Bitterroot River Water Quality Annual Report: 2022

Photo Credit: Lauren Elise

6/2/2023

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1. 2022 QA/QC Report for Bitterroot River Monitoring (MDEQ)

1.0 INTRODUCTION

This report presents 2022 nutrient and benthic algae monitoring results from the Bitterroot River Long-Term Trends Monitoring Project (BTMP) collected by the Bitterroot River Protection Association (BRPA), under guidance from the Montana Department of Environmental Quality (MDEQ), and in partnership with the Clark Fork Coalition (CFC), which assists with data management and reporting. This report also summarizes and presents the results of quality assurance and quality control analysis by MDEQ. The purpose of the report is to present monitoring results and assess compliance with water quality targets.

2022 represented the fourth year of what is envisioned as a long-term monitoring effort on the Bitterroot River. Further analysis of annual results from this monitoring program will be accomplished on a five-year schedule with a statistical evaluation and trends analysis. The first 5-year trends report is anticipated in 2024 and will include data from 2019 through 2023.

2.0 HISTORY AND BACKGROUND

MDEQ completed Total Maximum Daily Loads (TMDLs) for the Bitterroot River watershed beginning with the 2003 Upper Lolo Creek TMDLs. The Bitterroot Headwaters TMDLs (the West and East Forks of the Bitterroot River) were completed in 2005. In 2011, DEQ completed the Bitterroot Temperature and Tributary Sediment TMDLs, and in 2014 completed the remaining Bitterroot Watershed TMDLs.

In 2019, the Bitterroot watershed became the Water Quality Division's Nonpoint Source Program priority watershed for a 2-3 year timeframe (MDEQ 2019a). More detail about concurrent water quality improvement activities and objectives can be found within the Pilot Level I Priority: Bitterroot Watershed Protect Plan (MDEQ 2019b). A major focus of the priority project includes tracking nutrient trends on the mainstem Bitterroot River, which led to the creation of the BTMP.

3.0 MONITORING PROGRAM

The sampling design and primary objective of this monitoring effort is to detect long-term trends in nutrient and benthic algae chlorophyll concentrations in the Bitterroot River. Additional details on the project's objectives can be found in the Quality Assurance Project Plan (MDEQ 2022).

The objectives will be met by:

1. **Summer monitoring:** The BRPA collects nutrient samples, TSS, and field constituents during summer at six sites on the Bitterroot River on eight sampling occasions – twice monthly, July through October.
2. **Benthic algae monitoring:** The BRPA, with assistance from the UM Watershed Health Clinic, collects summer benthic algae samples for chlorophyll-*a* and ash-free dry weight at six sites on the Bitterroot River in early August and September.

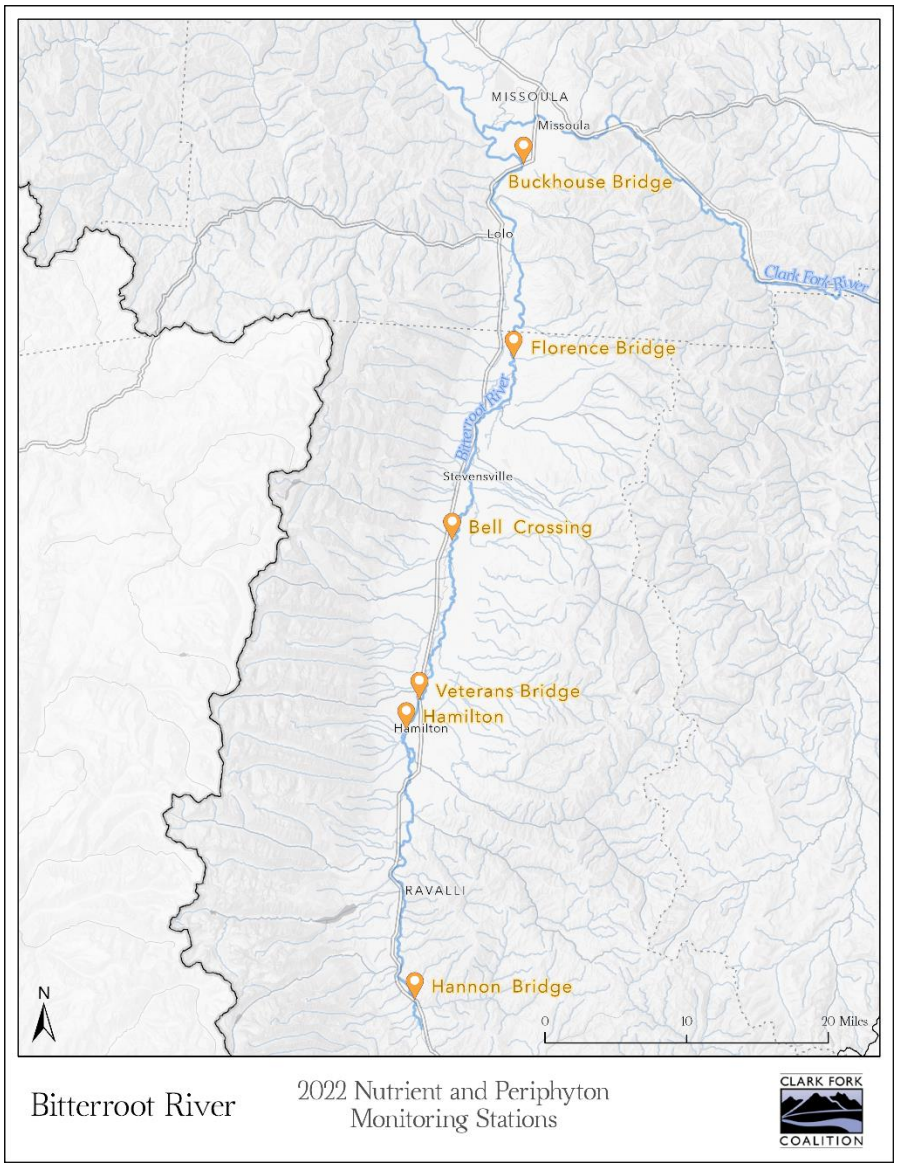


Figure 1. *2022 Bitterroot River Nutrient and Periphyton Monitoring Sites.*

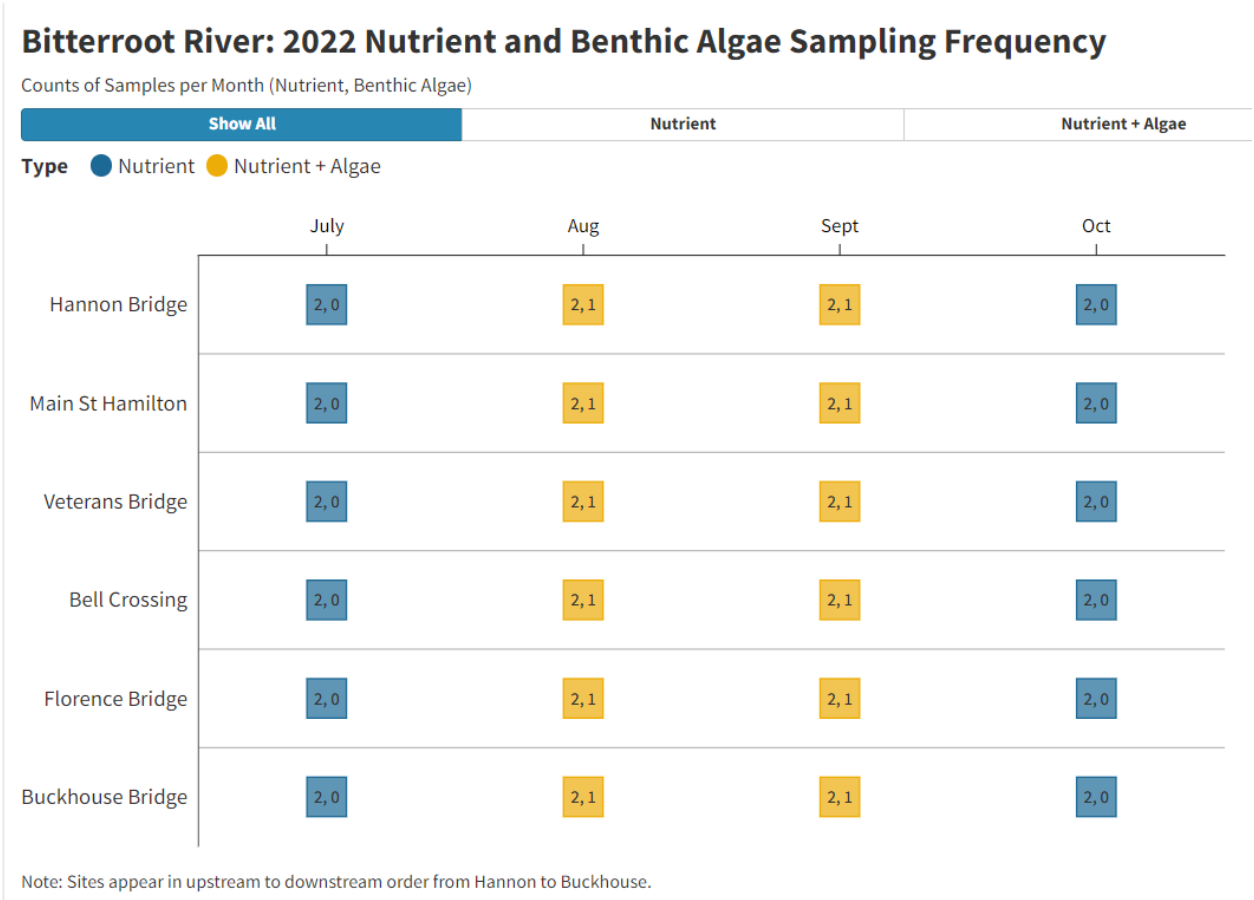


Figure 2. *Count of samples and type of monitoring conducted at each station for the 2022 Bitterroot River nutrient and benthic algae monitoring season. Interactive graphic link.*

Specifically, the BTMP measures:

- Nutrients: total phosphorus (TP), total persulfate nitrogen (TPN), nitrate + nitrite nitrogen (NO_2+NO_3-N), ammonia nitrogen (NH_3+NH_4-N), and soluble reactive phosphorus (SRP).
- Total Suspended Solids (TSS).
- Field parameters: water temperature (˚C), dissolved oxygen (mg/l), pH (standard units), redox potential (mv), specific conductance (µs/cm), total dissolved solids (mg/l), and turbidity (NTU).
- Benthic algae: chlorophyll-*a* (mg/m^2) and ash-free dry weight (g/m^2).

All nutrient samples were analyzed by Energy Laboratory in Helena, MT, and benthic algae samples were analyzed by the UM Watershed Health Clinic. Sampling, QA/QC and analytical methods are described in the QAPP (MDEQ, 2023). The **QA/QC Report for 2022 Bitterroot Mainstem Long-Term Nutrient Trends Monitoring** is attached to this report. Monitoring station locations are displayed in both **Table 1** and **Figure 1.** Nutrient samples were collected at all six stations twice a month from July to October, with monthly algae sampling in August and September, as displayed in **Figure 2**. Rationale for sampling locations is explained in more detail in the QAPP (MDEQ, 2023).

All 2021 and 2022 project data are available in interactive format on the project website: https://storymaps.arcgis.com/stories/e1f6335c0e61443182e545c2cf240a80. This StoryMap, created by the Clark Fork Coalition, presents data from this report along with other nutrient monitoring efforts in

the region. Additionally, most figures presented in this report are available in a digital and interactive format as well (linked in this document).

Table 1: *BTMP Monitoring Locations, from upstream to downstream*

Station	Name/Location	Latitude	Longitude
COMBITR02	Bitterroot River at Buckhouse Bridge	46.83194	-114.05306
COMBITR03	Bitterroot River at Florence Bridge	46.63309	-114.05096
BITR-C05BITRR24	Bitterroot River at Bell Crossing	46.4436	-114.12630
COMBITR04	Bitterroot River at Veterans Bridge, Hamilton*	46.2792	-114.1606
BITR-C05BITRR03	Bitterroot River at Main Street, Hamilton	46.2475	-114.17722
BITR-C05BITTR06	Bitterroot River at Hannon Memorial Bridge	45.9725	-114.1411

*Veterans Bridge is not formally part of the BTMP. The site is part of a separate BRPA monitoring program and data from the site are included in this report courtesy of BRPA. Note that sites in Table 1 are listed in downstream to upstream order starting at Buckhouse Bridge.

4.0 DATA QA/QC SUMMARY

All laboratory and field data were reviewed and validated per guidance in the QAPP (Department of Environmental Quality, 2023) attached to this report. This section briefly summarizes the results. The overall project data had:

- 55 results "J" flagged for result value between the method detection limit (MDL) and LRL, meaning they are estimated values.
- 2 Total Nitrogen, mixed forms results were "B" flagged for field blank contamination.

No results during the 2022 field season were rejected for analysis. The overall project sample completeness rate for sites included in the QAPP is 98.9%, well over the required 90% in the SAP.

5.0 NUTRIENT TARGETS

The Total Maximum Daily Load (DEQ, USEPA 2014) established the following nutrient targets for the mainstem of the Bitterroot River:

- Total phosphorus as P: 30 µg/L
- Total Nitrogen as N: 300 µg/L

DEQ also uses 100 ug/L nitrate + nitrite as a benchmark for assessment purposes on the Bitterroot River. When concentrations are equal or greater than 100 ug/L during the growing season it can be assumed that the stream is saturated for nitrate and detrimental eutrophication impacts may ensue (Suplee 2013).

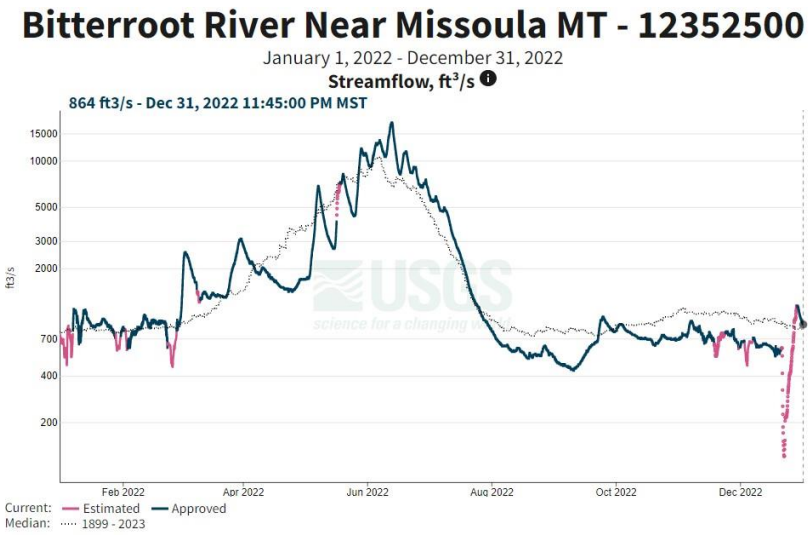
Although no targets currently exist for algal growth in the Bitterroot River, targets developed for the Clark Fork River as part of the Voluntary Nutrient Reduction Program may be useful to provide context for interpretation of chlorophyll-a results and are included here for that purpose:

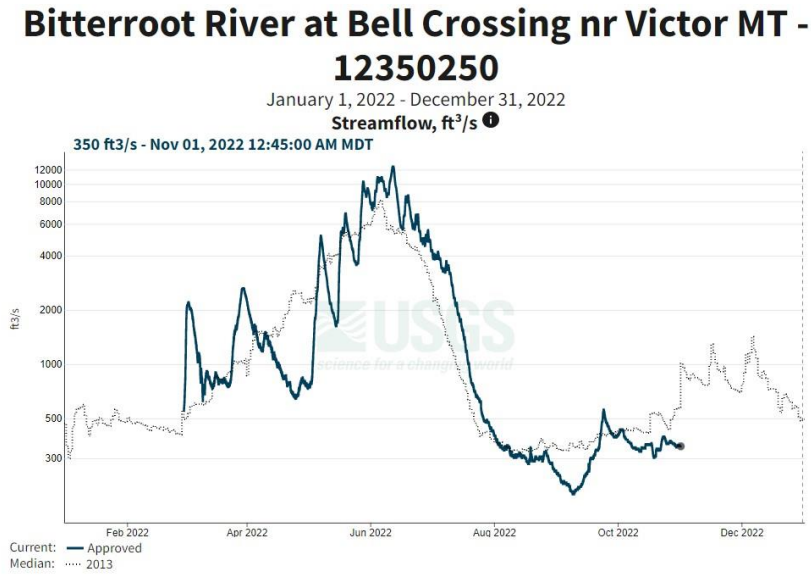
- (Summer mean) - Benthic 100 mg/square meter algal chlorophyll-a
- (Maximum) - Benthic 150 mg/square meter algal chlorophyll-a

6.0 NUTRIENT RESULTS

Streamflow conditions during spring runoff and summer months influence nutrient concentrations and algal densities. Years with less-than-average peak flows and early summer low flows typically see higher algal densities, and conversely, years with higher peak flows tend to produce less algal density. **Figure 3** presents three 2022 annual hydrographs (including the median daily flow for the period of record at each site) from stations in the study area to provide context for interpreting nutrient and algae results (USGS, 2022).

In general, discharge in the Bitterroot River during 2022 closely tracked with the historical average, though the rising limb of all three hydrographs included several mini-peak flow events on the way to the actual annual peak, which at all three locations was slightly higher than average. Summer and early fall saw slightly lower than average discharge at all three locations, except for a short event of higher than average flows in late September. (**Figure 3**).





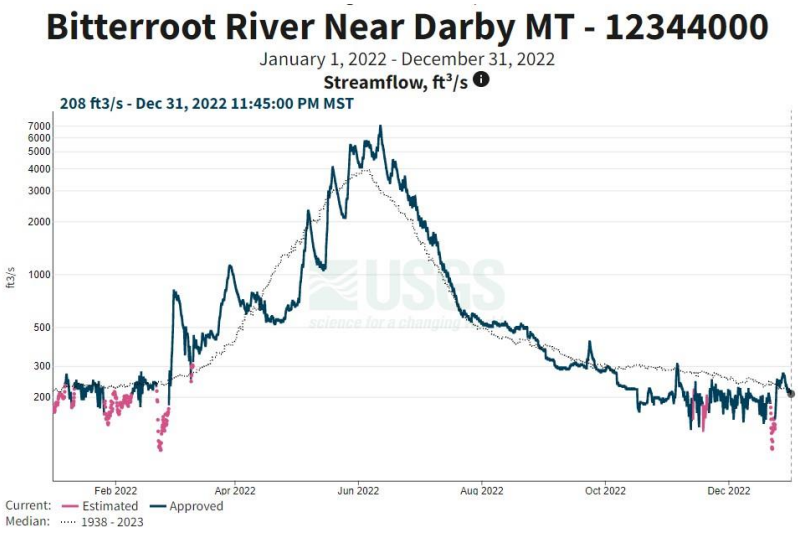


Figure 3. *2022 Hydrographs from USGS continuous monitoring stations (USGS, 2022).*

6.1 TOTAL PHOSPHORUS

Results of total phosphorus (TP) monitoring are presented in **Figure 4**. TP concentrations were below the target of 30 ug/l. Concentrations were generally below 20 ug/l at all stations besides Veterans Bridge in early and late September.

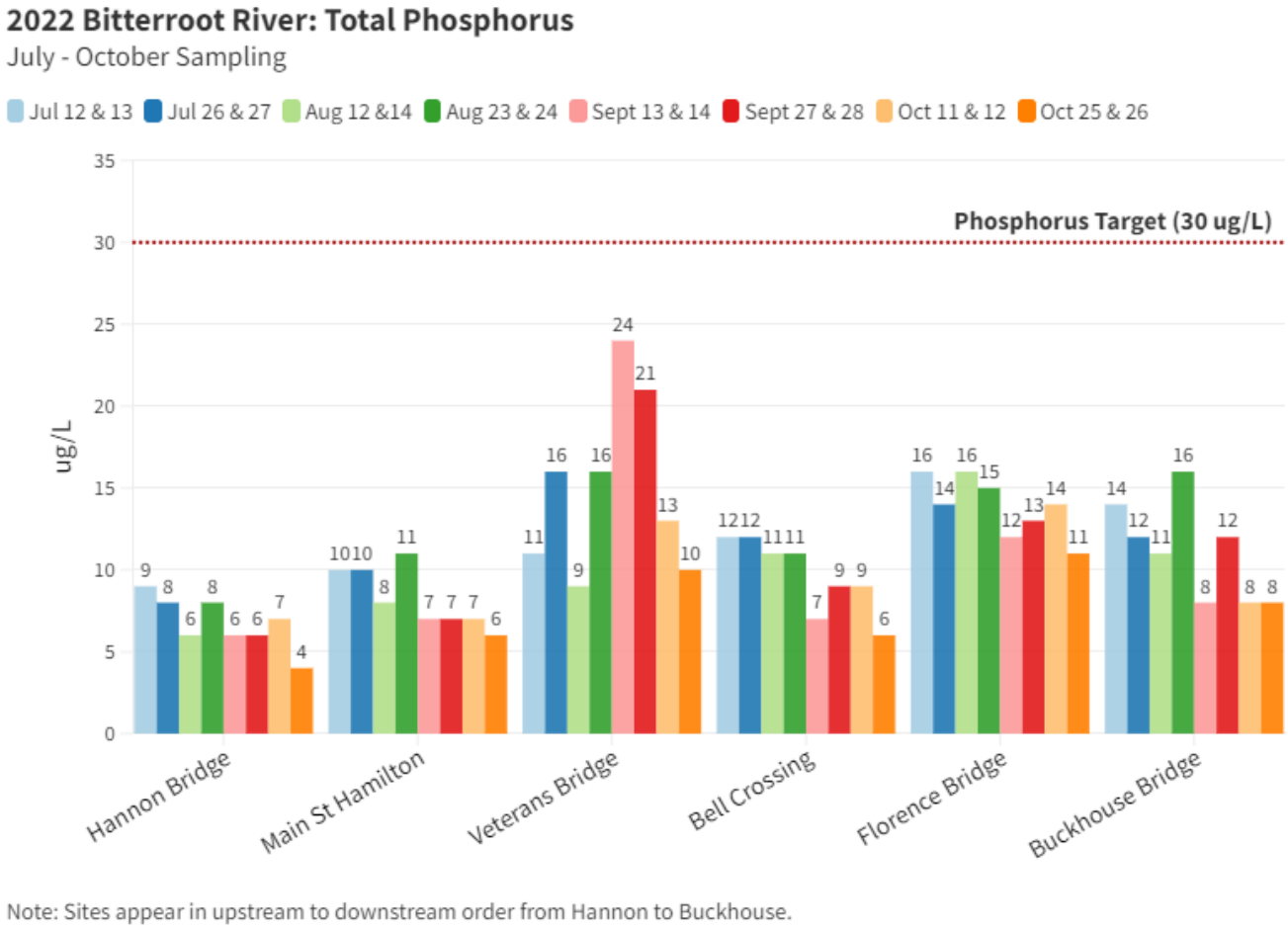
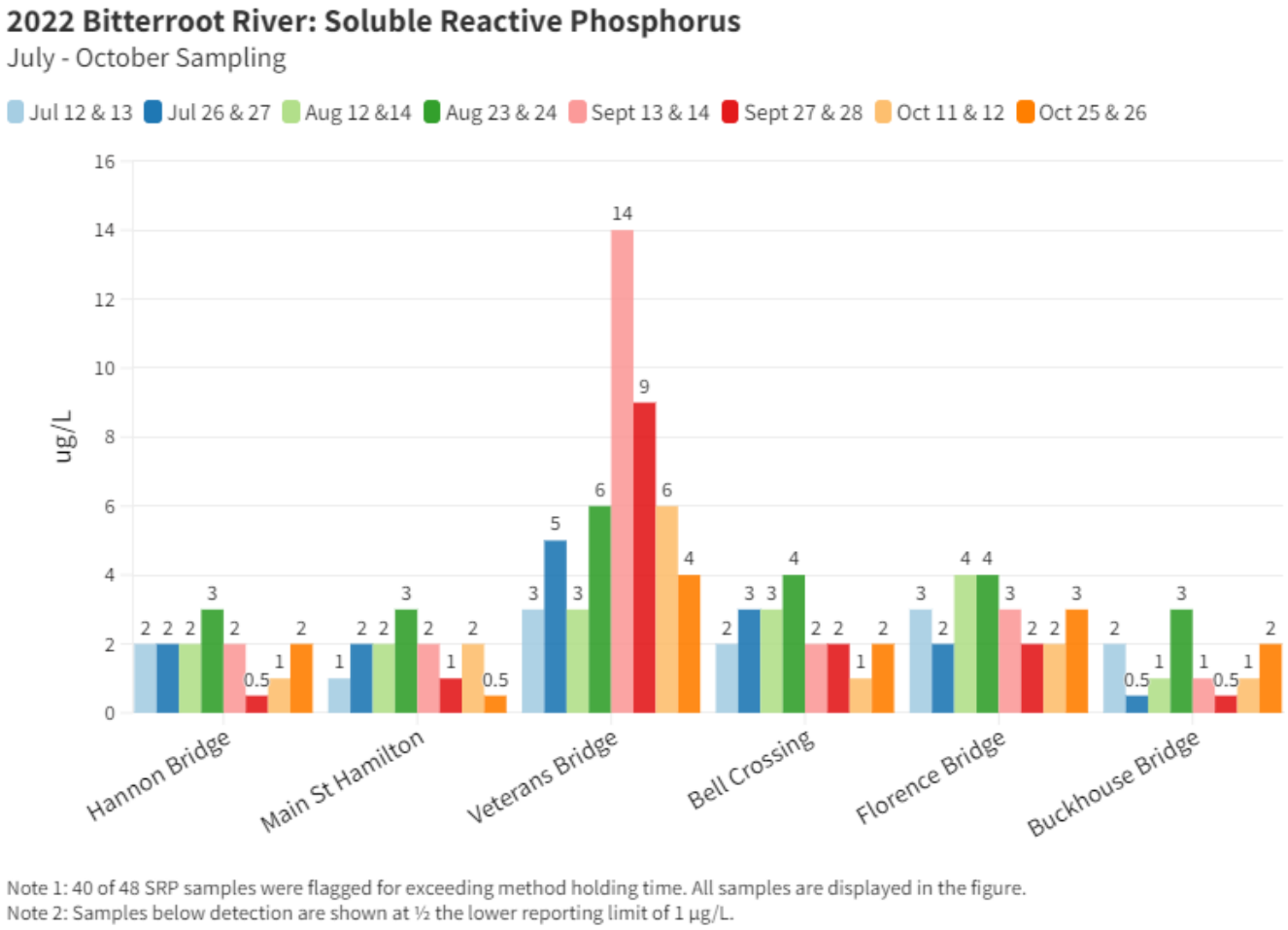


Figure 4. *Bitterroot River: 2022 Total Phosphorous.* *Interactive graphic link.*

6.2 SOLUBLE REACTIVE PHOSPHORUS

Soluble Reactive Phosphorous (SRP) results are presented in **Figure 5**. SRP concentrations were generally 10 ug/l or less, except in early September at Veterans Bridge, where concentrations were 14µg/l.



Note 1: 40 of 48 SRP samples were flagged for exceeding method holding time. All samples are displayed in the figure.
Note 2: Samples below detection are shown at ½ the lower reporting limit of 1 µg/L.

Figure 5. *Bitterroot River: 2022 Soluble Reactive Phosphorous.* *Interactive graphic link.*

6.3 TOTAL NITROGEN

Results of Total Persulfate Nitrogen (TPN) monitoring are presented in **Figure 6**. TPN concentrations were below the target of 300 µg/l at all sites and on all occasions for 2022. TPN was slightly higher at the two downstream sites, Florence and Buckhouse, than it was at the four upper sites for all occasions.

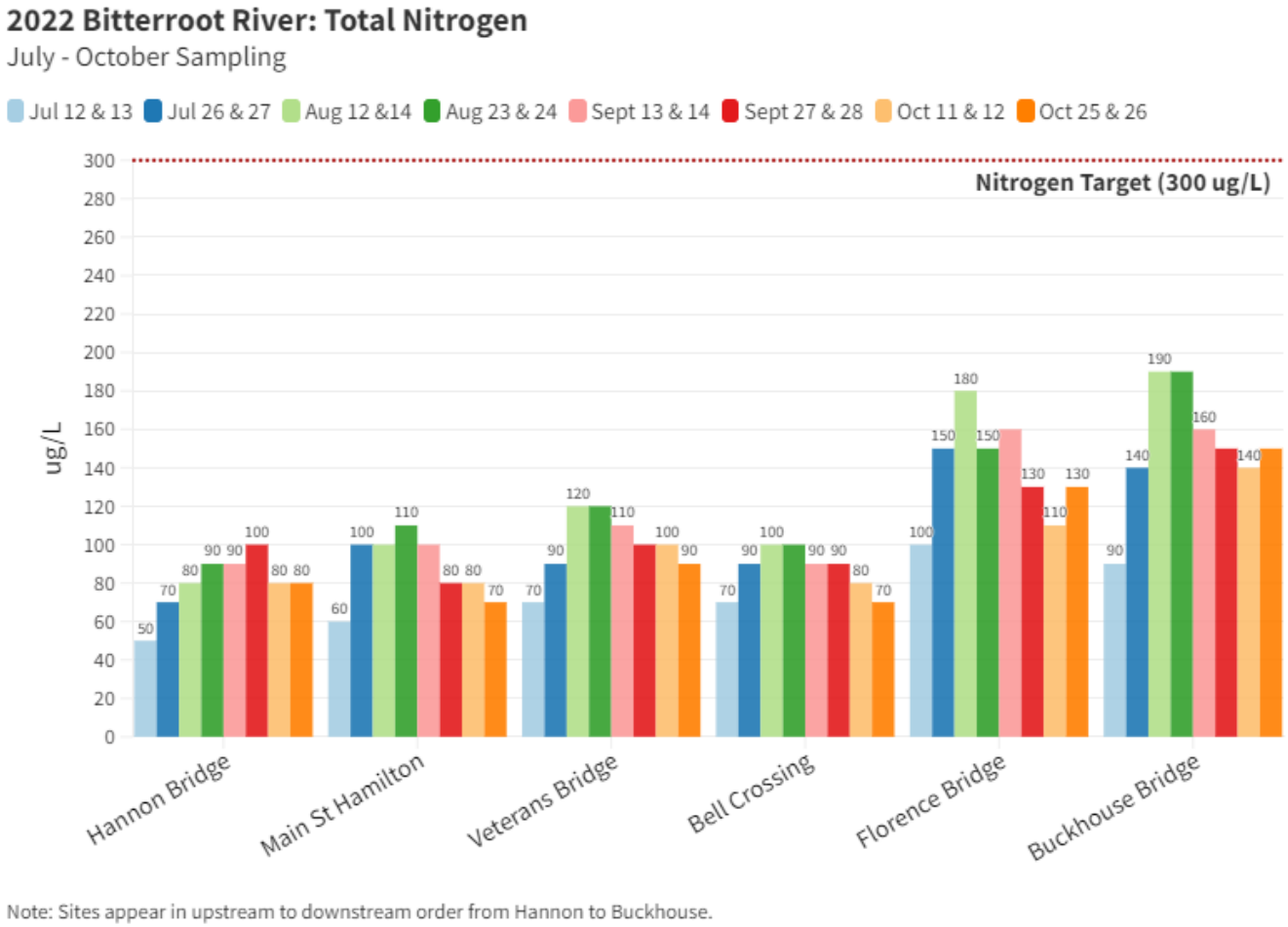


Figure 6. *Bitterroot River: 2022 Total Persulfate Nitrogen.* *Interactive graphic link.*

6.4 NITRATE + NITRITE

Results of nitrate + nitrite monitoring are presented in **Figure 7**. There are no numeric standards for nitrate + nitrite, but as discussed in Section 5.0, MDEQ uses 100 µg/L as a benchmark for assessment purposes. Nitrate + nitrite concentrations were well below this benchmark on all sampling occasions in 2022. As with TPN, nitrate + nitrite was higher at the two downstream sites, Florence and Buckhouse, than it was at the four upper sites for most occasions. Nitrate + nitrite as a percentage of total nitrogen is shown in **Table 2**.

Table 2: 2022 *Nitrate + nitrite as a percentage of total nitrogen.*

Site	Average Nitrate + Nitrite	Average Total Nitrogen	Mean Percentage Nitrate + Nitrite of Total Nitrogen
Hannon	11.25	80	14%
Hamilton Main Street	7.13	87.5	8%
Veterans Bridge	8.88	100	9%
Bell Crossing	3.75	86.25	4%
Florence	17.75	138.75	13%
Buckhouse Bridge	31.25	151.25	21%

(Note: below detect values calculated at ½ detection limit)

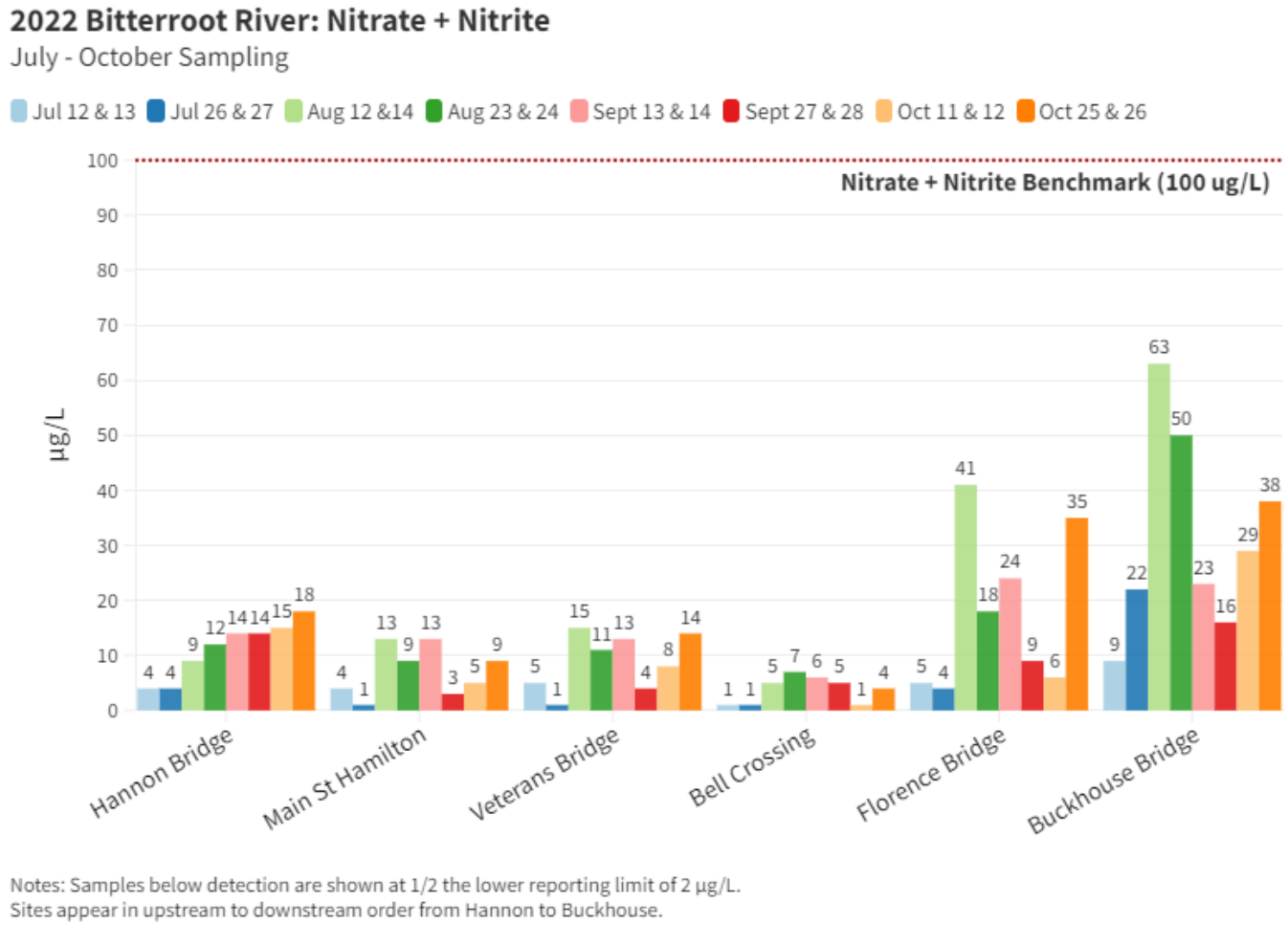


Figure 7. *Bitterroot River: 2022 Nitrate + Nitrite.* *Interactive graphic link.*

6.5 AMMONIA

Results of ammonia monitoring are presented in **Figure 8**. Concentrations were undetected in 25% of all samples (reported at ½ the lower reporting limit of 10 µg/L) with the highest recorded samples of 30 µg/L at 5 of the 6 stations.

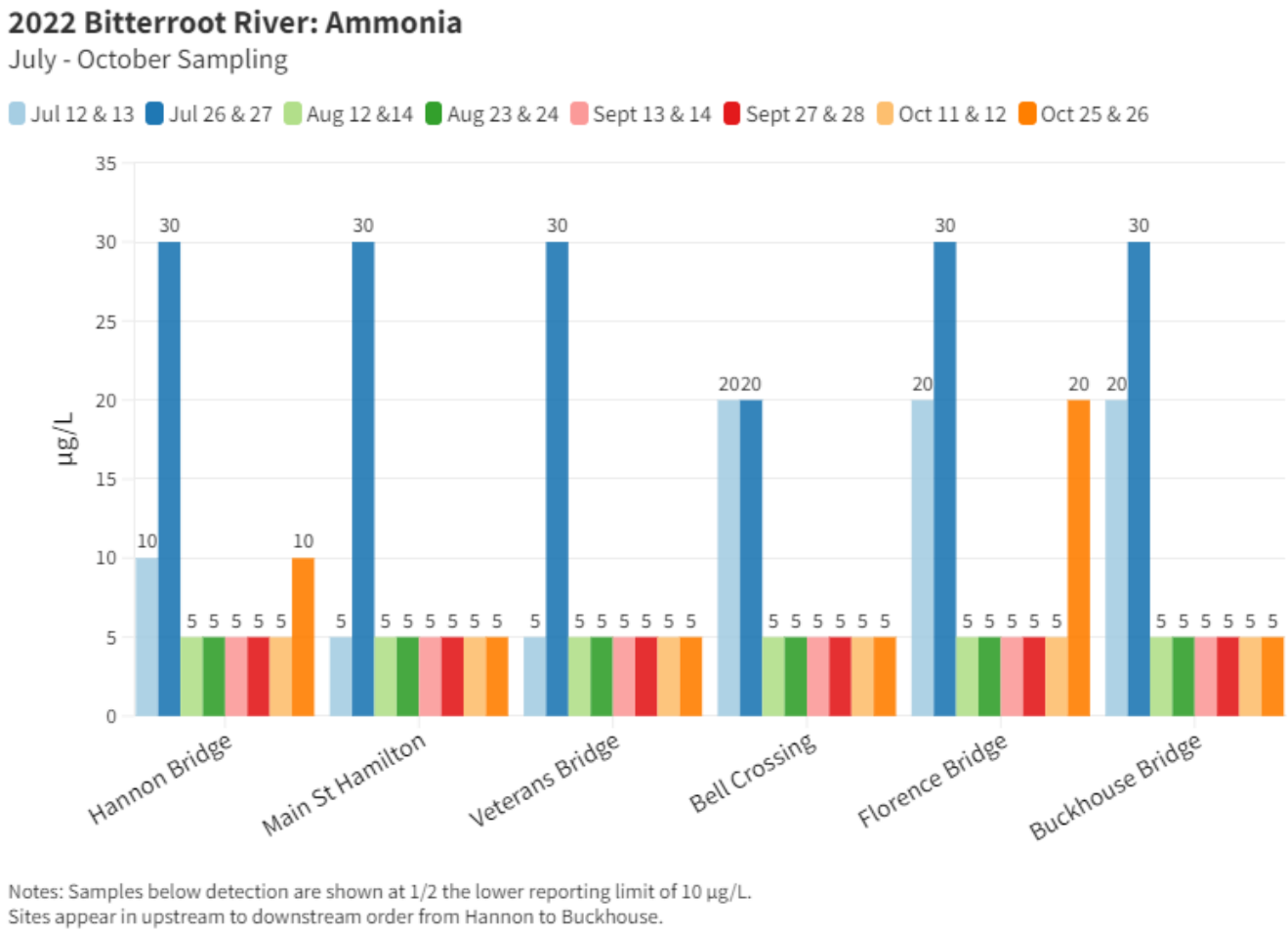


Figure 8. *Bitterroot River: 2022 Ammonia.* *Interactive graphic link.*

7.0 NITROGEN – PHOSPHORUS RATIOS

Since the observation of Redfield (1934 and 1958) that marine phytoplankton contains a molecular C:N:P ratio of 106:16:1 (40:7:1 by mass), the relative concentrations of N and P have been used to estimate which of these nutrients might be limiting, preventing additional primary production (algae growth) in aquatic ecosystems. Redfield also recognized that the ratio is an average with considerable variation by species, season, and environment. A departure from this ratio is assumed to imply nutrient deficiency such that by identifying which nutrient is responsible for enhanced algae growth, management actions can be directed toward the nutrient with the highest impact.

It is important to note that the C:N:P ratios in the above literature for benthic algae are for the internal contents of the algal matrix (cellular C:N:P concentration), not water column concentrations. The C:N:P of the benthic algal material is a much better estimator of nutrient limitation than water column TN:TP ratio. This is especially true for benthic algae; while water column total nutrients can be good estimators of optimal stoichiometry for phytoplankton (where suspended algal biomass is a large fraction of the total nutrients in the water column) benthic algae are more loosely coupled with the water column and respond only to bioavailable nutrients.

Total nitrogen-phosphorus ratios (by mass) were calculated for 2022 water column chemistry results and are shown below in **Figure 9**. The N:P Redfield ratio (by mass) is 7:1, and the color-coded thresholds in **Figure 9** are based on the following from Suplee and Watson (2013): "*Studies of benthic algae show that it is necessary to move some distance above or below the Redfield ratio in order to be strongly convinced that a lotic waterbody is P or N limited (Dodds, 2003). When a benthic algal Redfield ratio (by mass) is <6, N limitation is suggested, and when it is >10 P limitation is indicated (Hillebrand and Sommer, 1999). Thus, there is a range of N:P values between about 6 and 10 where one can state, for practical purposes, that algal growth is co-limited by N and P.*"

We also include dissolved N: P ratios (by mass) in **Figure 10** with caveats: the Redfield ratio is based on total N: P and the dissolved N:P ratios are simply presented for comparison.

For total N:P ratios, phosphorous limitation was far more common than nitrogen limitation. Nitrogen limitation was evident in only 2 of 48 samples, at Veterans Bridge during September. In contrast, 25 samples suggested phosphorous limitation and another 21 were indeterminate. Dissolved N:P ratios were more suggestive of nitrogen limitation, particularly at the two midstream sites of Veterans Bridge and Bell Crossing, where no phosphorous limitation was apparent. At the most downstream site, Buckhouse Bridge, estimated nutrient limitation was primarily phosphorous limited.

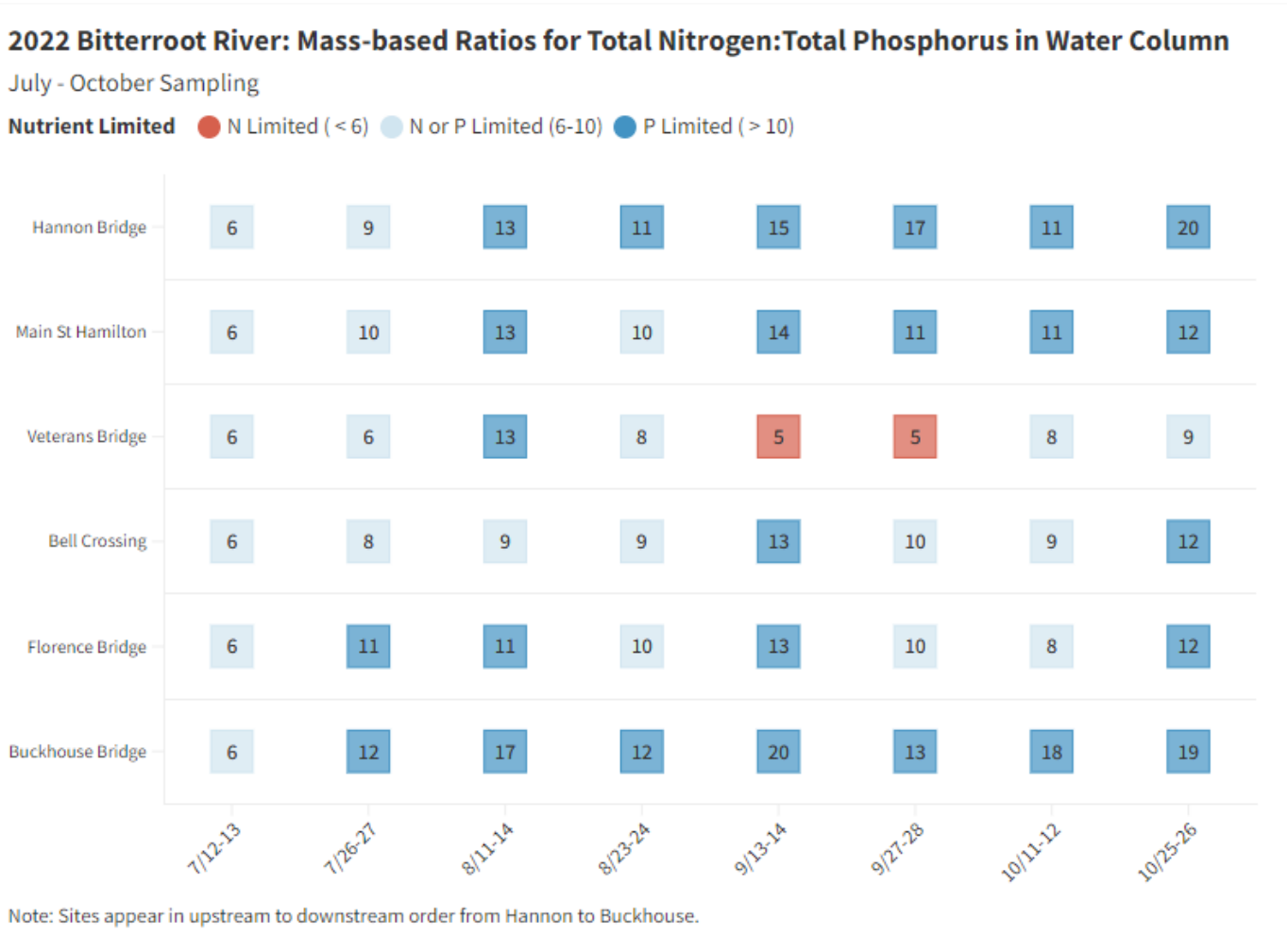


Figure 9. *Bitterroot River: 2022 Mass-based N:P ratios for Total N:P. [Interactive graphic link]*

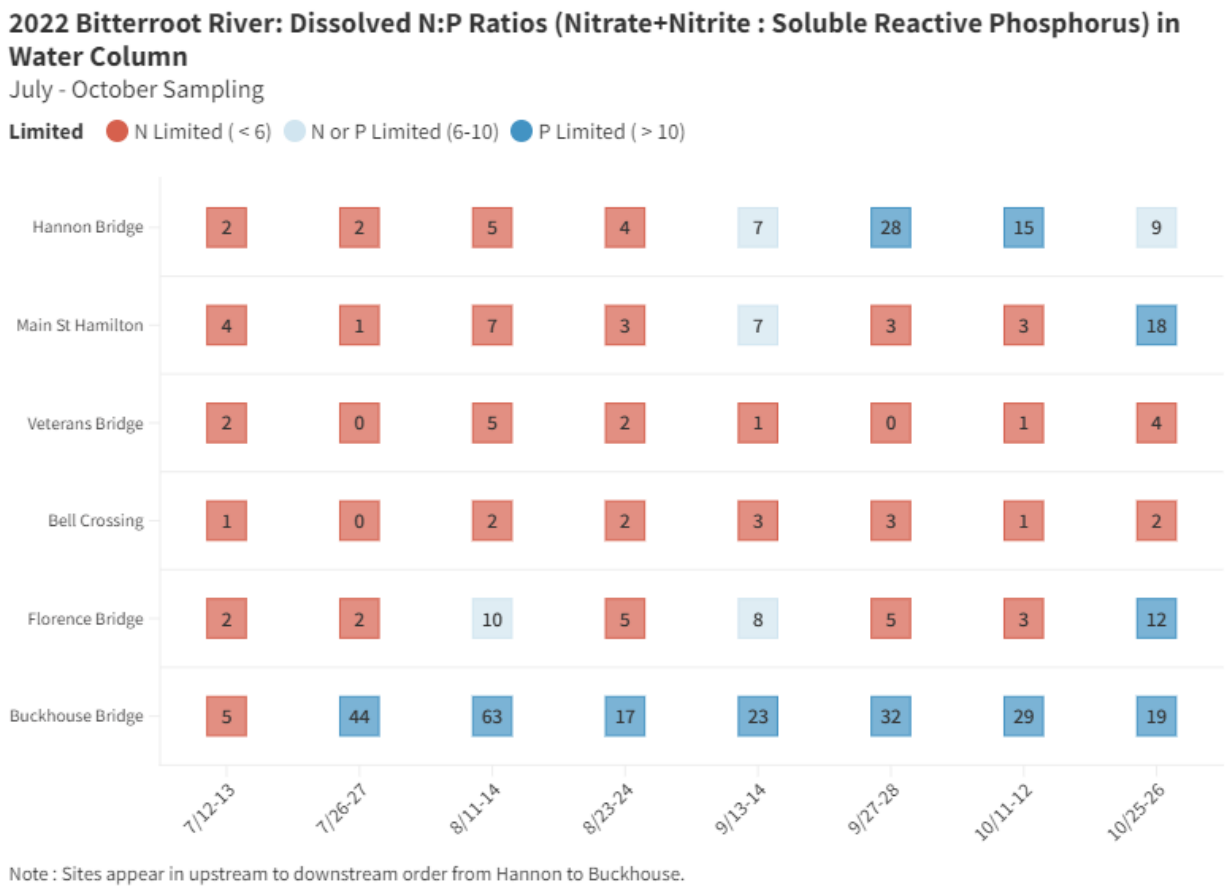


Figure 10. Bitterroot River: *2022 Dissolved N:P Ratios. [Interactive graphic link]*

8.0 BENTHIC ALGAE RESULTS

Benthic algae were sampled according to the QAPP at all sites in August and September. Averages for chlorophyll-*a* and ash free dry weight from each sample date are shown in **Figures 11 and 12**. Although no numeric standards for benthic algae chlorophyll-*a* are established for the Bitterroot River, the targets developed for upper Clark Fork River include a summer maximum of 150 mg/m^{2}and a summer mean of 100 mg/m^2. These targets are included here to provide context for interpreting the Bitterroot results. Chlorophyll-*a* concentrations in the Bitterroot were below both targets at all sites, with the highest concentrations found at Bell Crossing during the September sampling.

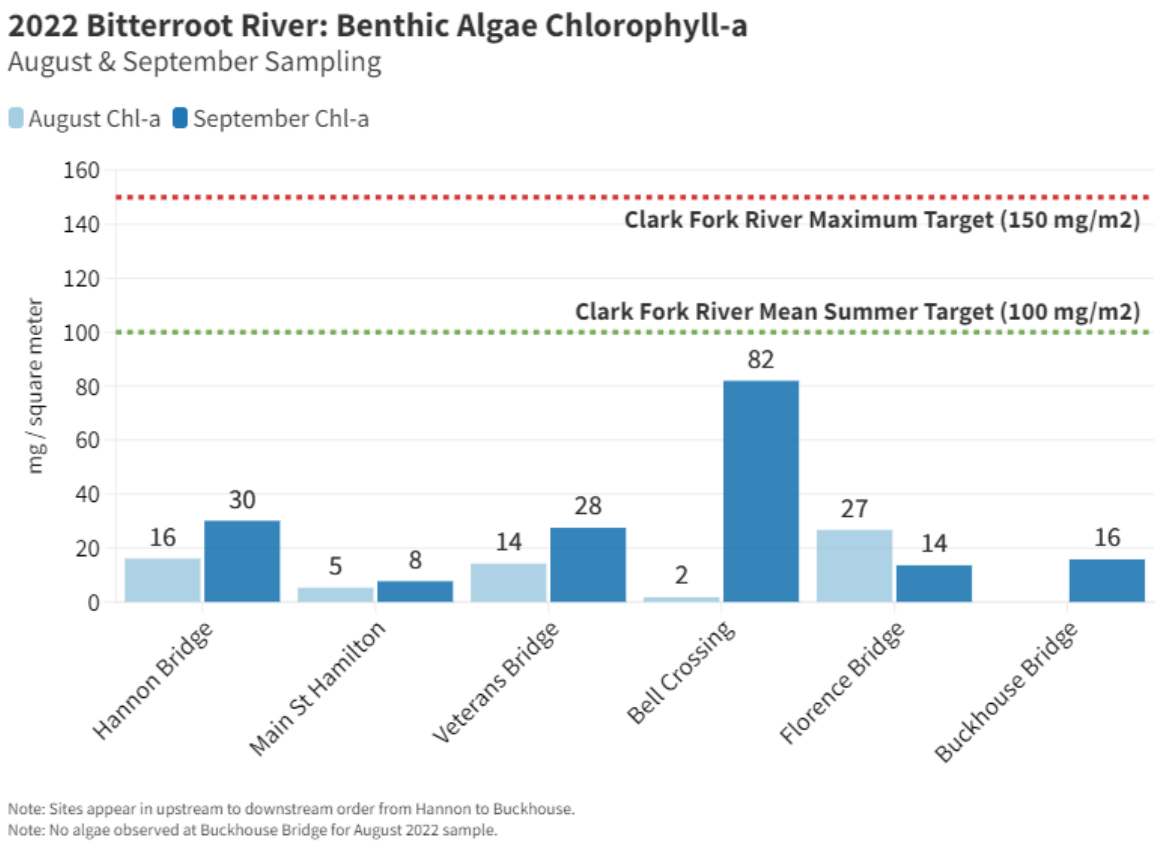


Figure 11. *Bitterroot River: 2022 Benthic Algae Chlorophyll-a. Interactive graphic link.*

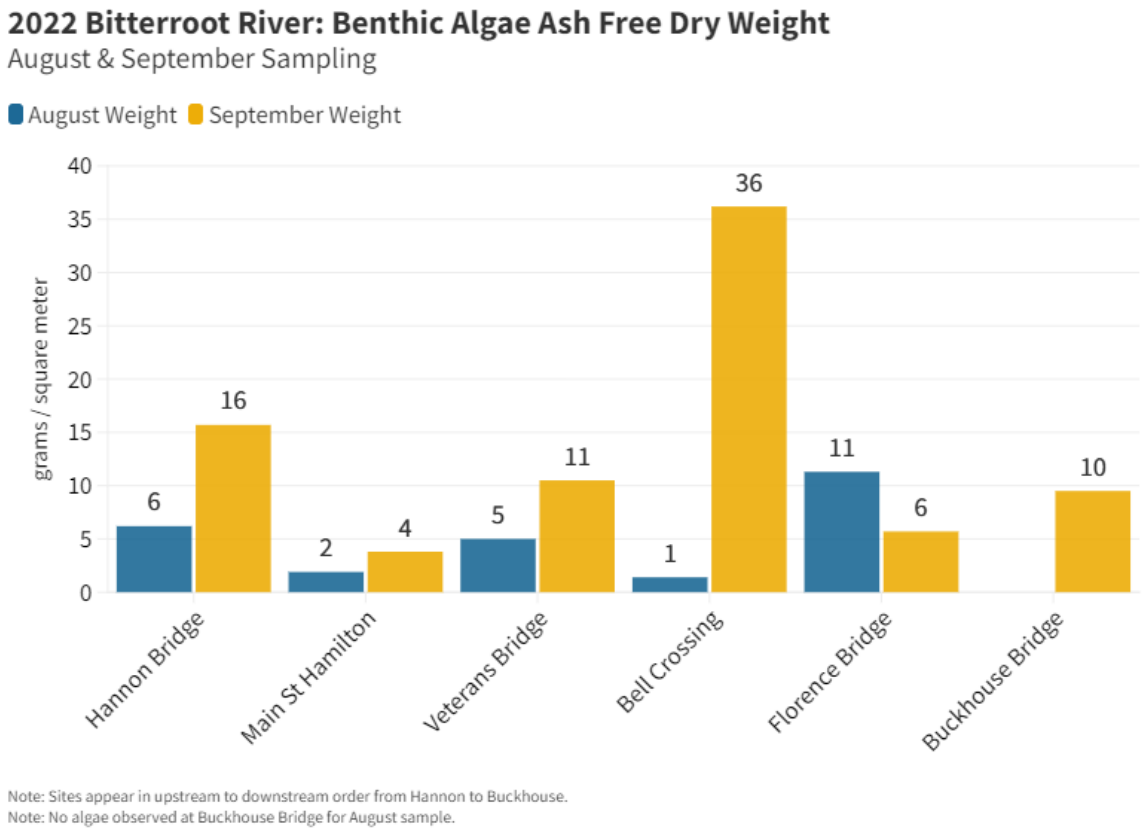


Figure 12. *Bitterroot River: 2022 Benthic Algae Ash Free Dry Weight.* *Interactive graphic link.*

9.0 REFERENCES

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