BATIQUITOS 2022 ANNUAL WATER QUALITY REPORT

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Background

The Batiquitos Lagoon in north San Diego County consists of 610 acres with a drainage basin of about 55,000 acres. The watershed basin includes the cities of Carlsbad, San Marcos, and Encinitas, with its primary freshwater tributaries being San Marcos Creek from the east and Encinitas Creek which flows north along Green Valley, entering the lagoon under El Camino Real and La Costa Avenue, respectively.[1] A dam built in 1952 to create Lake San Marcos in the upper watershed dramatically reduced the amount of freshwater flow into San Marcos creek and subsequently the lagoon. Consequently, accumulated silt has been filling up Batiquitos Lagoon, and the lagoon was expected to fill up within 50 years. In response, a dredging and enhancement project began in 1994 to allow tidal exchange with the ocean, thus slowing down the siltation process. Completed in 1997, the dredging project was funded by the Port of Los Angeles. Even so, Batiquitos Lagoon remains listed as a 303(D) - impaired waterbody under federal and state Clean Water Act regulations for sedimentation.

In addition, there have been numerous concerns regarding water quality in San Marcos Creek as a result of the release of water from Lake San Marcos. For example, during rainstorm events, lake operators have released “acre-feet of polluted water into the lower San Marcos Creek, ending up in the Batiquitos Lagoon Ecological Reserve and ocean”.[2] The Batiquitos Lagoon Foundation believes the Lake San Marcos dam operations and water releases are among the most significant ongoing threats to the lagoon’s water quality.[2] These concerns have been brought to the attention of the San Diego Regional Water Quality Control Board, underscoring the need for on-going water quality monitoring in the Batiquitos watershed (or “BTQ”).

For the 10-year period 2009-2018, San Diego Coastkeeper (SDCK) monitored BTQ on a regular schedule. Data for 2009-2016 are posted on the California Environmental Data Exchange Network (CEDEN). In the spring of 2019, Preserve Calavera created the North San Diego County Watershed Monitoring Program (NSDCWMP) to carry on the decade-long work of SDCK of assessing the health of local surface waters. Water quality in three coastal watersheds, all of which are part of the Carlsbad Hydrologic Unit (Fig. 1) and including BTQ (Fig. 2), is evaluated by sampling water at multiple locations on a bimonthly basis and measuring basic physical (temperature, conductivity, turbidity), chemical (pH, dissolved oxygen, nutrient and ammonia), and biological (total and pathogenic coliform bacteria) parameters.

NSDCWMP is an all-volunteer citizen science effort with a leadership management team comprised of three Preserve Calavera board members (also leaders of the Buena Vista Creek and Batiquitos Lagoon monitoring teams). Technical advisors from the California Water Resources Control Board as well as the San Diego Regional Water Quality Control Board (SDRWCB) provide guidance to the NSDCWMP. Data are posted at www.preservecalavera.org and on the CEDEN website and shared with SDRWCB and the city of Carlsbad.

Historically, SDCK monitored three sample sites within the BTQ (Fig. 3); two located on San Marcos Creek (BTQ020 and BTQ030), and the third on Encinitas Creek (BTQ010). Water is typically present year-round at BTQ010 and BTQ020; in contrast, BTQ030 is often dry during the summer and fall seasons. When water is present at BTQ030 during the dry season, it is likely the result of overflow or release from the San Marcos Lake Dam.

The NSDCWMP began in July 2019, with BTQ samples collected in July, September and November of that year. Although dissolved oxygen, pH and conductivity were within ranges considered "normal" for such watersheds, some exceedances of macronutrients (nitrogen and phosphorus) and bacterial indicators were observed.[3] No samples were collected from BTQ030 due to lack of water at this site. This annual monitoring effort continued in 2020 with an abbreviated schedule (due to COVID restrictions)[4], and in 2021 with a return to a full bi-monthly schedule.[5]

The purpose of this annual report is to 1) interpret the health of Batiquitos Lagoon for the testing period in 2022 and 2) look at historic trends (2009-present). Monitoring was conducted on a bimonthly schedule over the entire year (January, March, May, July, September, and November). Each water quality parameter was measured using standardized procedures and evaluated for anomalies against pre-established quality assurance/quality control (QA/QC) guidelines, including the analysis of field and lab blanks and sample duplicates. The overall state of the watershed compared with the previous year's (2019-21) monitoring data was summarized below for each parameter. Also, new to this year's report is the inclusion of a composite scorecard of water quality for each site as well as for the watershed in total.

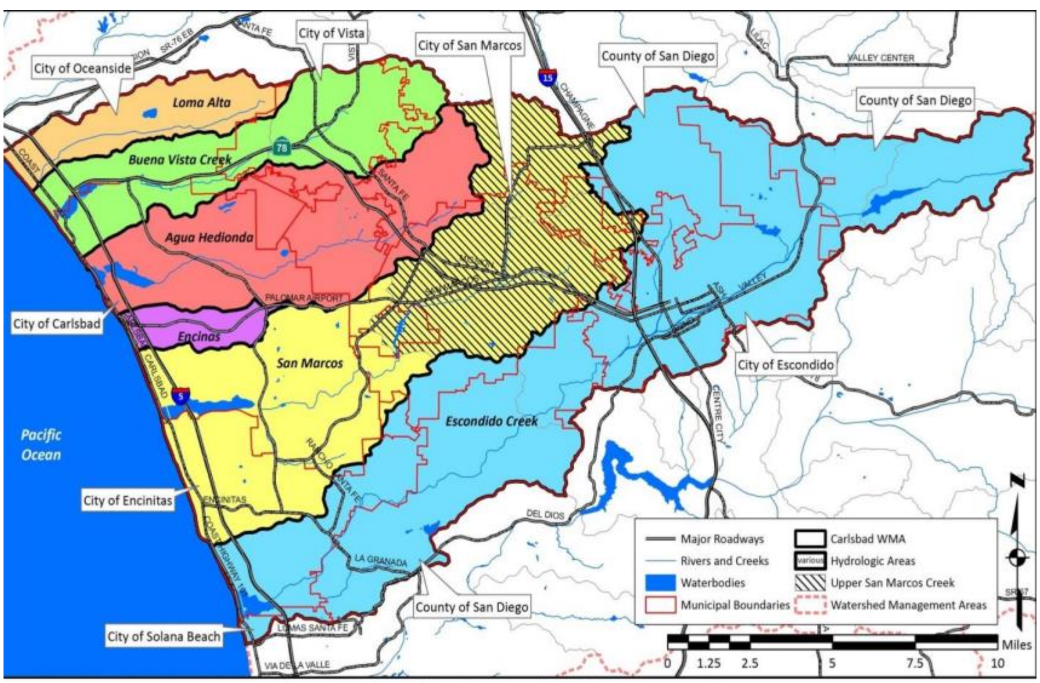


Figure ES-1: Carlsbad Watershed Management Area

Figure 1. Image from Prioritizing Invasive Species Management in the Carlsbad Hydrologic Unit
http://www.escondido.org/Data/Sites/1/media/pdfs/pubworks/carlsbad/150423_Final_Draft_Carlsbad_WQIP_Submittal.pdf

Figure 2. Image from Batiquitos Lagoon Ecological Reserve
https://wildlife.ca.gov/Lands/Places-to-Visit/Batiquitos-Lagoon-ER

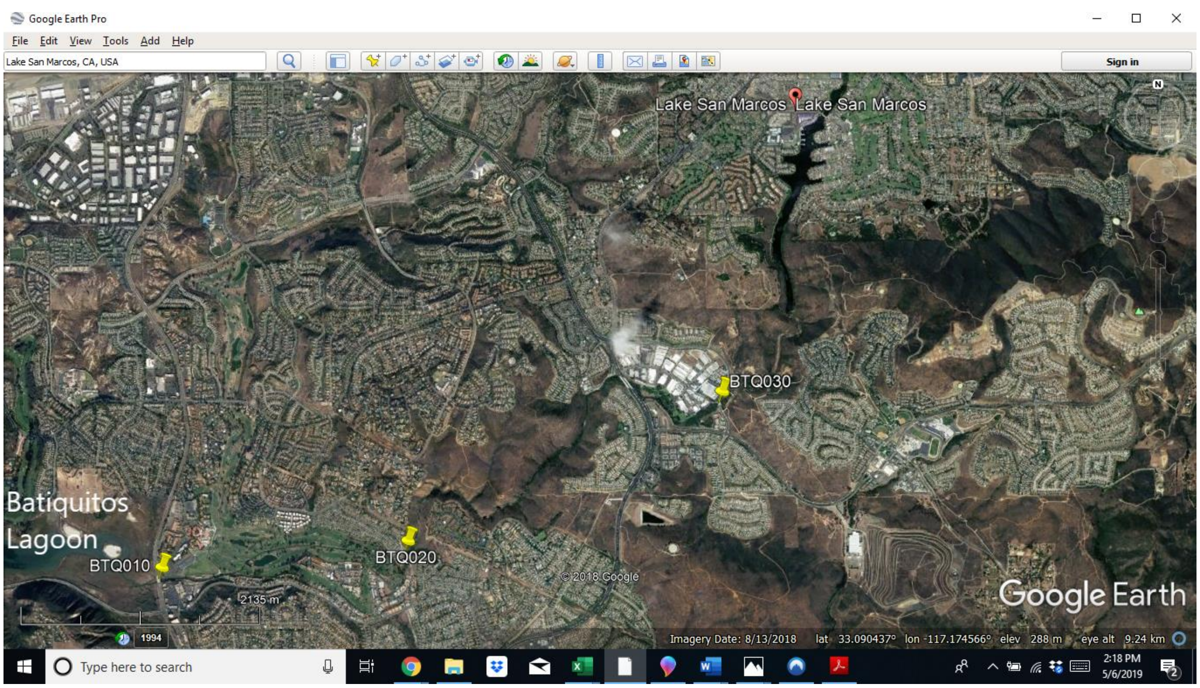


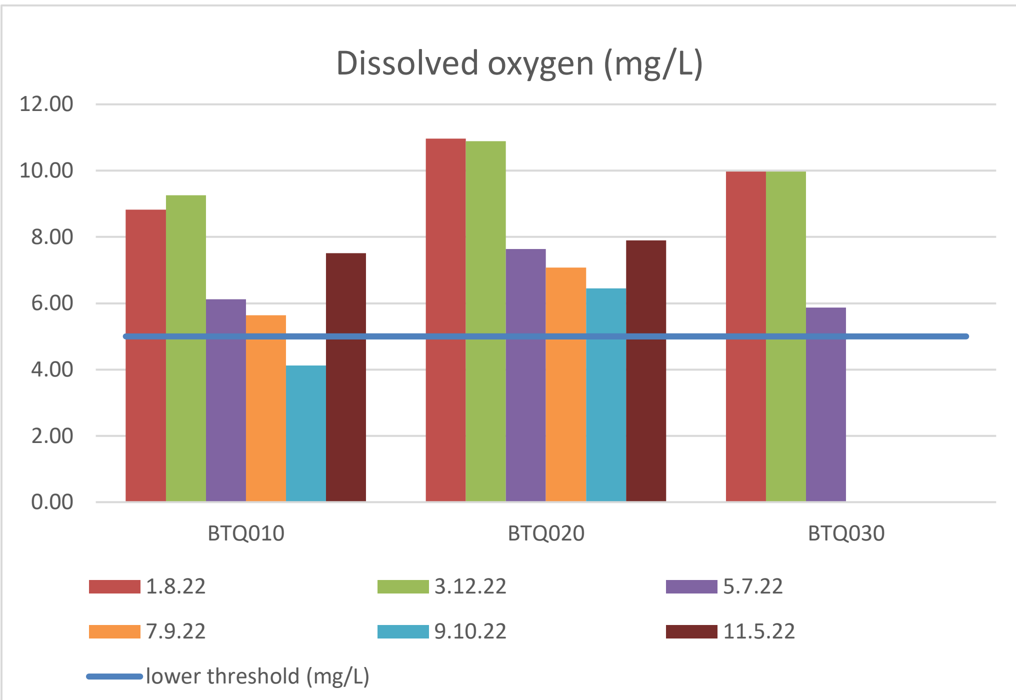
Figure 3. Batiquitos sampling sites.

Sampling Sites

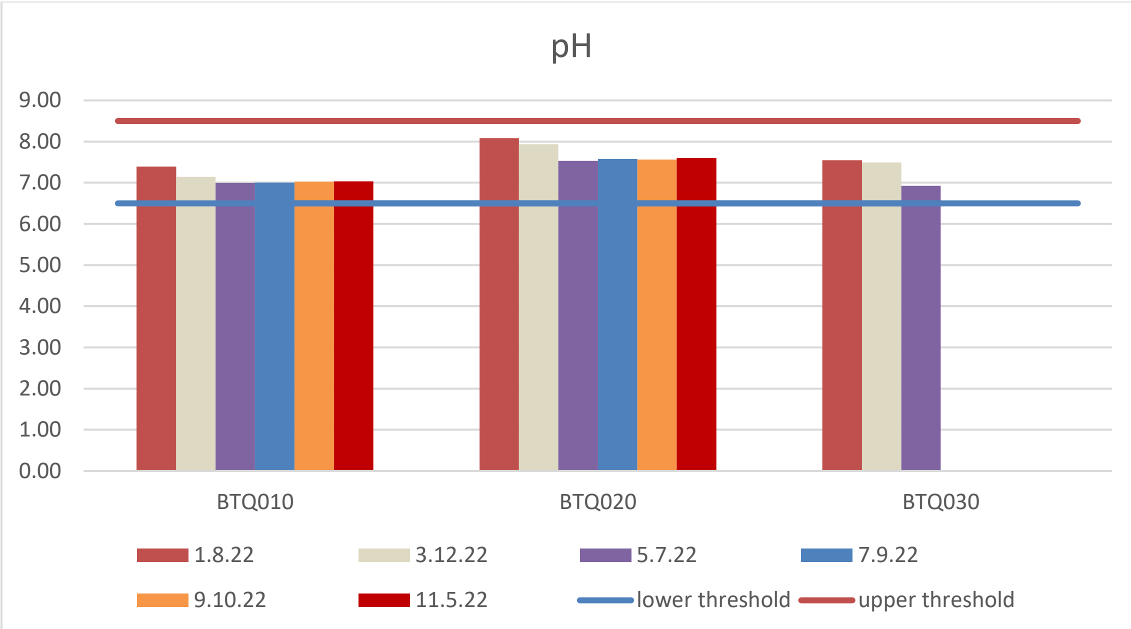
The Batiquitos team sampled the same three sites (BTQ 010, BTQ020, and BTQ030) as had been tested by SDCK (Fig. 3). Water samples were collected at all 3 sites for each sampling event, except for July, September and November for BTQ030, which was dry during these events. As a result, no data were presented for BTQ030 for these events.

Field Parameters

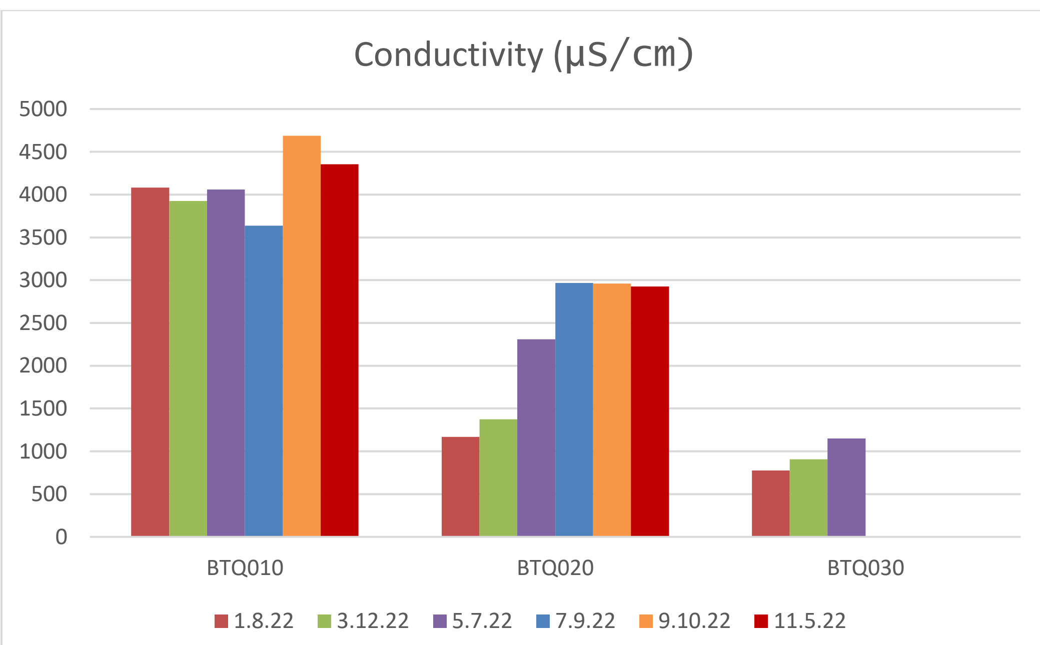
Dissolved oxygen (DO) for all six sampling events and sites was greater than the San Diego Basin Plan 3 threshold of 5.0 mg/L, except for BTQ010 on September 10. The decrease in DO from March through September corresponded to an increase in water temperature (12 to 22 deg C) at these sites over that period. The relatively higher levels of DO at BTQ020 suggested a higher degree of primary productivity compared to the other 2 sites. Limited measurements from 2020 and 2021 prevent a meaningful comparison of recent annual trends. These results suggest a healthy amount of oxygen in the water for aquatic animals for the period covered by these sampling events.



The pH ranged between 6.9 and 8.1 across all 3 sites for the entire year, well within the acceptable range for the Basin Plan 3 of 6.5-8.5. The relatively higher pH at BTQ020 compared to the other 2 sites (similar to the trend observed for DO, and consistent with the data reported for 2020) also supports the hypothesis that a higher degree of primary productivity is characteristic of this site. The pH was not measured in July, September and November for BTQ030 due to a lack of flow.



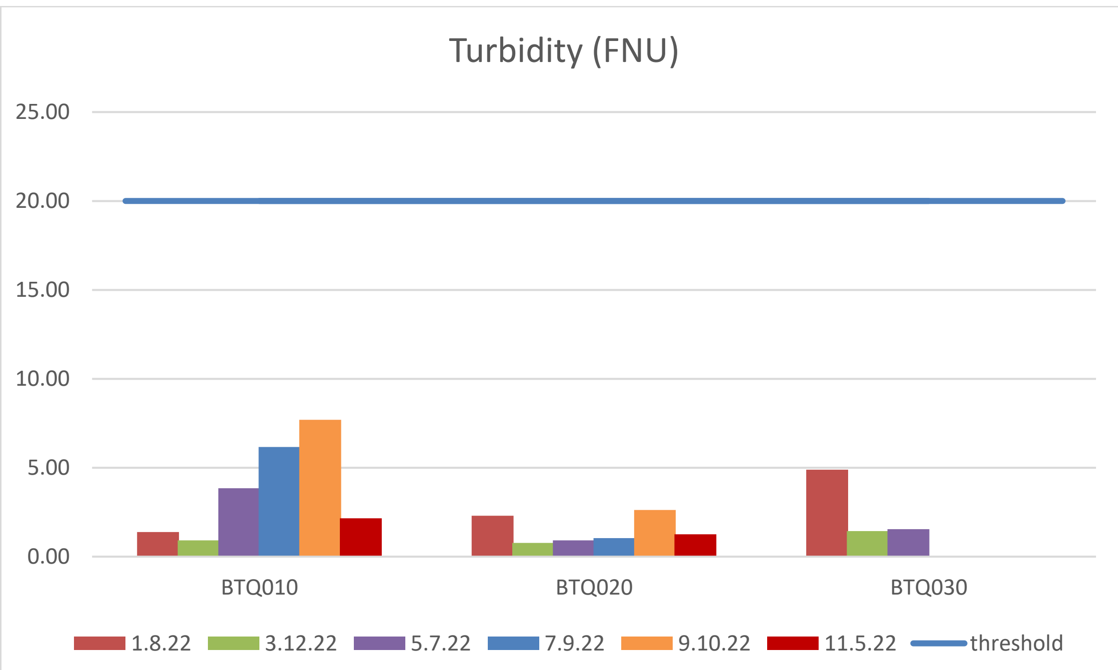
Conductivity fluctuated between 3500-4600 **µ**S/cm for BTQ010; 1000-3000 **µ**S/cm for BTQ020; and 750-1100 **µ**S/cm for BTQ030 (no measurements in July, September and November due to lack of flow). Conductivity appeared to be relatively stable for BTQ010, whereas it appeared to increase through July for the other 2 sites, perhaps due to a corresponding decrease in freshwater runoff into the dry season. The variability across sampling events was lower than for 2021, but the trends among sites (i.e., BTQ010 > BTQ020 > BTQ030) was similar to previous years, perhaps indicative of the increasing level of urbanization from the top to the bottom of the watershed. There is no threshold for conductivity, as it merely reflects the amount of dissolved minerals in the water.



Laboratory tests

Turbidity (cloudiness), total coliform, *E. coli*, nitrates, total and reactive phosphorus, and ammonia are measured in the lab on grab samples collected in the field.

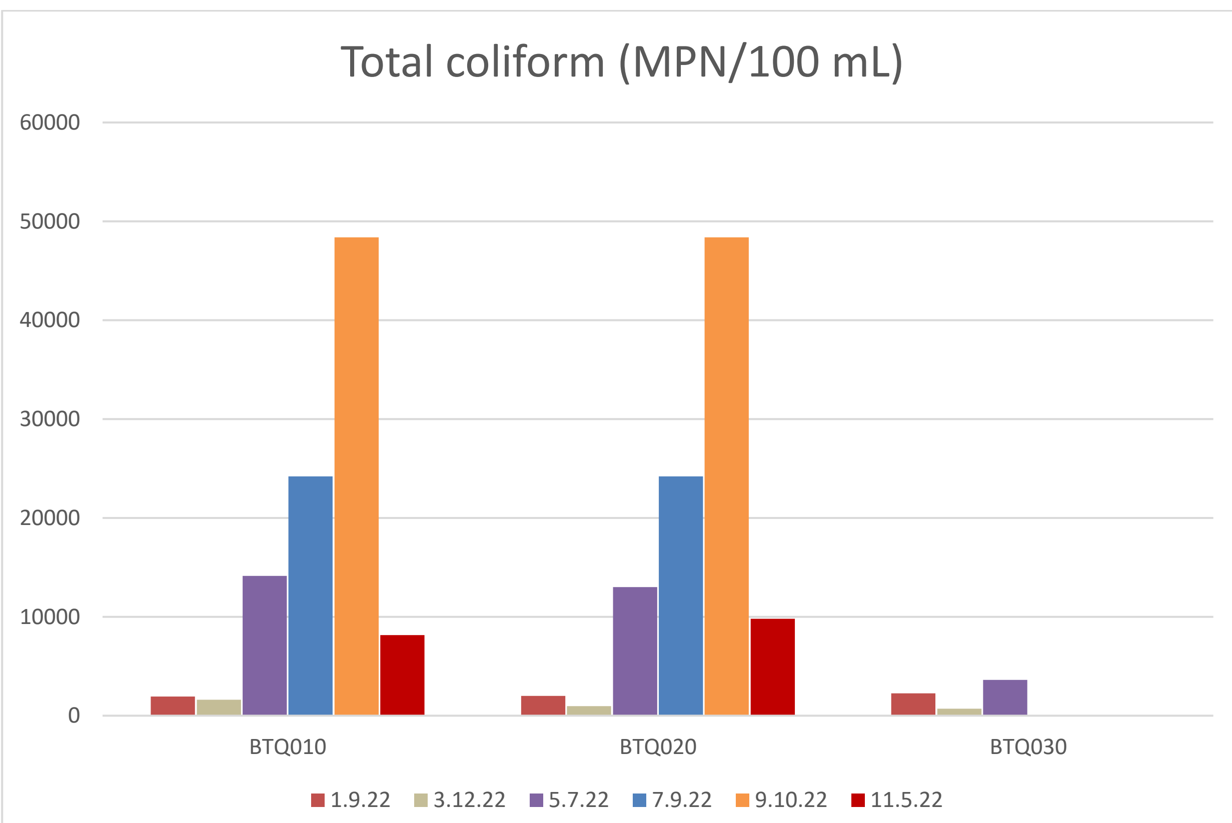
High turbidity can hinder light penetrating water which may affect photosynthesis. The threshold is 20 FNU, and all measurements were well under threshold. There were no obvious spikes in turbidity across the sites, similar to the data reported for 2021, but in contrast to 2020 where such spikes corresponded to recorded precipitation (and subsequent increased runoff flow) during selected sampling events. A possible trend of interest was the apparent increase in turbidity over time (through September) for BTQ010, the site with the highest degree of adjacent urbanization. No data were available for July, September and November at BTQ030 due to lack of flow. It should also be noted that the precision for turbidity based on field and lab duplicate samples for BTQ010 for the May and November sampling events were poor (RPD > 70%), and that measurable turbidity (2 FNU) was reported for the field blank sample collected for BTQ020 during the November sampling event.

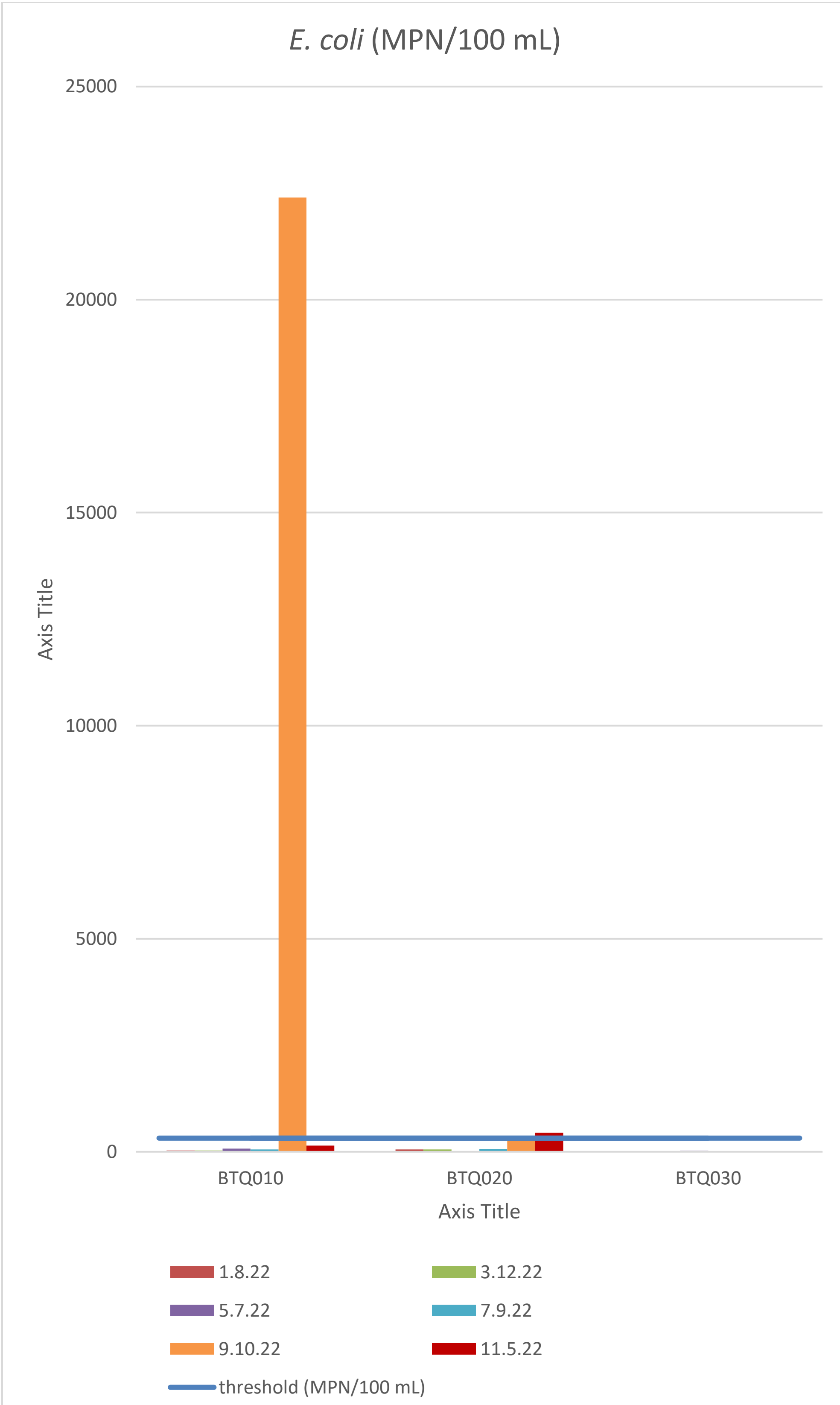


Coliforms are a group of bacteria found in the digestive tracts of animals, including humans and their wastes. They are also found in plant and soil material. Because they are not reliable indicators of pathogenic bacteria and/or origin, there is no threshold for the measurement of total coliform (TC). Similar to previous years (e.g., 2020-21), TC jumps noticeably between May through September, with a noticeable decline for November for BTQ010 and BTQ020. This steady increase over time was also observed in 2021, but differed slightly from the trend reported in 2020, where the November TC value remained elevated. The simplest explanation for these trends is the effect of ambient temperature and runoff associated with rainfall events coinciding with a specific sampling event. For example, the levels of TC observed in 2022 directly coincided with increasing ambient temperature through September, with a noticeable decrease for the November sampling event. The effect of runoff would certainly depend on the magnitude/severity of a given precipitation event, but for moderate rainfall and resultant runoff would be secondary to temperature in terms of influencing TC levels.[3]

E. coli is a better, but not perfect, indicator of pathogenic bacteria. The IDEXX Quanti-tray/Colilert method utilized in this program measures all *E. coli* (pathogenic or not). The threshold for *E. coli* is 320 MPN/100 mL[4]. Three of 15 measurements were above or near threshold, with the September and November values for BTQ010 and BTQ020 above the threshold. Interestingly, both events were associated with rainfall, strongly suggesting that local runoff most likely contained fecal matter. A similar number of exceedances and site pattern was reported for *E. coli* at these sites in 2021, with the timing of exceedances also reported in the warmer (May through November) months. Moreover, the highest levels of *E. coli* reported in 2020 was during the November sampling event where measurable precipitation was also likely a contributing factor.

It should be noted that the precision of TC and *E. coli* measurements in sample duplicates analyzed for the January and May sampling events was poor, approaching and/or exceeding 100% RPD in both cases. In contrast, the levels of TC and *E. coli* measured in field blanks were consistently low (i.e., < 10% of measured levels in actual field samples), suggesting that field collection is not a contributor to the poor precision reported for sample duplicates.



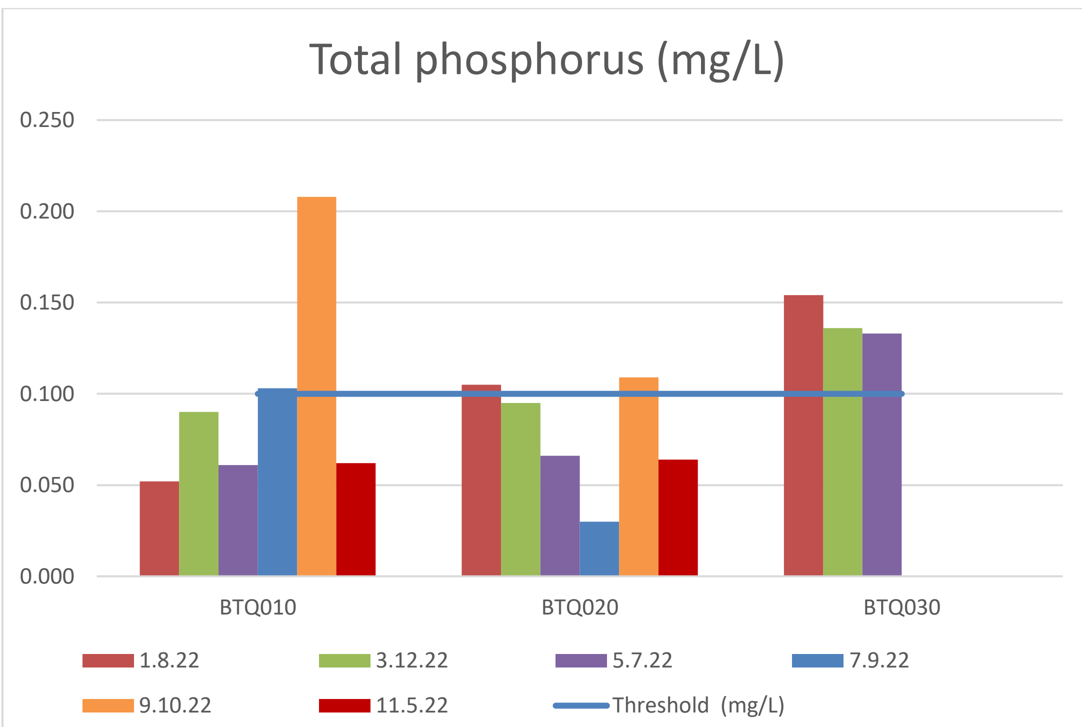


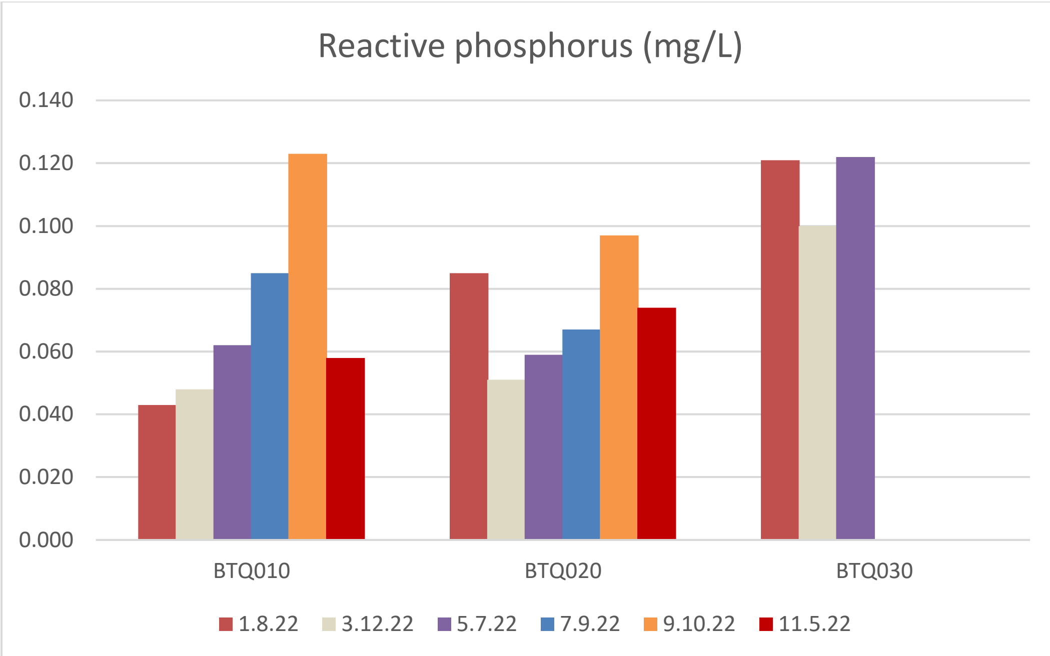
E. coli (MPN/100 mL)
25000
20000
15000
10000
5000
0
Axis Title
BTQ010
BTQ020
BTQ030
Axis Title
1.8.22
3.12.22
5.7.22
7.9.22
9.10.22
11.5.22
threshold (MPN/100 mL)

Elevated total phosphorus (TP) is often the result of fertilizer runoff and can lead to algal blooms. The threshold for TP in San Diego watersheds is 0.1 mg/L[6]. For 2022, the range for total phosphorus was 0.03 to 0.21 mg/L with 7 of the 12 measurements at or above the threshold, most notably the measurement for BTQ010 (and BTQ020 to a lesser extent) associated with the precipitation recorded for the September event. As was observed in 2019-21, TP was most frequently exceeded at BTQ030, perhaps indicating its enrichment in water released from Lake San Marcos.

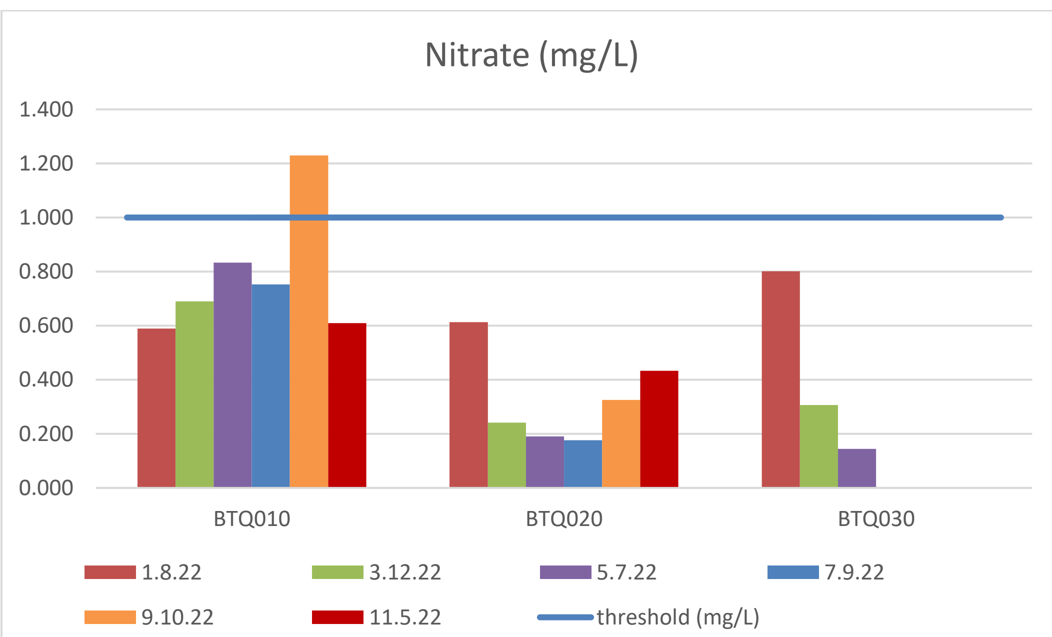
Reactive phosphorus (RP, aka "polyphosphates") is the ionic form of this element that is preferred by living organisms, otherwise known as "bioavailable" phosphorus. There is no water quality threshold for RP. As was observed in 2019-21, no apparent trend by site or sampling event was observed for the 2022 data.

It should also be noted that RP exceeded TP for only a single measurement (BTQ020 in July), constituting an improvement over previous recent years, where multiple instances of RP > TP were noted. In addition, the precision achieved with TP and RP measurements in field and lab sample duplicates was largely deemed acceptable (i.e., RPD < 25%). Taken together, these data indicate an improvement in the quality and consistency of TP and RP measurements in 2022 versus previous years.

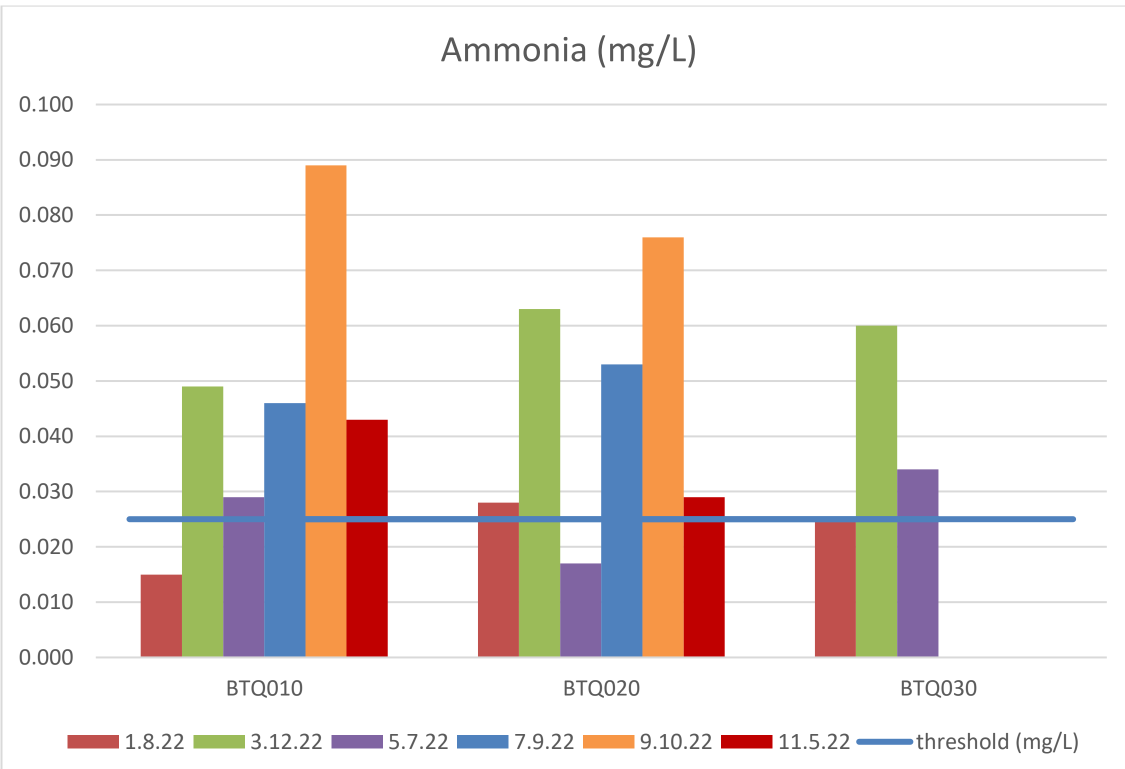




As with phosphorus, nitrate also_enters waterways via fertilizer runoff. Similar to 2019-21, BTQ010 had higher levels of nitrate compared to the two other sites, with the notable exception of the January sampling event, where this trend was somewhat reversed (i.e., BTQ010 ~ BTQ020 < BTQ030). Most nitrate values, however, remain below the threshold of 1.0 mg/L. The lone exception was the measurement for BTQ010 for the September event, for which measurable precipitation was recorded.



Lastly, for ammonia, the threshold is 0.025 mg/L. Similar to 2020-21, multiple measurements exceeded the threshold, however, the number of exceedances (12 of 15 total measurements) were higher than in recent previous years. Moreover, the exceedances were irrespective of site, whereas in previous years, few to no exceedances were recorded for BTQ030. Like many of the other parameters, the highest concentrations were observed for the September event, when precipitation was a factor. Beyond that, no obvious pattern or trend was discernable in the data over time and/or across sites. It is noteworthy, however, that ammonia levels in field blank samples collected at BTQ020 in March and November (0.065 and 0.074 mg/L, respectively) were greater than all but 4 of the 15 measurements, as well as being well above the threshold of 0.025 mg/L. These results suggest that the ammonia data for 2022 should be interpreted with caution, and that both the analytical method and selection of threshold level should be reviewed for relevancy and utility for future monitoring cycles.

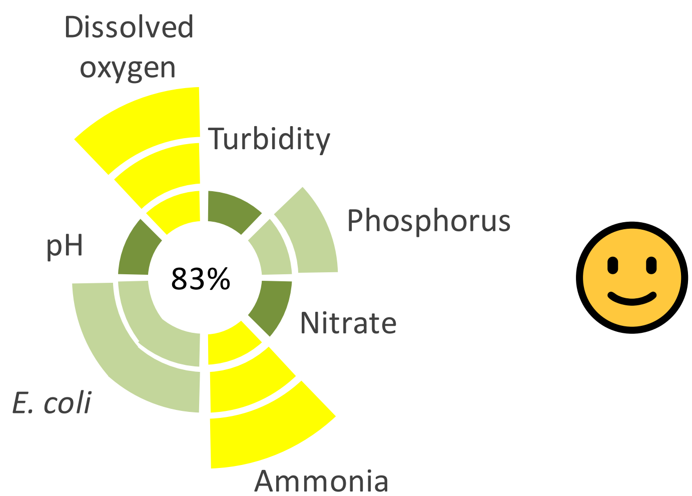


Water Quality Report Card (new)

New to the 2022 Annual Report is the inclusion of composite water quality "fan" diagrams generated from scores (0-5) for each of the seven parameters with an established threshold (pH, DO, turbidity, TP, nitrate, ammonia and *E.coli*) for each site as well as the watershed as a whole. A composite ranking (as a percentage) is computed from the weighted averages of all parameter scores (with *E. coli* weighted double). Rankings are arbitrarily classified as follows: 90-100% (Excellent); 80-90% (Good); 70-80% (Fair); 60-70% (Poor); <60% (Terrible).

Overall, the BTQ watershed was graded "Good" (83% composite ranking) for 2022. Parameters that were deemed as improvable were DO and ammonia. Across sites, BTQ010 was graded lowest (77%) with ammonia and TP identified as improvable. BTQ020 was graded intermediate (80%) with ammonia identified as improvable. BTQ030, the highest site in the watershed, was gradient as having excellent water quality (91%),

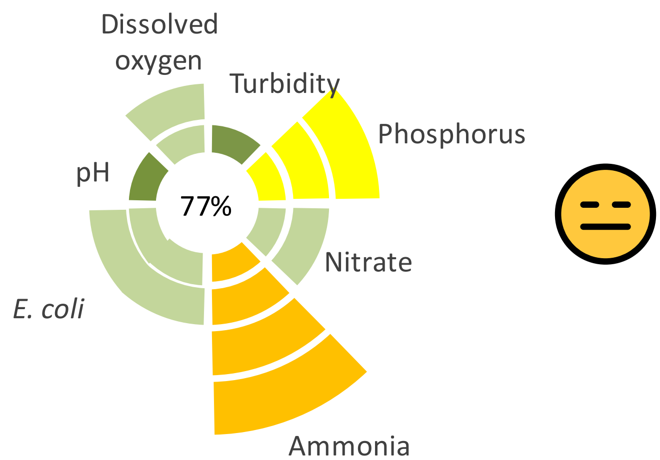
Batiquitos/San Marcos watershed 2022



Good -> bad ≡ green → red;
increasing depth of wedge ⇒ bad

Design from InfoDiagrar

BTQ010 Site 2022



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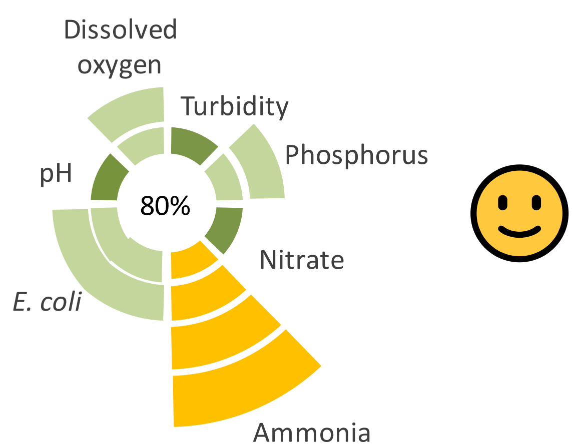
BTQ020 Site 2022



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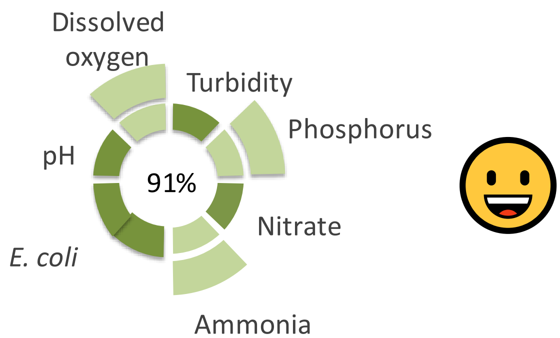
BTQ030 Site 2022



Good -> bad ≡ green → red;
increasing depth of wedge ⇒
bad

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Final thoughts

Threshold exceedances for *E. coli,* total phosphorus and ammonia for November at BTQ010 and BTQ020 highlight the interplay between the seasonal climatic pattern (ambient temperature increase through the middle of the calendar year) and the timing of runoff from precipitation events as they affect water quality. In 2022, measurable precipitation coinciding with the September and November sampling events likely served to mobilize contaminants into the BTQ watershed. For microbial constituents such as total coliforms and *E. coli*, the juxtaposition of runoff mobilization onto the warmest ambient temperatures of the year likely resulted in comparatively elevated levels.

The general trends in water quality, both over the annual sampling cycle and across the 3 BTQ sites, were similar to those observed in recent years (i.e., 2019-21). A new composite water quality metric or "ranking" suggests that water quality across the 3 BTQ sites is good, and in the case of the uppermost site (BTQ030), water quality is excellent (albeit for flow that is intermittent). As BTQ030 is arguably situated in an area with the lowest degree of urban development, the relative rankings follow the hypothesis that water quality is impacted by the degree of urban development.

Lastly, the value of QA/QC in validating and correctly interpreting basic water quality monitoring data cannot be understated. In the 2022 data set, poor precision for specific parameters -- namely ammonia, total coliforms and *E. coli* – for some sample duplicates raises issues regarding the accuracy of such data.

This is especially critical for ammonia, which is typically measured at levels at or near a low-level threshold. Thus, NSDCWMP should consider revisiting the performance limits of such assays, the utility and relevance of current thresholds, as well as to continue to emphasize the importance of standardized procedures in their training of field and lab personnel to minimize measurement artifacts and anomalies.

[1]https://batiquitoslagoon.org/about.html
[2]https://batiquitoslagoon.org/blf_newsletter_2-2018.pdf
[3]Batiquitos 2019 Annual Report
[4]Batiquitos 2020 Annual Report
[5]Batiquitos 2021 Annual Report
[6]https://www.waterboards.ca.gov/sandiego/water_issues/programs/basin_plan/docs/R9_Basin_Plan.pdf

Acknowledgements

The authors thank Paige DeCino, coordinator for the NSDCWMP, and her team of volunteers.

APPENDIX A

Sampling Site BTQ010 (Encinitas Creek @ Levante St. Bridge) – January 2022

July 2022

Sampling Site BTQ020 (San Marcos Creek @ end of Gibraltar Ave) - January 2022.

July 2022

Sampling Site BTQ030 (San Marcos Creek @ Melrose Ave bridge), January 2022.

July 2022 (no flow)