Summary of Data

Water quality sampling occurred at six sites within the Lake Glenville watershed on 12/15/22. All sites were located as close as possible to sites sampled in previous monitoring years; the location for the Glenville Creek sample was moved back downstream to its original location. On the 06/06/22 sampling, the sample location on Glenville Creek was moved upstream to where Hwy. 107 crosses the stream, due to high water at the downstream location. The 12/15/22 sampling was a wet weather sampling, the area around the lake received 1.65 inches of rain from 12/14/22 – 12/15/22 (Figure 1). The suite of parameters sampled included water temperature, dissolved oxygen (DO), pH, specific conductivity, turbidity, fecal coliform, ammonia, nitrite/nitrate, phosphate, and alkalinity. The data collected during this wet weather sampling is decidedly different from what has been observed previously. It is important to keep in mind that this sampling was intended to detect pollutants that are being flushed into the waterways and assess possible sources, at least at the subwatershed scale.

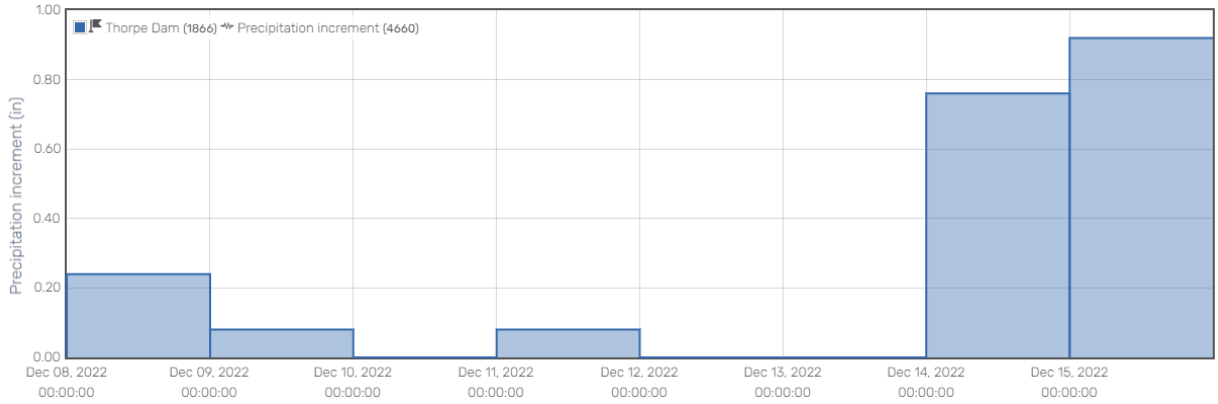


Figure 1. Precipitation for the week preceding sampling.

Turbidity during the sampling event was 7.6 NTU at Cedar Creek, 9.0 NTU at Hurricane Creek, 18.6 NTU at Norton Creek, 11.7 NTU at Mill Creek, 6.3 at Glenville Creek, and 6.2 NTU at Pine Creek. The regional Volunteer Water Information Network mean is 11.4 NTU. The state standard for North Carolina streams that carry the Trout Waters (Tr) designation is that turbidity shall not exceed 10 NTU. Pine Creek, Mill Creek, Norton Creek, Hurricane Creek, and Cedar Creek all carry the Tr classification. Glenville Creek is too small to be classified under this system.

Dissolved oxygen is the amount of oxygen dissolved in water. The concentration of dissolved oxygen in surface water is affected by temperature and has both a seasonal and a daily cycle. Cold water can hold more dissolved oxygen than warm water. In winter and early spring, when the water temperature is low, the dissolved oxygen concentration is high. In summer and fall, when the water temperature is high, the dissolved oxygen concentration is often lower.

Dissolved oxygen is important for ecological health as most aquatic organisms need oxygen to survive and grow. Some species, such as trout and stoneflies, require high DO levels (>6 mg/L) for survival, and trout show improved reproductive health when DO levels are above 10 mg/L. Dissolved oxygen concentrations for the sampling event ranged between 9.2 mg/L and 10.4 mg/L.

An increase in observed acidity has been a concern over the course of the last few samplings in both the tributaries to Lake Glenville and the lake itself. As has been stated previously, acidic waters are not uncommon for high elevation streams in the area. Depths to bedrock are shallow with thin soils and rock types do not have a mineralogy that buffers groundwater as it moves through the ground and remerges in the streams. However, there are anthropogenic sources which can increase the acidity in streams to levels which are unhealthy for trout (below 5.0). High elevation areas of eastern Tennessee and Western North Carolina receive elevated rates of atmospheric acid deposition in comparison with other areas on the east coast, resulting in increased episodic stream acidification events, adding to the acidification of soil and surface waters. Episodic stream acidification occurs when heavy rain downpours bring increased acidic deposition to soils and water bodies, resulting in periods of increased stream flow and decreased water pH.

We would expect to observe the most acidic (lowest pH) stream waters during a rainfall event. At one site, this was the case; Mill Creek had a pH of 5.4, the lowest pH value observed to date. The pH of clean rain is 5.6. At other sites, pH values ranged from 6.1 to 7.4. This is an improvement from what has been observed previously. The issue of acidity is complicated by the fact that rain is, on average, much more acidic in the summer than in the winter. Continued monitoring of acidity will help increase awareness of any potential problems. It is important to note that although the effects of the issue are felt locally, it originates at a regional, continental scale and is not a “stand-alone” problem. It relates intimately with energy, land use, urban, transport, and other socioeconomic issues.

Ammonia concentrations were higher than those previously observed at all the sampled locations, with the exception of Glenville Creek. Ammonia values ranged from 0.09 mg/L to 0.25 mg/L. Ammonia is produced by bacterial decomposition of organic matter that accumulates in stream sediment. We would expect to see higher ammonia values during rainfall events where those sediments are being mobilized and transported.

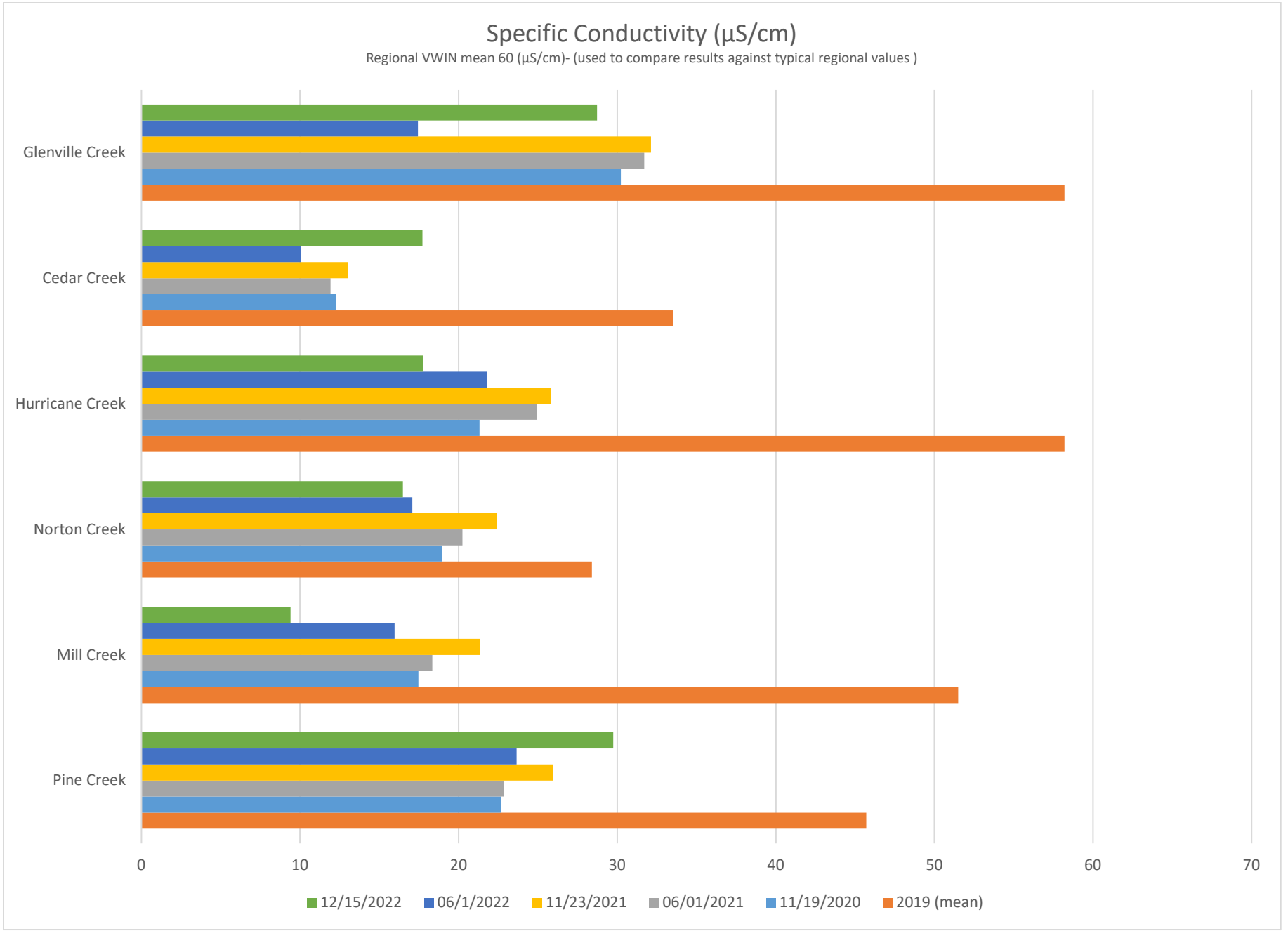
As a sort of side note, an observant reader will likely have noticed that Glenville Creek is a frequent outlier among all the sites. The drainage area of Glenville Creek (198 acres) is significantly smaller than Lake Glenville’s next smallest subwatershed (Hurricane Creek: 1578 acres) and vastly smaller than the lake’s largest subwatershed (Norton Creek: 6161 acres). This small drainage area makes the hydrologic and chemical regime of Glenville Creek much different than the other subwatersheds.

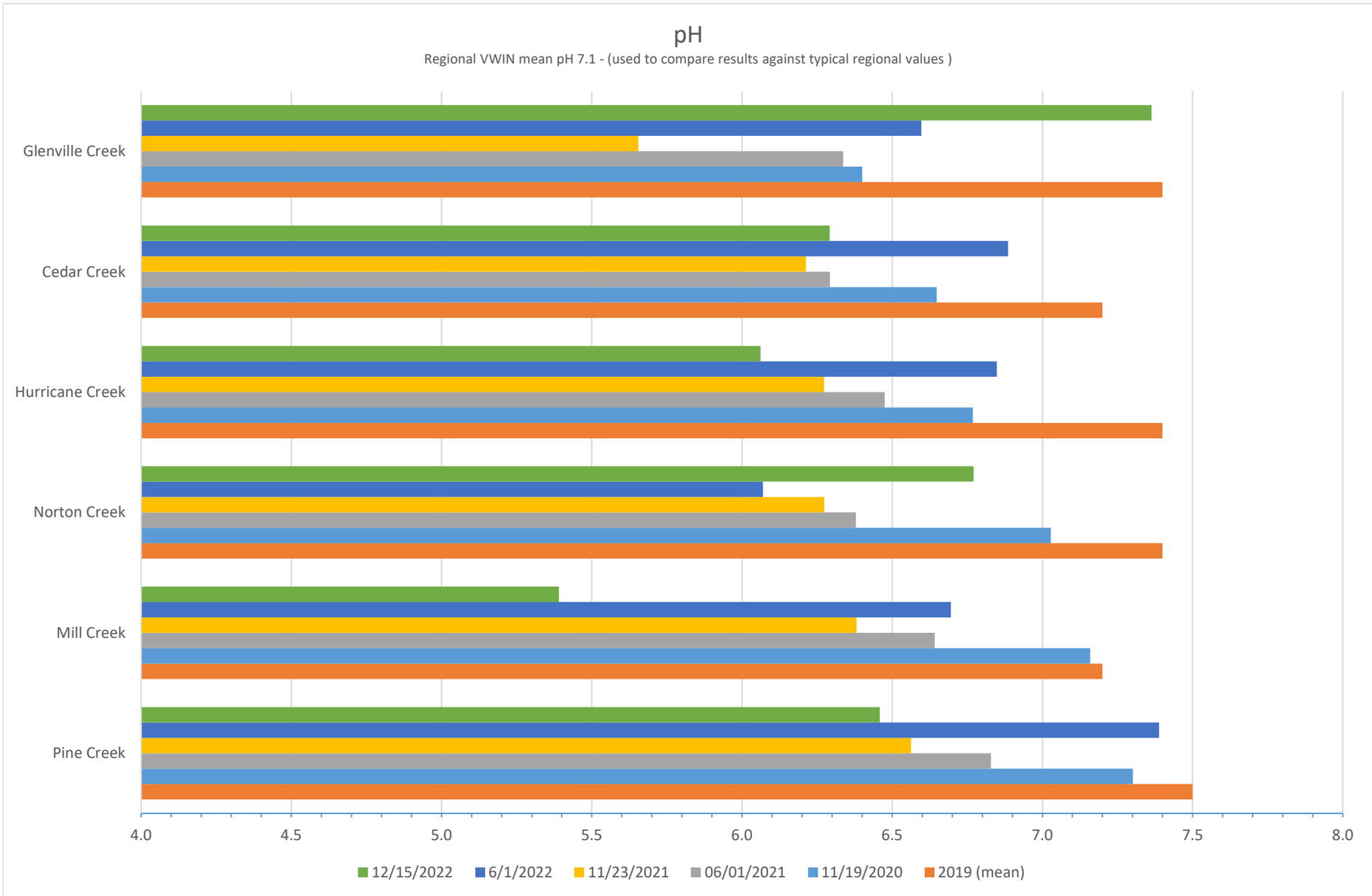
Nitrite/Nitrate-Nitrogen concentrations were very low, ranging between 0.2 mg/L and 0.3 mg/L, well below the regional VWIN average of 0.5 mg/L. Phosphorous concentrations were also very low and ranged from 0.02 mg/L to 0.05 mg/L. These low nutrient values are a positive indicator of the health of the watershed.

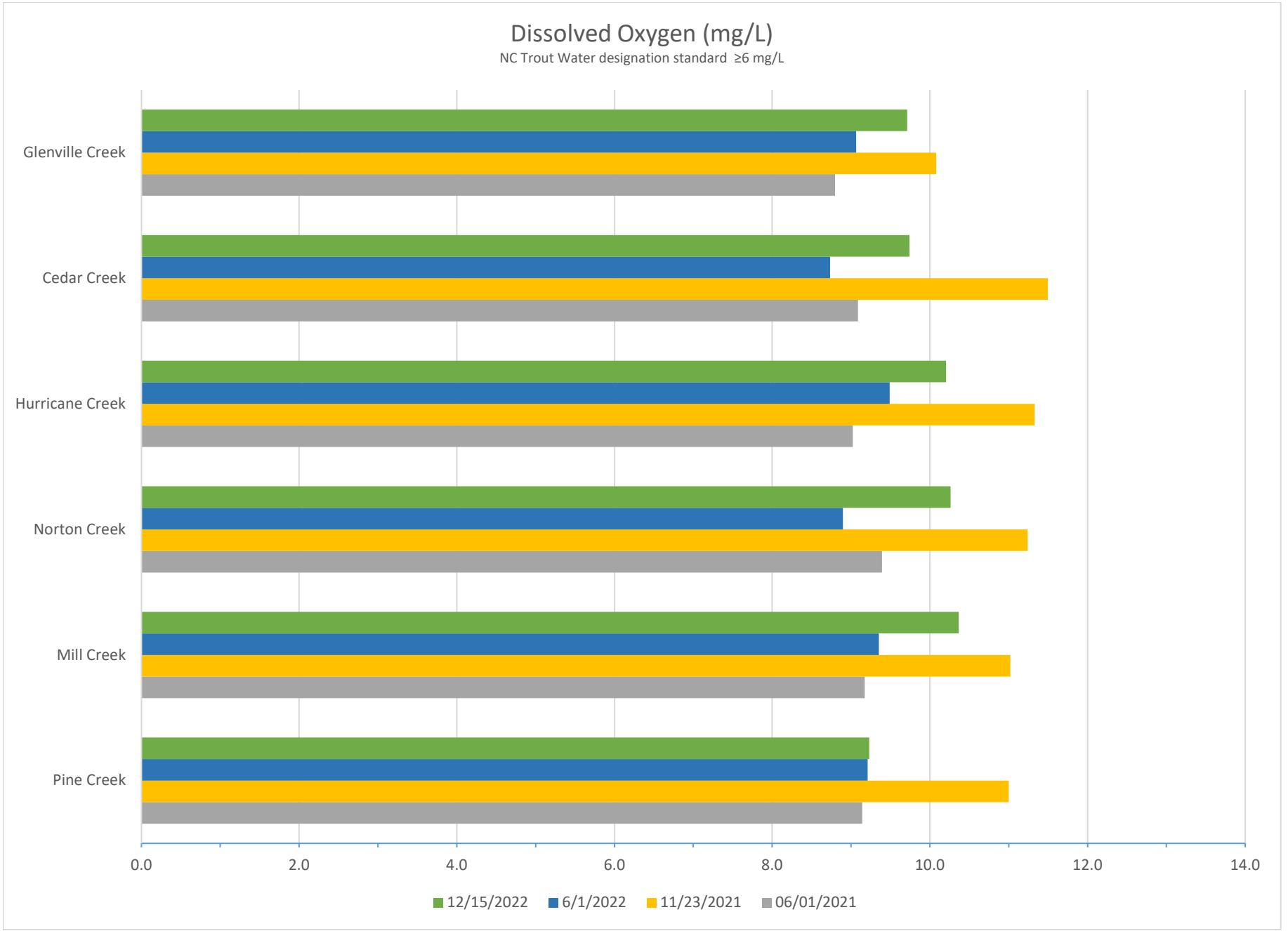
Under state rules, fecal coliform in fresh waters "shall not exceed a geometric mean of 200 colony forming units (CFU)/100 mL based upon at least five consecutive samples examined during any 30-day period, nor exceed 400 CFU/100 mL in more than 20 percent of the samples examined during such period.". As such, any single sample is difficult to compare to the state standard, but as a rule of thumb low numbers are good and numbers exceeding 200 CFU/100 mL are bad. However, violations of the state standard are expected during heavy rainfall events and may be caused by uncontrollable nonpoint source pollution. Nonpoint source pollution comes from contaminants that end up on the ground naturally or from human activity. Rainwater and snowmelt pick up these contaminants as it washes over yards, sidewalks, driveways, parking lots, and fields and deposits them into lakes and streams as nonpoint source pollution. Common sources of nonpoint source pollution in the Lake Glenville watershed could include:

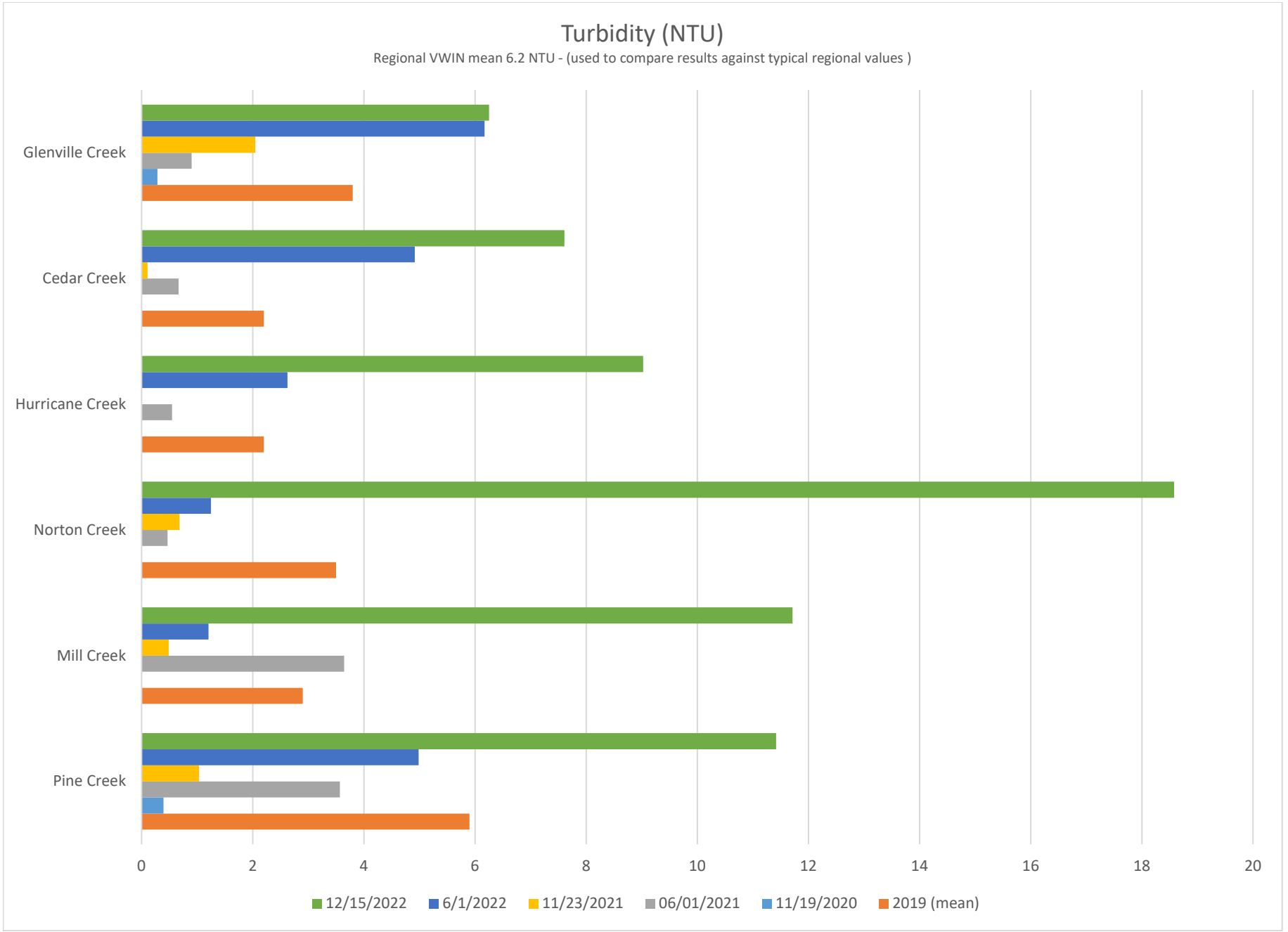
- animal production operations and feedlots;
- agricultural activities;
- stream bank and shoreline erosion;
- timber harvesting;
- land development;
- on-site sewage disposal units;
- atmospheric deposition.

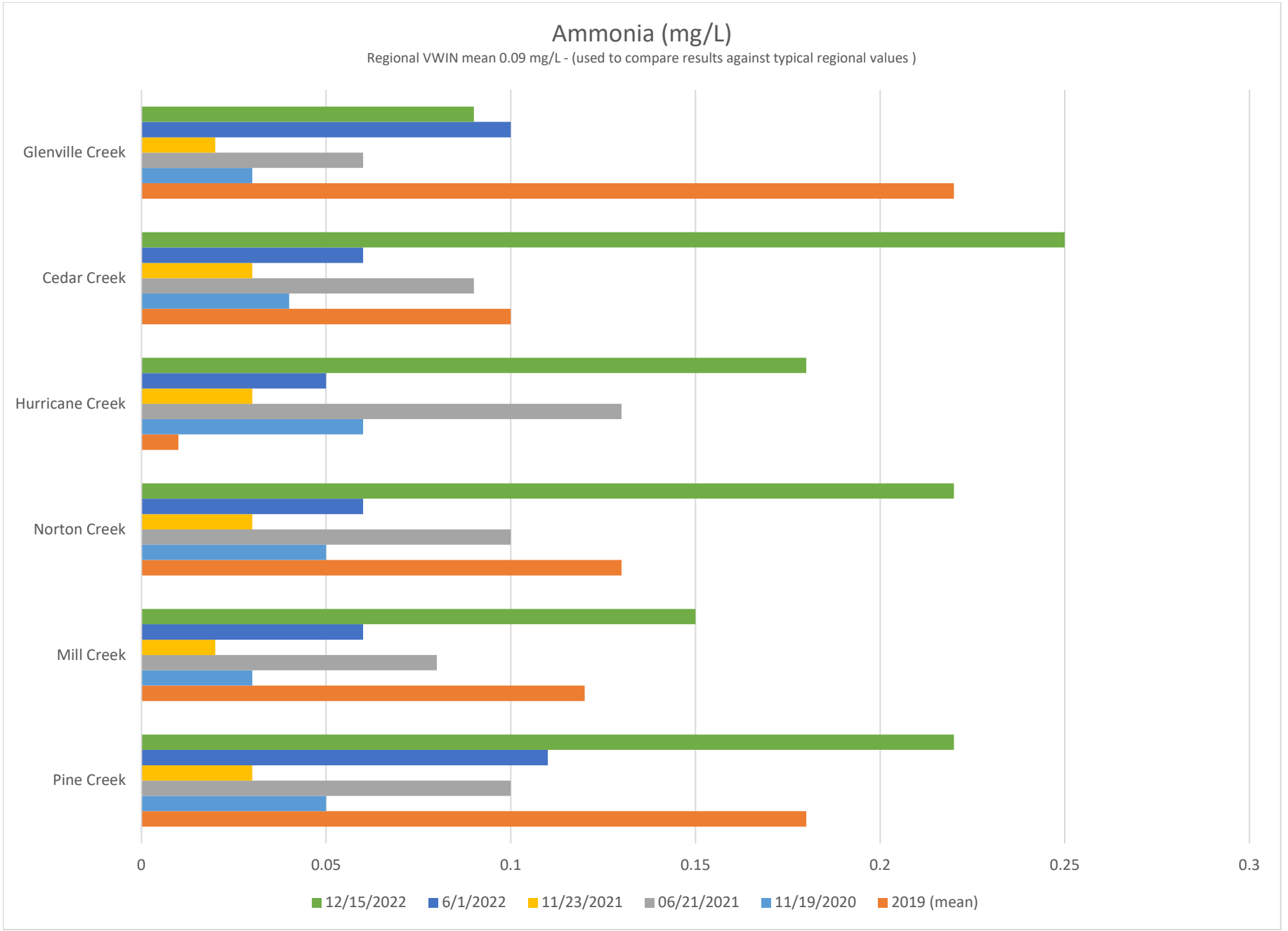
Fecal coliform concentrations ranged from 69 CFU/100 mL to > 2740 CFU/100 mL. The highest value was on Norton Creek. Development at a golf club, a large ranch within the watershed, or cattle farms near Norton Creek could be a possible sources of bacteria. Dispersed, failing septic systems are also possible sources of bacteria. Increased sampling with *E. Coli* DNA analysis would help track down and identify the exact source.

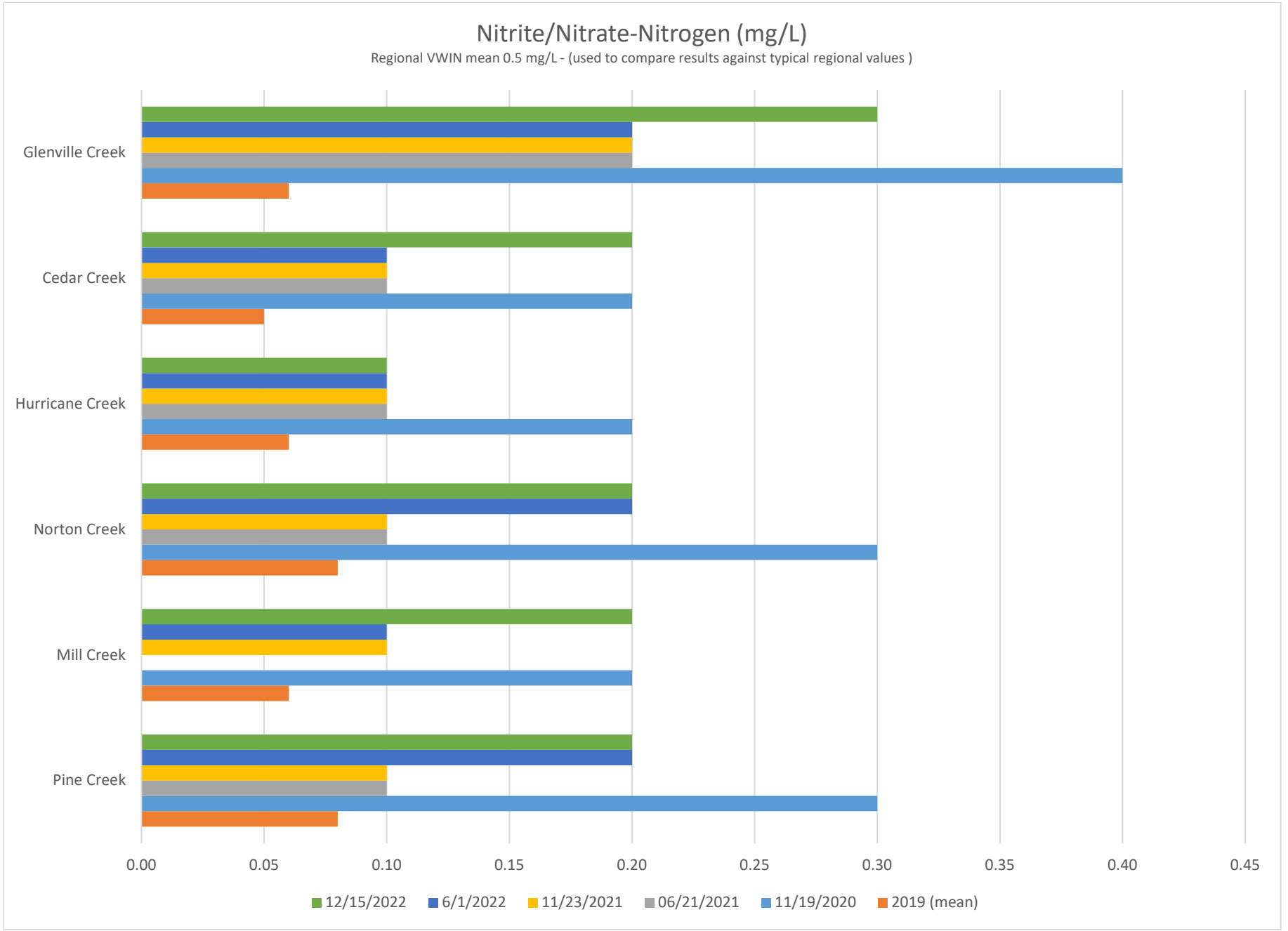

Specific Conductivity (µS/cm)
Regional VWIN mean 60 (µS/cm)- (used to compare results against typical regional values)
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
0
10
20
30
40
50
60
70
12/15/2022
06/1/2022
11/23/2021
06/01/2021
11/19/2020
2019 (mean)

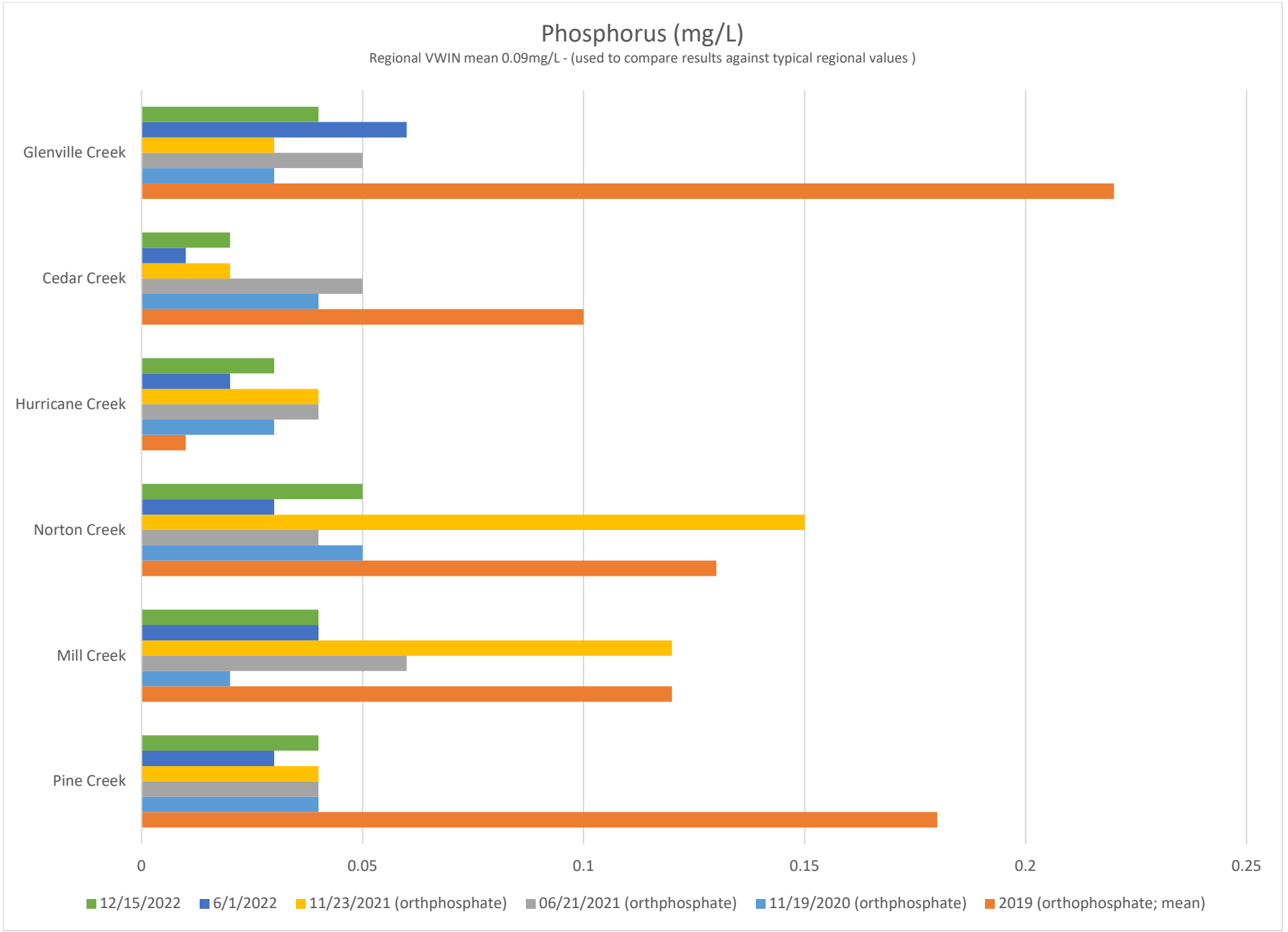

pH
Regional VWIN mean pH 7.1 - (used to compare results against typical regional values)
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
12/15/2022
6/1/2022
11/23/2021
06/01/2021
11/19/2020
2019 (mean)

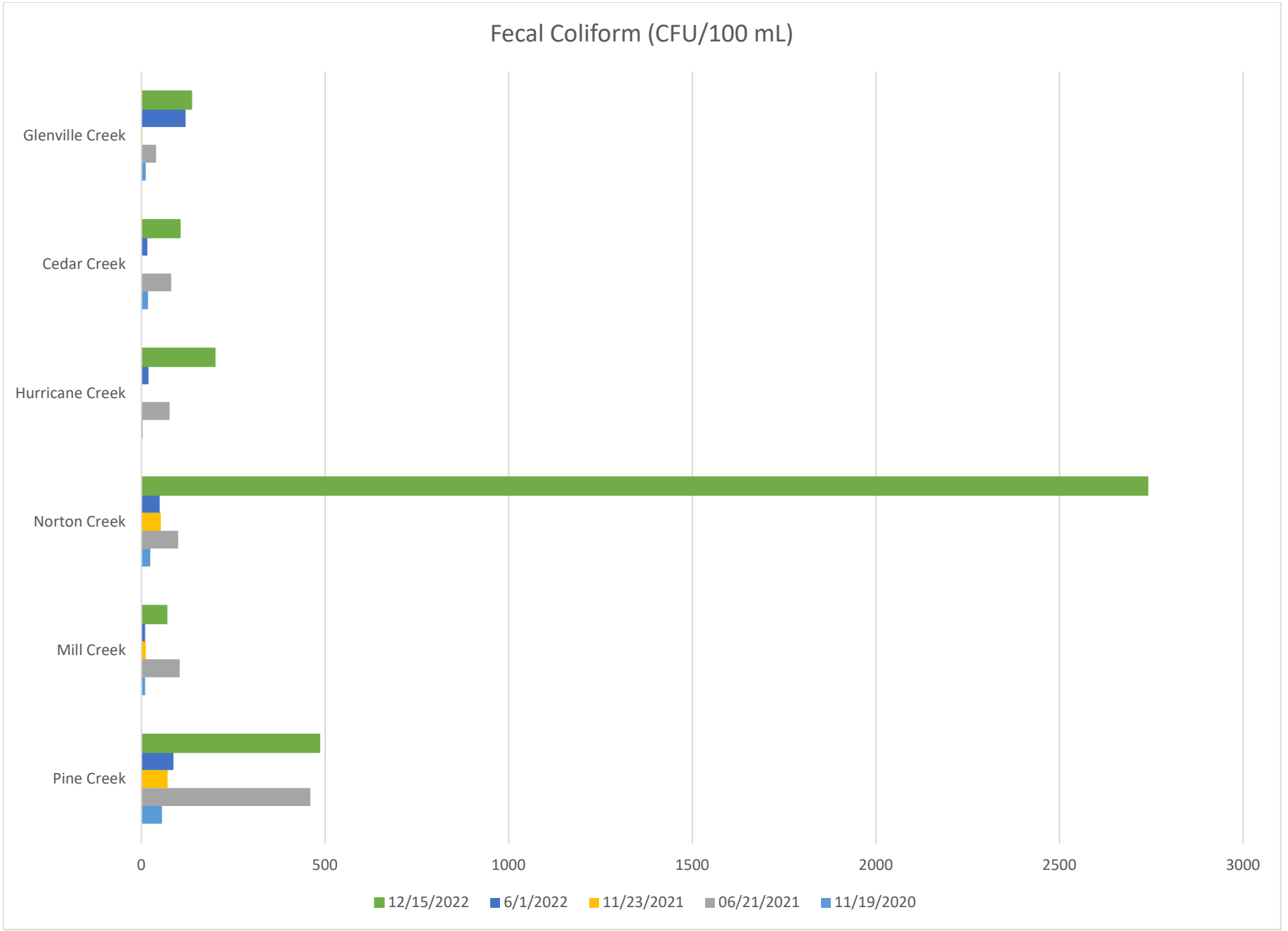

Dissolved Oxygen (mg/L)
NC Trout Water designation standard ≥6 mg/L
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
12/15/2022
6/1/2022
11/23/2021
06/01/2021

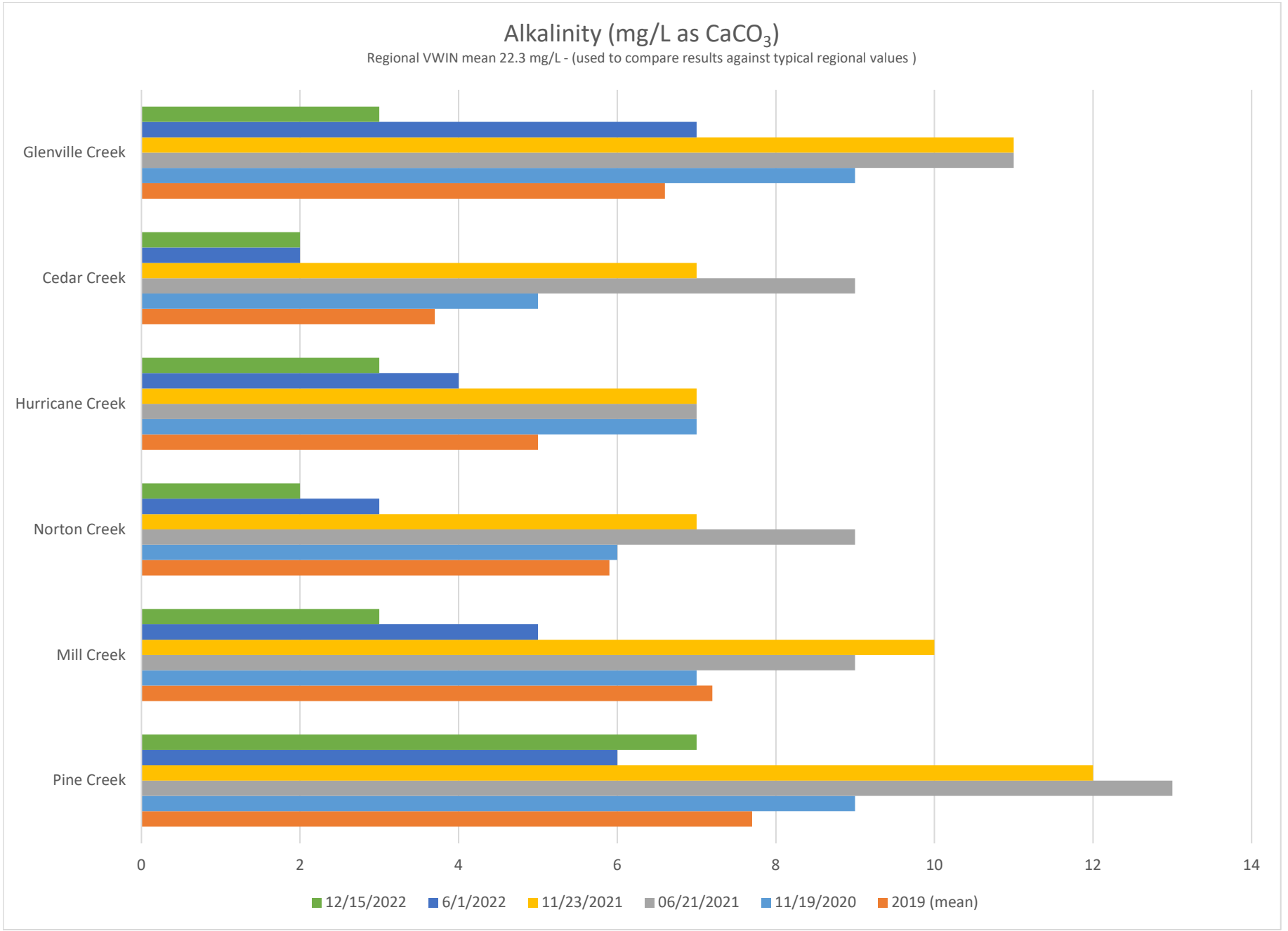

Turbidity (NTU)
Regional VWIN mean 6.2 NTU - (used to compare results against typical regional values)
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
0
2
4
6
8
10
12
14
16
18
20
12/15/2022
6/1/2022
11/23/2021
06/01/2021
11/19/2020
2019 (mean)

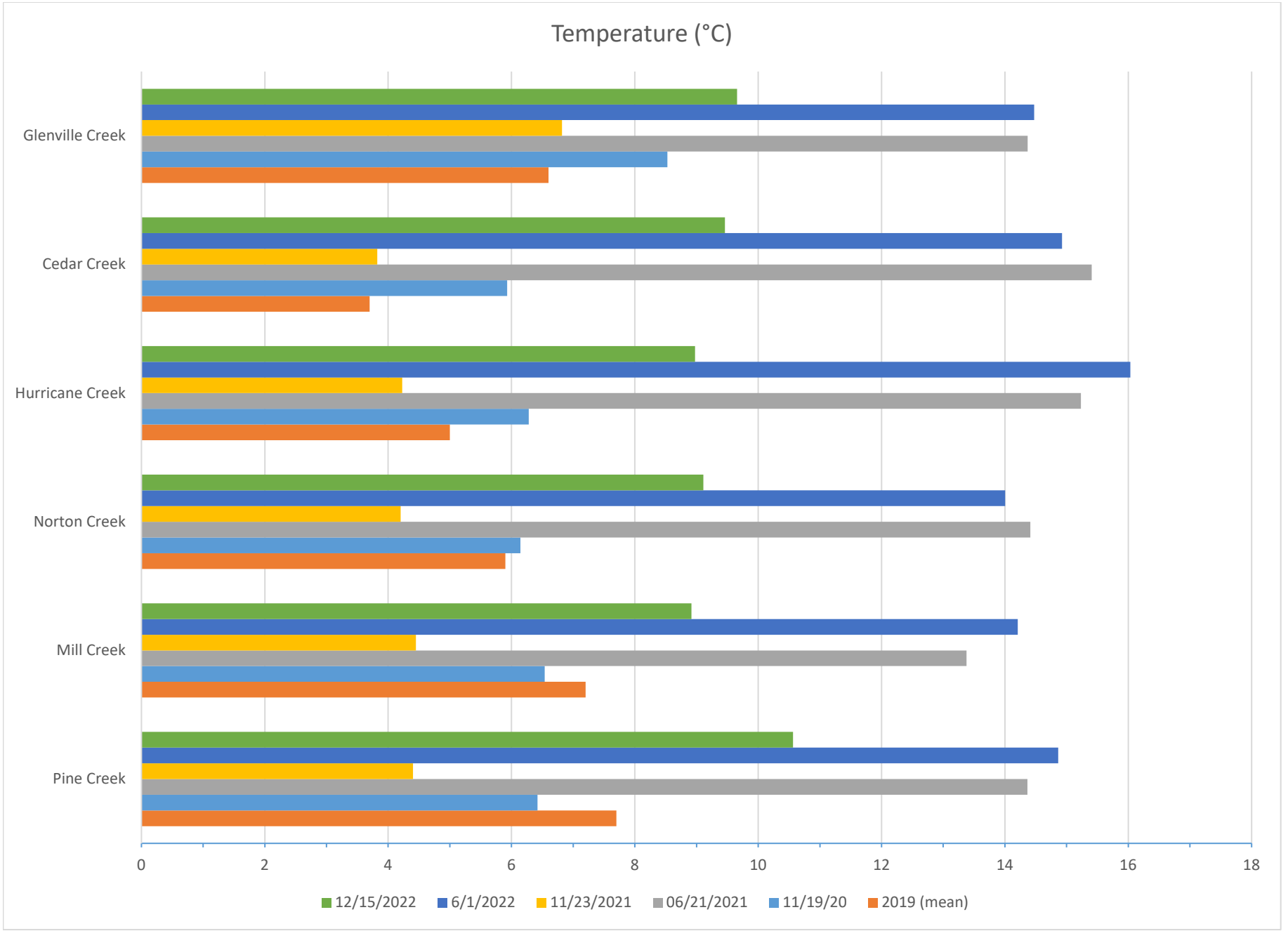

Ammonia (mg/L)
Regional VWIN mean 0.09 mg/L - (used to compare results against typical regional values)
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
0
0.05
0.1
0.15
0.2
0.25
0.3
12/15/2022
6/1/2022
11/23/2021
06/21/2021
11/19/2020
2019 (mean)


Nitrite/Nitrate-Nitrogen (mg/L)
Regional VWIN mean 0.5 mg/L - (used to compare results against typical regional values)
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
12/15/2022
6/1/2022
11/23/2021
06/21/2021
11/19/2020
2019 (mean)


Phosphorus (mg/L)
Regional VWIN mean 0.09mg/L - (used to compare results against typical regional values)
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
0
0.05
0.1
0.15
0.2
0.25
12/15/2022
6/1/2022
11/23/2021 (orthphosphate)
06/21/2021 (orthphosphate)
11/19/2020 (orthphosphate)
2019 (orthophosphate; mean)


Fecal Coliform (CFU/100 mL)
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
0
500
1000
1500
2000
2500
3000
12/15/2022
6/1/2022
11/23/2021
06/21/2021
11/19/2020


Alkalinity (mg/L as $CaCO_3$)
Regional VWIN mean 22.3 mg/L - (used to compare results against typical regional values)
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
0
2
4
6
8
10
12
14
12/15/2022
6/1/2022
11/23/2021
06/21/2021
11/19/2020
2019 (mean)


Temperature (°C)
Glenville Creek
Cedar Creek
Hurricane Creek
Norton Creek
Mill Creek
Pine Creek
0
2
4
6
8
10
12
14
16
18
12/15/2022
6/1/2022
11/23/2021
06/21/2021
11/19/20
2019 (mean)