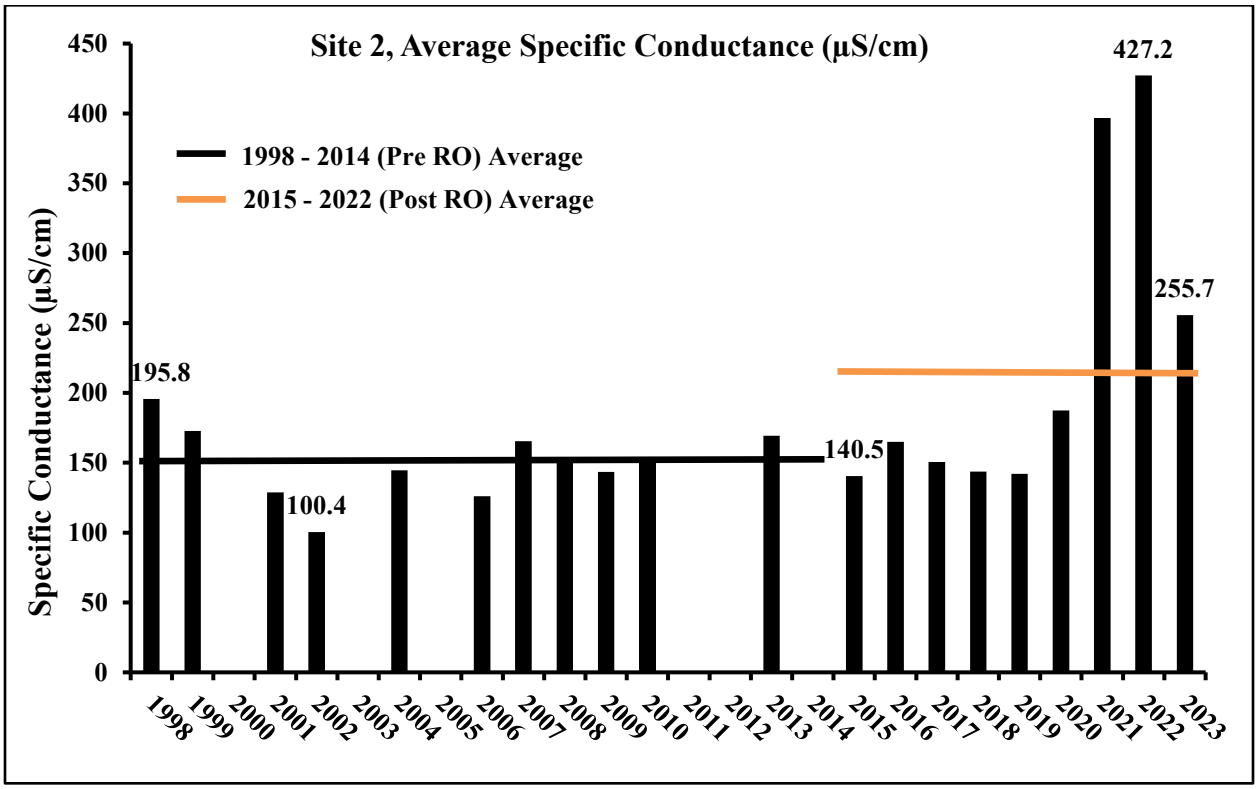

Figure 12. WSR specific conductivity at Site 2, 1998 - 2023.

Oxidation reduction potential (ORP) measures the ability of a lake or river system to break down waste products, such as contaminants and/or dead biological material. ORP was consistent among sample sites ranging between 297 to 385 mV (Figure 13). The 2023 total WSR average of all six sites combined was 337 mV.

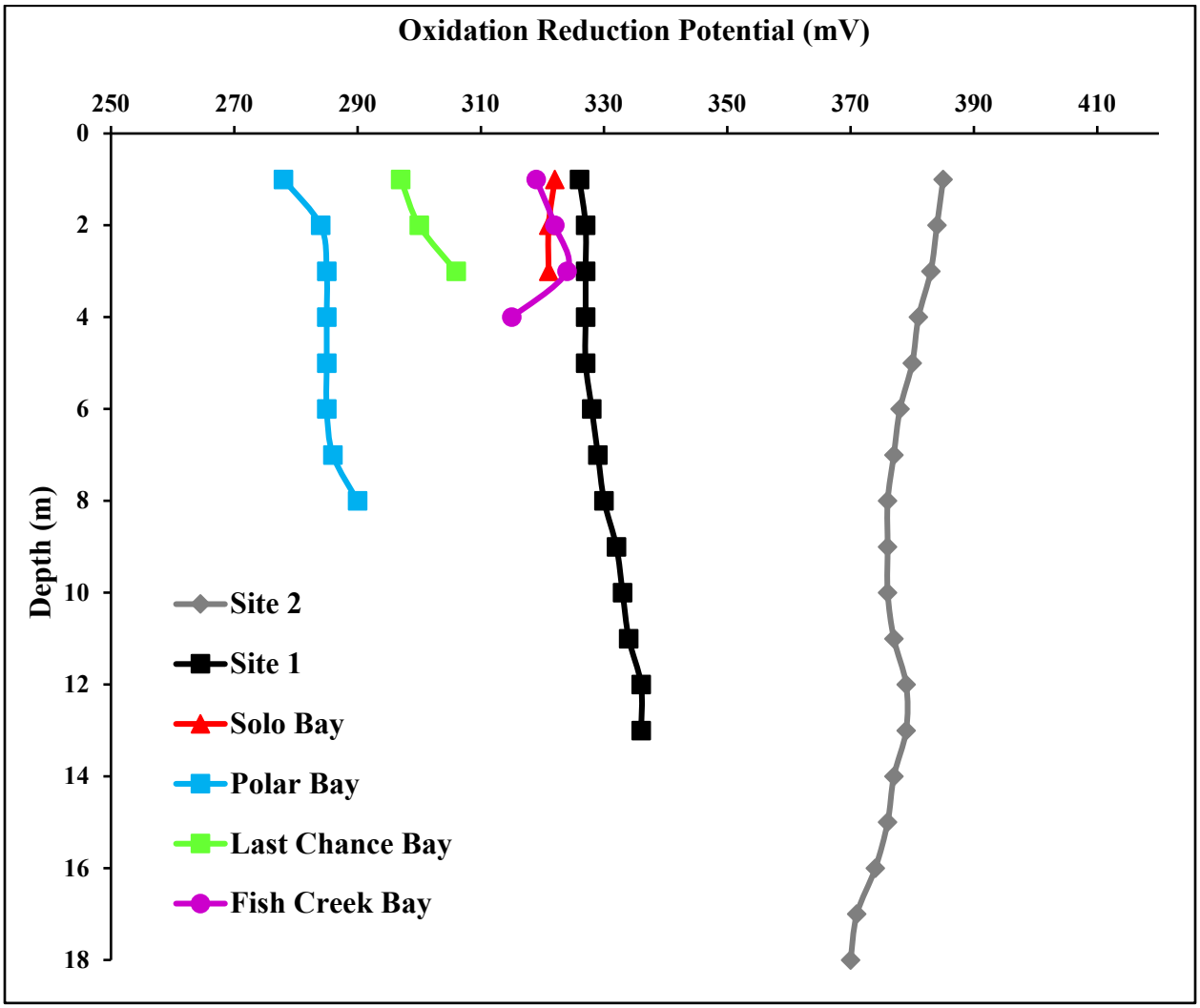

Figure 13. WSR oxidation reduction potential (mV) profiles, April 14, 2023.

From 2019 - 2023 water quality data were collected at Fish Creek at Pond F and the RO Channel downstream of Outfall 002 (Figure 1). On April 14, 2023, the water temperature in the RO Channel was 1.6 °C and the water temperature in Fish Creek was 0.1 °C (Figure 14).

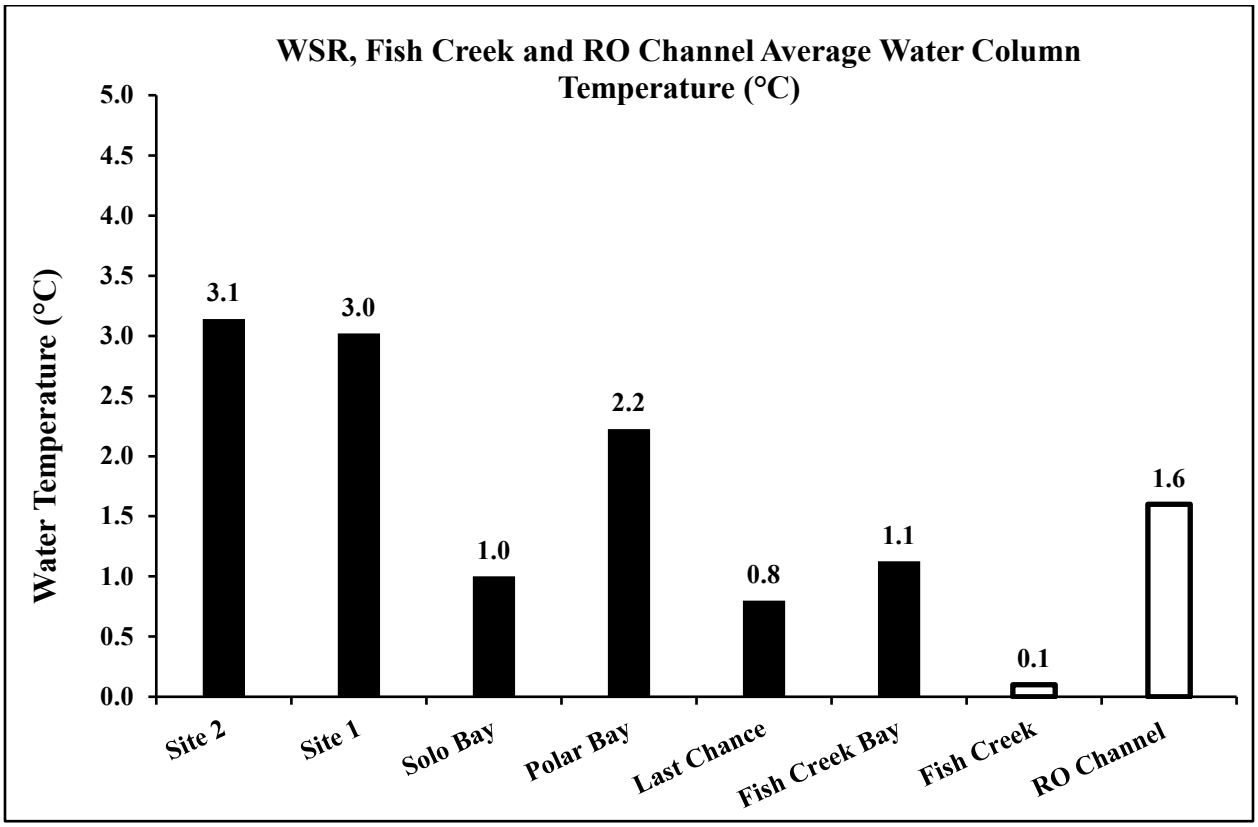

Figure 14. Water temperatures in Fish Creek, RO Channel (1 meter depth) and WSR (average for water column), April 14, 2023.

The DO in Fish Creek and the RO Channel was higher when compared to the average DO in the six WSR sample sites (Figure 15). Most of the RO water discharged flows though Pond AB and into the RO Channel on the north side of Centerline Road. On Aril 14, 2023, about 10 percent of the discharged RO water was flowing out of Pond AB's natural outlet and into Fish Creek. This RO water combined with natural hydraulic agitation during movement downstream and the exposure to air contributed to its higher DO concentration.

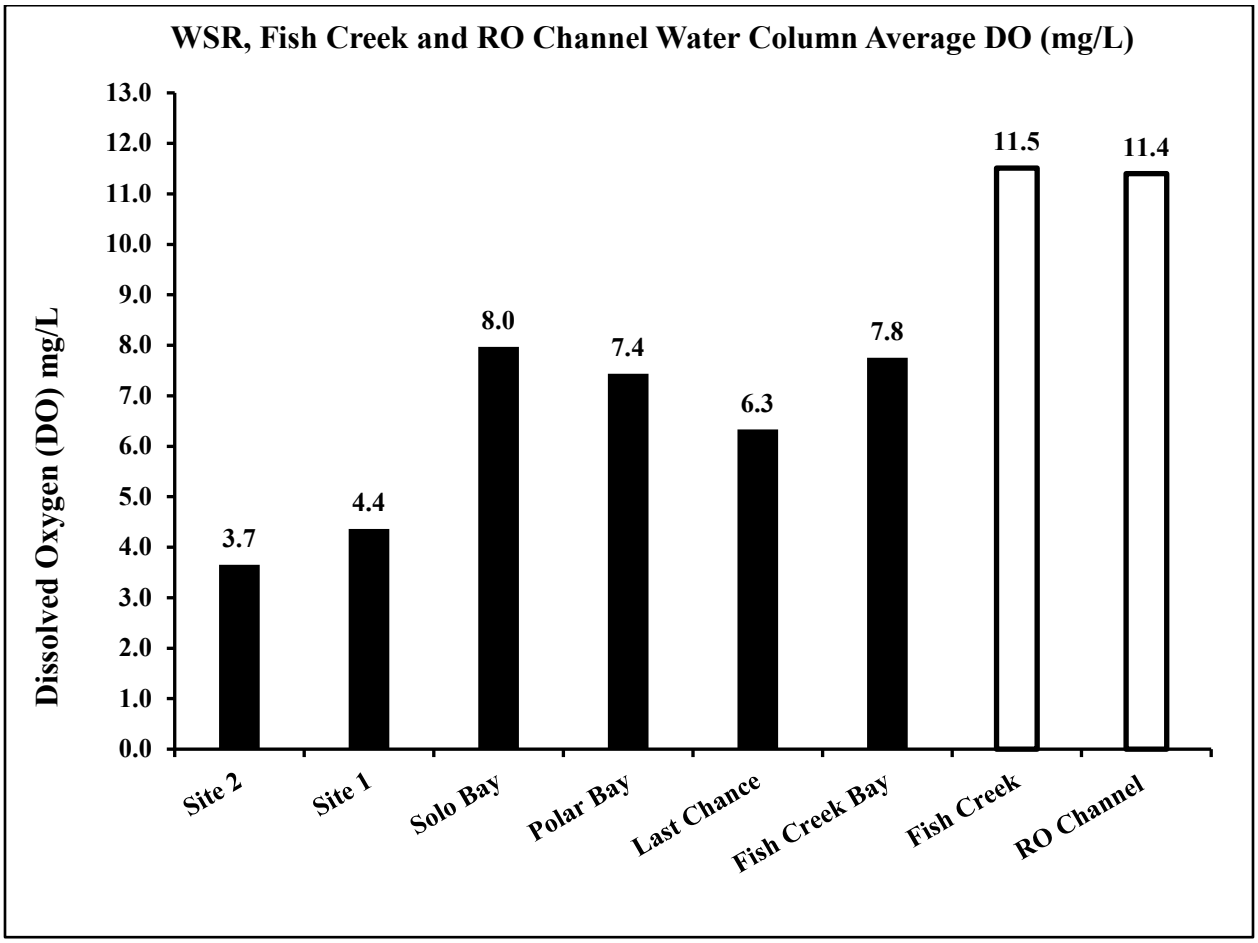

Figure 15. Dissolved oxygen in the WSR (average for water column), Fish Creek and RO Channel (1 meter depth) (mg/L), April 14, 2022.

The RO water discharged from Outfall 002 is mixed with non-contact ground water from de-watering wells which adds minerals and raises the specific conductance before it is discharged into the Fish Creek drainage. The RO Channel specific conductance measurement of 52.1 µS/cm was taken downstream of Outfall 002 and had the lowest recorded value of all sites in 2023 (Figure 16). During the 2022 and 2021 sampling, the RO Channel specific conductance was measured at 494 µS/cm and 455 µS/cm respectively, more than double the specific conductance measured in 2019 and 2020 (Figure 17).

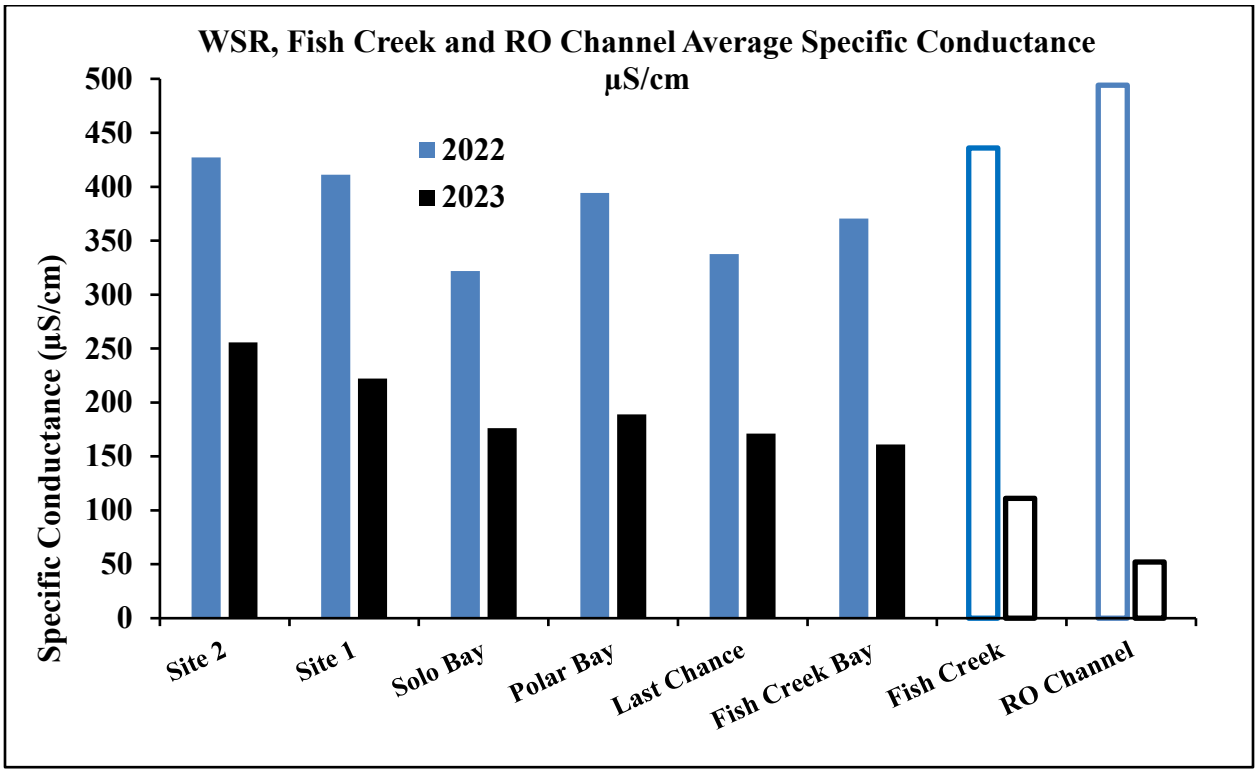

Figure 16. Specific conductance in the WSR (average for water column), Fish Creek and RO Channel (1 meter depth) µS/cm.

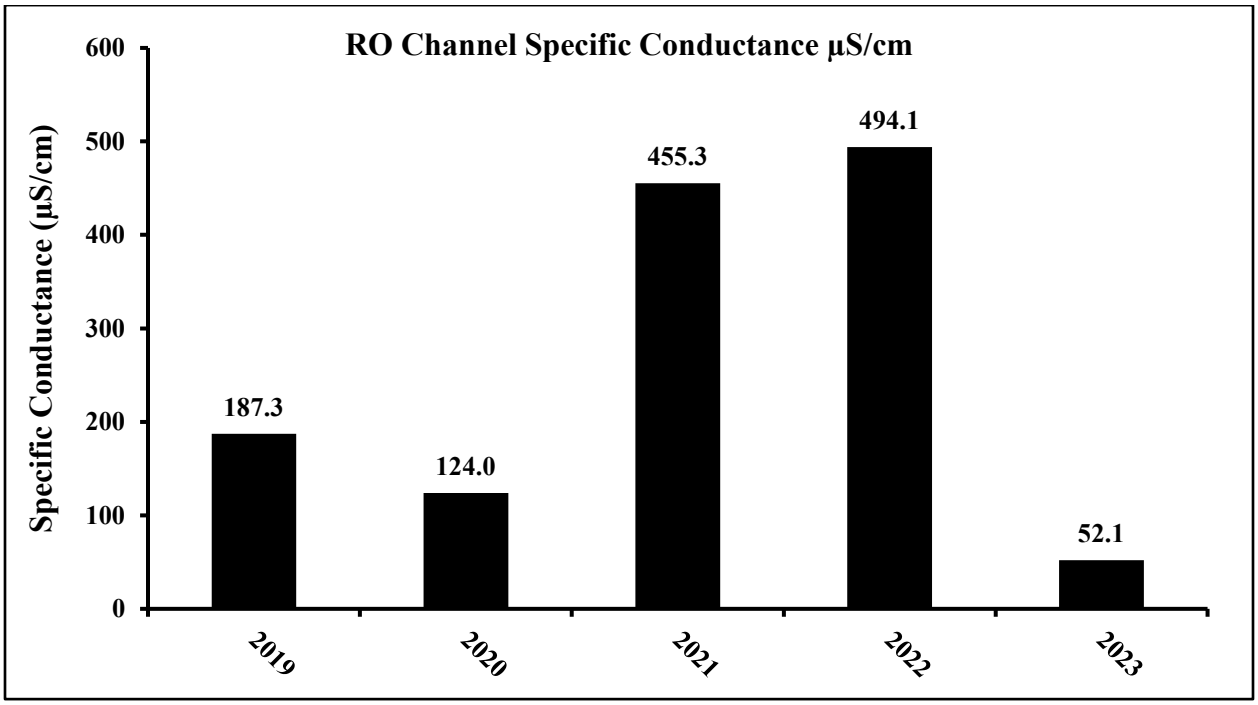

Figure 17. Specific conductance in the RO Channel (µS/cm), taken downgradient of Outfall 002, 2019-2023.