Real-Time Water Quality Deployment Report

Teck Duck Pond Operations 2022

Government of Newfoundland & Labrador
Department of Environment & Climate Change
Water Resources Management Division

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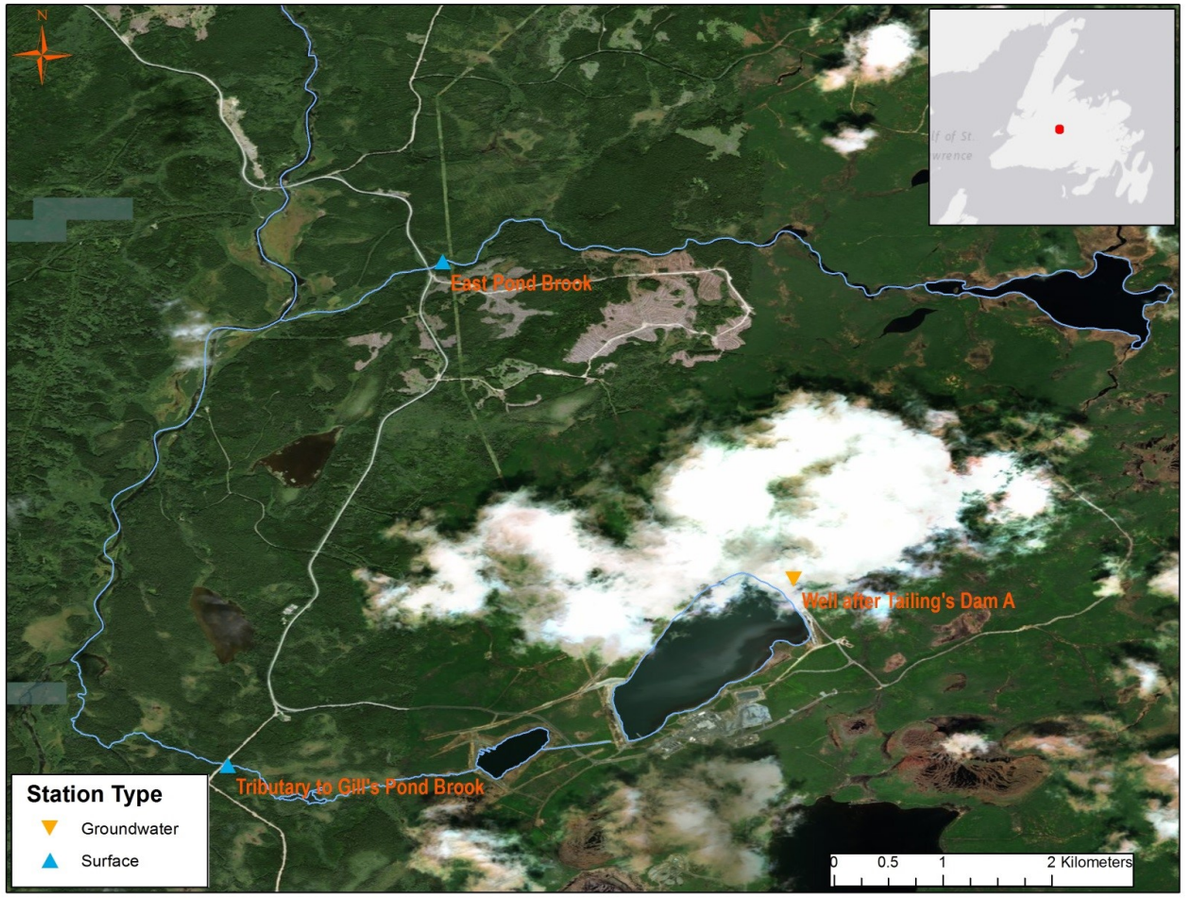
Real-time water quality (RTWQ) monitoring of surface and groundwater quality on Teck: Duck Pond Operations (DPO) site is carried out by the Department of Environment and Climate Change, Water Resources Management Division. Work is undertaken in circumstances where industrial development has the potential to impact water bodies. The RTWQ program consists of more than 30 stations across the province.

RTWQ work at Teck Duck Pond Operations has been ongoing since 2006 with the installation of three monitoring stations: East Pond Brook station, Tributary to Gill's Pond Brook station, and Monitoring Well after Tailings Dam A station. These stations, identified in the photo to the right, were situated to observe water quality at key locations over the course of the Teck DPO project. East Pond Brook station was placed to intercept potential seepage from underneath flow control structures that maintain the tailings management area. Tributary to Gills Pond Brook is placed to observe water quality following the ultimate discharge of treated effluent from the polishing pond into the environment. Well after Tailings Dam A is also located in the East Pond Brook watershed, but is immediately adjacent to the flow control structure that ensures the tailings management area drains towards the polishing pond and the eventual discharge point above Tributary to Gills Pond Brook station. In this report, notable events and trends from 2022 are identified and discussed in relation to previous years.

Work under the RTWQ program is conducted according to the *Protocols Manual for Real-Time Water Quality Monitoring in NL*. Hydrolab DS5X multi-parameter sondes are used at Teck Duck Pond surface stations. In May 2021, WRMD upgraded monitoring equipment at the well station.



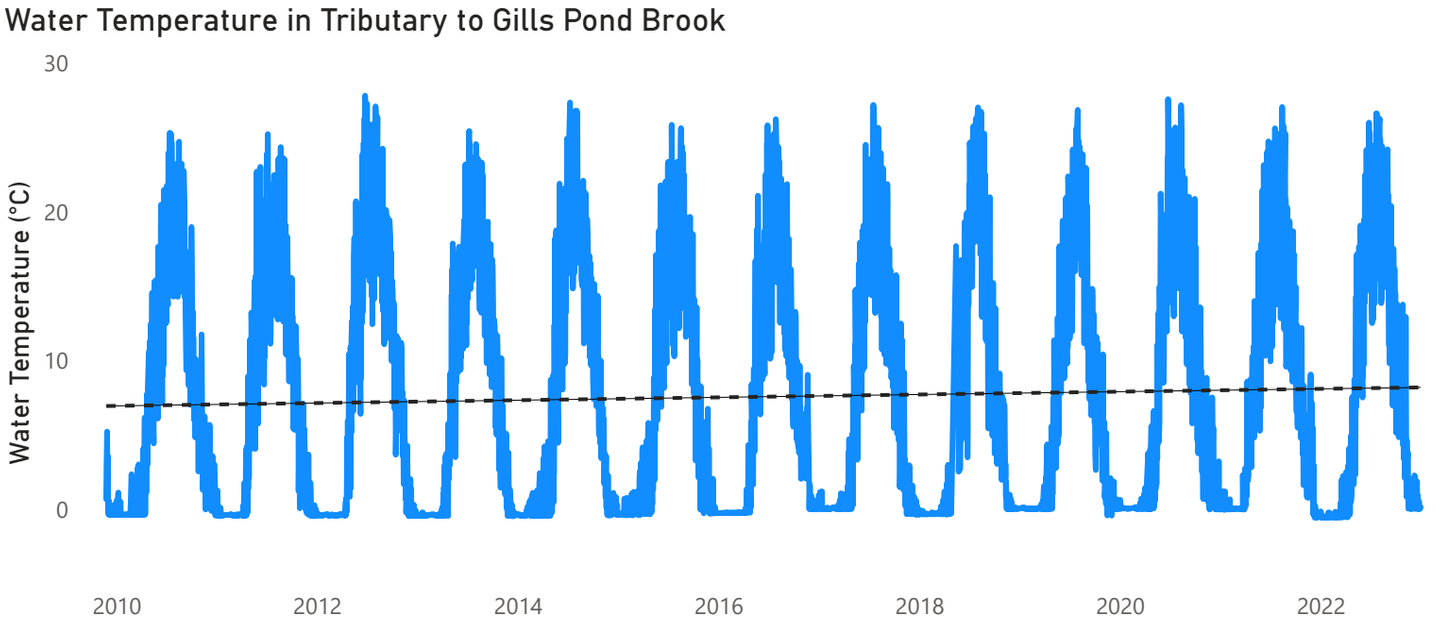
Surface Water Temperature

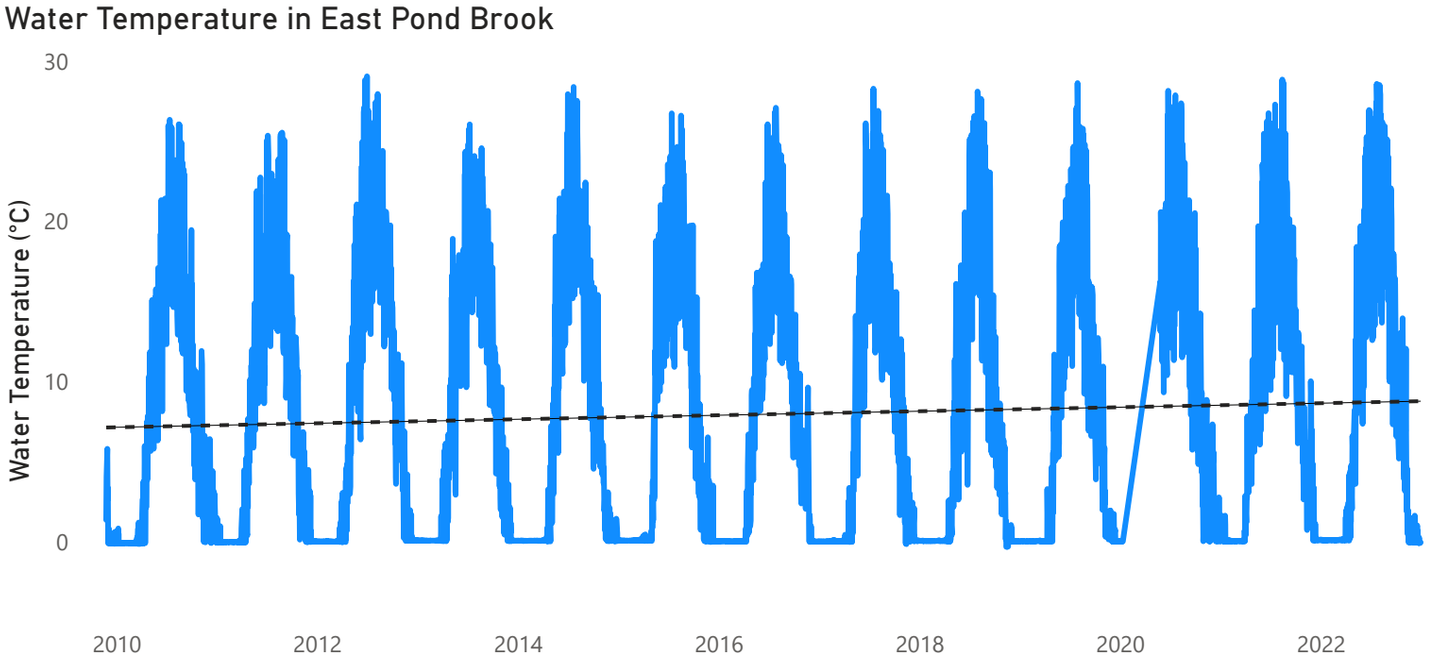
Water Temperature is a crucial factor used to describe water quality. Temperature has major implications on both the ecology and chemistry of a water body, governing processes such as the metabolic rate of aquatic plants and animals and the degree of dissolved oxygen saturation. Further, many other parameters (specific conductivity, dissolved oxygen saturation) use temperature to calculate values.

Both stations had higher average temperatures when compared to previous years; however, the maximum temperature reached is lower than previous years. There is an increasing trend, indicated by the black dashed line to the right, at both stations. This warming trend is most likely do to climate change rather than local influences.

Temperatures generally peak in July and August, when air temperatures are warmest. Conversely, water temperatures generally approach (and sometimes exceed) 0°C in December and remain low until March. East Pond Brook is on average slightly warmer than Tributary to Gill's Pond; it is a larger stream with less canopy cover, which may influence the water temperature.

Gills Pond Brook	7.84	-0.55	26.61
2022	Average	Minimum	Maximum
2010-2021	7.23	-0.54	27.80
	Average	Minimum	Maximum
East Pond Brook	8.14	-0.09	28.58
2022	Average	Minimum	Maximum
2010-2021	7.55	-0.32	29.05
	Average	Minimum	Maximum





Surface Water pH

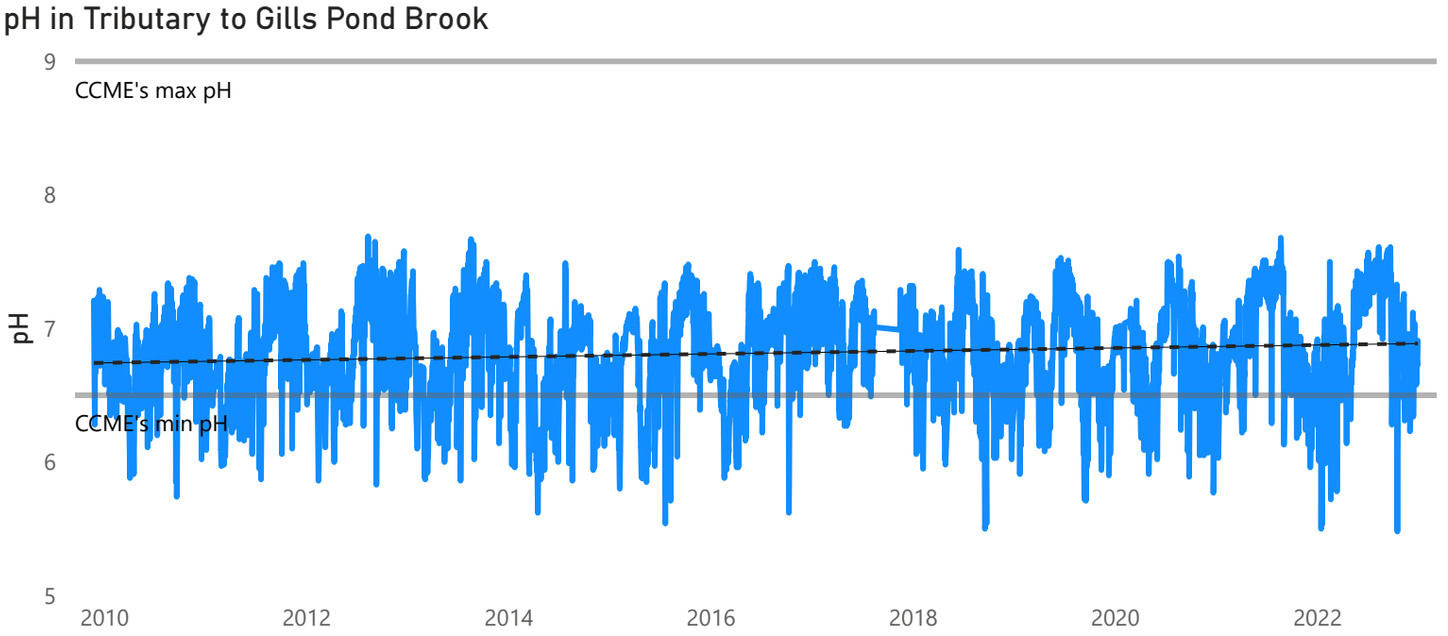
pH indicates the acidity or alkalinity of a solution. A value of 7.00 pH units denotes a neutral solution, lower values are acidic, and higher values are basic. pH is influenced by precipitation runoff and tends to decrease as stage increases.

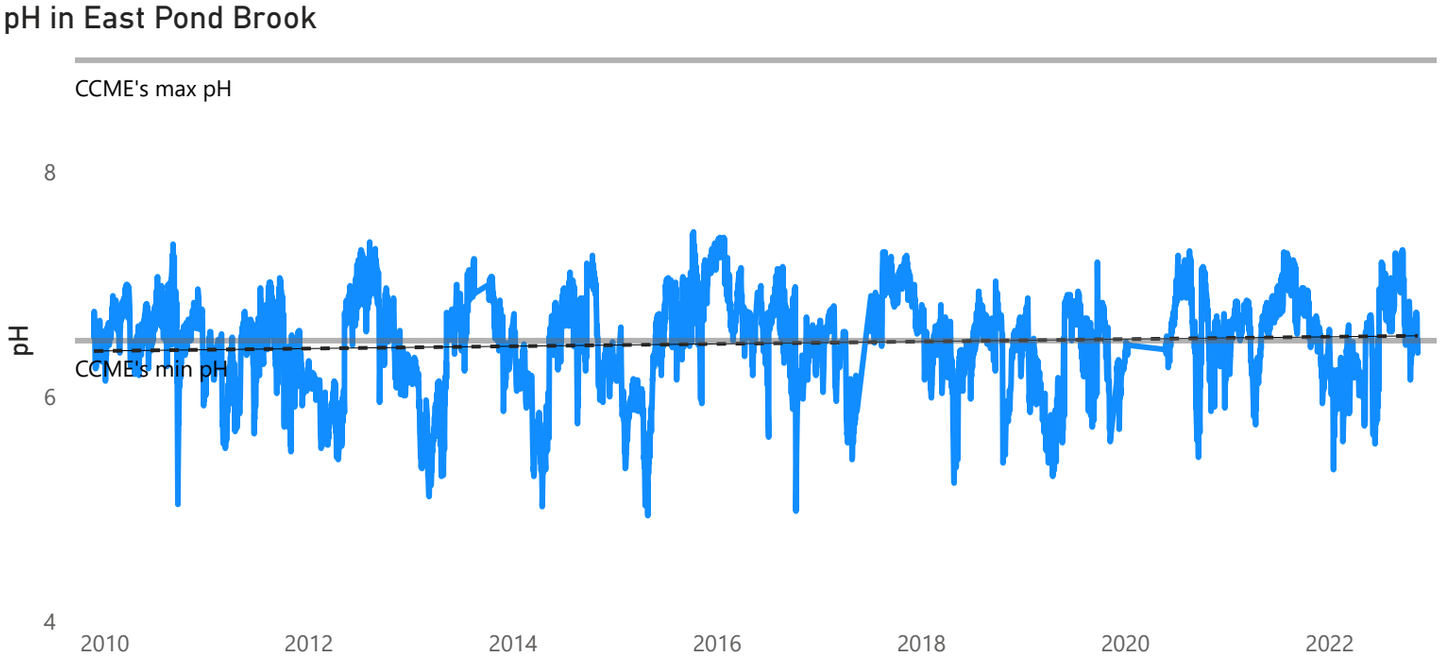
The Canadian Council of Ministers of the Environment (CCME) guideline noted on the pH graph is a range by which to compare pH levels across Canada. It does not indicate the health of the brook. Since 2010, both stations have recorded values below CCME's maximum pH for the protection of Aquatic Life Guideline (pH 9); however, both stations are regularly below CCME's minimum pH for the protection of aquatic life guideline (pH 6.5).

Due to the soil composition and natural geology of Newfoundland and Labrador, many of the brooks and waterways in the province have naturally lower pH ranges. However, water in Tributary to Gills Pond Brook is influenced by treated effluent discharged from an upstream polishing pond, which is treated to maintain a near-basic pH of 7.0.

At both stations, pH is generally highest during the late summer or early fall and the pH is lowest towards the end of the winter into early spring. There is also a similar increasing trend (indicated by the black dashed line) at both stations. The average pH at East Pond Brook was slightly lower than previous years.

Gills Pond Brook	6.92	5.48	7.61
2022	Average	Minimum	Maximum
2010-2021	6.80	5.50	7.69
	Average	Minimum	Maximum
East Pond Brook	6.47	5.35	7.31
2022	Average	Minimum	Maximum
2010-2021	6.47	4.94	7.47
	Average	Minimum	Maximum





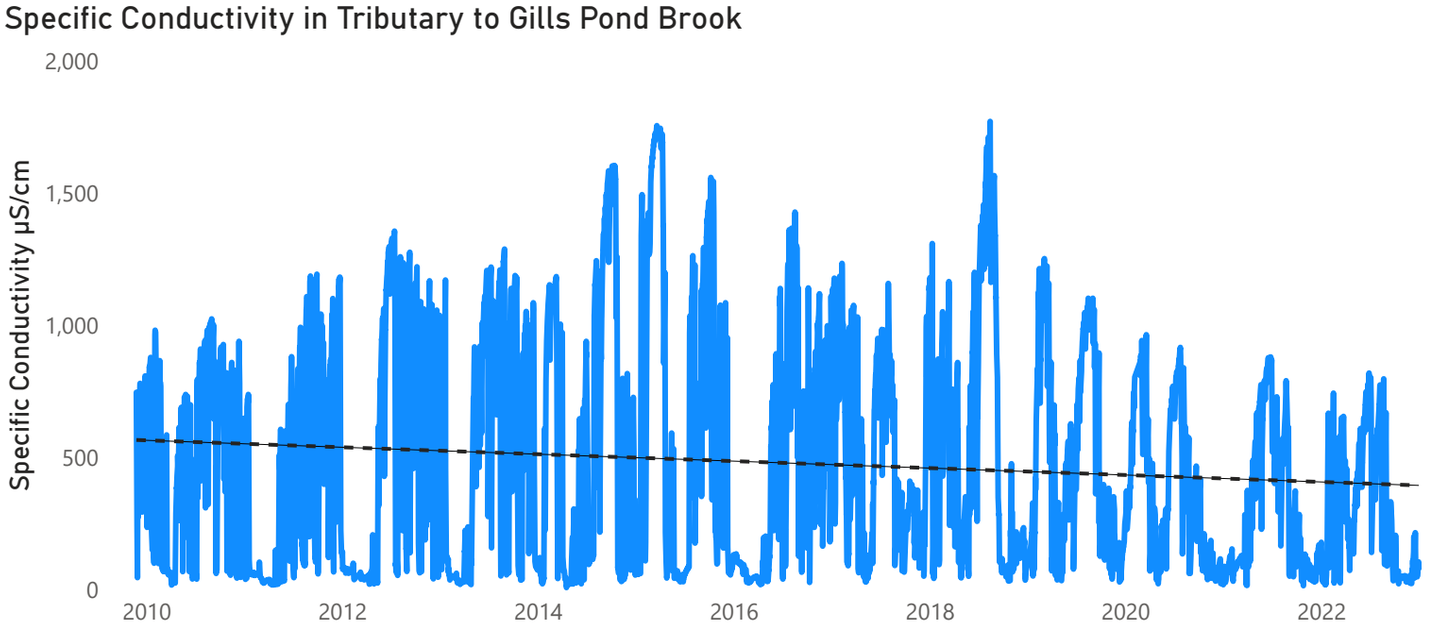
Surface Water Specific Conductivity

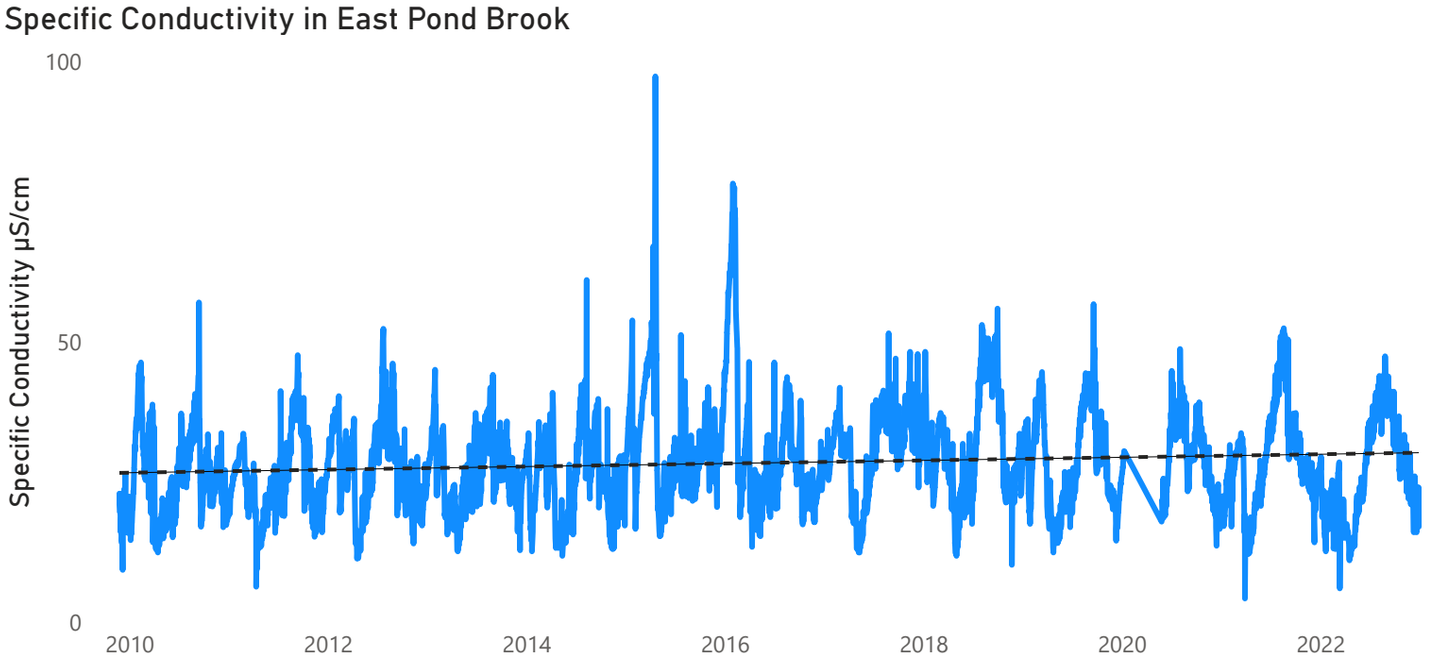
Conductivity relates to the ability of an electric charge to pass through a solution. Conductivity is highly influenced by the concentration of dissolved ions in solution; distilled water has zero conductivity (infinite resistance), while salty solutions have high conductivity (low resistance). Specific conductance is corrected to 25°C to allow comparison across variable temperatures.

There is a significant difference between the specific conductivity of Gills Pond Brook's waters and East Pond Brook's waters; this is influenced by the polishing pond effluent, upstream of Gills Pond Brook. The specific conductivity of Gills Pond Brook has decreased since the decommissioning of the mine as indicated by the black dashed trendline to the right. East Pond Brook has seen a slight increase in specific conductivity. This may be a result of other activities in the area or from the effects of increased precipitation events due to climate change, which stirs up the water column.

Cyclical patterns are also apparent at both sites. When water levels drop in the late summer, the concentration of dissolved ions become concentrated, which increases the specific conductivity. There is often a similar less pronounced peak in February or March.

Gills Pond Brook 2022	294.30 Average	18.30 Minimum	819.00 Maximum
2010-2021	491.31 Average	7.40 Minimum	1,771.00 Maximum
East Pond Brook 2022	26.59 Average	6.00 Minimum	47.40 Maximum
2010-2021	28.41 Average	4.20 Minimum	97.30 Maximum





Surface Water Dissolved Oxygen

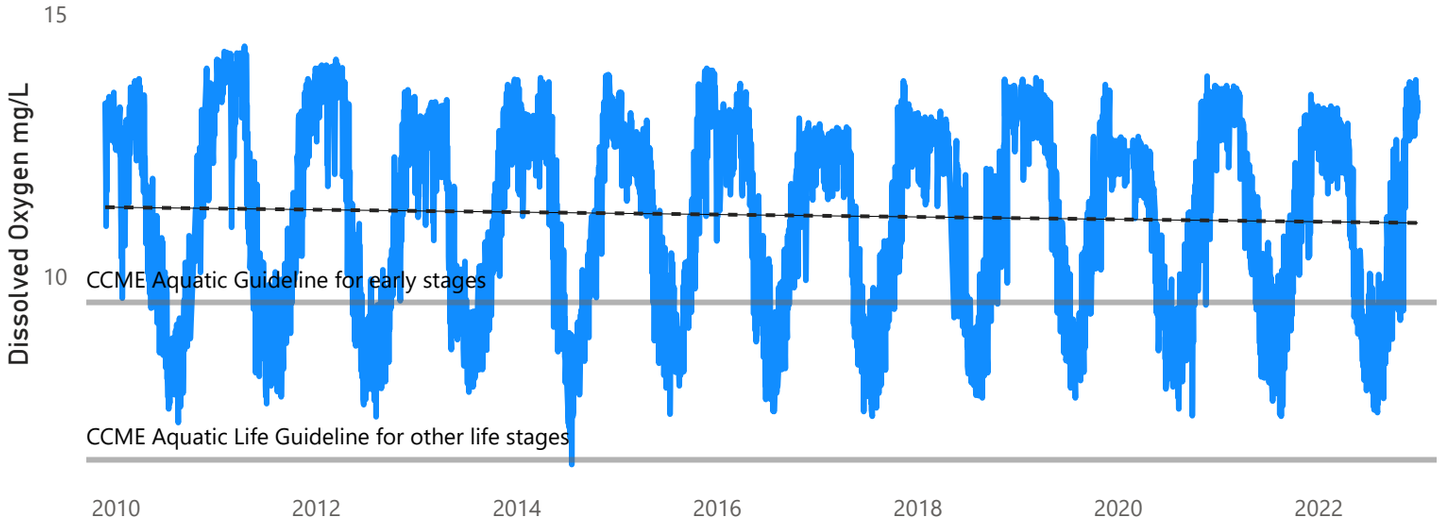
Dissolved oxygen (DO) is a metabolic requirement for life. The CCME guidelines for the protection for other life stages (6.5 mg/L) and the guideline for the protection for early life stages (9.5 mg/L) is indicated in grey on the DO graphs to the right. During 2022, both rivers met the CCME's guideline for other life stages; however, there were periods when both rivers did not meet the CCME's guidelines for early life stages.

The amount of dissolved oxygen in water depends on several factors, particularly water temperature. Cooler water can hold more dissolved oxygen; as a result of increasing water temperatures, the dissolved oxygen levels are decreasing. The trend lines, indicated with a black dashed line, for Gills Pond Brook and East Pond Brook illustrate this decreasing trend.

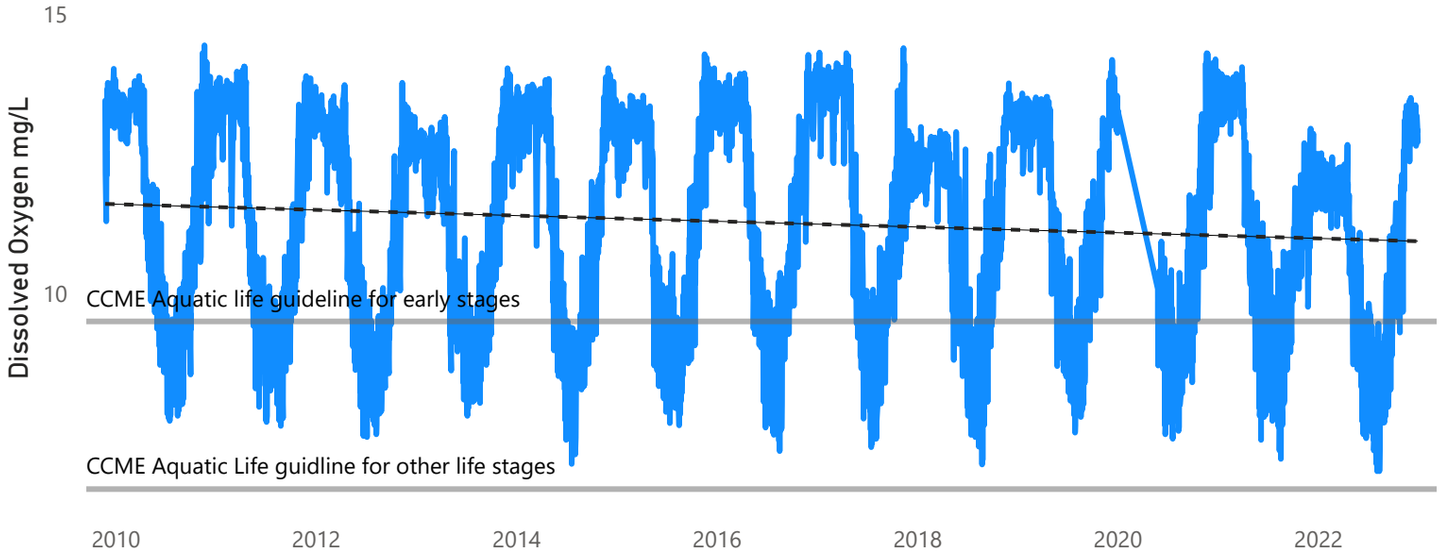
Over the 12 year deployment, cyclical fluctuations are apparent. During the winter when air and water temperatures are colder, dissolved oxygen levels are higher, and during the summer, the opposite it true.

Gills Pond Brook 2022	11.07 Average	7.40 Minimum	13.74 Maximum
2010-2021	11.18 Average	6.41 Minimum	14.38 Maximum
East Pond Brook 2022	10.67 Average	6.82 Minimum	13.50 Maximum
2010-2021	11.33 Average	6.94 Minimum	14.44 Maximum

Dissolved Oxygen in Tributary to Gills Pond Brook



Dissolved Oxygen in East Pond Brook



Surface Water Turbidity

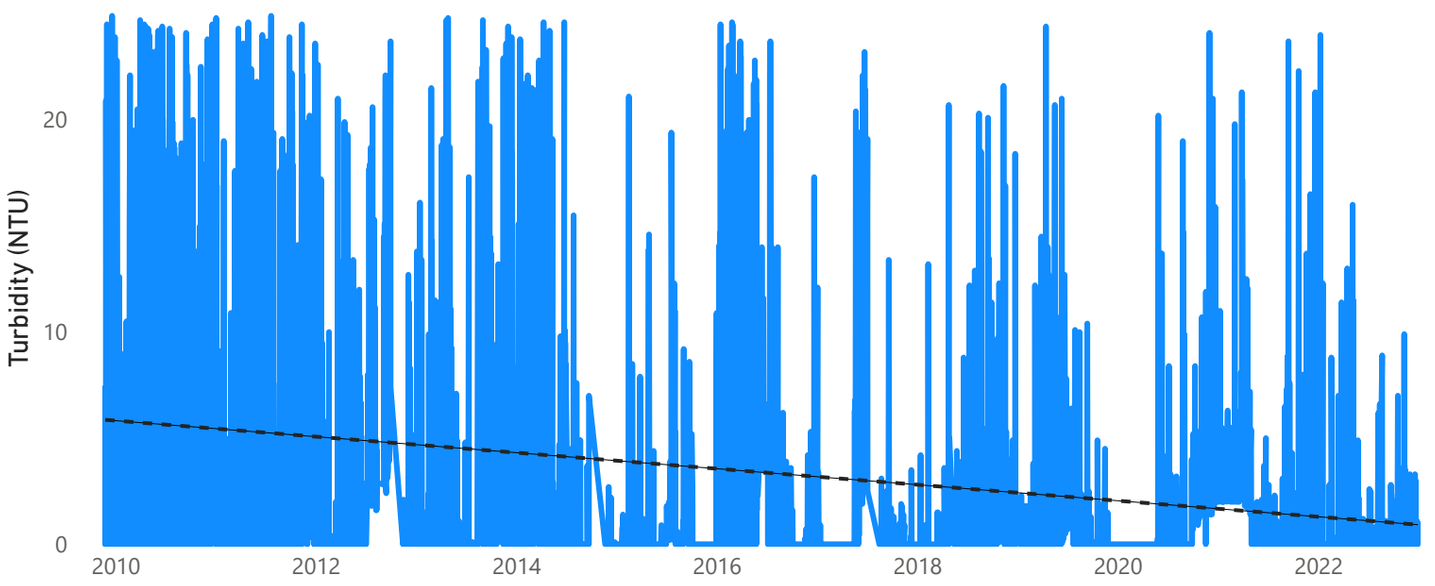
Turbidity sensors measure the amount of fine solids, such as silt, clay, or organic materials, suspended in the water column. This parameter is monitored because turbid waters can prevent light from reaching photosynthetic organisms, settle on benthic organisms and spawning areas, and damage delicate respiratory organs.

Turbidity levels at Gill's Pond Brook and East Pond brook are both generally low; however, turbidity sensors are prone to errors from debris that can get caught around the sensors. During the 12 years of deployment at Gills Pond Brook, the quality assurance and quality control readings and grab samples have recorded values ranging from 0.0 NTU to 2.4 NTU and 0.2 to 4.1 NTU respectively. During the 12 years of deployment at East Pond Brook, the quality assurance and quality control readings and grab samples have recorded values ranging from 0.0 NTU to 3.1 NTU and 0.2 to 2.3 NTU respectively. The deployed sensors will often return readings much higher throughout the deployment due to sediment becoming trapped in the sensor's protective cage. In order to see an accurate picture of the fluctuations at the site, readings above 25 NTU were omitted from this report.

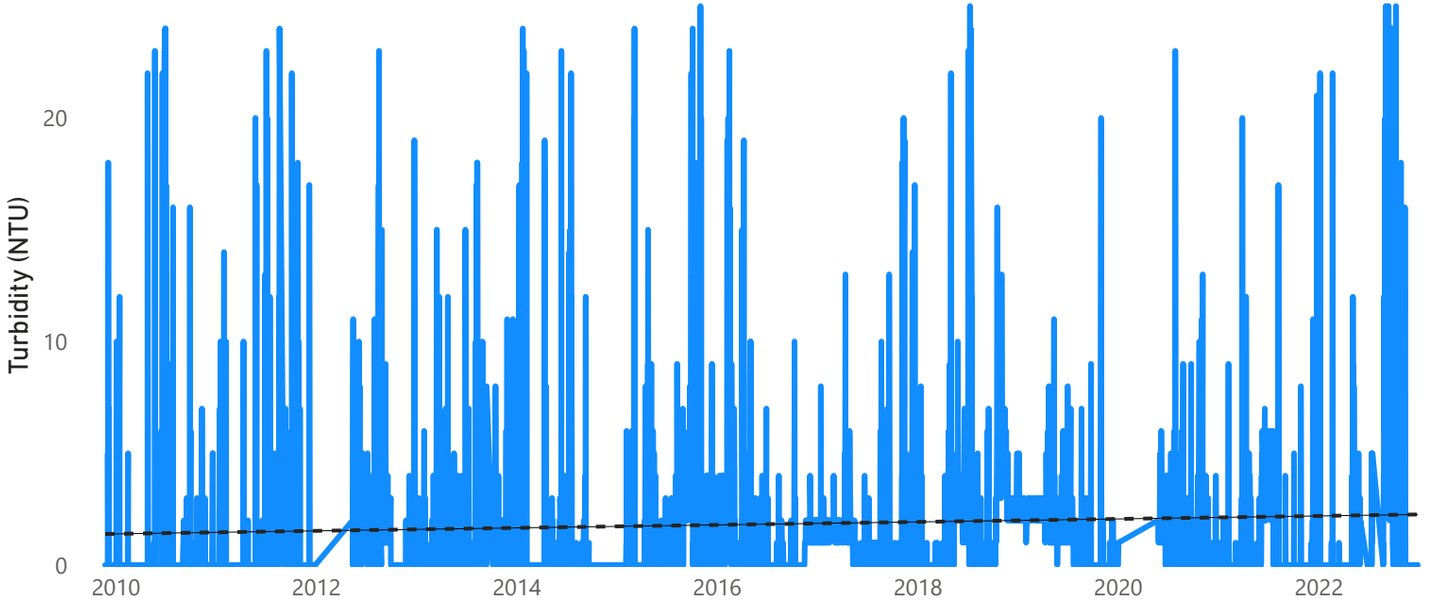
A trendline For Gills Pond Brook values shows how turbidity dropped after nearby mining operations concluded. Conversely, turbidity at East Pond Brook has marginally increased during this same time frame; possibly as a result of increased extreme weather events.

Gills Pond Brook 2022	0.21 Average	0.00 Median
2010-2021	0.88 Average	0.00 Median
East Pond Brook 2022	1.53 Average	0 Median
2010-2021	0.65 Average	0 Median

Turbidity in Tributary to Gills Pond Brook



Turbidity in East Pond Brook



Well Water Temperature

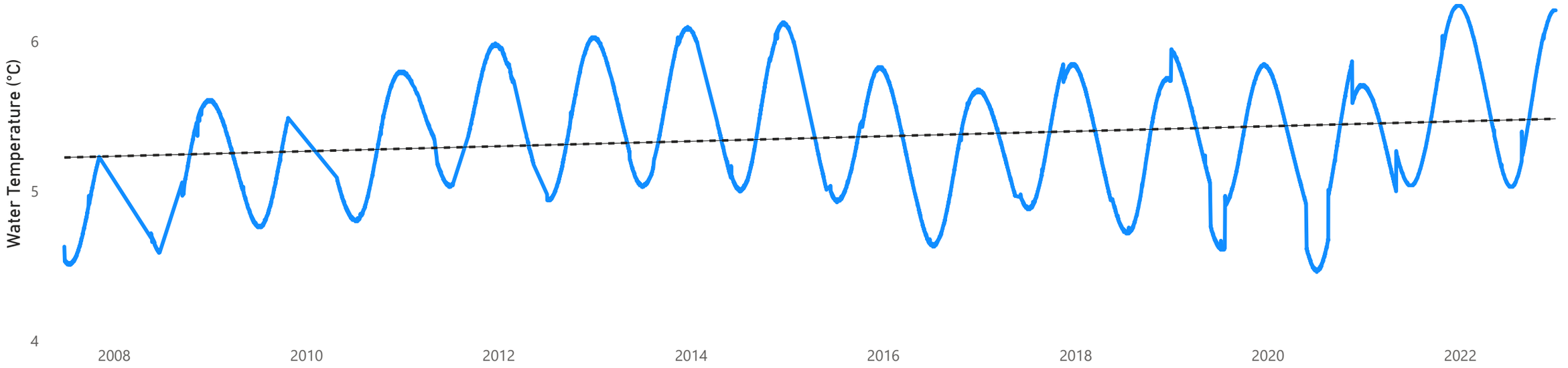
2022	5.65 Average	5.03 Minimum	6.24 Maximum
2007-2021	5.34 Average	4.46 Minimum	6.24 Maximum

In 2022, the water temperature in the well after tailings pond ranged from 5.03°C to 6.24°C. The average temperature was 5.65°C compared to 5.34°C observed in past years. The highest temperatures observed in the well, 6.24°C, occurred in December of 2021 and January of 2022. The lowest temperatures occurred in 2020.

There has been a general warming trend, which is indicated by the black dashed line below. The average water temperature in 2011, the first complete year of deployment, was 5.54°C, 0.11°C cooler than 2022. Temperatures slightly dipped from 2016 until 2020.

The coolest temperatures tend to occur in July, while the warmest temperatures occur in December and January. This is a stark contrast to surface water which displays the opposite pattern. This is due to delayed seasonal warming as a result of the insulative properties of soil. Overall the well water temperatures are fairly consistent throughout the year, with a temperature range of 1.21°C in 2022. The overall temperature range (2007-2022) was 1.78°C.

Water Temperature in Well after Tailings Pond



Well Water pH

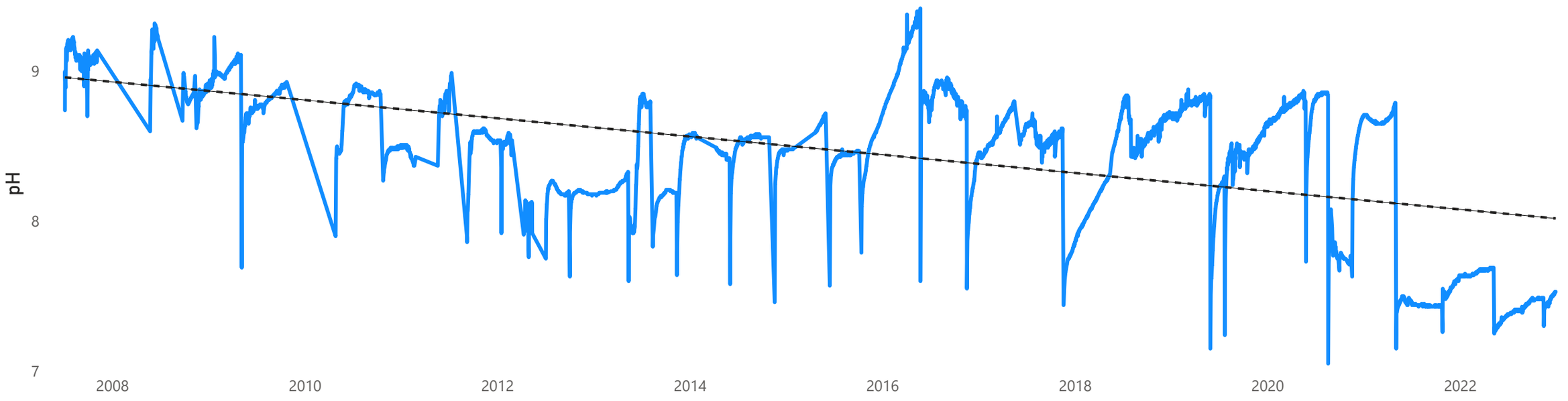
2022	7.51 Average	7.25 Minimum	7.69 Maximum
2007-2021	8.50 Average	7.05 Minimim	9.42 Maximum

In 2022, the average pH was 7.51 pH units, nearly 1 pH unit lower than the 2007-2021 average (8.5 pH units). As previously mentioned, waters in Newfoundland tend to be slightly acidic (lower pH) due to the soil composition and geology. When monitoring began, the pH was much higher; however, it has been trending towards more typical readings for the island.

The general decreasing trend, is indicated by the black dashed line below. The average pH in 2008 was 8.92 pH units, which is 1.41 pH units higher than 2022. This is opposite to the two surface water stations which show an increasing pH trend. The downward trending pH in the well may be a result of the decommissioning of the mine, or it may be a result of warming water temperatures. This correlation was noted in 2021; the pH at this site often decreases when water temperatures increase.

When the sonde is removed, the well is purged, which is represented in the graph by downward spikes. Because the pH sensor requires longer to stabilize than other sensors, the disruption is more evident. In 2021 the well sonde was changed to an EXO. The pH readings have been lower since this change was made.

pH in Well after Tailings Pond

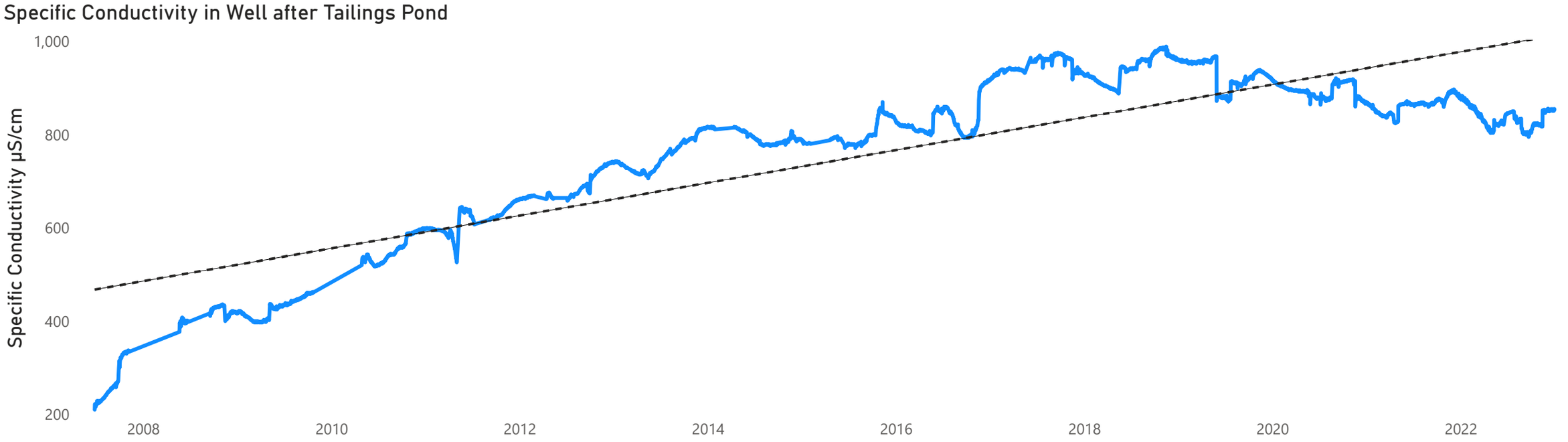


Well Water Specific Conductivity

2022	835.02 Average	794.90 Minimum	883.57 Maximum
2007-2021	763.94 Average	210.00 Minimum	989.00 Maximum

In 2022, the average specific conductivity was 835.02 µS/cm. The average specific conductivity for 2007-2021 was 763.94 µS/cm. The maximum specific conductivity in 2022 was 883.57 µS/cm, and the maximum specific conductivity overall was 989.00 µS/cm, which occurred on 11/15/2018.

There is an increasing trend for specific conductivity from 2007 to 2014; followed by a plateau phase from 2014 to 2016; another increase from 2016 to 2018; and finally, a decreasing trend from 2018 onward. The conductivity most likely increased from 2007 to 2014 as a result of mining activities. From 2014-2016 the water level in the tailings pond was lowered to perform long-term stabilization work. The lowering of water levels may have concentrated the tailings pond, resulting in the increased specific conductivity from 2016 to 2018.

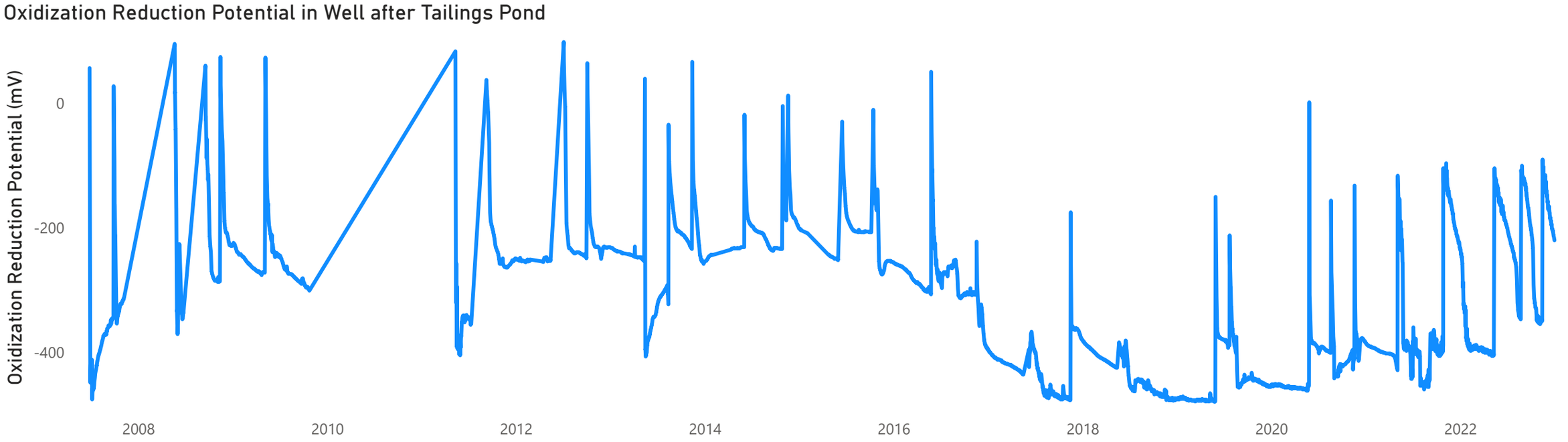


Well Water
Oxidization Reduction Potential

2022	-271.09 Average	-406 Minimum	-90 Maximum
2007-2021	-323.54 Average	-480 Minimum	99 Maximum

In 2022, the average oxidization reduction potential (ORP) was -90 mV. The average ORP for 2007-2021 was 99 mV. The maximum ORP in 2022 was -90 mV, and the maximum specific conductivity overall was 99 mV.

Like pH, the ORP sensor takes longer to settle than other sensors, resulting in upward spikes in the data. ORP values increased from 2007 until 2015, with a plateau occurring from 2010 to 2014. ORP dropped throughout 2016 to 2018, and once again plateaued until 2021. Since 2021, ORP has been increasing again.



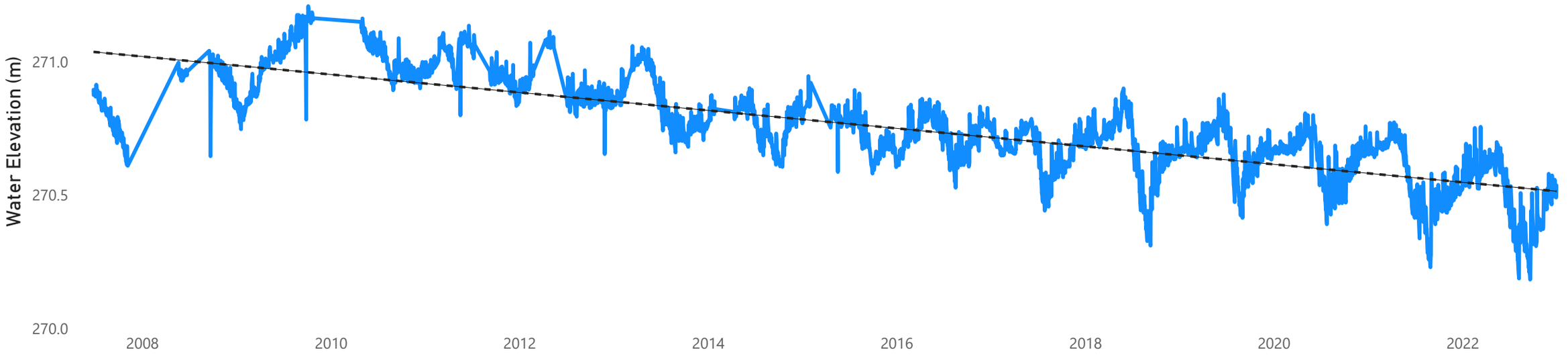
Well Water Elevation

2022	270.49 Average	270.18 Minimum	270.76 Maximum
2007-2021	270.76 Average	270.23 Minimum	271.21 Maximum

Water elevation indicates the surface of the aquifer above sea level. In 2022, the average water elevation was 270.49 m, 27 cm lower than the 2007-2021 average, 270.76 m. The lowest elevation in 2022 was 270.18 m, which is the lowest recorded elevation since monitoring began in 2007. The highest elevation in 2022 was 270.76 m, and a there was a total range of 0.58m.

The well reached maximum water elevation on 10/6/2009, and the water elevation has been decreasing since.

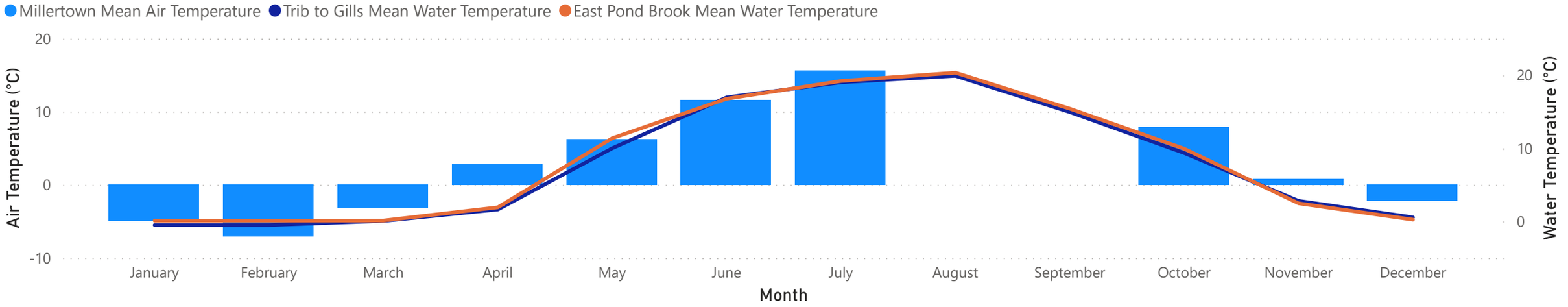
Water Elevation in Well after Tailings Pond



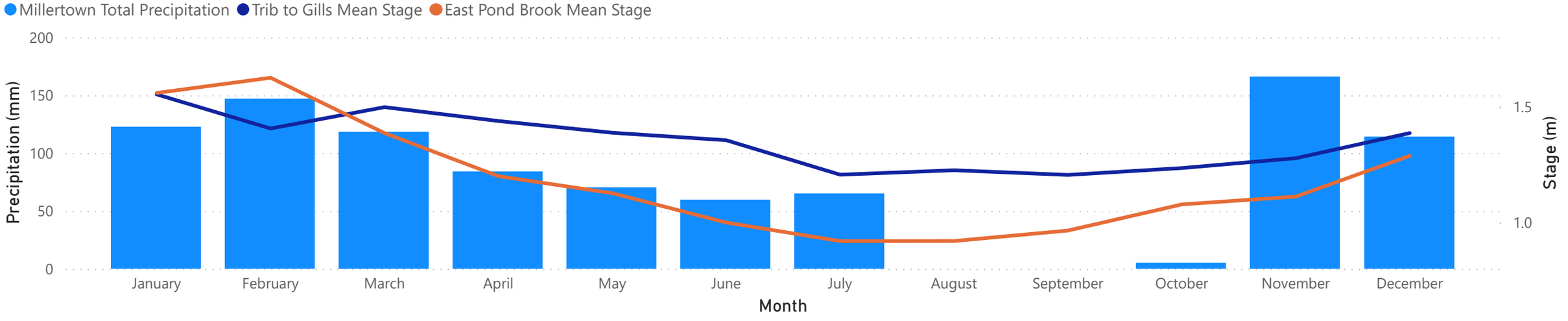
Climate Data from Millertown Climate Station

Precipitation data and air temperature from Environment Canada's Millertown, Newfoundland and Labrador weather station. There is no data available from this weather station from July 30th to October 9th, and again from October 10th to October 26th.

Millertown Mean Air Temperature and TECK Surface Mean Water Temperature

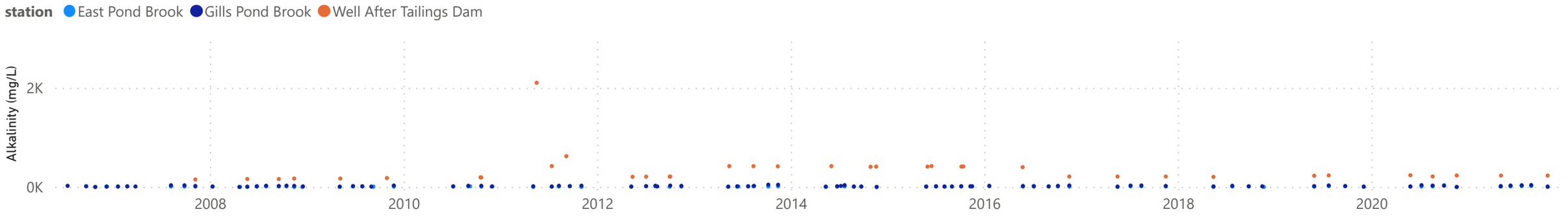


Millertown Total Precipitation and TECK Mean Water Levels (Stage)

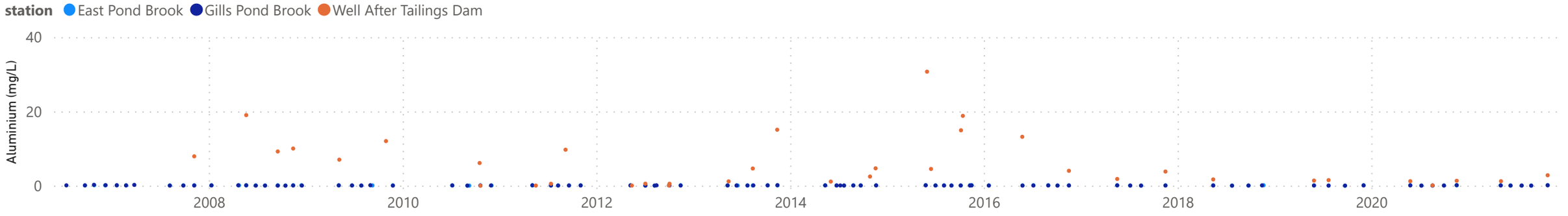


Appendix - Grab Sample Graphs

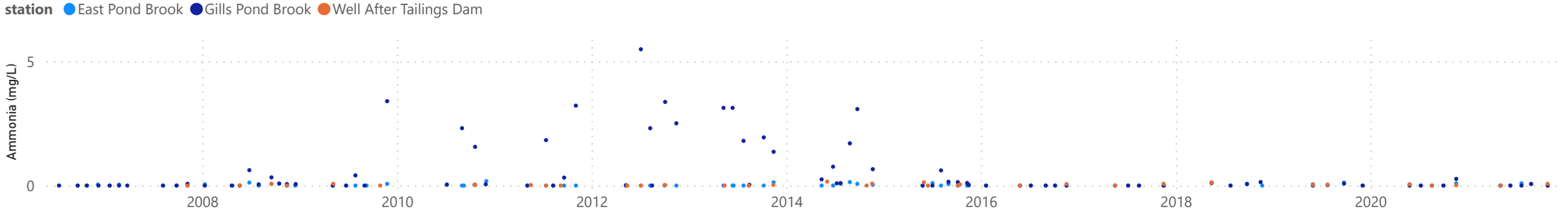
Grab Samples Alkalinity (mg/L)



Grab Samples Aluminium (mg/L)

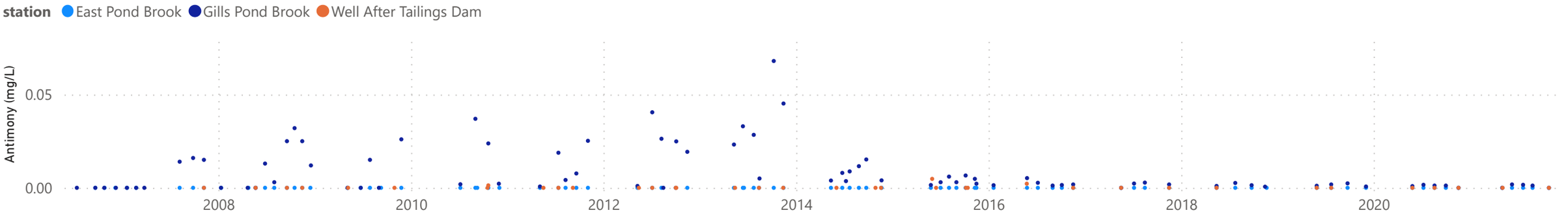


Grab Samples Ammonia (mg/L)

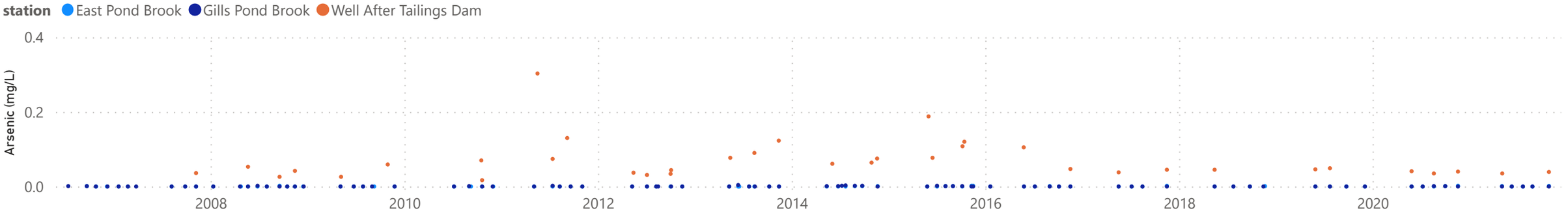


Appendix - Grab Sample Graphs

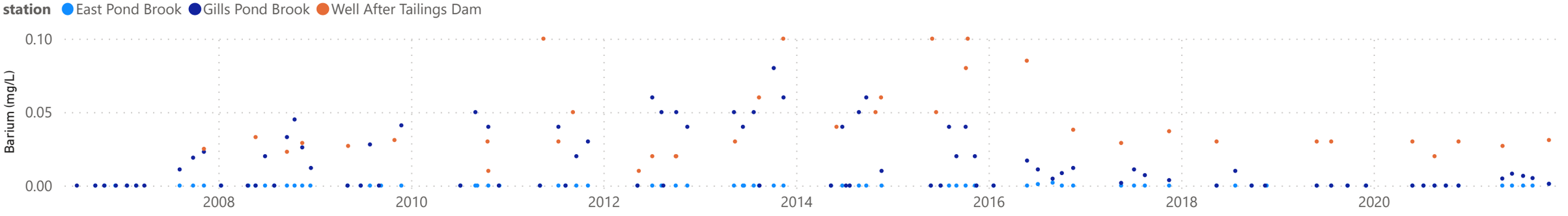
Grab Samples Antimony (mg/L)



Grab Samples Arsenic (mg/L)

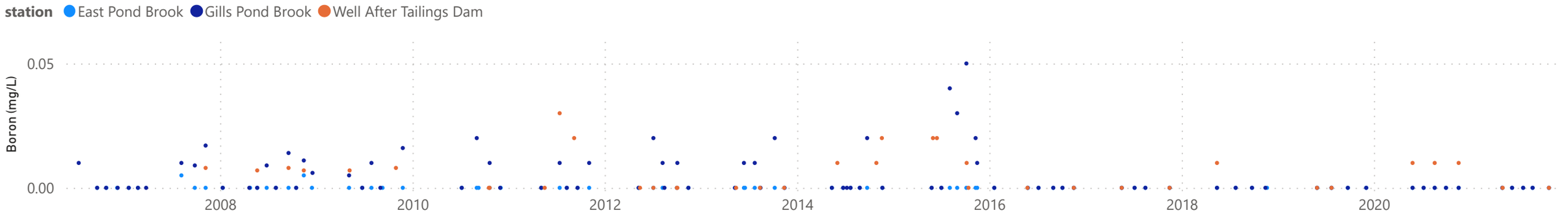


Grab Samples Barium (mg/L)

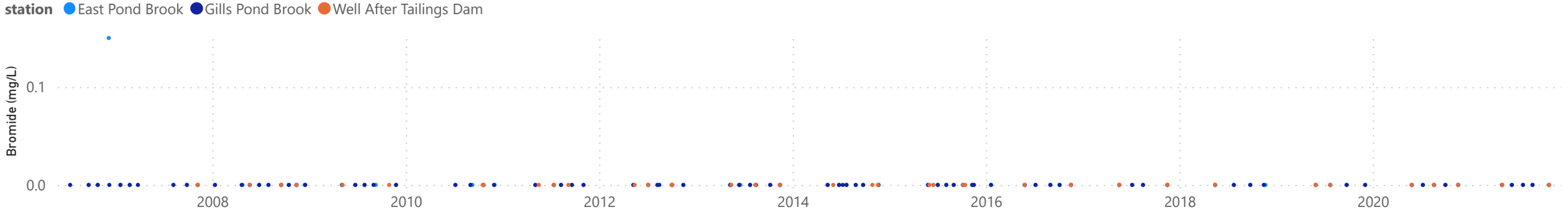


Appendix - Grab Sample Graphs

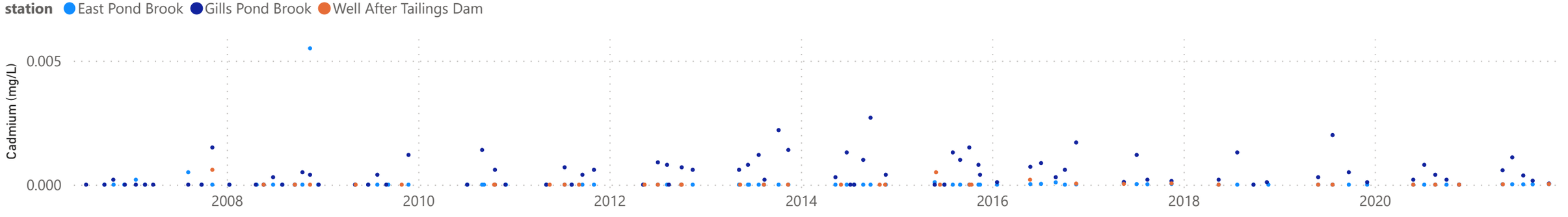
Grab Samples Boron (mg/L)



Grab Samples Bromide (mg/L)

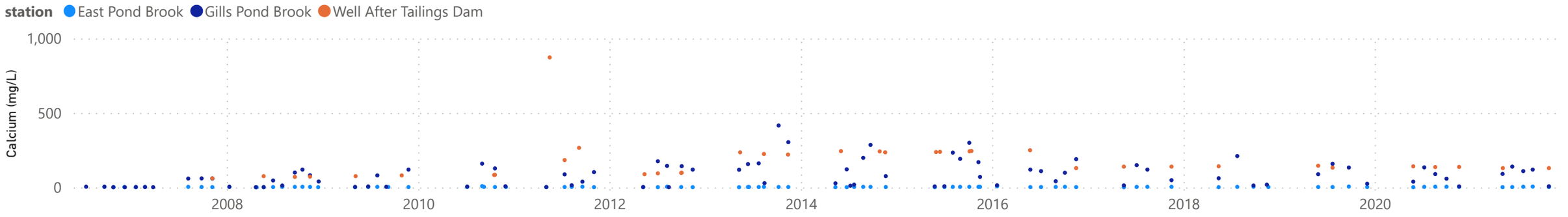


Grab Samples Cadmium (mg/L)

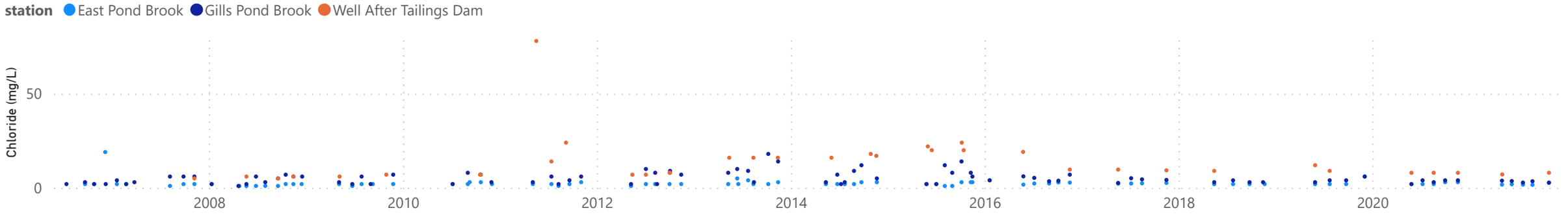


Appendix - Grab Sample Graphs

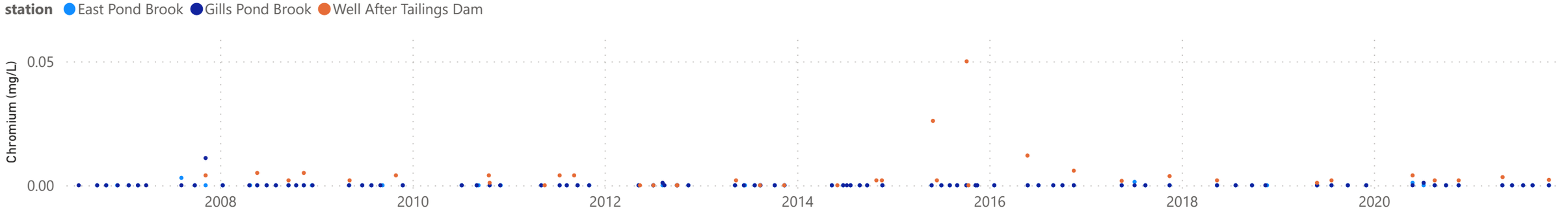
Grab Samples Calcium (mg/L)



Grab Samples Chloride (mg/L)

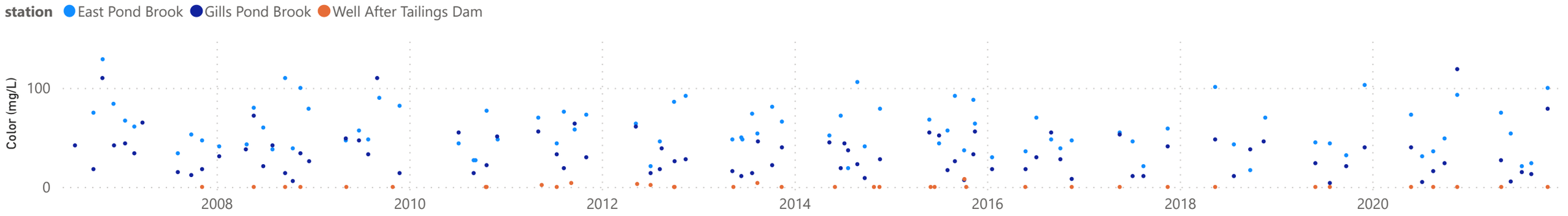


Grab Samples Chromium (mg/L)

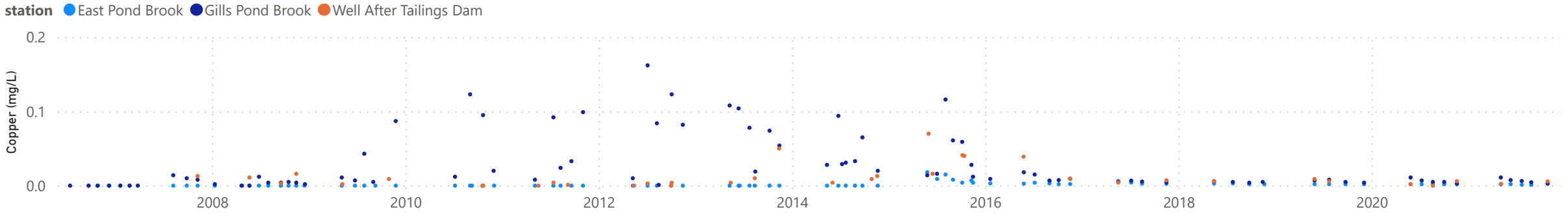


Appendix - Grab Sample Graphs

Grab Samples Color (mg/L)



Grab Samples Copper (mg/L)



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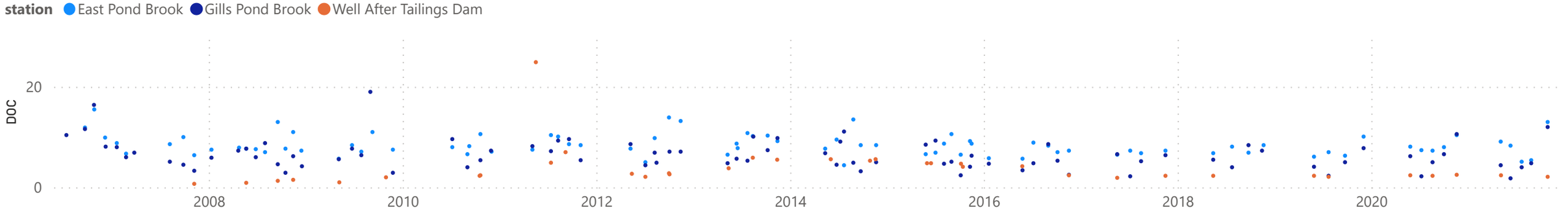
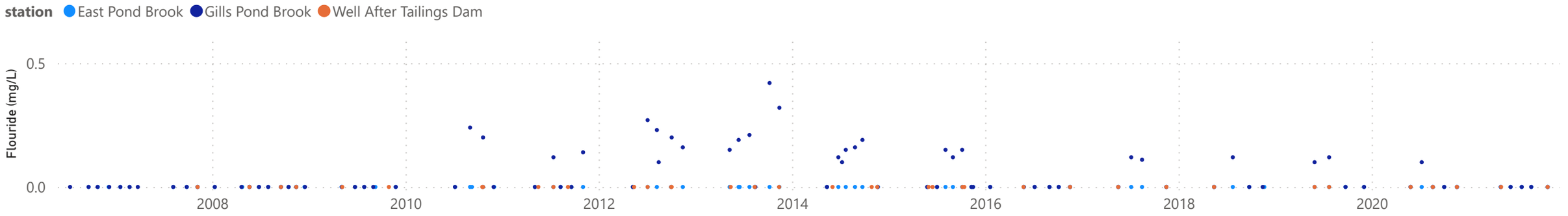
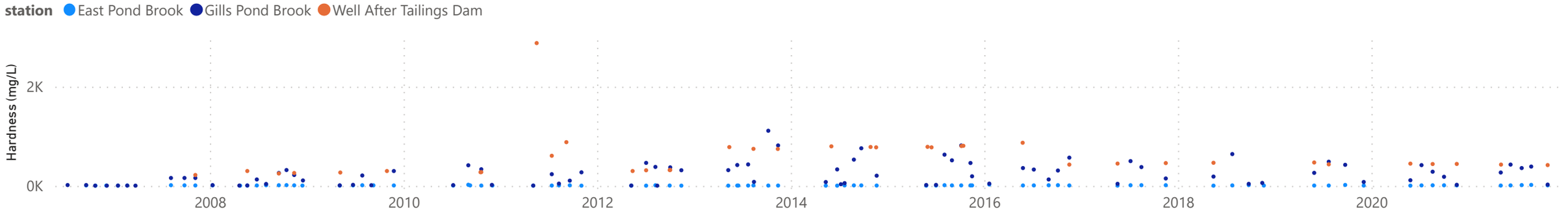


Appendix - Grab Sample Graphs

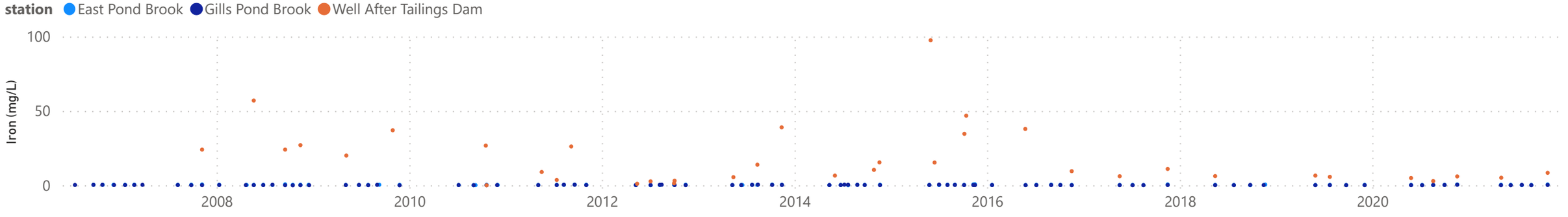
Grab Samples Flouride (mg/L)



Grab Samples Hardness (mg/L)

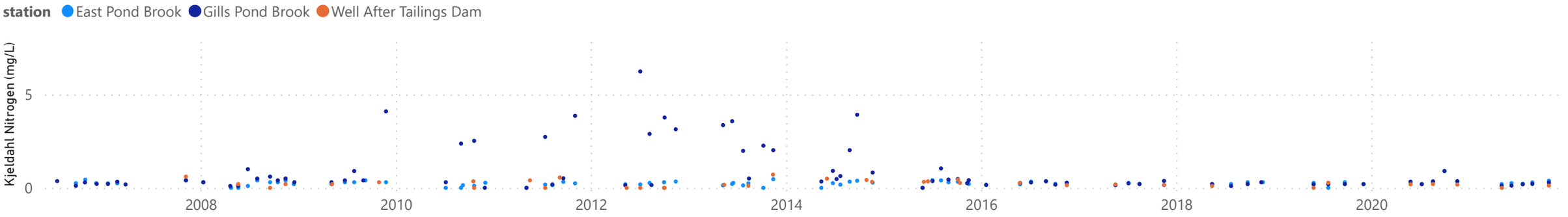


Grab Samples Iron (mg/L)

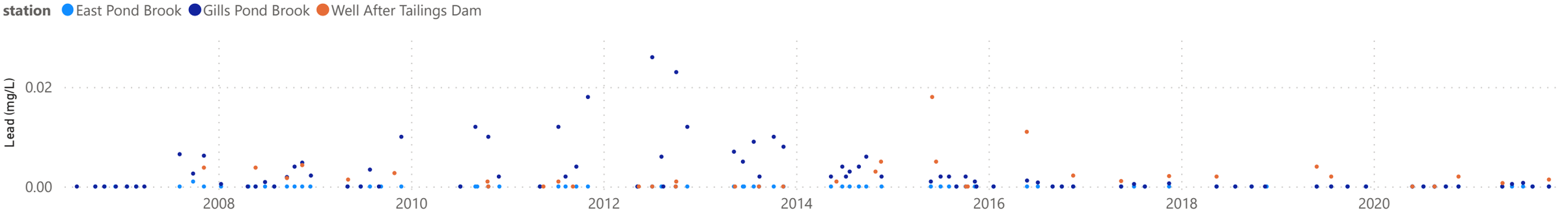


Appendix - Grab Sample Graphs

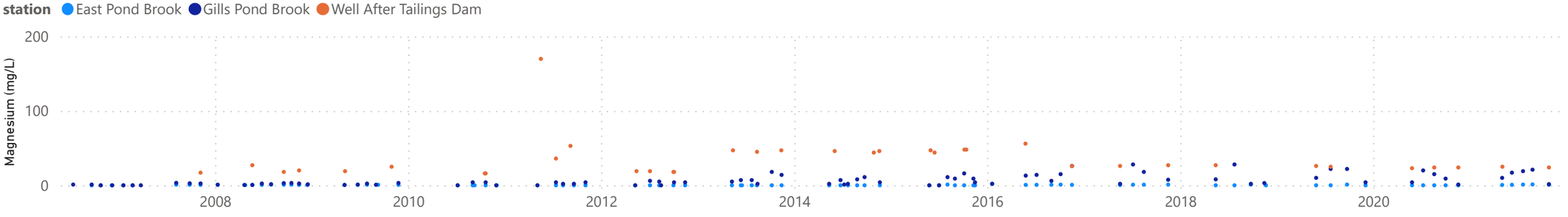
Grab Samples Kjeldahl Nitrogen (mg/L)



Grab Samples Lead (mg/L)

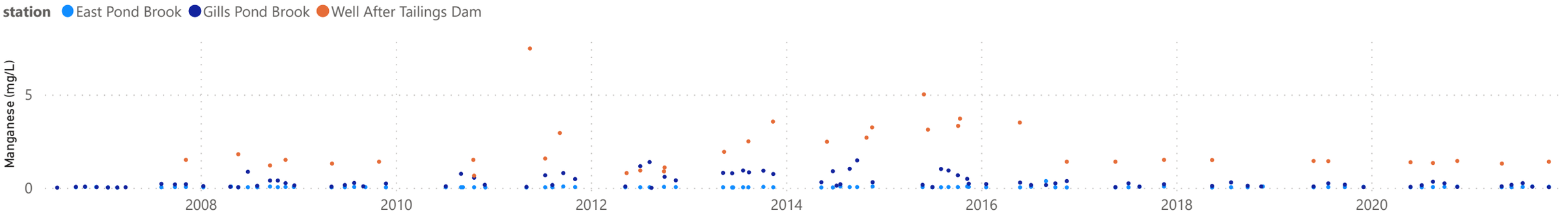


Grab Samples Magnesium (mg/L)

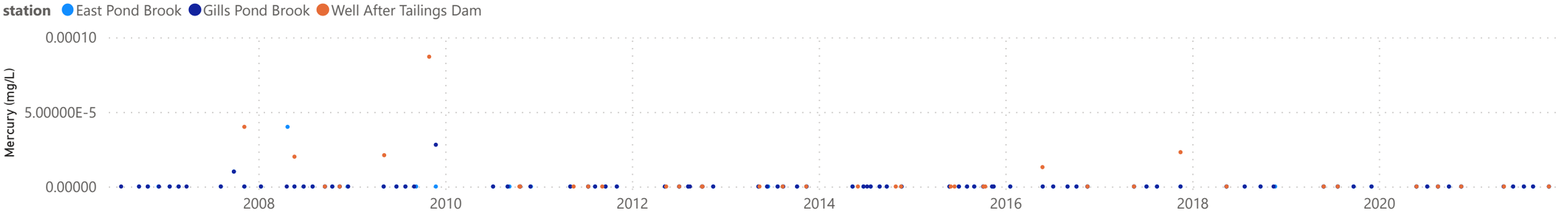


Appendix - Grab Sample Graphs

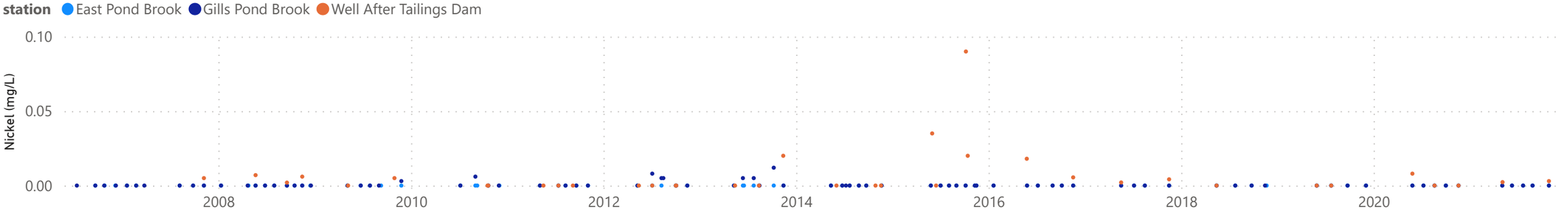
Grab Samples Manganese (mg/L)



Grab Samples Mercury (mg/L)

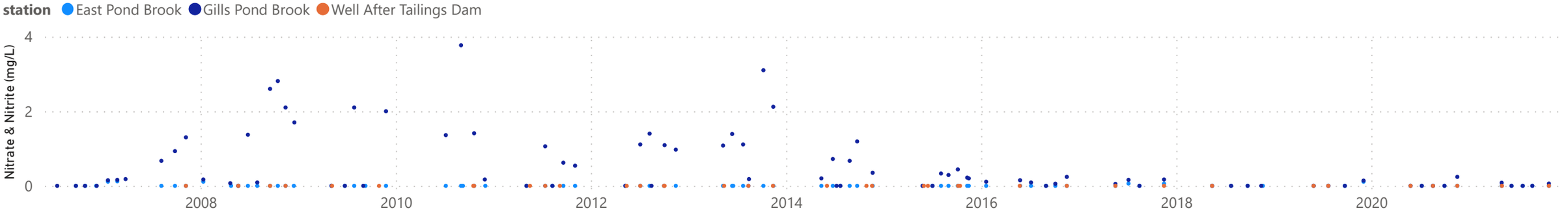


Grab Samples Nickel (mg/L)

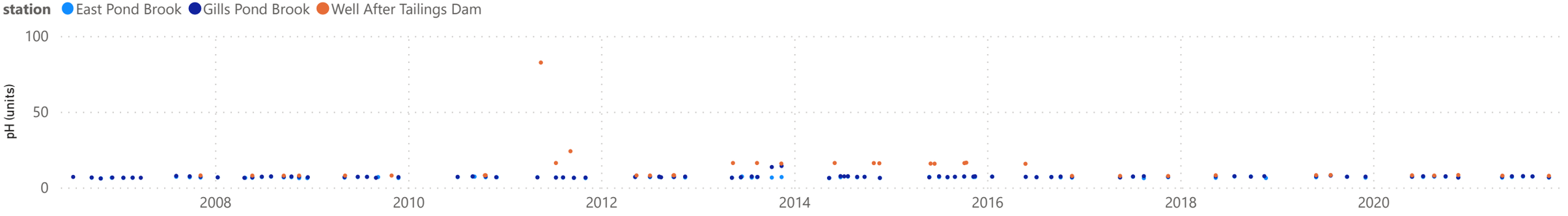


Appendix - Grab Sample Graphs

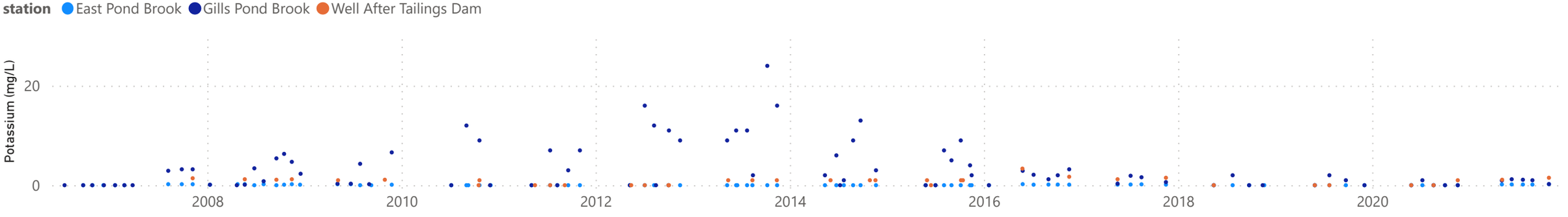
Grab Samples Nitrate & Nitrite (mg/L)



Grab Samples pH (units)

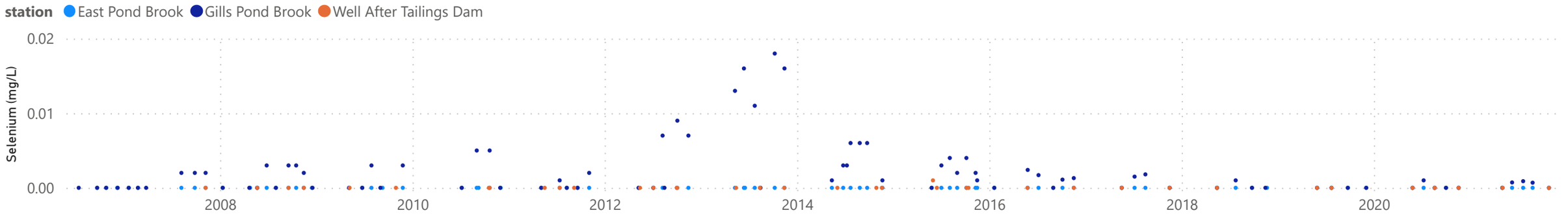


Grab Samples Potassium (mg/L)

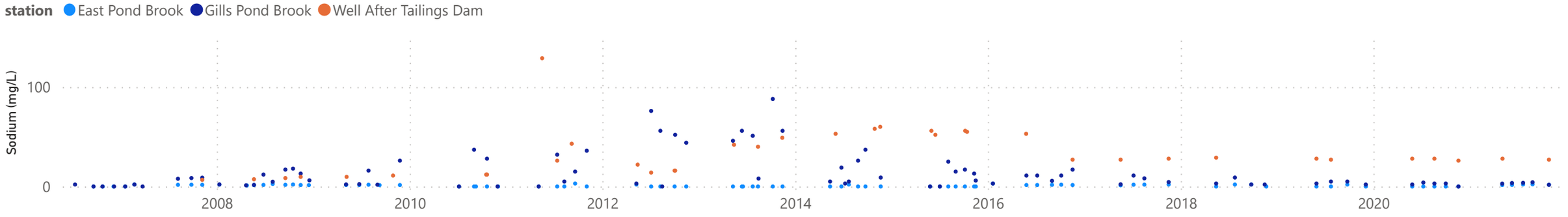


Appendix - Grab Sample Graphs

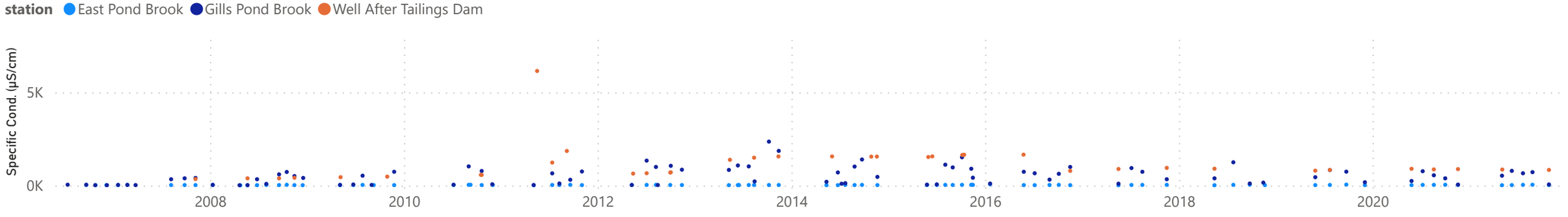
Grab Samples Selenium (mg/L)



Grab Samples Sodium (mg/L)

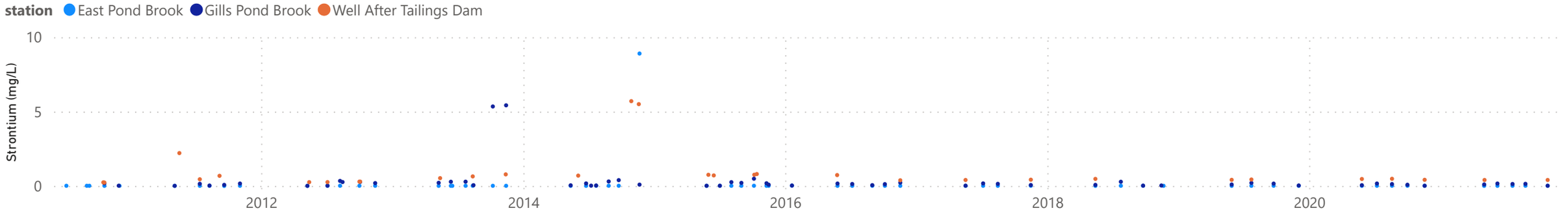


Grab Samples Specific Conductivity (µS/cm)

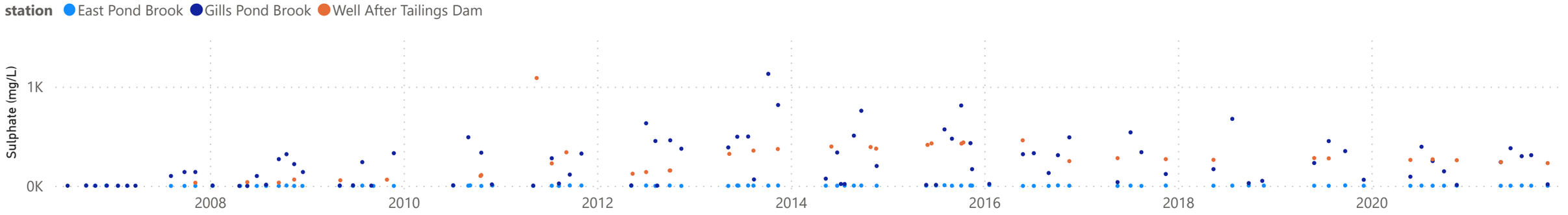


Appendix - Grab Sample Graphs

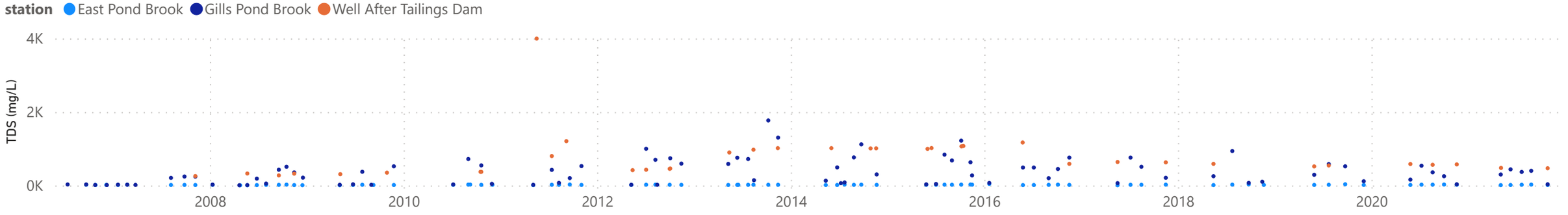
Grab Samples Strontium (mg/L)



Grab Samples Sulphate (mg/L)

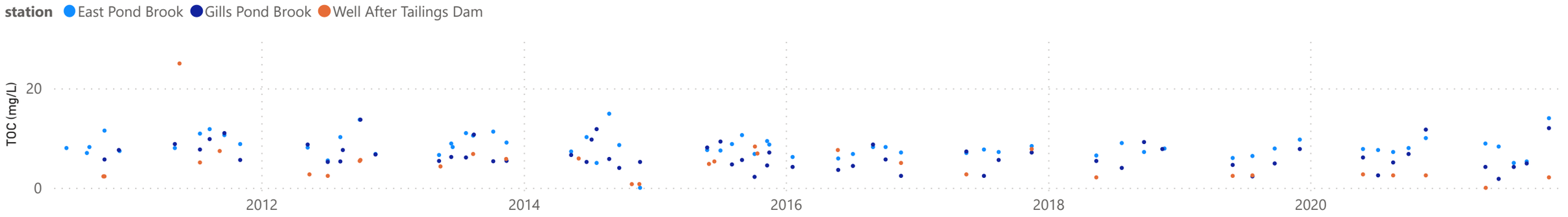


Grab Samples Total Dissolved Solids (mg/L)

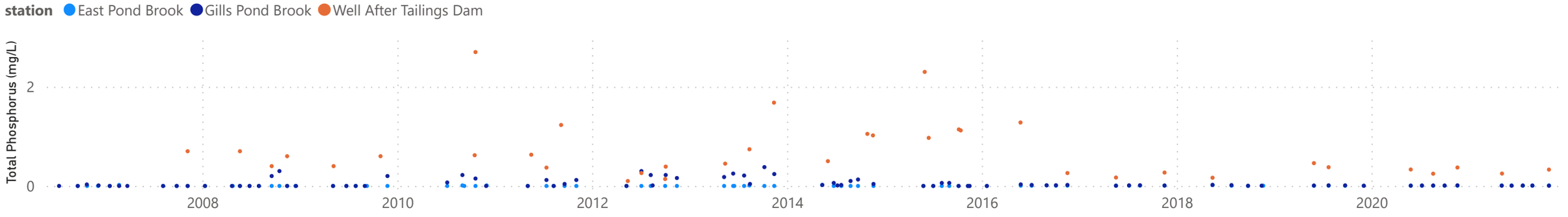


Appendix - Grab Sample Graphs

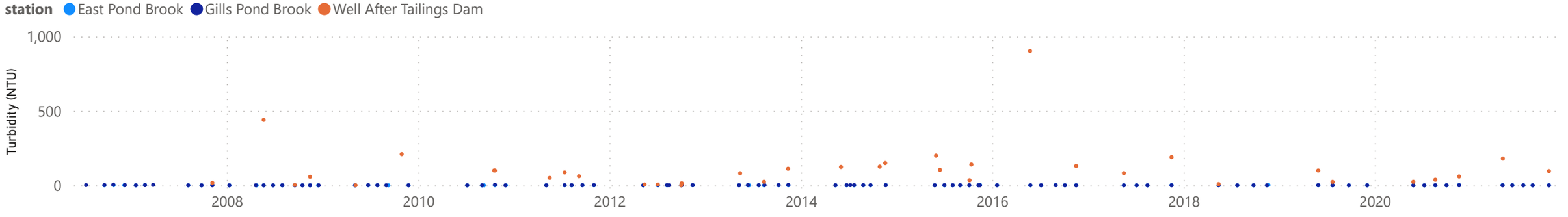
Grab Samples Total Organic Carbon (mg/L)



Grab Samples Total Phosphorus (mg/L)

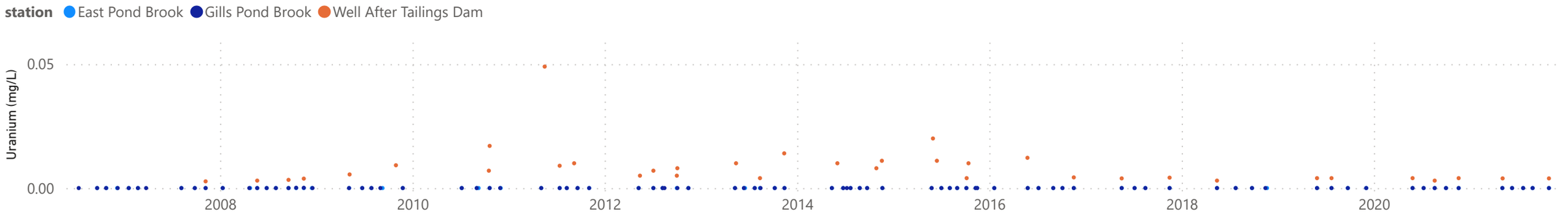


Grab Samples Turbidity (NTU)



Appendix - Grab Sample Graphs

Grab Samples Uranium (mg/L)



Grab Samples Zinc (mg/L)