Glenns Creek Water Quality Data Analysis Report

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Executive Summary

This report details the monitoring results, data quality, and pollutant loading for the Glenns Creek Watershed, located in Woodford and Franklin Counties. This monitoring was performed in 2021 and 2022 with the goal of producing data to support a watershed plan and formal designated use assessment.

Field observations noted the presence of scattered trash, widespread erosion and sedimentation, and abundant algal growth throughout the watershed. The scattered trash indicates the need for increased community stream litter cleanups and improved stormwater trash interception. The erosion and sedimentation reveal unstable channel morphology seeking to adapt to changes in the hydrology and the imperviousness of the upstream land use. Efforts reduce the volume and velocity of stormwater by detention, infiltration, or redirection of stormwater or decreasing the areas covered by impervious surfaces would help reduce further impacts while stream restoration or bank stabilization efforts will be necessary to improve existing impacts, particularly in the downstream portion of the watershed. Abundant algal growth is driven by high concentrations of nutrients in the watershed. Invasive plant species observed in the headwaters should be treated immediately to prevent spreading to downstream environments.

In situ measurements indicated no exceedances for water temperature or dissolved oxygen but one exceedance of regulatory levels for pH (likely due to the abundance of algal growth) and high conductivity in the headwaters in Versailles due to sodium chloride (likely due to road salting).

Laboratory results indicated exceedances of benchmarks and regulatory criteria for *E. coli*, nitrogen, phosphorus, total dissolved solids, chloride, iron, and lead. For all parameters, pollution loading sources were traced to headwater drainages upstream of Millville.

For *E. coli* swimming recreational criteria were exceeded at all sites upstream of Millville and wading uses may periodically be impacted in some locations. To achieve recreational targets, reductions efforts should be targeted towards the Camden Creek watershed, upstream of Steele Road along Glenns Creek and Dorans Run, the Versailles karst basin draining to Big Spring Park, and Grassy Springs tributary in that order of priority.

Nitrogen loading was highest from the Camden Creek watershed, with other prominent sources including areas upstream of Steele Road along Glenns Creek and Dorans Run, downstream of the wastewater treatment plant in Versailles, and upstream of Big Spring Park in Versailles. For phosphorus, the wastewater treatment plant was the largest source with other contributions from the Camden Creek watershed, with other prominent sources including Glenns Creek, Dorans Run, and Camden Creek.

High dissolved solids, lead, and chloride are due to sources in the Versailles area, particularly due to road salt from urban runoff. Elevated iron concentrations are likely linked to suspended sediment.

The data was found to be sufficient for its purpose and will inform subsequent watershed planning efforts.

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1 Background

The Glenns Creek Watershed (HUC12-051002050709) is located in Woodford and Franklin Counties, with a drainage area of 33.9 square miles. Its headwaters are located in the city of Versailles and its mouth drains into the Kentucky River, just south of Frankfort and the I-64 overpass.

In 2020, a group of partners including Kentucky Water Resources Research Institute (KWRRI), the Kentucky Division of Water (KDOW), the University of Kentucky College of Agriculture, Food and the Environment Cooperative Extension Service (UK CES), Watershed Watch in Kentucky, Kentucky River Watershed Watch, the Kentucky Division of Environmental Program Support, and Beam Suntory mutually agreed to perform monitoring of the Glenns Creek Watershed. This agreement was based upon the local importance and interest of the community in these waterbodies, volunteer data indicating the potential presence of impairments, and recent spills resulting in fish kills and a desire to evaluate recovery. The goal of the monitoring was to produce data of sufficient quality and quantity to support the formal assessment of the warmwater aquatic habitat and primary contract recreation designated uses of Glenns Creek and its tributaries and to support the development of a watershed plan.

Monitoring was performed between March 2021 and February 2022 according to the "Glenns Creek Monitoring Plan Quality Assurance Project Plan" (QAPP) (Evans, 2020). This report details the monitoring results, data quality, and pollutant loading for the data collected during the effort.

2 Methods

Water quality monitoring consisted of two event types: monthly water quality events and *E. coli* events. All monitoring was conducted by KWRRI and UK CES at nine locations (Table 1 and Figure 1) over a one-year period.

In all events, stream flow, field observations, and in situ measurements were collected at each site. Stream flow was measured using an OTT MF Pro Water Flow Meter mounted to a top-set wading rod utilizing automatic water depth sensors for segment depth, fixed period averaging over 30 seconds for the velocity measurements, and the mid-section flow calculation option. A zero-velocity check was performed daily, prior to measurements. A Hanna multimeter (Model HI98194) was used to measure dissolved oxygen, dissolved oxygen percent saturation, pH, specific conductance, and water temperature with calibration (3-point for pH, 1 point for conductivity, and saturated air for dissolved oxygen) occurring within 24 hours of measurement and typically the morning of the sampling. Field observations were recorded at each site location.

Monthly water quality monitoring was conducted during 12 events between March 2021 to February 2022. Though initially schedule to begin in November 2020, the sampling was delayed due to permissions at sampling locations and COVID-19 restrictions on laboratory delivery. Events were typically prescheduled for a set day of the week with some flexibility to capture at least two wet weather events (at least 0.1 inches of rainfall) over the monitoring period. Grab samples were collected at each site for *E. coli*, bulk parameters (5-Day carbonaceous biochemical oxygen demand, turbidity, total dissolved solids, total suspended solids, chloride, fluoride, bromide, nitrate, nitrite, sulfate, orthophosphate), nutrient parameters (ammonia, total Kjeldahl nitrogen (TKN), total organic carbon, total phosphorus), metal parameters (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc), and alkalinity parameters (total hardness, acidity, alkalinity, carbonate alkalinity, and bicarbonate alkalinity). Grab samples were preserved according to method specifications and transported to the Division of Environmental Program

Support laboratory for analysis within method holding times and temperature requirements, utilizing standard chain-of-custody procedures.

An additional four *E. coli* events were conducted in May 2021 such, in conjunction with the monthly events, five *E. coli* samples were collected within 30 days.

Table 1 - Glenns Creek Watershed Sampling Location Summary

Site ID (Short)[1]	Site Description	Latitude	Longitude	Land use Description	Incremental Drainage Area (sq mi)[2]	Total Drainage Area (sq mi)[2]
51	Big Springs Park, 175 meters below Park Str bridge	38.053411	-84.733386	City of Versailles, Park Access	2.45	2.45
50	Glenns Creek Headwaters, d/s of WWTP outfall off access road	38.061164	-84.752486	Downstream of wastewater treatment plant and headwaters	0.96	3.41
49	Camden Creek, private drive off SR 1659	38.084792	-84.771309	Horse farms and research farm	6.65	6.65
42	Glenns Creek Baptist Church, above SR1685 bridge	38.096515	-84.793226	Horse farms, other agriculture	9.11	19.17
48	Grassy Springs Tributary, below SR1659	38.114637	-84.803505	Horse farms, other agriculture	4.83	4.83
47	Millville Community Park, Off SR 1659	38.120661	-84.826159	Downstream of Grassy Springs Tributary and Upstream of Millville, pasture, distillery	4.24	28.77
46	Below Millville, u/s of Castle and Key	38.143159	-84.831548	City of Millville, forest and pasture	2.59	30.85
45	Above Old Crow, d/s of tributary at 1.75 stream mile	38.148830	-84.835429	Distillery, forest, pasture, warehousing	1.32	32.17
44	Mouth / Below Distilleries, private drive off SR 1659	38.14749	-84.84925	Distilleries, warehousing, forest	1.64	33.80

[1]Full Site identification is DOW040130XX, where XX are the last two numbers retained in the shortened site ID.
[2]Includes karst drainage

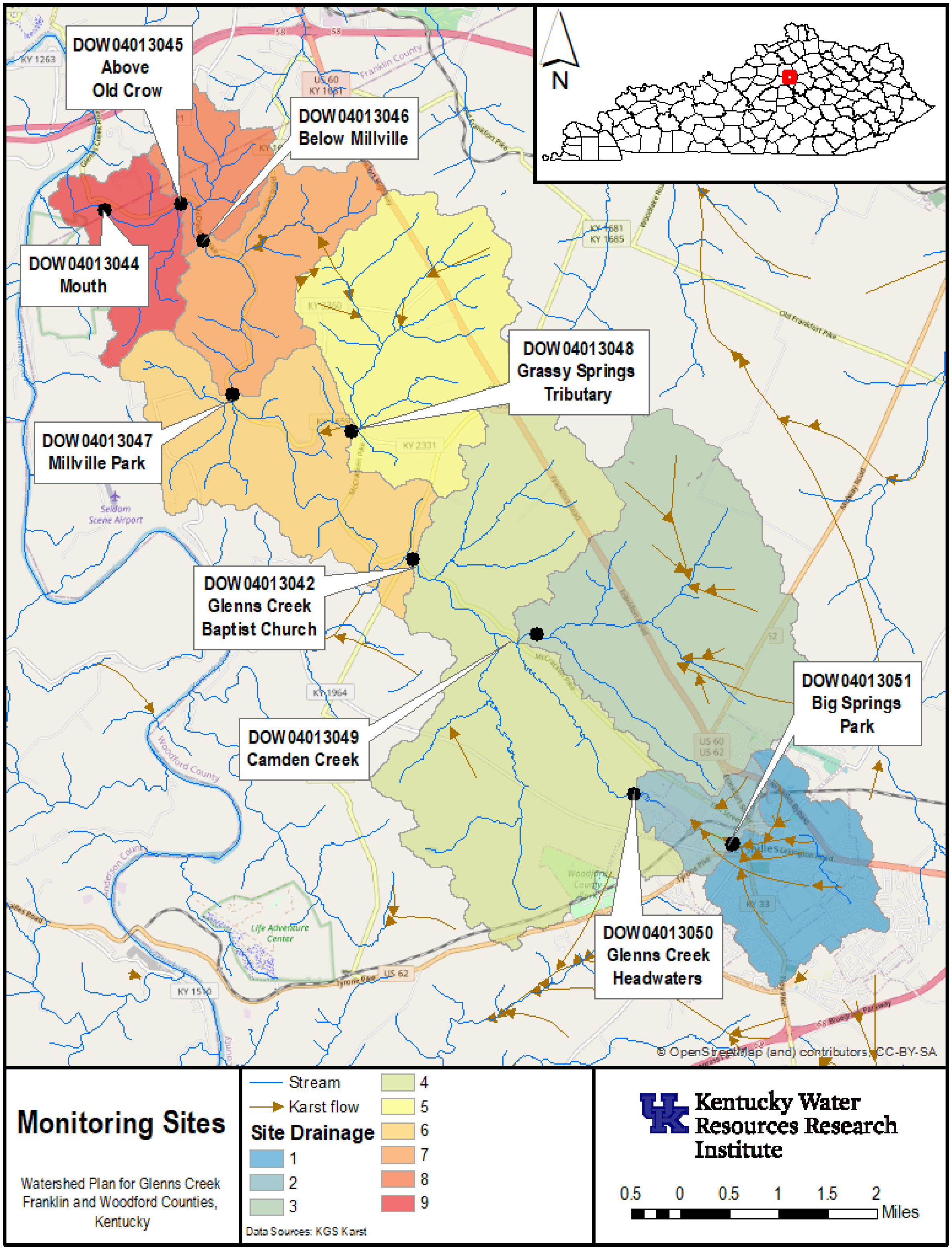


Figure 1: Glenns Creek Monitoring Locations

3 Benchmarks

To evaluate the nature and extent of impairments in the watersheds, results were compared to applicable water quality criteria. Both numeric and narrative criteria are applicable for this analysis. Numeric criteria are those for which a specific concentration of the pollutant is directly linked with impairment in the designated use. Other parameters, such as nutrients, specific conductance, suspended solids, or dissolved solids, are expressed as narrative statements in regulation due to the variable relationship between biological integrity and concentration levels in different waterbodies. For this plan, the narrative criteria have been translated using watershed-specific information into "benchmarks" that represent levels below which the narrative criteria are likely to be met in these streams. For the purposes of this plan, we refer to the criteria and narrative benchmarks all as "benchmarks" for simplicity. The benchmarks used for this analysis are summarized in Table 2.

The water quality criteria for surface waters in Kentucky are found in 401 KAR 10:031. The regulation provides minimum water quality criteria for all surface waters as well as criteria that apply to specific designated uses. All streams monitored have designated uses of warmwater aquatic habitat (WAH), primary contact recreation (PCR), and secondary contact recreation (SCR). Criteria for PCR are applicable during the recreation season of May 1 through October 31. SCR criteria are applicable to the entire year. WAH criteria are often divided between acute (protective of aquatic life based on one-hour exposure) and chronic (protective of aquatic life based on 96 hours of exposure). Domestic water supply (DWS) criteria apply to the existing points of public water supply intakes.

Because SCR use assessment utilizes fecal coliform rather than *E. coli* as an indicator and fecal coliform was not collected for this project, direct assessment of SCR use is not possible. However, comparisons will be made with the SCR standards via a conversion equation developed based on the Kentucky River Basin monitoring results for fecal coliform and *E. coli* (Akasapu and Ormsbee, 2011).

For nutrient parameters, no regulatory numeric standard has been established due to the regional variability in the relationship between biological integrity and concentration levels. Narrative-based benchmarks were translated into numeric levels based on 75th and 95th percentiles of least human impacted sites in the Bluegrass Bioregion (Evans, 2022), updating the values previously specified in the QAPP to reflect more recent research. Specific conductance benchmarks were based on relationships between aquatic life and conductivity in Central Appalachian Streams (US EPA, 2011). For total suspended solids, sediment problems in the watershed are best addressed by targeting the severe erosion assessments and not by water quality loading calculations. However, a benchmark was utilized for loading purposes based on published total maximum daily load (TMDL) thresholds in other states (Rowe, Essig, and Jessup, 2003).

4 Quality Assurance

Acceptance criteria for accuracy, precision, and sensitivity for laboratory chemistries and field measurement quality controls are detailed in the QAPP and summarized in Table 3. Accuracy and sensitivity for in-situ measurements represent the minimum requirements of field equipment used in this project. Laboratory results were to be excluded if any of the following qualifiers were found:

- Analyte detected in associated method blank (B flag),
- Holding time exceeded or sample improperly preserved (H, P, or T flag)
- Laboratory control outside of acceptance criteria or calibration criteria exceeded (O or V flag)

For matrix spike exceedances (M flag) and QC limit exceedances (Q), data was reviewed to determine whether rejection or qualification was most appropriate.

Table 2 - Water Quality Benchmarks

Parameter	Water Quality Benchmark
PCR Regulatory Water Quality Standard	
E. coli[1]	Instantaneous: 240 CFU/100mL; 30-day geometric mean: 130 CFU/100mL
WAH Regulatory Water Quality Standard	
pH	Between 6.0 and 9.0 SU, and not to fluctuate more than 1.0 SU over 24 hours
Temperature	31.7°C (89°F)
Flow	Not altered to a degree that will adversely affect the aquatic community
Dissolved oxygen	> 5.0 mg/L as a 24-hour average; or > 4.0 mg/L for instantaneous
Specific Conductance	Indigenous aquatic community is not adversely affected
Total Suspended Solids	Indigenous aquatic community is not adversely affected
Nutrients	Not elevated to a level that results in an eutrophication problem
Un-ionized Ammonia[2]	0.05 mg/L
Chloride	DWS: 250 mg/L, Acute: 1200mg/L, Chronic: 600 mg/L
Fluoride	DWS: 4 mg/L
Iron	DWS: 0.3 mg/L, Acute: 4.0 mg/L, Chronic: 1.0 mg/L
Sulfate	DWS: 250 mg/L
Antimony	DWS: 5.6 µg/L
Arsenic	DWS: 10 µg/L, Acute: 340 µg/L, Chronic: 150 µg/L
Barium	DWS: 1000 µg/L
Beryllium	DWS: 4 µg/L
Cadmium	DWS: 5 µg/L, Acute: e^(0.9789*(ln Hardness)-3.866) , Chronic: e^(0.7977*(ln Hardness)-3.90)
Chromium	DWS: 100 µg/L
Copper	DWS: 1300 µg/L, Acute: e^(0.9422(ln Hardness)-1.700), Chronic: e^(0.8545(ln Hard*)-1.702)
Lead	DWS: 15 µg/L, Acute: e^(1.273*(ln Hardness)-1.460) , Chronic: e^(1.273*(ln Hardness)-4.705)
Mercury	DWS: 2.0 µg/L, Acute: 1.4 µg/L, Chronic: 0.77 µg/L
Nickel	DWS: 610 µg/L, Acute: e^(0.8460*(ln Hardness)+2.255), Chronic: e^(0.8460*(ln Hardness)+0.0584)
Selenium	DWS: 170 µg/L, Chronic: 5.0 µg/L
Silver	Acute: 5.0 µg/L
Thallium	DWS: 0.24 µg/L
Zinc	DWS: 7400 µg/L, Acute/Chronic: e^(0.8473*(ln Hardness)+0.884)
Non-regulatory Reference Point	
E. coli[1]	SCR Comparison values (Akasapu and Ormsbee, 2011) Instantaneous: 676 CFU/100mL; 30-day geometric mean: 386 CFU/100mL
Biochemical Oxygen Demand, 5-Day Carbonaceous	30 mg/L (US EPA Multi-Sector Permit)
Specific Conductance	Primary: 500 µS/cm, Secondary: 300 µS/cm (US EPA, 2011)
Total Phosphorus as P[3]	Primary: 0.35 mg/L, Secondary: 0.20 mg/L
Total Kjeldahl Nitrogen[3]	Primary: 0.8 mg/L, Secondary: 0.5 mg/L
Nitrate+Nitrite as N[3]	Primary: 2.0 mg/L, Secondary: 1.0 mg/L
Ammonia as N	0.05 mg/L
Total Suspended Solids	80 mg/L (Rowe, Essig, and Jessup, 2003)

NOTE: PCR = primary contact recreation, WAH = warmwater aquatic habitat, DWS: Domestic Water Supply,

[1]Geometric mean based on not less than five samples taken during a 30-day period. Instantaneous standard is not to be exceeded in 20% or more of all samples taken during a 30-day period. If less than five samples are taken in a month, this standard applies.

[2]Un-ionized ammonia shall be determined from values for total ammonia-N, in mg/L, pH and temperature, by means of the following equations: Un-ionized ammonia (mg/L) = 1.2*{total ammonia (mg/L as N)/[1+10^(pH_a – pH)]}, where pH_a = 0.0902 + [2730/(273.2+T_c)] and where T_c = temperature, °C.

[3] Values updated from the QAPP to reflect data from Evans 2022.

Table 3 – Acceptance Criteria for Field Measurements and Laboratory Chemistries

Type	Parameter	Units	Field / Lab Method	Accuracy (%R or ±)	Precision[1] (% RPD)	Sensitivity (LOQ)
In Situ	Flow	cfs	DOW 2010	±0.05 ft/sec	N/A	0.01 ft/sec
	Dissolved Oxygen	mg/L	*In situ*	±0.2	20	±0.2
	% Saturation (not required)	%	*In situ*	± 1	20	±1
	pH	SU	*In situ*	±0.5	20	±0.5
	Specific Conductance	µS/cm	*In situ*	±1	20	±1
	Temperature, Water	˚F	*In situ*	±0.1	20	±0.1
E. coli	*Escherichia coli*	MPN/ 100mL	SM 9223 B	N/A	20	1
Bulk	Biochemical Oxygen Demand, 5-Day Carbonaceous	mg/L	SM20 5210B	80-120	20	2
	Turbidity	NTU	EPA 180.1 r2	90-110	20	0.1
	Total Dissolved Solids	mg/L	SM20 2540 D	95-105	20	20
	Total Suspended Solids	mg/L	SM20 2540 C	95-105	20	1.5
	Chloride	mg/L	EPA 300.0 r2.1	80-120	20	0.6
	Fluoride	mg/L	EPA 300.0 r2.1	80-120	20	0.03
	Bromide	mg/L	EPA 300.0 r2.1	80-120	20	0.03
	Nitrate (as N)	mg/L	EPA 300.0 r2.1	80-120	20	0.03
	Nitrite (as N)	mg/L	EPA 300.0 r2.1	80-120	20	0.03
	Sulfate	mg/L	EPA 300.0 r2.1	80-120	20	0.2
	Orthophosphate (as P)	mg/L	EPA 300.0 r2.1	80-120	20	0.05
Nutrient	Ammonia (as N)	mg/L	EPA 350.1 r2	80-120	20	0.05
	Total Kjeldahl Nitrogen (TKN)	mg/L	EPA 351.2 r2	80-120	20	0.5
	Total Organic Carbon	mg/L	SM20 5310 C	80-120	20	0.25
	Total Phosphorus (as P)	mg/L	EPA 200.7 r4.4	80-120	20	0.02
Metals	Aluminum	µg/L	EPA 200.8 r5.4	80-120	20	5
	Antimony	µg/L	EPA 200.8 r5.4	80-120	20	1
	Arsenic	µg/L	EPA 200.8 r5.4	80-120	20	1
	Barium	µg/L	EPA 200.8 r5.4	80-120	20	0.5
	Beryllium	µg/L	EPA 200.8 r5.4	80-120	20	0.5
	Cadmium	µg/L	EPA 200.8 r5.4	80-120	20	0.5
	Calcium	µg/L	EPA 200.7 r4.4	80-120	20	0.5
	Chromium	µg/L	EPA 200.8 r5.4	80-120	20	0.5
	Cobalt	µg/L	EPA 200.8 r5.4	80-120	20	0.5
	Copper	µg/L	EPA 200.8 r5.4	80-120	20	1
	Iron	mg/L	EPA 200.7 r4.4	80-120	20	0.05
	Lead	µg/L	EPA 200.8 r5.4	80-120	20	0.5
	Magnesium	µg/L	EPA 200.7 r4.4	80-120	20	0.5
	Manganese	µg/L	EPA 200.8 r5.4	80-120	20	1
	Molybdenum	µg/L	EPA 200.8 r5.4	80-120	20	1
	Nickel	µg/L	EPA 200.8 r5.4	80-120	20	1
	Potassium	µg/L	EPA 200.7 r4.4	80-120	20	1
	Selenium	µg/L	EPA 200.8 r5.4	80-120	20	0.5
	Silver	µg/L	EPA 200.8 r5.4	80-120	20	0.5
	Sodium	µg/L	EPA 200.7 r4.4	80-120	20	0.5
	Thallium	µg/L	EPA 200.8 r5.4	80-120	20	1
	Vanadium	µg/L	EPA 200.8 r5.4	80-120	20	0.5
	Zinc	µg/L	EPA 200.8 r5.4	80-120	20	5
	Mercury	µg/L	EPA 245.1 r3	80-120	20	0.05
	Total Hardness (as CaCO3)	mg/L	EPA 200.7 r4.4	80-120	20	0.82
Alkalinity	Acidity	mg/L	SM20 2320 B	80-120	20	5
	Alkalinity (as CaCO3)	mg/L	SM20 2320 B	80-120	20	5
	Alkalinity, Carbonate (as CaCO3)	mg/L	SM20 2320 B	80-120	20	5
	Alkalinity, Bicarbonate (as CaCO3)	mg/L	SM20 2320 B	80-120	20	5

[1] Indicates minimum laboratory precision for water quality parameters

Field blanks, field duplicates, and laboratory split samples (*E. coli*) were collected during each sampling event at one location. For field blanks, results were expected to be below the limit of quantitation (LOQ) for most parameters. For field duplicates, a relative percent different of 20% was expected if both results were greater than or equal to five times the LOQ. If one or both results were less than or equal than five times the LOQ, the absolute difference between the between the results was compared to twice the LOQ. If results exceeded these criteria, further investigation into the data quality and corrective action was to be undertaken.

4.1 Sample Collection and Representativeness

Monitoring was conducted during 16 total events over a one-year period, with dates and antecedent rainfall conditions detailed in Table 4. Wet weather events were captured during steady rainfall on September 22, 2021 (0.87 inches) and February 2, 2022 (0.72 inches rainfall). Intermittent light showers occurred throughout the May 18, 2021 *E. coli* event and intermittent rainfall began to fall during collection of the last two sites on January 19, 2022. All other events were collected during dry conditions.

Table 4 – Summary of monitoring events and weather conditions

Monitoring Event			5-Day Antecedent Rainfall (in)[1]	Event Rainfall (in)[1]
Date	**Event**	**Type**		
3/16/21	Monthly	Dry	1.26	0
4/20/21	Monthly	Dry	0.01	0
5/11/21	*E. coli*	Dry	0.12	0
5/13/21	*E. coli*	Dry	0.06	0
5/18/21	*E. coli*	Intermediate	0.02	0.03
5/25/21	Monthly	Dry	0	0
5/27/21	*E. coli*	Dry	0.85	0
6/15/21	Monthly	Dry	0.63	0
7/20/21	Monthly	Dry	2.13	0
8/17/21	Monthly	Dry	1.96	0
9/22/21	Monthly	Wet	0.77	0.87
10/19/21	Monthly	Dry	0.34	0
11/16/21	Monthly	Dry	0.70	0
12/14/21	Monthly	Dry	1.15	0
1/19/22	Monthly	Intermediate	0.21	0
2/2/22	Monthly	Wet	0.07	0.72

[1]Weather data obtained from Franklin County Mesonet site located in Frankfort at 38.12°, -84.88°

According to weather data from Frankfort, KY, precipitation was recorded on 127 days (35%) from March 2021 to February 2022. This includes 26 days with rainfall from 0.5 to 1.0 inches, and 12 days with more than 1 inch. According to NOAA's Comparative Climatic Data, Lexington averaged 133 days with precipitation per year from 1872 to 2020, so the year was near the normal. With only 20% of the monthly monitoring events conducted in dry weather, this dataset underrepresents wet weather conditions over the monitoring year.

Restrictions in accessibility of field sites, laboratory unavailability, or collection errors resulted in some data not being collected or analyzed by the laboratory.

On March 16, 2021, the field duplicate samples were filled with blank water rather than sample water, so no field duplicate data was available during that event. The *E. coli* result from the site in which the blank was collected also returned a less than result, so this data was also rejected believing this bottle was also filled with deionized water by mistake. Results for other parameters returned normal values.

On September 22, 2021, high water levels made stream flow measurements unsafe at Sites 45 and 46. Also on September 22, a locked gate prevented access to Site 50 preventing collection of data at that site. On two events, nutrient bottles were either improperly preserved (Site 48, October 19, 2021), broke during transport (Site 50, November 16, 2021), or analyzed outside of the hold time by the laboratory (Site 51, May 25, 2021) resulting in the exclusion of nitrite, nitrate, and orthophosphate data for these site events. Finally, due to an ice storm causing laboratory closure following the February 2, 2022 event, laboratory personnel was unable to complete the *E. coli* analysis, resulting in no data for those parameter for that event. The field duplicate bottle for metals also broke during transport during the February 2 event.

Finally, typos and missing data from field data were corrected for Site 48 (2/22 event all field measurements) and Site 42 (conductivity, 2/22). Also, the conductivity measurement for Site 49 on July 20 was rejected due to what appears to be a recording of the dissolved oxygen in the wrong text place.

4.2 Sensitivity

No laboratory blanks had levels above the LOQ for any parameter during this study. Additionally, the field equipment met the minimal requirements for use.

Field blank laboratory results were also below reporting limits for all parameters, with the exception of the parameters shown in Table 5, including aluminum (4 events), *E. coli* (1 event), chloride (1 event), copper (1 event), fluoride (1 event, 9/22/21), iron (1 event, 11/16/21), and turbidity (5 events). Of these exceedances, most are minor exceedances of the LOQ, and the sensitivity is considered of sufficient quality for acceptance in the study, with the exception of aluminum and *E. coli*.

For aluminum, positive results over multiple events could potentially indicate low-level contamination, possibly due to either the sample bottles or the deionized water used for blanks. Aluminum results may be biased high as a result of potential contamination. Therefore, aluminum results for these dates were excluded from analysis.

For *E. coli*, KDOW staff alerted the field team of some recent field blank samples being positive for fecal coliform (but not *E. coli*) subsequent to the October sampling event. These occurrences happened with multiple field technicians. A trip blank (filled in a controlled environment prior to sampling and place in a resealable bag in the cooler) was utilized during the November event to evaluate whether the issue arose from field collection, the source bottles, or deionized water used in blanks. Reminders were made on wearing gloves and replacing them between each sample.

On December 14, 2021, a result of 2 MPN/100 mLs was obtained for *E. coli* in the field blank, as compared to a lowest sample result of the event of 149.7 MPN/100mL. Thus, any bias this contamination may have caused appears to have been minimal, so results were accepted.

Another trip blank was utilized for the January and February events without detection. Thus, the source of contamination was not identified. So despite only one positive field blank for *E. coli*, a low-level fecal coliform contamination was present across sampling events.

Table 5 – Summary of field blank exceedances of LOQs.

Date	Parameter	Result	Unit	LOQ
3/16/2021	Aluminum	17.30	µg/L	10
4/20/2021	Aluminum	10.80	µg/L	10
5/25/2021	Aluminum	14.70	µg/L	10
6/15/2021	Aluminum	15.60	µg/L	10
2/02/2022	Chloride	1.48	mg/L	1.2
3/16/2021	Copper	6.78	µg/L	5
12/14/2021	*E. coli*	2	MPN/100mL	1
9/22/2021	Fluoride	0.04	mg/L	0.03
11/16/2021	Iron	0.11	mg/L	0.1
3/16/2021	Turbidity	0.19	NTU	0.1
4/20/2021	Turbidity	0.12	NTU	0.1
5/25/2021	Turbidity	0.56	NTU	0.1
9/22/2021	Turbidity	0.81	NTU	0.1
1/19/2022	Turbidity	0.14	NTU	0.1
2/02/2022	Turbidity	0.15	NTU	0.1

4.3 Precision

The laboratory duplicate precision was within the acceptance criteria for all parameters with one exception. The laboratory duplicate for total suspended solids on April 20, 2021 at Site 44 was outside of duplicate precision controls (Q-flagged). However, because the result for this sample was less than the LOQ, the result was utilized in the analysis.

Field duplicate precision was evaluated against criteria for relative percent difference and absolute difference depending on the concentration of results. The results are summarized in Table 6, with the absolute difference (blue shading) when both results are less than five times the LOQ and the relative percent difference (unshaded) when both results were greater. All data fell within the acceptance criteria with the exceptions (red shading) of aluminum (3 events), manganese (1 event), orthophosphate (1 event), total suspended solids (1 event), and turbidity (3 events). For total suspended solids, and turbidity, data was accepted because these exceedances are likely attributed to small variations in the particulate concentrations between samples. However, for aluminum (6/15, 7/20, and 9/22), orthophosphate (3/16), and manganese (10/19), all data associated with these sampling events on these dates were excluded from analysis due to the lack of precision.

For *E. coli*, laboratory split sample acceptance criteria were not specified in the QAPP, in part due to the variability inherent in the method. The absolute and relative percent differences for laboratory split samples are shown in Table 7, with an average relative percent difference of 19% and a range of 0% to 72%.

In one of the few comprehensive analyses of uncertainty for *E. coli*, McCarthy et al. (2008) found the combined relative uncertainty from both storage and analytical sources averaged 33% with a range from 15% to 67%. They also found the average analytical uncertainty of 22% with a range of 12-51%, similar to the IDEXX provided uncertainty of 27%. Because this study was similar to these published values, the precision of the *E. coli* data was accepted.

Table 6 – Relative percent differences or absolute differences for field duplicates

Characteristic[1]	LOQ	Unit	4/20	5/25	6/15	7/20	8/17	9/22	10/19	11/16	12/14	1/19	2/2
Acidity	5	mg/L	<LOQ	<LOQ	2.18	1.31	1.36	2.59	1.98	<LOQ	1.87	0.48	1.41
Alkalinity (as CaCO3)	5	mg/L	2%	1%	2%	1%	1%	0%	1%	1%	2%	1%	1%
Alkalinity, Bicarbonate (as CaCO3)	5	mg/L	2%	1%	2%	1%	1%	0%	1%	1%	2%	1%	1%
Aluminum	20	µg/L	3.4	4.5	21%	36%	0%	54%	10%	8.7	3%	4.2	N/A
Ammonia (as N)	0.05	mg/L	0.031	<LOQ	<LOQ	<LOQ	<LOQ	0.077	<LOQ	<LOQ	<LOQ	<LOQ	0.014
Barium	0.5	µg/L	8%	9%	3%	1%	3%	11%	3%	0%	4%	0%	N/A
Bromide	0.03	mg/L	0.021	0.006	0.052	0	0	<LOQ	0.003	0.001	0.002	0.001	13%
Calcium	1	mg/L	5%	8%	1%	12%	3%	5%	7%	2%	7%	13%	N/A
CBOD-5	2	mg/L	<LOQ	<LOQ	<LOQ	<LOQ	2	2.6	<LOQ	<LOQ	<LOQ	<LOQ	31%
Chloride	1.2	mg/L	1%	0%	0%	1%	0%	0%	0%	0%	1%	0%	1%
Copper	5	µg/L	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.67	<LOQ	<LOQ	<LOQ	<LOQ	N/A
Fluoride	0.03	mg/L	2%	0%	0%	0%	2%	1%	0%	0%	1%	0%	1%
Hardness, Total	2.06	mg/L	5%	9%	0%	12%	3%	5%	7%	1%	7%	13%	N/A
Iron	0.1	mg/L	<LOQ	<LOQ	<LOQ	0.080	0.108	12%	<LOQ	0.062	<LOQ	<LOQ	N/A
Lead	0.5	µg/L	0.04	0.05	0.03	0.171	0.09	0.53	0.484	<LOQ	0.132	<LOQ	N/A
Magnesium	1	mg/L	5%	12%	0%	11%	1%	7%	7%	1%	4%	13%	N/A
Manganese	1	µg/L	7%	6%	2%	9%	2%	18%	36%	0%	13%	13%	N/A
Nitrate & Nitrite (as N)	0.02	mg/L	3%	3%	1%	0%	3%	4%	3%	0%	2%	4%	7%
Nitrate (as N)	0.06	mg/L	1%	0%	0%	0%	1%	3%	0%	0%	0%	0%	2%
Organic Carbon, Total	0.4	mg/L	0.095	0.033	0.04	0.147	0.07	1%	0.208	0.054	0.05	0.051	4%
Orthophosphate (as P)	0.02	mg/L	33%	1%	1%	2%	0%	3%	4%	1%	0%	0%	1%
Phosphorus, Total (as P)	0.06	mg/L	4%	2%	2%	4%	2%	1%	5%	1%	1%	2%	N/A
Potassium	2	mg/L	<LOQ	0.61	<LOQ	0.31	0.15	0.27	<LOQ	0.65	0.13	0.18	N/A
Sodium	1	mg/L	6%	3%	1%	10%	0%	9%	6%	1%	3%	12%	N/A
Solids, Total Dissolved	40	mg/L	0%	1%	11%	1%	5%	2%	5%	0%	5%	0%	3%
Solids, Total Suspended	3	mg/L	<LOQ	<LOQ	5	1	1	4%	6	<LOQ	0	1	31%
Sulfate	0.6	mg/L	2%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
Total Kjeldahl Nitrogen (as N)	0.5	mg/L	<LOQ	<LOQ	0.031	<LOQ	0.027	0.04	0.408	<LOQ	0.159	<LOQ	8%
Turbidity	0.1	NTU	1%	2%	13%	6%	24%	8%	24%	16%	15%	23%	0%
Vanadium	0.5	µg/L	<LOQ	<LOQ	0.06	<LOQ	0.0	0.289	0.098	<LOQ	0.074	<LOQ	N/A
Zinc	10	µg/L	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	2.6	<LOQ	<LOQ	<LOQ	<LOQ	N/A

Note: Shading indicates the following: grey – both results below laboratory LOQ and differences are based on estimated results, blue - one or both results were less than five times the LOQ, but difference is less than twice the LOQ, red – exceeds 20% relative percent difference. Field duplicates on 3/16 and 2/2 were not collected for one or more parameters.

[1] No quantifiable results were obtained in either the sample or field duplicate for carbonate alkalinity, antimony, arsenic, beryllium, cadmium, chromium, cobalt, molybdenum, nickel, nitrite, selenium, silver, or thallium. Therefore, these parameters were not included in the summary table.

Table 7 – E. coli laboratory split sample data evaluation

Date	*E. coli* (MPN/100 mL) Site 51	*E. coli* (MPN/100 mL) Lab Split Sample	Abs. Diff. (MPN/100 mL)	RPD(%)
04/20/2021	93.4	123.6	30.2	28%
05/11/2021	166.4	113.7	52.7	38%
05/13/2021	172.3	128.1	44.2	29%
05/18/2021	426	201	225	72%
05/25/2021	135.4	129.6	5.8	4%
05/27/2021	>2,420	2,419.6	0.4	0%
06/15/2021	836	833	3	0%
07/20/2021	206.4	290.9	84.5	34%
08/17/2021	5,475	5,172	303	6%
09/22/2021	7,890	6,970	920	12%
10/19/2021	410.6	579.4	168.8	34%
11/16/2021	151.5	137.6	13.9	10%
12/14/2021	547.5	547.5	0	0%
01/19/2022	435.2	461.1	25.9	6%

4.4 Accuracy

All laboratory fortified blanks and calibration verification samples were within acceptable ranges for all parameters, except for two parameters: acidity and bromide.

Four acidity results were excluded due to calibration verification limit exceedances (V flags) including May 25 results for Site 42, 50, and 51, and April 20 results for Site 50. All bromide data from the April 20 event was also excluded due to calibration verification limit exceedances (V flags).

Matrix spike limits were exceeded for aluminum (2 samples), ammonia (1 sample), bromide (1 sample), calcium (1 sample), hardness (1 sample), silver (4 samples), sodium (1 sample), and total Kjeldahl nitrogen (3 samples). However, in all cases the laboratory fortified samples were within control, and therefore the results were accepted.

5 Results

Monitoring results are summarized for each parameter in Appendix A. The field calibration log is included in Appendix B.

5.1 Field Observations and Measurements

5.1.1 Field observations

Field observations were recorded during each site visit (16) including the presence of color, filamentous algae, garbage, odor, and suds as well as descriptions of potential pollution contributions such as sedimentation or erosion, descriptions of trash types, wildlife observed, and other factors. Table 8 summarizes these field observations.

Filamentous algae growth was present at all sites during 44% to 75% of the sampling events. Algal growth was abundant, covering at least 75% of the channel during at least one event at each site and as much as 95% at most sites. Examples are shown in Figure 2. Intense rainfall events would periodically detach the algal growth from the bed substrate where the abundant organic matter were observed floating downstream until they accumulate in mats on large boulders, woody debris, or stream edges.

Table 8 – Frequency and type of field observations present during site visits

Site ID	Algae	Suds	Garbage	Garbage Type	Color	Color Type	Odor	Odor Type	Other
44	56%	81%	19%	tires, clothing	31%	brown/clear, green/clear, gray	13%	sewage, decaying algae	geese, deer, turtles, duck, sediment, erosion
45	75%	94%	75%	clothing, Styrofoam, plastic	38%	brown/clear	19%	alcohol, decaying algae, diesel	erosion
46	56%	94%	69%	plastics, Styrofoam, clothing, vegetables	25%	brown, brown/clear	13%	decaying algae	sediment
47	75%	100%	6%	plastic	25%	brown, brown/clear	6%	alcohol	Sediment and erosion
48	75%	50%	0%	grass clippings	25%	brown/clear	0%		geese, deer
42	50%	88%	13%	plastics, grass clippings	44%	brown/clear	6%	livestock downstream	grass clippings, erosion, and sediment
49	44%	81%	13%	plastic	44%	brown/clear	0%		abundant aquatic life, sediment, and expansion of wetland
50	88%	25%	25%	plastic	13%	brown/clear	44%	sewage treatment	
51	69%	0%	81%	clothing, plastic, paper, grass clippings	25%	brown, brown/clear	0%		sediment, knotweed, children's footprints

The smell of decaying algae was noted at three downstream sites during the monitoring and heaps or decaying algal mats were observed at most locations. While spring growth (April and May) was most abundant, fall or winter growth was present at all sites except Site 42 and 46, with particularly abundant growth noted in November at Sites 47 (75% coverage) and Site 49 (90% coverage).

Natural suds were frequently observed at most sites, with the exception of Site 51.

Garbage, including clothing items, plastic bottles, Styrofoam cups, paper, tires, and even disposed squash was found at all sites except Sites 42 and 48. Sites 42, 48, and 51 each had grass trimmings in the stream during at least one site due to mowing to the stream edge at or upstream of the site. Garbage was most frequently noted in Big Spring Park, Site 51, and on large boulders and woody debris near Sites 45 and 46.

Due to turbidity, brown/clear or brown color was observed at most sites. Site 44 had a grayish color on June 15 (Figure 3) and a green/clear color on February 2. Staining from purple bacteria was observed on boulders along the stream edges at Site 44 (Figure 3) and Site 48 on April 20.

Glenns Creek headwaters downstream of wastewater treatment plant (Site 50) in April

Glenns Creek at Millville Park (Site 47) in April

Glenns Creek at Steele Road (Site 42) in May

Algae growth at Millville Park (Site 47) in November

Figure 2: Examples of dense algal growth on Glenns Creek and its tributaries

Grey colored water on June 15

Pink color on rocks on April 20 suspected to be caused by purple bacteria

Figure 3: Unusual colors observed at Glenns Creek near the mouth (Site 44)

Odors observed were indicate of surrounding land use (alcohol smell near distilleries, sewage effluent smell near the wastewater treatment plant) but the smell of livestock downstream of Site 42 and sewage and diesel near Site 44 could be indicative of potential pollution sources.

The most abundant wildlife was noted at Site 44, with deer, turtles, geese, and duck frequently observed during site visits. Site 48 also frequently had multiple deer near the site and geese on the farm upstream. Livestock were noted in and along the stream downstream of Site 42 on several occasions. The aquatic wildlife was frequently visible at Site 49, including darters, clams, crayfish, snails, and other aquatic organisms. Turkey vultures were observed roosting in multiple locations along the McCracken Pike along Glenns Creek.

The invasive Japanese knotweed (Figure 4) was observed along the stream in Big Spring Park (Site 51) but was not observed at any downstream locations. Footprints of children playing along the stream (Figure 4) were also noted at Big Spring Park on multiple occasions.

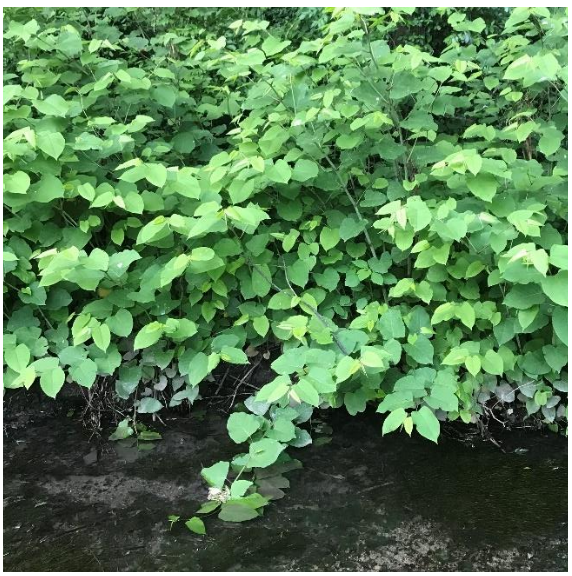


Figure 4: Invasive Japanese knotweed (left) and children's footprints in the stream edge (right) in Big Spring Park (Site 51) in May 2021

5.1.2 Erosion and Sedimentation

With the exception of Site 50, all stream reaches showed instability with active erosion, sedimentation, and transport of sediment and large woody debris. Channel degradation via widening and entrenchment was most evident in the lower reaches (Sites 42, 44-47) of Glenns Creek, while aggradation was more common in the headwaters (Sites 48, 42, 49, 51).

According to the NOAA Atlas 14-point frequency estimates for Versailles, KY, the 24-hour rainfall for the 1-year storm is 2.15 inches, and 2-year storm is 3.05 inches. According to the daily rainfall values at the Franklin County Mesonet site, rainfall was recorded on 117 days during the project period. Four days exceeded two inches, including August 19 (3.45 in.), August 30 (2.11 in.), August 31 (2.05 in.), and January 1 (2.26 in.). An additional five days had over 1 inch of precipitation, including June 21, July 17, December 6, December 11, and January 9. Four monitoring events - September 22, January 19, December 14, and July 20 - each had one or more large precipitation events that occurred in the interval since the prior monitoring event.

In conjunction with these events, large woody debris, including fallen logs of over 30 feet in length, were transported away (Site 45 on July 20, Site 44 on Sept 22) or newly fallen or deposited (Site 44 on Jan 19, Site 45 on Feb 2) at multiple sites along the lower reaches of Glenns Creek (Figure 5).

Signs of channel widening and entrenchment in the form of scour on bedrock, large shifts in the bed substrate, removal of vegetation, and bank slumping or erosion were noted at multiple sites and dates, some which are shown in Figures 6 and 7.

Sedimentation / siltation was noted at multiple sites across multiple events (Site 44 on Aug 17; Site 46 on June 15 and July 20, Site 47 on May 25 and July 20; Site 42 on June 15). At Site 49 on Camden Creek, a wetland fringe area located on the left bank just upstream of the cattle crossing / riffle was observed to be gradually expanding each month from June 15 to February 2.

At Site 51, the braided channel changed frequently over the sampling period with accumulation of large amounts of urban particulates sediment observed on May 13 and July 20. Dark brown and grey sediment was observed being transported through the site during the February 2 precipitation event. The removal of accumulated sediment and scouring of the stream channel was observed during the August 17 (due to local thunderstorm on 8/16), September 22, December 14, and January 19 events. Bank slumping and pocking in the floodplain along the stream was particularly evident on January 19.

These visual observations reveal an unstable channel morphology seeking to adapt to changes in the hydrology and the imperviousness of the upstream land use.

Log jam across Glenns Creek near the mouth (Site 44) on May 18

Log jam at Site 44 has been transported downstream by high flows as of September 22

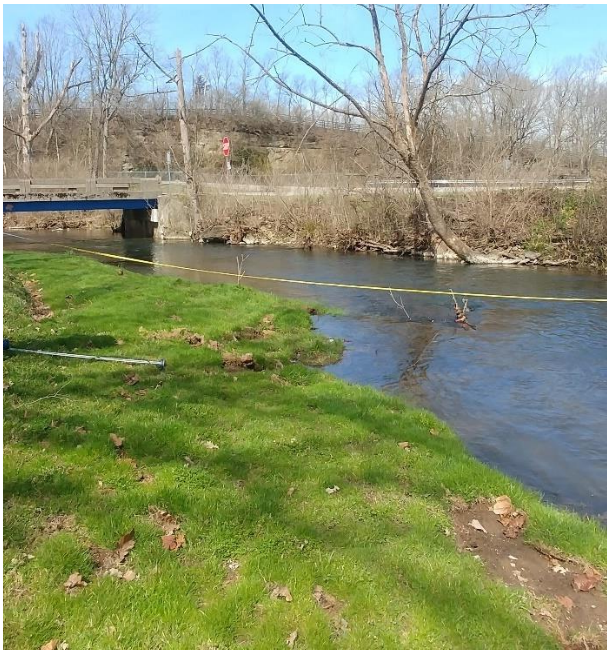
Newly deposited large woody debris at Site 45 on July 20. A fallen tree was also observed upstream.

New woody debris downstream of Site 44 on January 19

Tree near collapse on right bank of Site 44 on January 19.

Honeysuckle bush roots are exposed and undermined on left bank of Site 45 on January 19

Figure 5: Large woody debris transport and tree falls along Glenns Creek in response to heavy rainfall



Downstream view from left bank in March 2021 during first sampling

Downstream view from left bank on September 22 after storm events sheared off surface vegetation

Upstream view from left bank of bed scour on January 19

Downstream view from left bank on February 2 showing erosion of unprotected soil from bank

Figure 6: Progression of bank erosion and bed scour at Glenns Creek near Steele Road (Site 42)

Figure 7: Bank erosion on right bank at Site 44 on January 19. Eroded bank is approximately six feet high.

Sedimentation at Glenns Creek at Millville Park (Site 47) on July 20

Sedimentation gradually accumulated along the left bank of Camden Creek (Site 49) expanding a wetland (February 2)

Figure 8: Sedimentation at Millville Park (Site 47) and Camden Creek (Site 49).

Downstream view from left bank on March 16

Downstream view from left bank on July 20. Sedimentation and pondweed growth

Downstream view from left bank on November 16. Sediment has been transported out by heavy rainfall.

Downstream view from left bank on December 14. Vegetation has been sheared from banks.

Upstream view from left bank on January 19. Bank slumping along causing holes in floodplain

Downstream view from left bank on February 2. Erosion of exposed soils on bank

Figure 9: Channel instability in Big Spring Park (Site 51) over the project period

5.1.3 Stream Flow

Stream flow was present and measured at all sites, with the exception of one event due to unwadeable conditions. A zero calibration was performed prior to the initial measurement during each monitoring event. Between 12 and 30 intervals were measured across each stream cross-sectional area. Stream flow results are summarized in Table 9 and Figure 10.

Table 9 – Stream flow measurements

Day	44	45	46	47	48	42	49	50	51
16-Mar	66.76	57.09	73.09	56.42	10.17	41.42	14.99	10.89	2.101
20-Apr	14.25	18.82	18.12	20.07	1.474	13.19	3.878	2.626	0.726
11-May	33.16	38.25	33.43	39.93	3.792	24.61	10.19	6.018	1.38
13-May	27.51	30.46	25.49	21.69	2.213	20.63	7.422	6.603	1.163
18-May	16.28	18.39	15.98	15.4	0.947	11.49	4.024	3.844	0.522
25-May	7.554	7.803	8.412	12.86	0.481	8.715	2.002	1.928	0.315
27-May	16.11	20.94	21.64	23.06	0.719	13.72	2.693	5.0	1.499
15-Jun	66.82	58.65	62.53	62.46	4.12	52.23	23.49	14.87	4.556
20-Jul	30.06	31.98	29.21	28.65	2.924	21.56	7.681	5.004	0.973
17-Aug	113.6	99.24	104.2	114.1	13.32	79.1	33.41	9.402	2.495
22-Sep	40.25	37.7	38.1	39.08	4.843	19.7	4.921	ND	4.001
19-Oct	24.44	24.02	23.97	20.2	1.332	22.62	7.563	6.176	1.388
16-Nov	19.52	19.7	18.17	20.22	1.862	14.11	5.055	3.583	0.812
14-Dec	88.64	82.69	76.52	70.81	10.13	62.12	30.48	10.27	2.703
19-Jan	39.58	32.28	36.09	33.74	3.83	29.07	14.85	6.877	1.152
2-Feb	30.76	25.87	24.43	26.62	2.555	16.83	5.44	4.248	2.044
Mean	**39.71**	**37.74**	**38.09**	**37.83**	**4.04**	**28.19**	**11.13**	**6.49**	**1.74**
Std Dev	29.57	24.89	26.78	26.62	3.83	20.22	9.86	3.40	1.20
95% CI	14.49	12.20	13.12	13.04	1.88	9.91	4.83	1.67	0.59

NOTE: ND = No data due to site access restriction on 9/22.

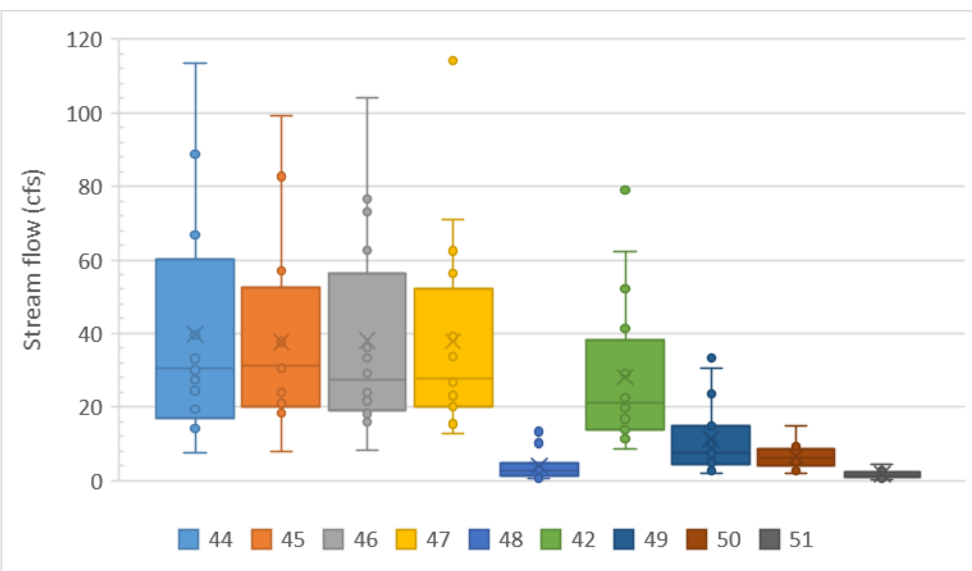
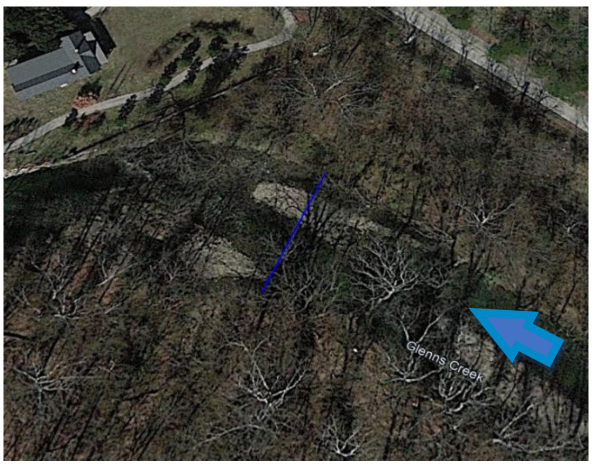


Figure 10: Box-plot of stream flow at Glenns Creek sites.

Stream flow measurements for the four downstream sites (44, 45, 46, and 47) did not show the expected increase in flow as the drainage area increases. No consistent relationship was discernable between the sites with the measured flow at the upstream Site 47 at Millville Park often exceeding measurements at Site 44 near the mouth and other downstream sites. The variation between the measurements at these sites could be due to one or more of three factors: 1) measurement error, 2) water withdrawals, or 3) sinking portions of the stream, which may be pirating flow from the channel.

Prior to all flow measurements, large obstacles such as woody debris, boulders, vegetation, algae, or other debris were displaced, where possible, from the cross-sectional area and approximately five feet upstream and downstream to provide a consistent measurement. However, the water depth at the downstream reaches of Glenns Creek restricted the number of reaches suitable for wading for flow measurement. For Sites 45 and 46, site conditions (see Figure 11) did not allow for such obstacles to be removed, resulting in potential measurement bias. At Site 45, large immovable boulders spanned the wadeable portion of the stream which may have biased results, while at Site 46, the measurement spanned a small island and some interstitial flow between the gravels may not have been captured.



Site 46, upstream of Castle and Key Distillery and downstream of Millville was positioned across a small island to allow for wading while also measuring perpendicular flow.

Site 45, between Castle and Key Distillery and Old Crow Distillery, included large boulders, some of which could not be displaced from the cross-sectional area during measurements.

Figure 11: Aerial images of stream flow cross-sections (blue lines) at Sites 45 and 46.

Two distilleries located in this area, Castle and Key and Glenns Creek Distilling, have water withdrawals from springs (Old Taylor Spring and Old Crow Spring, respectively) located in close vicinity to Glenns Creek in addition to several agricultural wells for livestock use in the area. These springs and wells have not been dye tested to determine their groundwater source water area, so it is unknown whether they are hydraulically connected to Glenns Creek. Therefore, it is possible that water withdrawals at these locations and via groundwater pirating may contribute to the variation in stream flows at these downstream locations.

Without a continuous monitoring gage located in the watershed and with dye tracing being outside the scope of this project, stream measurements could not be corrected or refined above the measured values.

Because of unsafe conditions to wade the stream, flow measurements could not be obtained for Sites 45 and 46 on September 22. To correct for this omission, an average flow for each site was utilized for these events to allow for loading calculations per KDOW instruction.

5.1.4 In situ Measurements

Average in situ measurements for each site are summarized in Table 10. All results may be found in Appendix A.

Table 10 – Average In-Situ Measurements by Site

Parameter	Site								
	44	45	46	47	48	42	49	50	51
Dissolved Oxygen (mg/L)	13.37	12.90	12.86	12.39	13.98	12.13	11.53	9.04	9.89
Dissolved Oxygen (% Sat)	135.43	129.83	129.76	123.86	141.81	118.28	113.81	91.91	101.11
Temperature, Water (°C)	15.43	15.11	15.06	14.66	15.27	13.78	13.53	14.99	15.01
pH (SU)	8.52	8.43	8.52	8.30	8.46	8.04	7.98	7.59	7.55
%>9.0 SU	6%	0%	0%	0%	0%	0%	0%	0%	0%
Conductivity (µS/cm)	459	471	460	465	423	498	412	662	680
% Conductivity > 500 µS/cm	20%	27%	27%	20%	7%	47%	0%	100%	93%

Despite the abundance of algae present in the streams, the lowest dissolved oxygen measurement at any site was 7.16 mg/L, well above regulatory thresholds (4.0 mg/L instantaneous, 5.0 mg/L as a 24-hour average) to protect aquatic life from low oxygen levels. A sensor was deployed at Site 50 for a 24-hour period on May 18-19 to evaluate whether diurnal fluctuations might result in lower values. The lowest measurement over that period was 5.83 mg/L at 7:00 AM, still well within protective criteria.

Dissolved oxygen percent saturation averaged 121% across all sites with a range of 75% to 203%. Oversaturation of dissolved oxygen is due to the large amount of algae conducting photosynthesis during the daytime and producing oxygen.

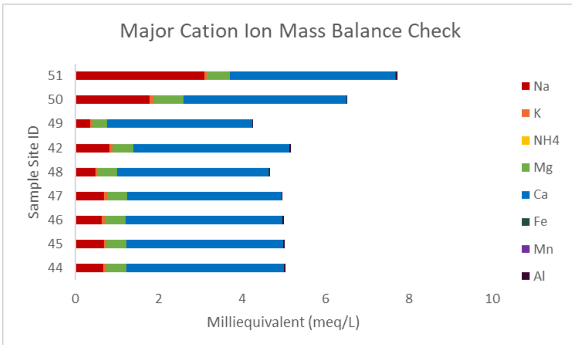
Water temperature never exceeded the water quality benchmark of 31.7 °C for WAH at any site, reaching a maximum of 24.54 °C.

pH averaged 8.15 SU across all sites, with a range of 7.06 SU to 9.07 SU. One value exceeded the 9.0 SU regulatory benchmark: Site 44 on April 20 which occurred in conjunction with the highest dissolved oxygen saturation level. The basic conditions across the watershed are due to limestone geology in combination with the heavy algal biomass producing lower levels of carbonic acid due to lower carbon dioxide concentrations in the water in times of peak photosynthesis. The exceedance of the pH criteria is suspected to be due to the algae abundance.

Conductivity averaged 502 µS/cm across all sites with a range of 287 µS/cm at Site 44 on May 11 to 877 µS/cm at Site 51 on February 2. Conductivity measurements from July 20 were excluded for all sites as outliers. The conductivity tended to drop from upstream to downstream, with the highest levels at Sites 50 and 51, likely due to the urban influence of Versailles.

To evaluate the sources of the high conductivity, the sums of the means of the most abundant cations and anions were converted from concentrations (mg/L) into milliequivalents/Liter (meq/L) by dividing by the atomic weight and then multiplying by the valence or charge. The sum of the milliequivalents of the anions or cations times 100 is typically within 10% of the conductivity. This is often used as a cross-check for accuracy of measurements. Based on the ratio between conductivity and total dissolved solids, a concentration of 300 mg/L total dissolved solids is equivalent to a conductivity of 500 µS/cm in Glenns Creek.

Figure 12 shows that natural calcium carbonate (limestone) and calcium bicarbonate, formed when dissolved carbon dioxide interacts with limestone, are responsible for much of the baseline conductivity levels across all sites (the equivalent of 350-400 µS/cm on average). This indicates that the lower conductivity benchmark of 300 µS/cm will be unattainable based on the geology of the area. The high conductivity levels at Sites 50 and 51 are due to higher concentrations of sodium chloride (NaCl, salt), suggesting the influence of road salt on those locations.



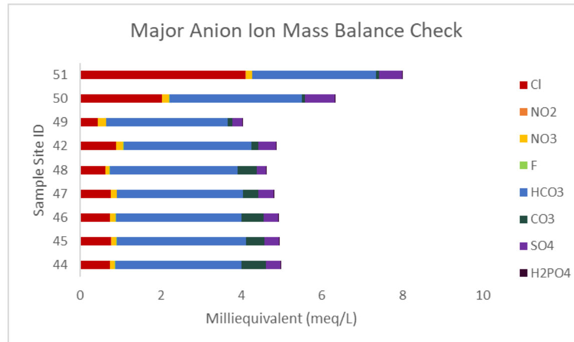


Figure 12: Mass balance of major cations (left) and anions (right) provide insight into high conductivity.

5.2 Laboratory Results

In summarizing laboratory results, all results less than the limit of detection were assumed to be at the detection limit for quantitation purposes. For results between the limit of quantitation and the limit of detection, the estimated result was reported if available.

5.2.1 E. coli

E. coli results across all sites averaged 711 MPN/100 mL with a range of 20 MPN/100mL at Site 44 on March 16 to 12,033 MPN/100 mL at Site 49 on August 17. Events on August 17 (dry), September 22 (wet), and May 27 (dry) were the highest three events, in that order. Concentrations were generally highest in the headwater sites with concentrations decreasing towards the mouth.

As summarized in Table 11, results indicate that five headwater sites (42, 48, 49, 50, and 51) all exceeded the PCR criteria for a geometric mean of 130 MPN/100mL for five samples collected in 30 days. Further, 20% or more of the samples collected in the 30-day period exceeded 240 MPN/100mL criteria at six sites (42, 45, 47, 49, 50, and 51). Thus, seven of the nine sites show some degree of PCR impairment.

Table 11 – Summary of E. coli results as compared to water quality criteria

	44	45	46	47	48	42	49	50	51
5 in 30 days									
Geometric mean (MPN/100 mL)	100	120	75	128	131	227	353	301	508
%>240 MPN/100 mL	0%	20%	0%	20%	0%	40%	60%	60%	100%
All Events (16)									
Mean (MPN/100 mL)	460	439	516	540	406	809	1335	573	1305
%>676 MPN/100 mL	13%	13%	7%	13%	20%	20%	20%	15%	27%

NOTE: Red indicates an exceedance of regulatory criteria for the geometric mean. Yellow indicates 20% or more of results exceeded instantaneous criteria or a non-regulatory benchmark.

Direct comparison with SCR is not possible since fecal coliform data was not collected. However, comparison against an *E. coli* concentration of 676 MPN/100mL was found in the Kentucky River Basin (Akasapu and Ormsbee, 2011) to be equivalent to 2,000 CFU/100mL for fecal coliform, the value at which 20% or more values are not to exceed for secondary contact recreational use. Using this evaluation, four sites (42, 48, 49, and 51) could potentially have impairments for SCR use.

5.2.2 Nutrients

Excess nutrient concentrations can impact aquatic life by fueling local algal blooms that can block out sunlight and clog fish gills. When these algae die, their decomposition can lower the dissolved oxygen levels causing fish to die. Certain types of algae can produce toxins that can create negative impacts on human and wildlife in harmful algal blooms. Lastly, excessive nutrient concentrations contribute to the dead zone in the Gulf of Mexico. Thus, concentrations of nitrogen and phosphorus are important water quality indicators.

Nitrogen

Nitrogen species including ammonia, nitrate, nitrite, nitrite+nitrate, and total Kjeldahl nitrogen (TKN) were measured (as N) for this project. Total nitrogen is the sum of nitrate, nitrite, and TKN concentrations. In calculating total nitrogen, “less than” results were assigned a value equal to the limit of detection. Means for each site, as well as the frequency at which benchmarks were exceeded are summarized in Tables 12 and 13 and Figure 13.

Ammonia, a form of organic nitrogen, ranged from <0.025 mg/L to 1.12 mg/L, with an average of 0.05 mg/L across all sites. Each site had only one to three measurements above the 0.05 mg/L limit of quantitation, which is also the bioregional threshold for “poor” conditions based on least human impacted sites for the Bluegrass Bioregion. One measurement, Site 50 on August 17, was substantially higher than all other values at 1.12 mg/L. No sites had concentrations exceeding the regulatory benchmark for unionized ammonia, calculated based on the pH and water temperature at the time of measurement. Thus, ammonia concentrations were higher than streams with little to no human impact, but concentrations were not measured at levels that would directly impact aquatic life.

TKN, a measurement of organic nitrogen, averaged 0.45 mg/L across all sites with a range of <0.2 mg/L to 2.19 mg/L. Based on least impacted sites in the Bluegrass Bioregion, values below 0.5 mg/L are considered “good,” between 0.5 and 0.8 mg/L “fair,” and greater than 0.8 mg/L “poor.” Sites had between 25% and 50% of values above the “fair” benchmark, and 0% to 20% above the “poor” benchmark. All sites averaged values in the “good” range, with the exception of Site 50, which averaged “fair” and had the highest overall concentrations. On average, the TKN represented 20% or less of the total nitrogen measured at each site.

The nitrate+nitrite concentrations averaged 2.16 mg/L with a range of 0.12 mg/L to 3.81 mg/L. Nitrite concentrations were rarely above the limit of quantitation (0.03mg/L), with the exception of one measurement of 0.33 mg/L at Site 51 on February 2. Otherwise, the nitrate+nitrite measurement was almost entirely comprised of nitrate. For nitrate+nitrite, values below 1.0 mg/L are considered “good,” between 1.0 and 2.0 mg/L “fair,” and greater than 2.0 mg/L “poor” based on least impacted sites in the Bluegrass Bioregion. Sites had between 83% and 100% of values above the “fair” benchmark, and between 17% and 100% of values above the “poor” benchmark. Sites 47, 42, 49, 50, and 51 all averaged concentrations above 2.0 mg/L with the highest concentrations at Site 49.

Table 12 – Summary of nutrient means by site

Parameter	44	45	46	47	48	42	49	50	51
Nitrogen									
Ammonia (mg/L as N)	0.032	0.015	0.039	0.041	0.037	0.034	0.038	0.153	0.046
Unionized Ammonia (mg/L as N)	0.004	0.003	0.004	0.003	0.003	0.001	0.001	0.002	0.001
Nitrogen, Total Kjeldahl (mg/L as N)	0.396	0.268	0.409	0.462	0.450	0.412	0.353	0.741	0.369
Nitrate (mg/L as N)	1.754	0.710	1.900	2.046	1.390	2.444	2.974	2.414	2.120
Nitrite (mg/L as N)	0.016	0.002	0.016	0.017	0.021	0.018	0.016	0.024	0.047
Nitrate+Nitrite (mg/L as N)	1.78	1.89	1.94	2.15	1.44	2.60	3.02	2.54	2.15
Nitrogen, Total	2.163	0.684	2.313	2.521	1.886	2.878	3.370	3.092	2.522
Phosphorus									
Orthophosphate (mg/L as P)	0.473	0.494	0.492	0.497	0.236	0.660	0.304	1.078	0.291
Phosphorus, Total (mg/L)	0.467	0.465	0.458	0.473	0.260	0.611	0.309	0.933	0.320

NOTE: Green indicates concentrations were "good," yellow indicates "fair," and red indicates "poor" as compared to bioregional benchmarks.

Table 13 – Summary of nutrient frequency of exceedance of bioregional benchmarks

Parameter	Use	Benchmark	44	45	46	47	48	42	49	50	51
Ammonia	BR (Poor)	0.05 mg/L as N	8%	8%	17%	25%	25%	8%	25%	30%	17%
Unionized Ammonia	WAH	0.05 mg/L as N	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nitrogen, Total Kjeldahl	BR (Fair)	0.5 mg/ L as N	25%	42%	25%	33%	42%	33%	33%	50%	25%
Nitrogen, Total Kjeldahl	BR (Poor)	0.8 mg/ L as N	0%	17%	0%	17%	0%	17%	0%	20%	8%
Nitrate+Nitrite	BR (Fair)	1.0 mg/L as N	83%	83%	83%	92%	92%	100%	100%	100%	100%
Nitrate+Nitrite	BR (Poor)	2.0 mg/L as N	42%	50%	58%	58%	25%	92%	92%	80%	67%
Phosphorus, Total	BR (Fair)	0.20 mg/L as P	100%	100%	100%	100%	83%	100%	92%	100%	100%
Phosphorus, Total	BR (Poor)	0.35 mg/L as P	92%	83%	83%	92%	8%	92%	17%	100%	25%

NOTE: BR indicates a bioregional benchmark. WAH indicates warmwater aquatic habitat use

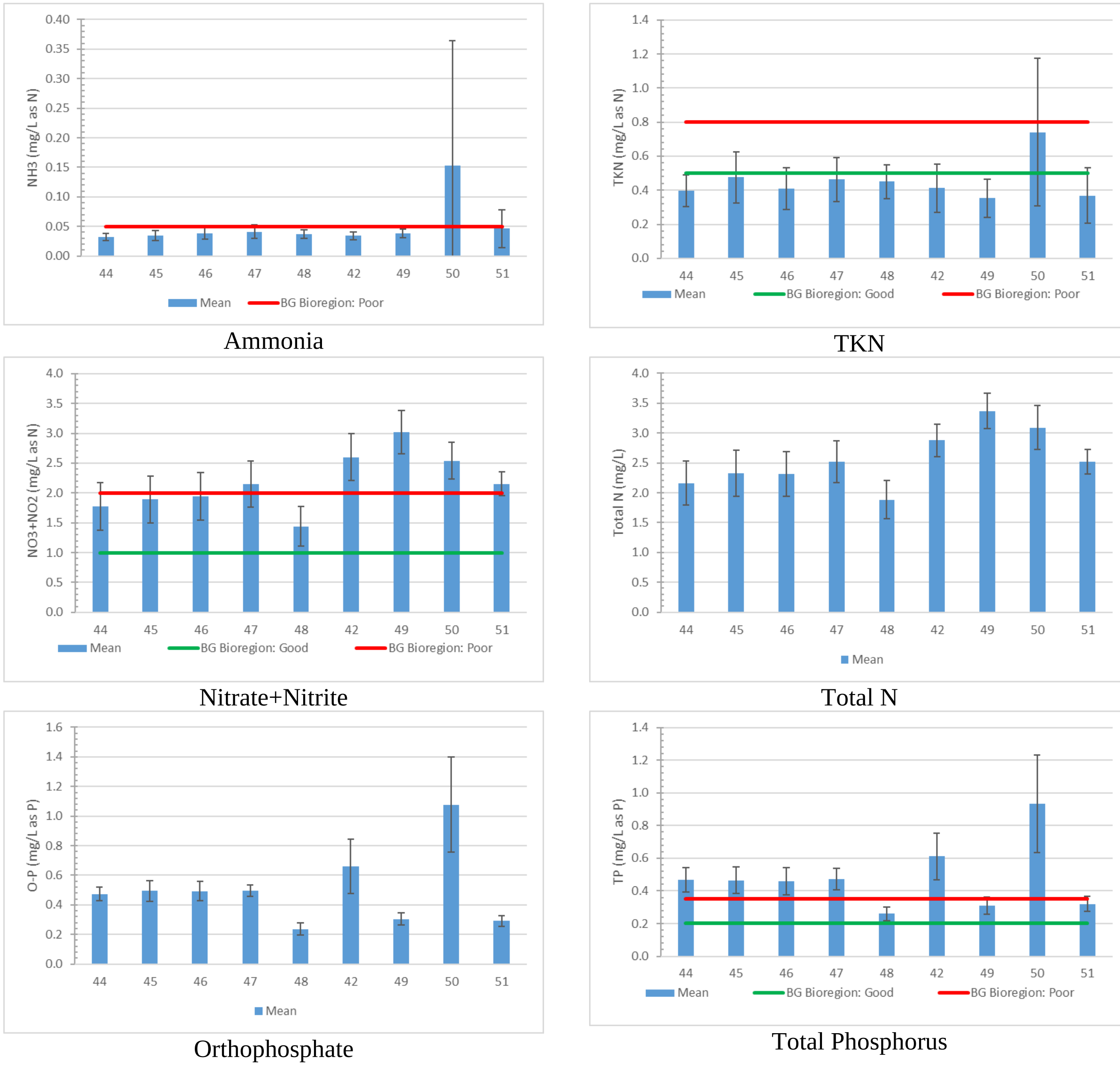


Figure 13: Site means and 95% confidence intervals for nutrient parameters as compared to bioregional benchmarks.

Phosphorus

Total phosphorus and orthophosphate (as P) were analyzed for each sampling location. Orthophosphate is the dissolved form of phosphorus that plants can directly uptake. Total phosphorus includes particulate-bound phosphorus and other forms of phosphorus. With the phosphorus-rich limestone in Central Kentucky, phosphorus levels are normally much higher than surrounding regions, with least human impact benchmarks for the Bluegrass Bioregion set at 0.2 mg/L and 0.35 mg/L for total phosphorus.

Table 12 indicates that, on average, the measured phosphorus was almost entirely orthophosphate, with both averaging 0.47 mg/L across all sites. Site 50 regularly had the highest concentrations with decreasing concentrations downstream at Sites 42 and constant at Sites 44-47. The headwater and tributary sites at Big Spring (Site 51), Camden Creek (Site 49), and Grassy Springs Tributary (Site 48) exceeded the benchmark of 0.35 mg/L less frequently, but all sites regularly exceeded the 0.20 mg/L benchmark (83% - 100% or results by site).

5.2.3 Alkalinity and Bulk Parameters

Alkalinity, Acidity, and Hardness

Alkalinity and acidity are measurements of the buffering capacity of water or the ability of the waterway to maintain a stable pH. Acidity evaluates the ability to neutralize bases via mineral acids such as sulfuric acid or hydrochloric acids. Alkalinity evaluates the presence of negatively charged anions and is subdivided into bicarbonate and carbonate forms. Hardness is similar to alkalinity but relates to the positive cations such as iron, calcium, and magnesium.

Means for each site are summarized in Table 14. Because of the high pH (>8.3) of the waterways, the acidity was commonly less than the limit of quantitation. Alkalinity ranged from 129 mg/L as $CaCO_3$ to 251 mg/L as $CaCO_3$ with the bicarbonate form being the most abundant due to the limestone geology. Hardness ranged from 151 to 284 mg/L.

Biochemical oxygen demand

Biochemical oxygen demand is a measure of rate of oxygen consumption in the stream due to consumption by microorganisms and due to chemical reactions. The highest biochemical oxygen demand concentration measured was 7.19 mg/L at Site 51, but most results were below the quantitation limit of 2.0 mg/L. There is no regulatory criterion for biochemical oxygen demand in streams, but EPA Multi-Sector Permits have a limit of 30 mg/L. All sites had concentrations well below these levels as shown in Table 14 and 15.

Solids and Turbidity

Solids are a measure of matter remaining after evaporation with dissolved solids passing through filter while suspended solids do not. Both suspended solids and turbidity measure the material suspended in the water column with the suspended solids measuring the weight while the turbidity measures the amount of light scattering. Dissolved solids indicate the weight of dissolved ions in the water and is related to the conductivity.

The maximum suspended solids concentration was 48 mg/L with a mean of 7.5 mg/L across all sites indicating low suspended sediment in the events captured, which primarily during dry weather. Turbidity had a maximum of 75.5 NTU and a mean of 5.3 NTU.

Dissolved solids concentrations ranged from 202 mg/L to 1,620 mg/L with a mean of 318 across all sites. The DWS criterion for total dissolved solids is 250 mg/L and is linked to hard water forming scale, a bitter taste, and corrosivity to pipes. This standard applies to drinking water intakes and not surface waters, but it was regularly exceeded at all sites, as shown in Tables 14 and 15. As shown in Figure 12 and discussed with the conductivity results, the geology is primarily responsible for the high dissolved solids concentrations with the exception of Sites 50 and 51, which have higher contributions of sodium chloride suggesting the influence of road salt on those locations. Based on ratios between conductivity and total dissolved solids, a concentration of 300 mg/L total dissolved solids is equivalent to a conductivity of 500 µS/cm, which may be a more appropriate target for this watershed.

Dissolved ions and Carbon

Dissolved ions including bromide, chloride, fluoride, and sulfate were also sampled as well as total organic carbon, with results summarized in Tables 14 and 15. Of these, only chloride had exceedances of benchmarks. Site 51 had a mean chloride concentration of 146 mg/L, with one sample collected on February 2 reaching 851 mg/L, above the chronic WAH limit. This indicates that road salt runoff may negatively impact aquatic life if these levels are maintained for over 96 hours.

Table 14 – Summary of alkalinity and bulk parameter means by site

Parameter	44	45	46	47	48	42	49	50	51
Acidity (mg/L)	2.50	2.50	2.50	2.66	3.09	3.69	4.39	8.19	6.49
Alkalinity (mg/L as $CaCO_3$)	208.50	208.67	206.17	201.58	205.25	196.58	185.17	199.64	187.00
Alkalinity, Bicarbonate (mg/L as $CaCO_3$)	190.75	195.67	189.83	191.17	193.42	193.50	183.83	199.64	187.00
Alkalinity, Carbonate (mg/L as $CaCO_3$)	18.23	13.57	16.70	11.43	14.07	5.17	3.45	2.50	2.50
Hardness, Total (mg/L as $CaCO_3$)	213.50	212.08	213.67	209.83	206.00	212.58	192.00	230.64	226.58
Biochemical Oxygen Demand, Carbonaceous 5-day (mg/L)	2.07	2.09	2.02	2.00	2.03	2.00	2.00	2.31	3.10
Solids, Total Dissolved (mg/L)	288.75	294.75	286.83	286.08	268.92	298.67	270.17	386.82	492.33
Solids, Total Suspended (mg/L)	6.08	6.50	10.33	7.17	6.63	8.88	6.96	3.77	10.50
Turbidity (NTU)	4.34	4.32	4.34	4.39	4.81	5.72	4.95	2.85	11.99
Bromide (mg/L)	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.04	0.06
Carbon, Total Organic (mg/L)	2.24	2.20	2.15	2.16	2.10	2.22	1.69	2.52	1.47
Chloride (mg/L)	25.87	27.17	25.97	26.73	22.19	31.32	15.06	72.07	145.77
Fluoride (mg/L)	0.26	0.26	0.27	0.27	0.25	0.28	0.21	0.39	0.25
Sulfate (mg/L as S)	17.23	17.38	17.61	18.00	10.94	21.11	11.89	35.10	27.66

Table 15 – Summary of alkalinity and bulk parameter percentage exceedance of benchmarks by site

Parameter	Use	Benchmark	44	45	46	47	48	42	49	50	51
Biochem. Oxyg. Demand, 5-Day Carbonaceous	NR	30 mg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Solids, Total Dissolved	DWS	250 mg/L	100%	100%	100%	100%	67%	92%	67%	100%	92%
Solids, Total Dissolved	NR	300 mg/L	33%	42%	25%	33%	8%	58%	8%	100%	92%
Solids, Total Suspended	NR	80 mg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chloride	DWS	250 mg/L	0%	0%	0%	0%	0%	0%	0%	0%	8%
Chloride	Chronic	600 mg/L	0%	0%	0%	0%	0%	0%	0%	0%	8%
Chloride	Acute	1200mg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fluoride	DWS	4 mg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sulfate	DWS	250 mg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%

NOTE: NR indicates a nonregulatory benchmark. DWS indicates domestic water supply use and are applicable at points of public water intakes. Acute (1-hour exposure) and chronic (96-hour exposure) criteria are related to warmwater aquatic habitat use. Yellow indicates a benchmark exceedance.

5.2.4 Metals

Numerous metal parameters were analyzed with results summarized in Tables 16 and 17. All parameters were below regulatory benchmarks, with the exceptions of iron and lead.

Iron concentrations reached a maximum of 1.08 mg/L at Site 42 on Glenns Creek near Steele Road, exceeding the chronic WAH criterion at this site on August 17. All sites, with the exception of Site 50, had at least one event in which levels exceeded 0.3 mg/L, the DWS limit criteria intended to protect against bad taste and appearance of the water. Elevated iron concentrations are likely linked to suspended sediment.

Lead concentrations exceeded the chronic WAH criterion, which is dependent upon the hardness concentration, twice during the study at Site 51 in Big Spring Park. These events occurred on September 22 and February 2, both wet weather events. Elevated lead levels are likely due to urban runoff.

Table 16 – Summary of metals means by site

Parameter	44	45	46	47	48	42	49	50	51
Aluminum (µg/L)	229.77	248.75	221.20	212.08	173.37	231.17	214.92	80.13	393.88
Antimony (µg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.54
Arsenic (µg/L)	0.53	0.53	0.53	0.53	0.54	0.51	0.52	0.50	0.57
Barium (µg/L)	19.07	18.59	18.23	18.36	16.87	20.08	19.78	21.22	26.82
Beryllium (µg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (µg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium (mg/L)	75.84	75.26	75.47	74.32	73.10	74.93	69.63	78.52	79.75
Chromium (µg/L)	0.55	0.56	0.56	0.55	0.51	0.55	0.51	0.50	0.80
Cobalt (µg/L)	0.33	0.33	0.32	0.33	0.26	0.29	0.24	0.26	0.29
Copper (µg/L)	2.04	2.07	2.07	2.00	2.09	2.00	2.00	2.00	3.02
Iron (mg/L)	0.17	0.13	0.18	0.19	0.15	0.24	0.15	0.10	0.19
Lead (µg/L)	0.35	0.35	0.35	0.35	0.24	0.45	0.27	0.46	2.04
Magnesium (mg/L)	5.89	5.86	6.12	5.87	5.71	6.17	4.42	8.39	6.71
Manganese (µg/L)	54.73	34.35	33.71	37.57	37.46	39.43	31.23	21.71	22.57
Molybdenum (µg/L)	0.53	0.53	0.53	0.58	0.50	0.59	0.50	0.73	0.69
Nickel (µg/L)	2.01	2.03	2.02	2.01	2.00	2.15	2.00	2.01	2.10
Potassium (mg/L)	2.28	2.29	2.27	2.40	1.67	2.81	1.58	4.31	2.22
Selenium (µg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Silver (µg/L)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Sodium (mg/L)	15.61	15.91	14.75	15.91	11.15	18.85	8.34	41.14	71.29
Thallium (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Vanadium (µg/L)	0.74	0.72	0.72	0.69	0.68	0.66	0.59	0.46	0.82
Zinc (µg/L)	5.84	5.55	6.29	5.80	5.00	8.32	5.00	16.02	10.61

Table 17 – Summary of metals percentage exceedance of benchmarks

Parameter	Use	Benchmark	44	45	46	47	48	42	49	50	51
Arsenic	DWS	10 µg/L,	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	Chronic	150 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	Acute	340 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Barium	DWS	1000 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Beryllium	DWS	4 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cadmium	DWS	5 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cadmium	Chronic	2.42-4.01 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cadmium	Acute	3.09-5.73 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium	DWS	100 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Copper	DWS	1300 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Copper	Acute	22.77-41.29 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Copper	Chronic	17.00-29.18 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Iron	DWS	0.3 mg/L	17%	8%	17%	8%	8%	17%	8%	0%	8%
Iron	Chronic	1.0 mg/L	0%	0%	0%	0%	0%	8%	0%	0%	0%
Iron	Acute	4.0 mg/L,	0%	0%	0%	0%	0%	0%	0%	0%	0%
Lead	DWS	15 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Lead	Chronic	1.49-3.33 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	17%
Lead	Acute	92.61-206.97 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nickel	DWS	610 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nickel	Acute	469.8-801.7 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nickel	Chronic	73.3-125.0 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Selenium	DWS	170 µg/L,	0%	0%	0%	0%	0%	0%	0%	0%	0%
Selenium	DWS	5.0 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Silver	Acute	5.0 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%
Thallium	DWS	0.24 µg/L	0%	0%	0%	0%	0%	0%	0%	0%	0%

NOTE: DWS indicates domestic water supply use and are applicable at points of public water intakes. Acute (1-hour exposure) and chronic (96-hour exposure) criteria are related to warmwater aquatic habitat use. Yellow indicates a benchmark exceedance.

5.3 Summary of Water Quality Concentrations

To simplify water quality data for public audiences, the percentage of exceedance (for concentration data) of the benchmarks was utilized to generate water quality health scores. These health scores, like report cards, assign letter grades to the frequency of exceedance at each site. Each parameter is "graded on a curve" such that letter scores for 1 parameter are similar to letter scores for other parameters. Letter grades for individual parameters are roughly based on KDOW's method for evaluating data for listing impairments or their TMDL Health Reports. The percent exceedance and the corresponding grade for each parameter are shown in Table 18. The water quality health scores for this project are summarized in Table 19.

Laboratory results indicated exceedances of benchmarks and regulatory criteria for *E. coli*, ammonia, total Kjeldahl nitrogen, nitrate+nitrite, total phosphorus, total dissolved solids / conductivity, chloride, iron, and lead.

Table 18 – Water quality health grade calculations by frequency of exceedance

Parameter	Benchmark	% of Results Exceeding				
		A	**B**	**C**	**D**	**F**
E. coli – Primary (Swimming)	240 MPN/100mL	0-10%	11-20%	21-33%	34-66%	67-100%
E. coli – Secondary (Wading)	676 MPN/100mL	0-10%	11-20%	21-33%	34-66%	67-100%
pH	6-9 SU	0-5%	6-10%	11-25%	26-66%	67-100%
Dissolved Oxygen	4 mg/L	0-5%	6-10%	11-25%	26-66%	67-100%
Conductivity	500 µS/cm	0-10%	11-25%	26-50%	51-66%	67-100%
Solids, Dissolved	300 mg/L	0-10%	11-25%	26-50%	51-66%	67-100%
Ammonia	0.05 mg/L as N	0-10%	11-25%	26-50%	51-66%	67-100%
Ammonia	3.0 mg/L as N	0-10%	11-25%	26-50%	51-66%	67-100%
Nitrogen, Total Kjeldahl	0.8 mg/L as N	0-10%	11-25%	26-50%	51-66%	67-100%
Nitrogen, Nitrate+Nitrite	2.0 mg/L as N	0-10%	11-25%	26-50%	51-66%	67-100%
Phosphorus, Total	0.35 mg/L as P	0-10%	11-25%	26-50%	51-66%	67-100%
Chloride	600 mg/L	0%	1-10%	10-20%	21-55%	56-100%
Iron	1.0 mg/L	0%	1-10%	10-20%	21-55%	56-100%
Lead	1.49-3.33 µg/L	0%	1-10%	10-20%	21-55%	56-100%

Table 19 – Summary water quality health grades for Glenns Creek sites

Parameter	**44**	**45**	**46**	**47**	**48**	**42**	**49**	**50**	**51**
E. coli – Primary Contact (Swimming)	A	B	A	B	A	D	D	D	F
E. coli – Secondary Contact (Wading)	B	B	A	B	B	B	B	B	C
Human Health Grade	**B**	**B**	**A**	**B**	**B**	**C**	**C**	**C**	**D**
pH	B	A	A	A	A	A	A	A	A
Dissolved Oxygen	A	A	A	A	A	A	A	A	A
Conductivity	B	C	C	B	A	C	A	F	F
Solids, Dissolved	C	C	B	C	A	D	A	F	F
Ammonia	A	A	B	B	B	A	B	C	B
Nitrogen, Total Kjeldahl	A	B	A	B	A	B	A	B	A
Nitrogen, Nitrate + Nitrite	C	C	D	D	B	F	F	F	F
Phosphorus, Total	F	F	F	F	A	F	B	F	B
Chloride	A	A	A	A	A	A	A	A	B
Iron	A	A	A	A	A	A	A	A	B
Lead	A	A	A	A	A	A	A	A	C
Overall Water Quality Health Grade	**B**	**B**	**B**	**B**	**A**	**C**	**B**	**D**	**D**

6 Loading Analysis Calculation

According to the "Watershed Planning Guidebook for Kentucky Communities" (2010), KDOW requires that pollutant loading be calculated according to the following generalized formula for each sampling event for each site and then averaged for the overall load:

Actual Concentration x Discharge (cfs) x Conversion Factor = Actual Load

The actual pollutant load is then compared against the target load to determine what load reductions are necessary. To calculate the target load, the same generalized formula is utilized but the benchmark concentration is substituted for the actual concentration.

The annual pollutant loads and target loads were calculated for all parameters in which loads can be calculated (i.e. not conductivity or pH) and for which exceedances were measured during the monitoring period. For *E. coli*, the primary contact recreational instantaneous criteria was utilized as the target. For chloride, iron, and lead, chronic criteria for WAH were utilized as targets. For all other parameters, non-regulatory regional interpretations of narrative criteria were utilized as targets.

Table 20 summarizes the percent reductions by site to achieve the specified target concentrations. Despite individual event exceedances for chloride, iron, and lead, the annual pollutant loading met the target load criteria across all sites.

Table 20 – Summary annual pollutant loads, target loads, and percentage reductions by site

Parameter	Unit	44	45	46	47	48	42	49	50	51
E. coli (Trillion/year) 240 MPN/100mL	Actual	352.5	278.9	377.7	376.0	17.4	401.8	273.6	39.4	16.7
	Target	86.2	82.4	83.4	82.5	8.9	61.9	24.6	13.5	3.7
	% Reduct.	76%	70%	78%	78%	49%	85%	91%	66%	89%
Ammonia (tons/year) 0.05 mg/L	Actual	1.57	1.64	1.77	2.02	0.16	1.01	0.46	1.31	0.09
	Target	2.22	2.03	2.1	2.07	0.23	1.56	0.63	0.36	0.1
	% Reduct.	0%	0%	0%	0%	0%	0%	0%	73%	0%
Nitrogen, Total Kjeldahl (tons /year) 0.8 mg/L	Actual	19.32	22.09	18.39	21.94	2.36	14.63	4.87	5.02	0.87
	Target	35.59	32.54	33.66	33.16	3.74	24.98	10.09	5.69	1.53
	% Reduct.	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nitrogen, Nitrate + Nitrite (tons/year) 2.0 mg/L	Actual	89.14	85.05	89.65	93.09	7.4	85.44	39.39	18.13	4
	Target	88.96	81.35	84.14	82.89	9.36	62.45	25.23	14.23	3.82
	% Reduct.	0%	4%	6%	11%	0%	27%	36%	21%	4%
Phosphorus, Total (tons/year) 0.35 mg/L	Actual	22.03	19.93	20.57	21.4	1.42	17.67	4.65	5.91	0.65
	Target	15.57	14.24	14.72	14.51	1.64	10.93	4.41	2.49	0.67
	% Reduct.	29%	29%	28%	32%	0%	38%	5%	58%	0%
Solids, Total Dissolved (tons/year) 300 mg/L	Actual	12354	11537	11572	11507	1203	8820	3343	2540	885
	Target	13344	12203	12621	12434	1404	9368	3784	2135	573
	% Reduct.	0%	0%	0%	0%	0%	0%	0%	16%	35%
Chloride (tons/year) 600 mg/L	Actual	952	917	932	935	82	799	159	485	263
	Target	26689	24405	25242	24867	2808	18736	7568	4270	1145
	% Reduct.	0%	0%	0%	0%	0%	0%	0%	0%	0%
Iron (tons/year) 1 mg/L	Actual	8.64	7.62	10.88	13.26	0.78	11.45	2.82	0.84	0.46
	Target	44.48	40.68	42.07	41.45	4.68	31.23	12.61	7.12	1.91
	% Reduct.	0%	0%	0%	0%	0%	0%	0%	0%	0%
Lead (tons/year) 2.31 µg/L	Actual	0.0227	0.0202	0.0221	0.0223	0.0012	0.0176	0.0041	0.0037	0.0044
	Target	0.1026	0.0940	0.0972	0.0957	0.0108	0.0721	0.0291	0.0164	0.0044
	% Reduct.	0%	0%	0%	0%	0%	0%	0%	0%	0%

NOTE: Red shading indicates the magnitude of the percentage load reduction required at the site.

Use of uncorrected stream discharge measurements at the time of arrival of grab sampling in load calculations can introduce bias and variability, particularly for events collected during wet weather conditions. The time of arrival at a given monitoring site will likely not reflect the same relative period in the hydrographic rise or fall of the stream, and therefore relative flow contributions from sites will not be proportionally represented. Time of arrival stream flow measurements can be corrected via continuous monitoring data and relationships between area and stream flow. However, such data was not collected under the scope of this project to perform such corrections. That said, such biases are expected to be minimal in this dataset based on field observations of the relative stream levels between monitoring sites during the project. Therefore, the measured stream flow for each site was utilized per KDOW protocol.

Also, as previously noted, wet weather conditions are under-represented in this dataset as compared to the monitoring year, so annual load calculations may be biased low.

Despite chloride, iron, and lead having exceedances, the overall nutrient load did not indicate a need for reduction. However, efforts to reduce the total dissolved solids load (and the associated conductivity) at Sites 50 and 51 may also address these parameters, particularly chloride.

Similarly, no load reductions were required for total Kjeldahl nitrogen, but reductions in the ammonia concentration would also reduce the TKN.

Efforts to reduce the pollutant load in the watershed should be focused on the headwater region, upstream of Site 47 at Millville Community Park. Table 21 evaluates the incremental load reductions necessary to achieve the target reductions. These incremental load reductions assume that if the load is reduced at upstream sites will also be reflected downstream. No load reductions are required below Site 47, but all sites above Millville Community Park require reductions to one or more parameters.

Table 21 – Incremental load reductions by site drainage area to achieve targets

Parameter	**Unit**	**44**	**45**	**46**	**47**	**48**	**42**	**49**	**50**	**51**
E. coli	Trillion/year	0	0	0	0	8.5	65.0	249.0	12.9	13.0
Ammonia	tons /year	0	0	0	0	0	0	0	0.95	0
Nitrogen, Nitrate + Nitrite	tons /year	0	0	0	0	0	4.93	14.2	3.72	0.18
Phosphorus, Total	tons /year	0	0	0	0.15	0	3.08	0.24	3.42	0
Solids, Total Dissolved	tons /year	0	0	0	0	0	0	0	93	312

For *E. coli*, the largest load reduction will come upstream of Site 49 in the Camden Creek watershed, which is primarily agricultural. This also coincides with the largest load reduction in nitrate. The lack of necessary load reductions at Site 50 for *E. coli* points to the effectiveness of the improved wastewater treatment plant in eliminating overflows in this area. However, nutrient load reductions for nitrate, ammonia, and phosphorus may be achieved through nutrient optimization at the wastewater treatment plant as well as other upstream land uses. Site 51 in Big Spring Park should be the focus of efforts to reduce dissolved solids, including road salt runoff, as well as *E. coli* from urban sources upstream.

7 References

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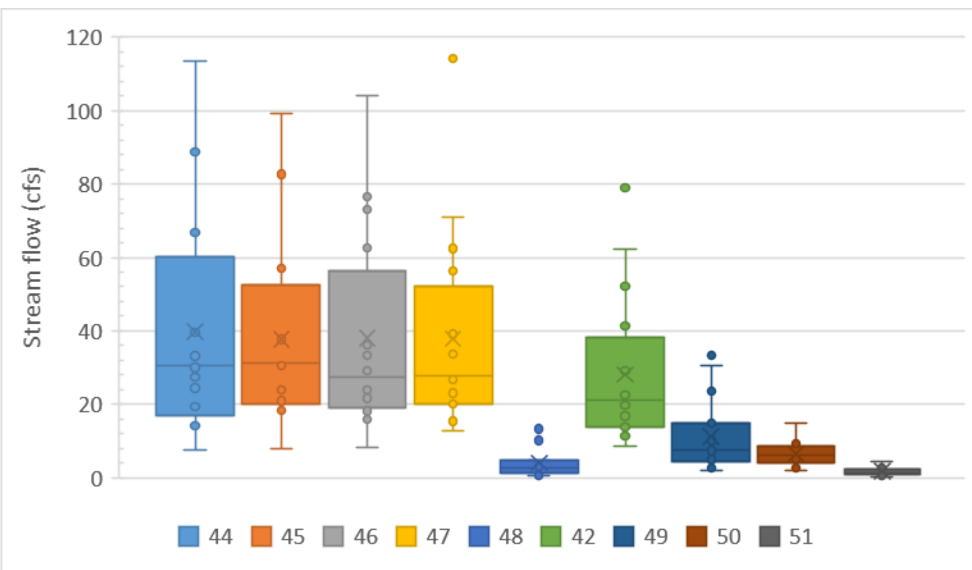
Appendix A: Concentration Tables and Charts

Stream Flow (cfs)

Day	44	45	46	47	48	42	49	50	51
16-Mar	66.76	57.09	73.09	56.42	10.17	41.42	14.99	10.89	2.101
20-Apr	14.25	18.82	18.12	20.07	1.474	13.19	3.878	2.626	0.726
11-May	33.16	38.25	33.43	39.93	3.792	24.61	10.19	6.018	1.38
13-May	27.51	30.46	25.49	21.69	2.213	20.63	7.422	6.603	1.163
18-May	16.28	18.39	15.98	15.4	0.947	11.49	4.024	3.844	0.522
25-May	7.554	7.803	8.412	12.86	0.481	8.715	2.002	1.928	0.315
27-May	16.11	20.94	21.64	23.06	0.719	13.72	2.693	5.000	1.499
15-Jun	66.82	58.65	62.53	62.46	4.12	52.23	23.49	14.87	4.556
20-Jul	30.06	31.98	29.21	28.65	2.924	21.56	7.681	5.004	0.973
17-Aug	113.6	99.24	104.2	114.1	13.32	79.1	33.41	9.402	2.495
22-Sep	40.25	37.7	38.1	39.08	4.843	19.7	4.921	ND	4.001
19-Oct	24.44	24.02	23.97	20.2	1.332	22.62	7.563	6.176	1.388
16-Nov	19.52	19.7	18.17	20.22	1.862	14.11	5.055	3.583	0.812
14-Dec	88.64	82.69	76.52	70.81	10.13	62.12	30.48	10.27	2.703
19-Jan	39.58	32.28	36.09	33.74	3.83	29.07	14.85	6.877	1.152
2-Feb	30.76	25.87	24.43	26.62	2.555	16.83	5.44	4.248	2.044
Mean	39.71	37.74	38.09	37.83	4.04	28.19	11.13	6.49	1.74
Std Dev	29.57	24.89	26.78	26.62	3.83	20.22	9.86	3.40	1.20
95% CI	14.49	12.20	13.12	13.04	1.88	9.91	4.83	1.67	0.59

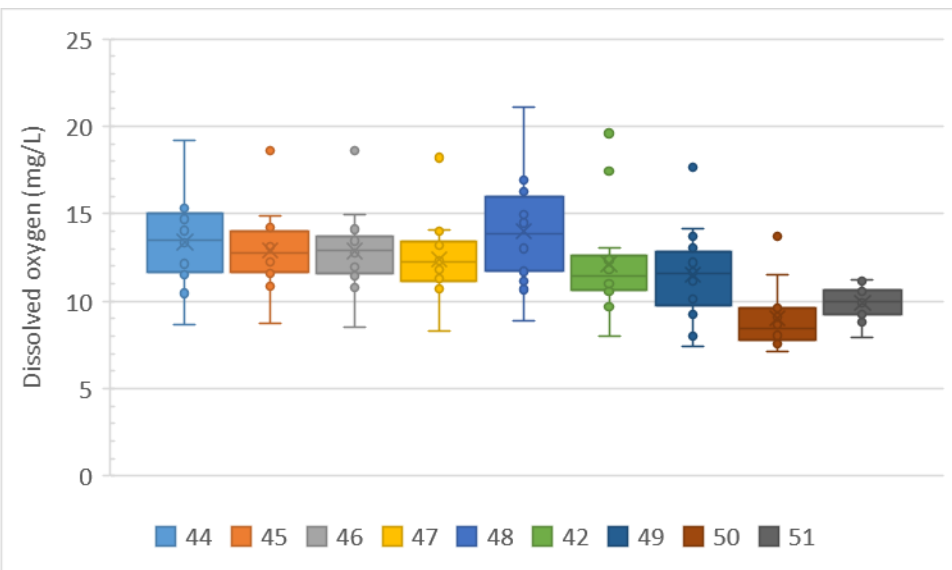
NOTE: Gray shading indicates estimated value. ND = No data due to site access restriction on 9/22.



Dissolved Oxygen (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	12.33	13.36	14.11	14.01	13.17	17.42	13.69	13.73	11.21
20-Apr	19.21	18.6	18.63	18.21	21.11	19.6	17.67	11.52	9.71
11-May	14.77	11.85	12.82	11.28	14.65	13.05	11.53	7.75	9.2
13-May	15.76	14.91	14.92	13.5	16.94	12.61	13.05	8.44	10.7
18-May	15.09	13.44	13.71	12.66	14.47	10.85	11.64	7.57	10.05
25-May	15.34	14.2	13.13	12.3	16.27	10.8	14.13	8.04	11.12
27-May	14.03	12.29	13.45	11.1	14.97	9.7	12.04	7.16	10.57
15-Jun	13.68	13.12	13.04	12.5	15.27	12.07	11.17	9.93	10.29
20-Jul	12.33	12.45	11.96	10.7	11.92	11.05	9.25	9.1	9.99
17-Aug	13.35	13.45	12.75	11.82	11.14	10.6	9.65	7.79	9.95
22-Sep	8.68	8.74	8.52	8.31	8.86	8.02	7.4	ND	7.9
19-Oct	12.14	12.23	10.78	12.18	16.25	11.79	11.3	9.48	9.26
16-Nov	10.45	10.87	12.1	13.21	13.3	12.35	11.57	8.64	9.91
14-Dec	10.57	10.97	10.79	10.9	10.68	10.55	7.98	8.46	8.86
19-Jan	11.5	11.61	11.45	11.52	11.7	11.02	10.13	8.36	8.78
2-Feb	14.69	14.38	13.67	14.05	13.02	12.56	12.21	9.62	10.74
Mean	**13.37**	**12.90**	**12.86**	**12.39**	**13.98**	**12.13**	**11.53**	**9.04**	**9.89**
Std Dev	2.54	2.16	2.19	2.11	2.94	2.81	2.49	1.71	0.91
95% CI	1.24	1.06	1.07	1.04	1.44	1.38	1.22	0.86	0.45

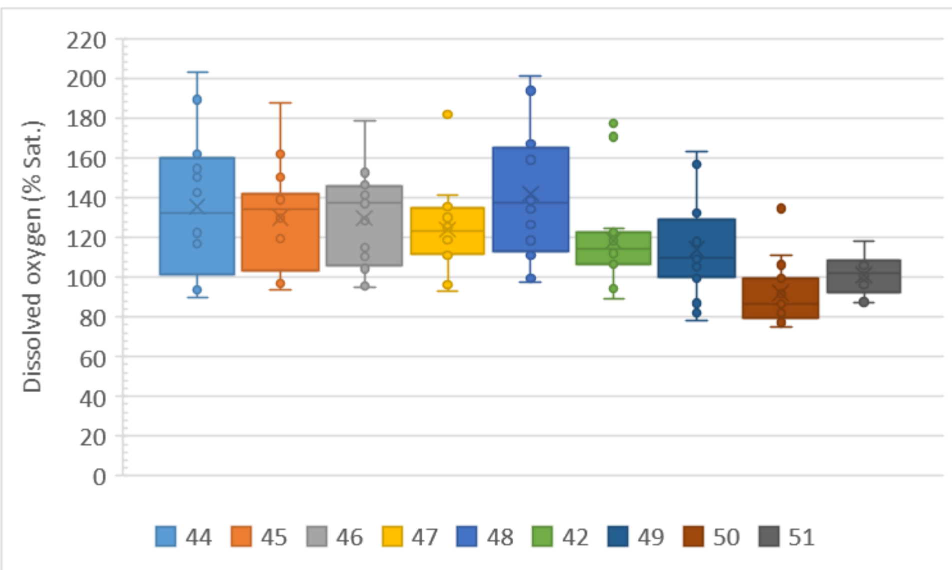
NOTE: ND = No data due to site access restriction on 9/22.



Dissolved Oxygen (% Saturation)

	44	45	46	47	48	42	49	50	51
16-Mar	122.3	129.6	137.6	135.3	134.1	170.5	132.1	134.5	108.1
20-Apr	203.3	187.7	178.8	181.7	200.8	177.3	163.3	111.2	96.0
11-May	116.7	119.1	128.2	110.9	135.3	122.7	109.6	75.2	91.0
13-May	154.4	138.9	141.4	130.0	158.9	115.0	119.0	82.2	104.8
18-May	162.0	142.2	146.5	135.9	160.1	111.9	120.0	78.4	100.9
25-May	189.1	162.0	152.4	141.5	193.6	121.0	156.6	86.7	118.0
27-May	163.6	140.7	154.7	125.3	166.9	106.4	134.5	77.2	108.0
15-Jun	150.1	141.8	141.2	133.0	168.7	124.4	117.7	106.1	109.8
20-Jul	142.3	139.3	137.1	121.4	138.8	118.3	99.5	99.6	106.0
17-Aug	150.2	150.1	142.6	130.3	126.4	115.9	105.0	88.0	109.3
22-Sep	96.6	97.2	95.0	92.9	97.2	88.8	81.9	ND	87.3
19-Oct	119.3	120.0	110.2	118.6	159.5	113.5	109.2	99.3	98.4
16-Nov	89.8	93.9	104.2	113.1	118.4	107.8	102.0	86.1	102.8
14-Dec	93.6	97.6	95.4	97.2	99.4	95.5	78.0	82.6	88.6
19-Jan	96.0	96.7	95.9	96.2	99.8	94.4	86.8	79.7	87.5
2-Feb	117.5	120.5	114.9	118.5	111.0	109.1	105.7	91.8	101.3
Mean	135.43	129.83	129.76	123.86	141.81	118.28	113.81	91.91	101.11
Std Dev	34.47	26.04	24.71	21.41	32.51	24.01	24.06	16.00	9.07
95% CI	16.89	12.76	12.11	10.49	15.93	11.77	11.79	8.10	4.44

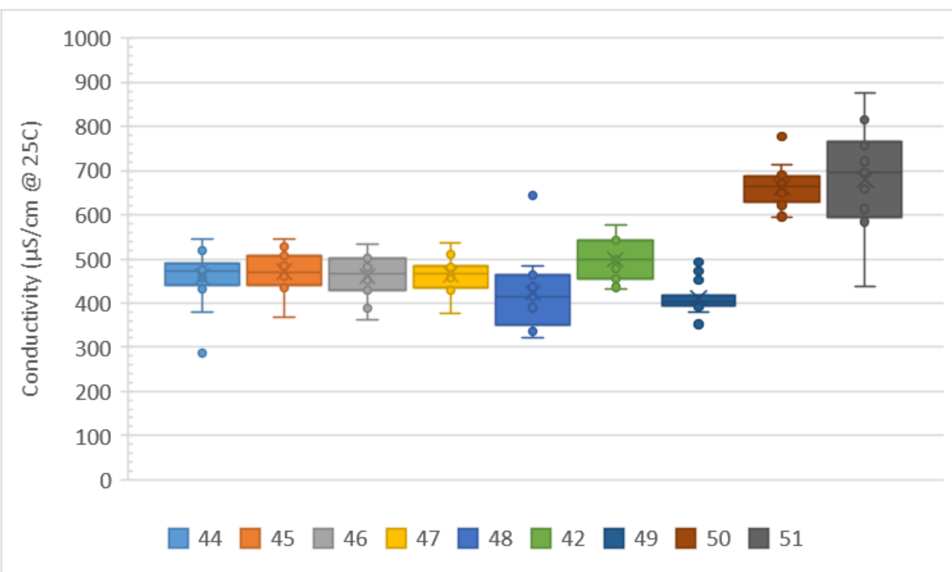
NOTE: ND = No data due to site access restriction on 9/22.



Conductivity (µS/cm)

	44	45	46	47	48	42	49	50	51
16-Mar	473	469	468	471	436	479	417	691	814
20-Apr	457	461	451	466	414	510	408	649	758
11-May	287	369	390	376	351	455	404	687	695
13-May	443	451	454	466	336	466	391	632	613
18-May	380	436	362	430	340	577	403	712	773
25-May	491	508	495	470	322	552	380	670	767
27-May	518	534	509	458	390	504	394	638	724
15-Jun	476	472	481	484	450	484	402	622	599
20-Jul*	*	*	*	*	*	*	*	*	*
17-Aug	441	443	389	445	419	436	401	596	589
22-Sep	481	490	502	510	485	542	453	ND	438
19-Oct	545	545	534	537	482	552	493	671	584
16-Nov	522	528	519	522	464	543	472	656	659
14-Dec	448	440	439	435	415	443	402	595	593
19-Jan	432	435	429	429	392	433	352	675	721
2-Feb	489	485	485	482	644	499	404	777	877
Mean	459	471	460	465	423	498	412	662	680
Std Dev	63	46	51	40	81	47	36	48	113
95% CI	32	23	26	20	41	24	18	25	57
%>500 µS/cm	20%	27%	27%	20%	7%	47%	0%	100%	93%

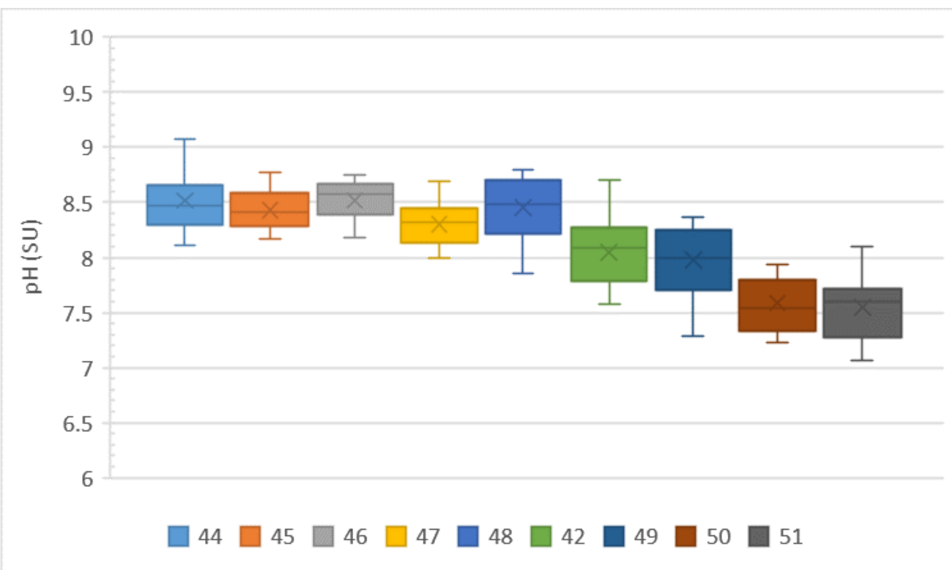
*NOTE: ND = No data due to site access restriction on 9/22. *July 20 event excluded as outliers*



pH (SU)

	44	45	46	47	48	42	49	50	51
16-Mar	8.74	8.77	8.74	8.69	8.42	8.70	8.18	7.83	7.54
20-Apr	9.07	8.65	8.75	8.40	8.68	8.35	8.32	7.69	7.75
11-May	8.47	8.54	8.59	8.38	8.79	8.20	8.25	7.54	7.69
13-May	8.44	8.31	8.63	8.48	8.69	8.10	8.23	7.60	7.85
18-May	8.63	8.51	8.64	8.41	8.49	7.77	8.02	7.52	7.26
25-May	8.95	8.55	8.62	8.42	8.72	7.81	8.37	7.32	7.59
27-May	8.66	8.34	8.53	8.20	8.79	7.59	8.27	7.23	7.23
15-Jun	8.48	8.44	8.38	8.04	8.47	7.93	7.60	7.33	7.29
20-Jul	8.38	8.39	8.41	8.19	8.32	7.85	7.54	7.51	7.39
17-Aug	8.25	8.28	8.18	7.99	7.86	7.58	7.29	7.30	7.27
22-Sep	8.58	8.62	8.56	8.46	8.40	8.30	8.20	ND	7.06
19-Oct	8.11	8.17	8.26	8.12	8.60	8.12	7.85	7.76	7.62
16-Nov	8.27	8.37	8.67	8.46	8.71	8.34	7.93	7.94	8.10
14-Dec	8.21	8.19	8.41	8.09	8.01	8.08	7.97	7.80	7.72
19-Jan	8.42	8.19	8.22	8.25	8.18	7.78	7.66	7.54	7.70
2-Feb	8.63	8.60	8.70	8.26	8.16	8.21	7.98	7.89	7.72
Mean	8.52	8.43	8.52	8.30	8.46	8.04	7.98	7.59	7.55
Std Dev	0.26	0.18	0.19	0.19	0.29	0.31	0.32	0.23	0.28
95% CI	0.13	0.09	0.09	0.09	0.14	0.15	0.16	0.12	0.13

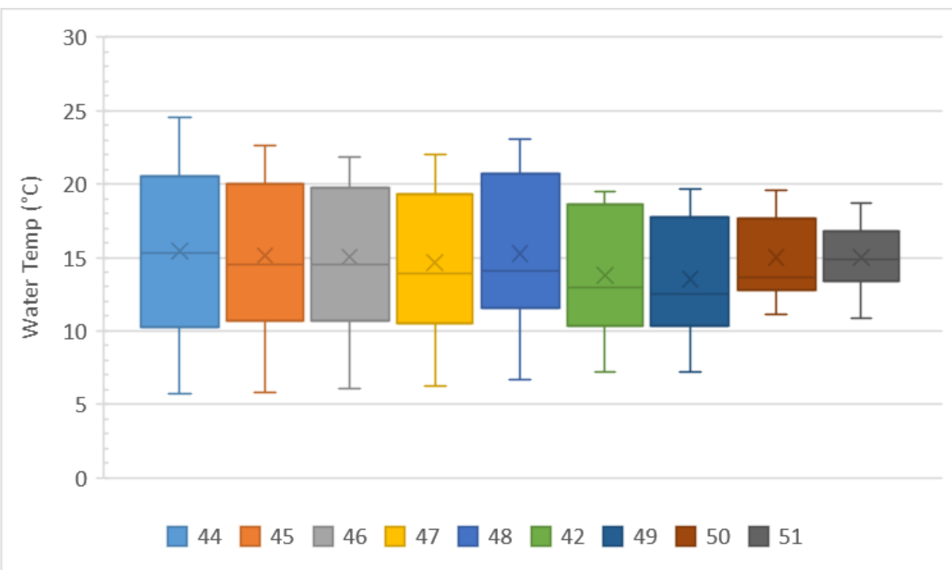
NOTE: ND = No data due to site access restriction on 9/22.



Temperature, Water (°C)

	44	45	46	47	48	42	49	50	51
16-Mar	13.40	13.37	13.29	12.66	14.46	12.92	12.34	12.79	12.62
20-Apr	16.15	14.24	14.27	14.02	12.66	11.00	11.04	12.68	12.95
11-May	11.67	14.84	14.84	13.73	13.73	12.23	12.12	13.44	13.70
13-May	14.44	13.17	13.06	12.47	11.80	10.61	10.38	13.11	13.38
18-May	18.50	17.71	17.91	18.09	17.15	16.45	15.92	15.98	14.51
25-May	24.54	22.60	21.84	21.97	23.10	19.49	19.68	17.79	15.30
27-May	22.39	21.27	21.22	20.32	21.28	18.94	18.93	17.63	15.39
15-Jun	19.73	18.98	18.53	17.56	19.64	16.81	16.22	16.92	16.79
20-Jul	22.22	21.67	21.5	20.28	22.08	18.45	17.67	18.38	16.77
17-Aug	20.75	20.27	19.96	19.38	21.06	18.69	17.76	19.60	18.71
22-Sep	19.28	19.26	19.16	19.28	18.37	18.72	18.10	ND	18.47
19-Oct	13.83	13.89	14.09	13.62	13.70	12.97	12.64	16.52	17.00
16-Nov	7.94	8.20	8.47	8.39	9.59	8.36	8.68	13.68	15.68
14-Dec	9.74	9.88	9.92	9.82	11.51	10.24	10.39	13.31	14.46
19-Jan	6.53	6.60	6.78	6.73	7.52	7.45	7.46	11.79	13.58
2-Feb	5.74	5.85	6.05	6.26	6.67	7.21	7.17	11.16	10.83
Mean	15.43	15.11	15.06	14.66	15.27	13.78	13.53	14.99	15.01
Std Dev	5.96	5.45	5.26	5.09	5.26	4.42	4.22	2.67	2.18
95% CI	2.92	2.67	2.58	2.49	2.58	2.16	2.07	1.35	1.07

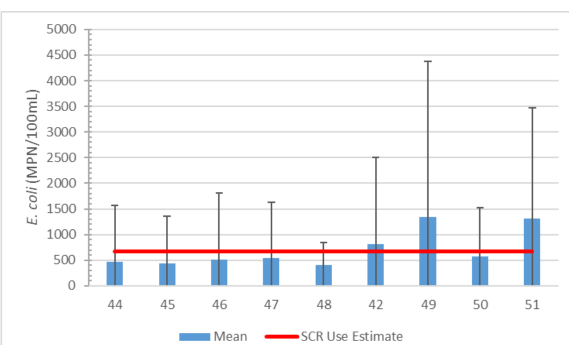
NOTE: ND = No data due to site access restriction on 9/22.

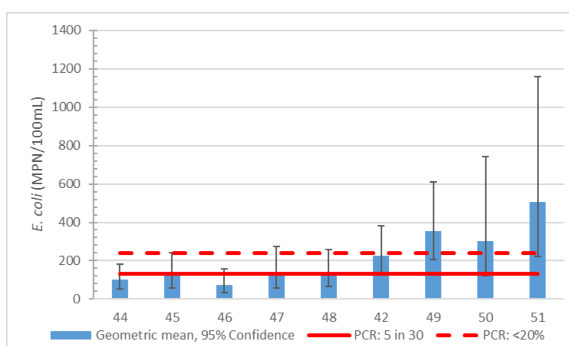


E. coli **(MPN/100mL)**

	44	45	46	47	48	42	49	50	51
16-Mar	20	161	98	121	122	480	228	Q	279
20-Apr	65.7	38.3	63.3	112.6	488.4	185	290.9	74.9	108.5
11-May	76.8	56.5	102.2	93.3	95.9	172.5	235.9	172.5	280.1
13-May	150	65	88.4	218.7	98.3	387.3	235.9	101.4	300.4
18-May	121	228	31	96	487	305	323	350	627
25-May	35.5	86.2	34.5	42	62.9	91	290.9	260.3	265
27-May	204.6	344.8	240	410.6	133.4	325.5	1046.2	1553.1	2419.6
15-Jun	187	282	231	256	480	428	364	465	834.5
20-Jul	193.5	387.3	365.4	325.5	1203.3	727	648.8	193.5	248.65
17-Aug	4352	3654	5172	4352	744	6867	12033	3441	5323.5
22-Sep	1100	860	630	1070	1480	1220	3090	ND	7430
19-Oct	93.4	76.7	151.5	224.7	154.1	435.2	360.9	344.8	495
16-Nov	29	79.8	167	49.6	78.9	228.2	325.5	101.7	144.55
14-Dec	178.9	149.7	201.4	272.3	248.9	201.4	248.1	172.3	365.7
19-Jan	88.2	117.8	166.4	461.1	209.8	82	307.6	214.3	448.15
2-Feb	ND	ND	ND	ND	ND	ND	ND	ND	ND
5 events in 30 days									
Geo. Mean (5 in 30 days)	100.2	120.0	74.7	127.6	131.0	227.1	352.9	301.1	508.0
95% CI	55-183	59-243	36-157	59-275	66-260	135-382	204-609	122-742	223-1158
%>130	47%	53%	60%	60%	67%	87%	100%	77%	93%
%>240	13%	33%	20%	47%	47%	60%	80%	46%	87%
All events (16)									
Mean	459.7	439.1	516.1	540.4	405.8	809.0	1335.2	572.7	1304.6
Std Dev	1108.2	913.8	1296.9	1084.9	432.5	1700.4	3048.1	943.6	2170.4
95% CI	560.8	462.4	656.3	549.1	218.9	860.5	1542.6	512.9	1098.4
%>676	13%	13%	7%	13%	20%	20%	20%	15%	27%

NOTE: ND = No data due to site access restriction on 9/22 and laboratory being closed due to ice on 2/22. Q = Data rejected because bottle filled with deionized water.

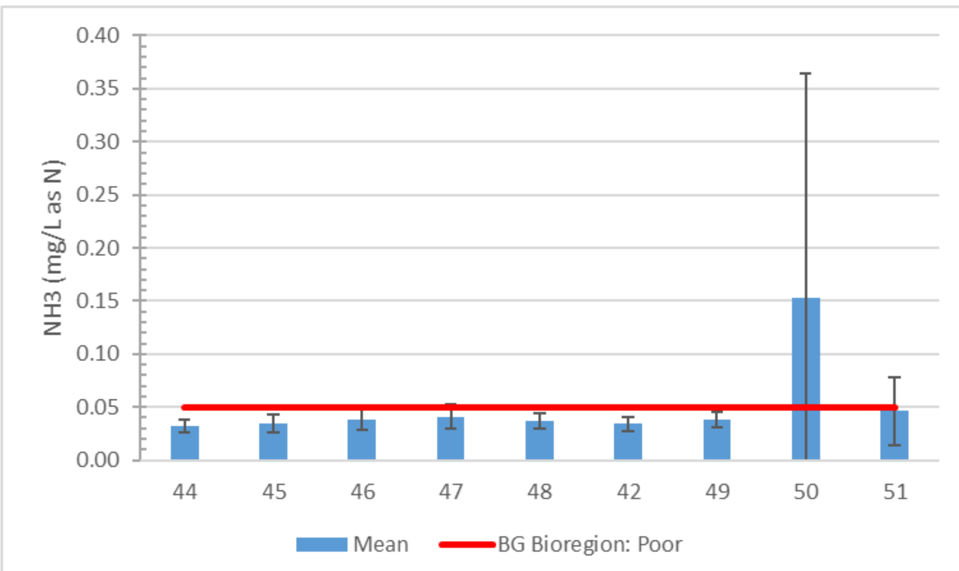




Ammonia (mg/L as N)

	44	45	46	47	48	42	49	50	51
16-Mar	0.027	0.028	0.028	0.032	0.032	0.026	0.034	0.030	<0.025
20-Apr	0.025	<0.025	0.068	0.056	0.056	0.049	0.065	0.048	0.057
25-May	0.035	0.047	0.049	0.037	0.039	0.06	0.042	0.027	0.039
15-Jun	<0.025	0.028	0.029	<0.025	<0.025	<0.025	0.026	0.036	0.029
20-Jul	0.03	0.036	<0.025	0.039	0.053	0.041	<0.025	0.046	<0.025
17-Aug	0.062	0.074	0.079	0.096	<0.025	0.044	0.032	1.120	0.029
22-Sep	0.036	<0.025	<0.025	0.027	<0.025	0.029	0.039	ND	<0.025
19-Oct	0.033	0.034	0.034	0.055	0.033	0.033	0.035	0.098	<0.025
16-Nov	0.035	<0.025	0.035	0.025	<0.025	<0.025	<0.025	ND	<0.025
14-Dec	0.027	0.045	0.042	0.047	0.043	<0.025	0.052	0.050	0.027
19-Jan	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-Feb	<0.025	<0.025	<0.025	0.03	0.057	0.029	0.054	0.053	0.222
Mean	0.032	0.015	0.039	0.041	0.037	0.034	0.038	0.153	0.046
Std Dev	0.010	0.008	0.018	0.021	0.013	0.012	0.013	0.340	0.056
95% CI	0.006	0.000	0.010	0.012	0.007	0.007	0.007	0.211	0.032

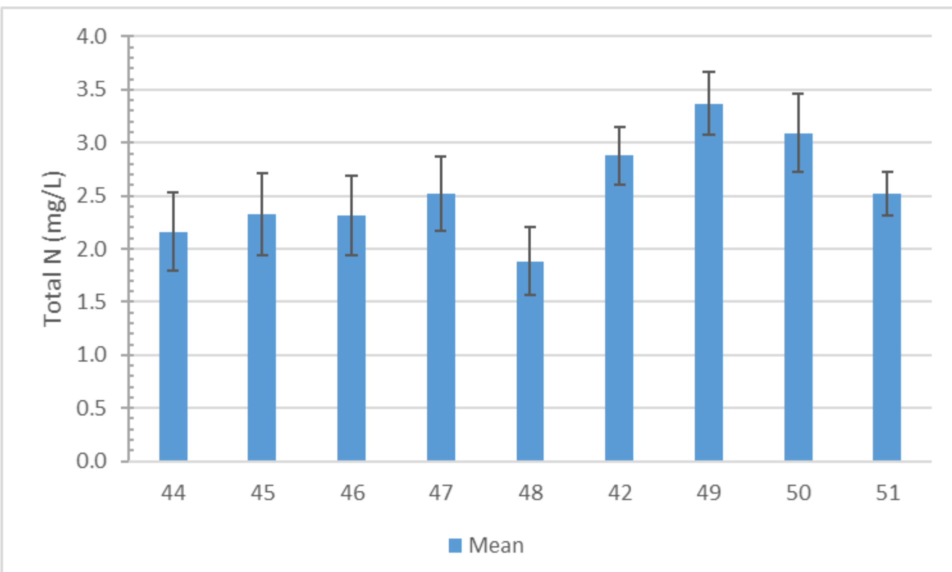
NOTE: ND = No data due to site access restriction on 9/22 and bottle broke at laboratory delivery on 11/16.



Nitrogen (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	2.138	2.463	2.295	2.620	2.314	3.251	3.215	2.889	2.745
20-Apr	1.240	1.369	1.002	1.358	1.371	2.125	2.875	2.536	2.521
25-May	0.816	1.138	1.387	1.716	0.571	1.933	2.198	2.772	2.365
15-Jun	2.705	3.373	2.854	3.256	2.429	3.092	3.843	2.800	2.726
20-Jul	2.264	2.375	2.838	2.556	1.684	3.067	3.735	4.395	2.305
17-Aug	2.621	2.731	2.629	2.730	1.773	3.096	3.146	3.748	2.248
22-Sep	1.639	1.591	1.716	1.938	1.672	2.489	2.879	ND	1.815
19-Oct	2.549	2.635	2.570	2.838	1.509	2.949	3.945	2.831	2.465
16-Nov	1.925	1.975	1.975	2.205	2.037	2.725	3.515	2.216	2.195
14-Dec	2.875	2.955	3.015	3.181	2.510	3.475	3.815	3.435	2.986
19-Jan	2.922	2.945	3.072	3.240	2.427	3.465	3.621	3.506	2.855
2-Feb	2.258	2.304	2.402	2.608	2.331	2.870	3.647	2.880	3.034
Mean	2.163	0.684	2.313	2.521	1.886	2.878	3.370	3.092	2.522
Std Dev	0.657	0.387	0.665	0.610	0.573	0.487	0.521	0.619	0.361
95% CI	0.372	0.000	0.376	0.345	0.324	0.276	0.295	0.366	0.204

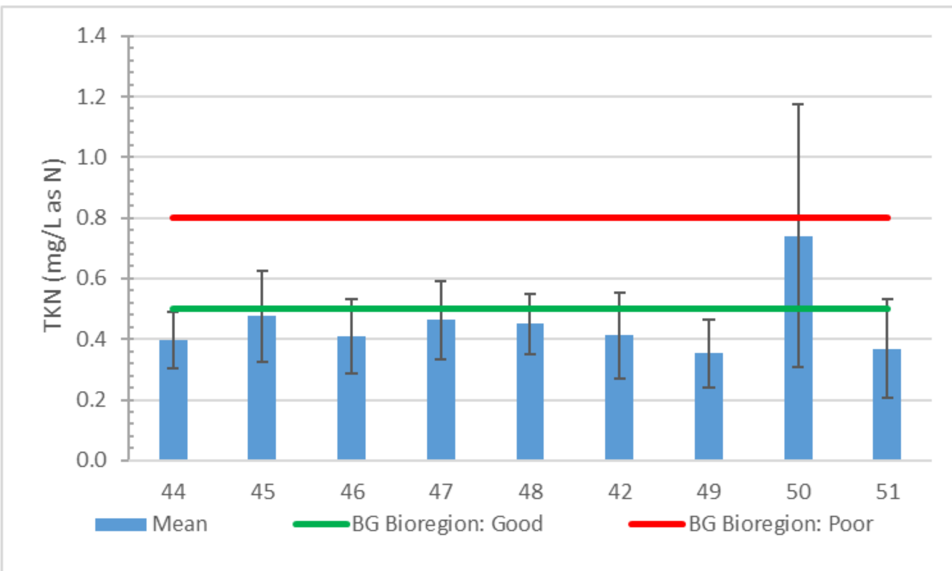
NOTE: ND = No data due to site access restriction on 9/22.



Nitrogen, Total Kjeldahl (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	0.453	0.706	0.420	0.575	0.619	0.816	<0.2	0.508	<0.2
20-Apr	0.581	0.511	<0.2	0.350	<0.2	<0.2	<0.2	0.281	0.236
25-May	0.412	0.499	0.759	0.762	0.441	0.686	0.578	0.749	<0.2
15-Jun	0.434	1.030	0.476	0.837	0.741	0.413	0.548	0.407	0.531
20-Jul	0.309	0.290	0.713	0.301	0.609	0.472	<0.2	2.190	<0.2
17-Aug	0.746	0.834	0.733	0.813	0.638	0.819	0.681	1.860	0.313
22-Sep	0.524	0.396	0.401	0.433	0.517	0.524	0.643	ND	0.670
19-Oct	0.274	0.31	0.265	0.423	0.304	0.204	<0.2	0.376	<0.2
16-Nov	<0.2	<0.2	<0.2	<0.2	0.332	<0.2	<0.2	ND	<0.2
14-Dec	<0.2	<0.2	<0.2	0.236	0.295	<0.2	<0.2	<0.2	0.341
19-Jan	0.267	<0.2	0.227	0.255	0.242	<0.2	0.246	0.308	<0.2
2-Feb	0.353	0.529	0.317	0.363	0.466	0.205	0.342	0.532	1.140
Mean	0.396	0.268	0.409	0.462	0.450	0.412	0.353	0.741	0.369
Std Dev	0.164	0.152	0.217	0.230	0.177	0.250	0.198	0.698	0.287
95% CI	0.093	0.000	0.123	0.130	0.100	0.141	0.112	0.433	0.162

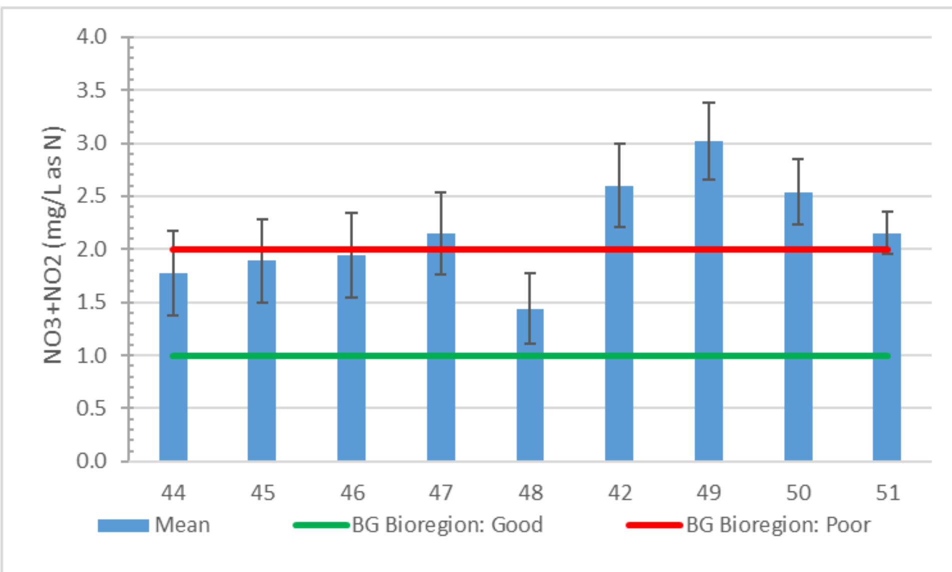
NOTE: ND = No data due to site access restriction on 9/22 and bottle broke at laboratory delivery on 11/16.



Nitrate+Nitrite (mg/L as N)

	44	45	46	47	48	42	49	50	51
16-Mar	1.63	1.78	2.02	2.11	1.63	2.45	2.93	2.31	2.43
20-Apr	0.697	0.90	0.797	1.08	1.18	2.06	2.91	2.53	2.45
25-May	0.399	0.641	0.614	0.959	0.119	1.25	1.54	2.00	2.13
15-Jun	2.37	2.43	2.36	2.41	1.83	2.64	3.29	2.44	2.24
20-Jul	1.93	2.08	2.17	2.25	1.06	2.61	3.46	2.23	2.10
17-Aug	1.90	1.91	1.91	1.91	1.13	2.36	2.49	1.88	1.98
22-Sep	1.17	1.28	1.40	1.82	1.17	2.11	2.28	ND	1.46
19-Oct	2.20	2.21	2.26	2.35	1.15	2.61	3.63	2.37	2.22
16-Nov	1.69	1.66	1.74	1.91	1.65	2.42	3.21	ND	1.93
14-Dec	2.59	2.83	2.84	2.92	2.23	3.53	3.58	3.25	2.63
19-Jan	2.58	2.84	2.8	3.34	2.11	3.81	3.54	3.19	2.59
2-Feb	2.18	2.12	2.38	2.71	2.02	3.35	3.36	3.16	1.66
Mean	1.78	1.89	1.94	2.15	1.44	2.60	3.02	2.54	2.15
Std Dev	0.71	0.69	0.71	0.69	0.59	0.70	0.63	0.50	0.36
95% CI	0.40	0.39	0.40	0.39	0.33	0.39	0.36	0.31	0.20

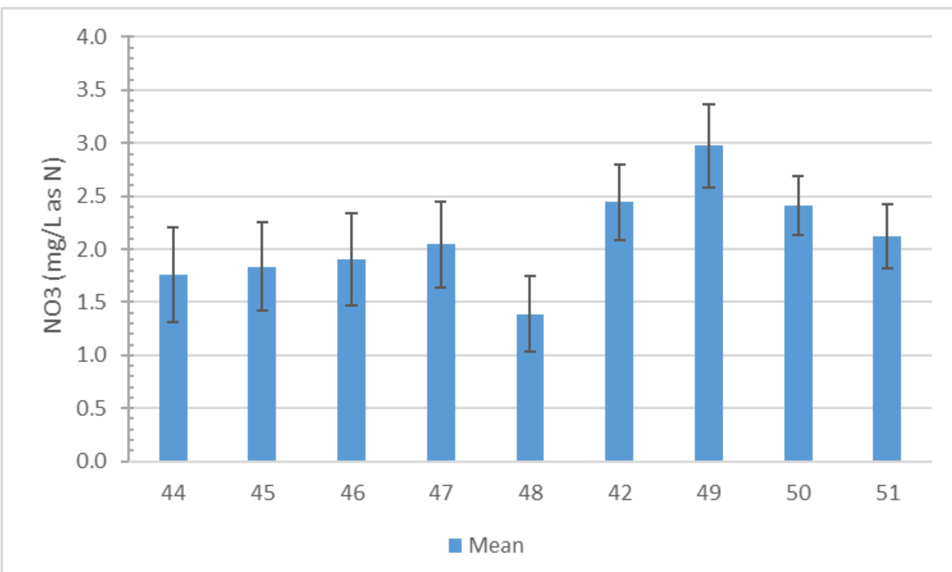
NOTE: ND = No data due to site access restriction on 9/22 and bottle broke at laboratory delivery on 11/16.



Nitrate (mg/L as N)

	44	45	46	47	48	42	49	50	51
16-Mar	1.67	1.74	1.86	2.03	1.68	2.42	3	2.36	2.53
20-Apr	0.644	0.843	0.787	0.985	1.1	1.91	2.66	2.24	2.27
25-May	0.384	0.622	0.609	0.934	0.115	1.21	1.6	1.98	H
15-Jun	2.25	2.32	2.36	2.4	1.66	2.66	3.28	2.37	2.18
20-Jul	1.94	2.07	2.11	2.24	1.06	2.58	3.52	2.19	2.09
17-Aug	1.86	1.88	1.88	1.9	1.12	2.26	2.45	1.85	1.92
22-Sep	1.1	1.18	1.3	1.49	1.14	1.95	2.22	ND	1.13
19-Oct	2.26	2.31	2.29	2.4	1.19	2.73	3.73	2.44	2.25
16-Nov	H	H	H	H	H	H	H	ND	H
14-Dec	2.66	2.74	2.8	2.93	2.2	3.26	3.6	3.22	2.63
19-Jan	2.64	2.73	2.83	2.97	2.17	3.25	3.36	3.17	2.64
2-Feb	1.89	1.76	2.07	2.23	1.85	2.65	3.29	2.32	1.56
Mean	1.754	0.710	1.900	2.046	1.390	2.444	2.974	2.414	2.120
Std Dev	0.756	0.419	0.733	0.682	0.602	0.599	0.666	0.450	0.480
95% CI	0.447	0.000	0.433	0.403	0.356	0.354	0.394	0.279	0.298

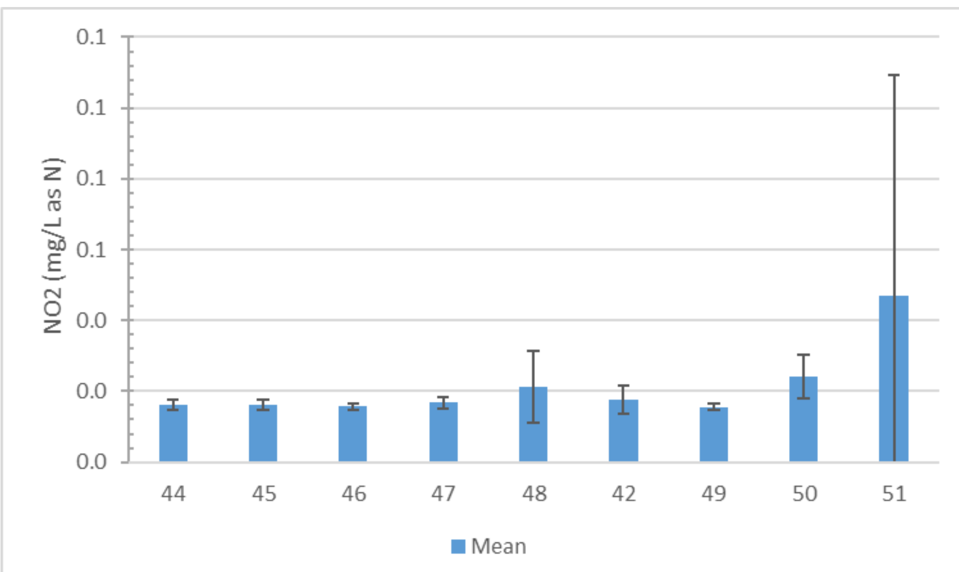
NOTE: ND = No data due to site access restriction on 9/22 and bottle broke at laboratory delivery on 11/16. H = Rejection due to hold time by the laboratory on 5/25 and 11/16.



Nitrite (mg/L as N)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.015	0.017	<0.015	<0.015	<0.015	<0.015	<0.015	0.021	<0.015
20-Apr	<0.015	<0.015	<0.015	0.023	0.071	<0.015	<0.015	<0.015	<0.015
25-May	0.02	0.017	0.019	0.02	<0.015	0.037	0.02	0.043	H
15-Jun	0.021	0.023	0.018	0.019	0.028	0.019	0.015	0.023	<0.015
20-Jul		<0.015	<0.015	<0.015	<0.015	<0.015	0.015	<0.015	<0.015
17-Aug	0.015	0.017	0.016	0.017	<0.015	0.017	0.015	0.038	<0.015
22-Sep	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.016	ND	<0.015
19-Oct	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
16-Nov	H	H	H	H	H	H	H	ND	H
14-Dec	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
19-Jan	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.028	<0.015
2-Feb	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.028	0.334
Mean	0.016	0.002	0.016	0.017	0.021	0.018	0.016	0.024	0.047
Std Dev	0.002	0.001	0.001	0.003	0.017	0.007	0.002	0.010	0.101
95% CI	0.001	0.000	0.001	0.002	0.010	0.004	0.001	0.006	0.063

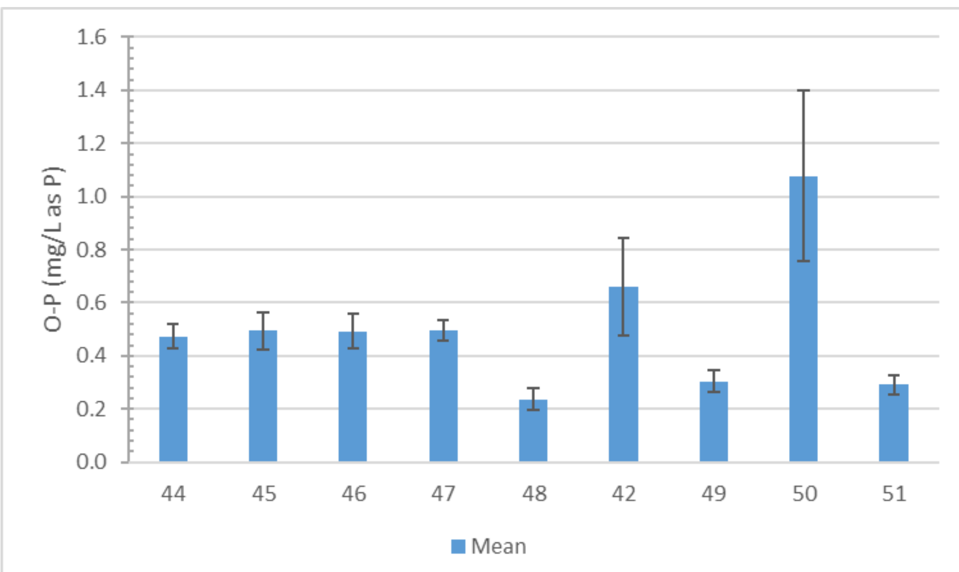
NOTE: ND = No data due to site access restriction on 9/22 and bottle broke at laboratory delivery on 11/16. H = Rejection due to hold time by the laboratory on 5/25 and 11/16.



Orthophosphate (mg/L as P)

	44	45	46	47	48	42	49	50	51
16-Mar	Q	Q	Q	Q	Q	Q	Q	Q	Q
20-Apr	0.43	0.438	0.424	0.458	0.128	0.789	0.194	1.12	0.208
25-May	0.616	0.766	0.737	0.607	0.117	1.44	0.222	1.99	H
15-Jun	0.456	0.464	0.463	0.457	0.241	0.456	0.352	0.635	0.34
20-Jul	0.473	0.503	0.513	0.521	0.256	0.599	0.293	1.02	0.312
17-Aug	0.583	0.6	0.595	0.574	0.32	0.571	0.43	1.76	0.325
22-Sep	0.438	0.438	0.439	0.485	0.288	0.678	0.319	ND	0.212
19-Oct	0.51	0.49	0.453	0.451	0.232	0.461	0.298	0.592	0.341
16-Nov	H	H	H	H	H	H	H	ND	H
14-Dec	0.399	0.409	0.407	0.416	0.284	0.449	0.359	0.737	0.325
19-Jan	0.451	0.462	0.488	0.532	0.26	0.563	0.313	1.04	0.303
2-Feb	0.377	0.37	0.401	0.464	0.23	0.593	0.264	0.807	0.25
Mean	0.473	0.114	0.492	0.497	0.236	0.660	0.304	1.078	0.291
Std Dev	0.076	0.070	0.103	0.060	0.066	0.294	0.068	0.491	0.053
95% CI	0.047	0.000	0.064	0.037	0.041	0.182	0.042	0.321	0.035

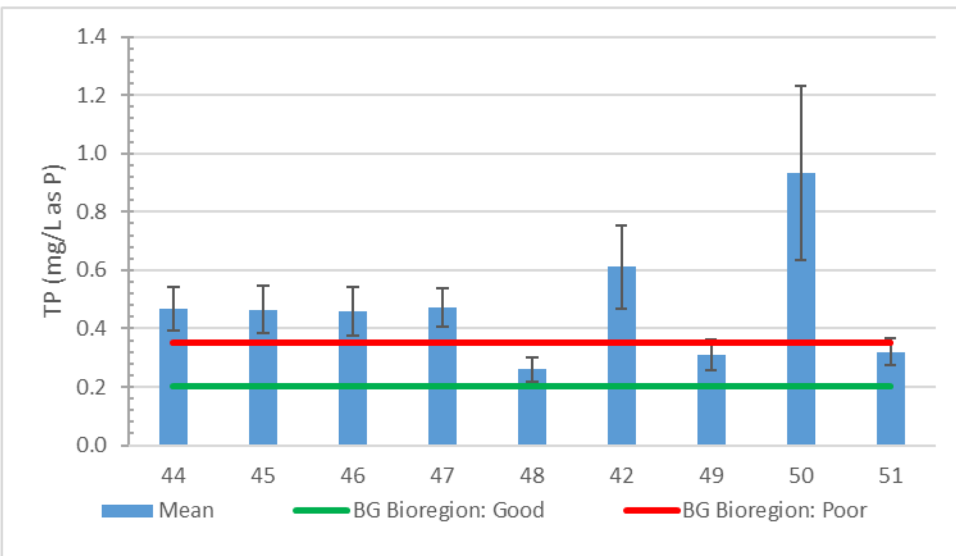
NOTE: ND = No data due to site access restriction on 9/22 and bottle broke at laboratory delivery on 11/16. H = Rejection due to hold time by the laboratory on 5/25 and 11/16. Q = Data rejected due to lack of precision



Phosphorus, Total (mg/L as P)

	44	45	46	47	48	42	49	50	51
16-Mar	0.303	0.299	0.292	0.342	0.272	0.338	0.288	0.408	0.258
20-Apr	0.398	0.424	0.365	0.413	0.188	0.705	0.198	0.977	0.254
25-May	0.548	0.696	0.658	0.549	0.123	1.300	0.216	1.850	0.251
15-Jun	0.434	0.455	0.449	0.457	0.232	0.451	0.329	0.586	0.323
20-Jul	0.445	0.451	0.485	0.506	0.272	0.658	0.277	0.94	0.282
17-Aug	0.816	0.811	0.826	0.797	0.395	0.76	0.547	1.700	0.382
22-Sep	0.444	0.453	0.46	0.502	0.326	0.712	0.323	ND	0.39
19-Oct	0.436	0.471	0.435	0.439	0.226	0.449	0.305	0.571	0.322
16-Nov	0.583	0.329	0.341	0.365	0.230	0.493	0.268	ND	0.274
14-Dec	0.401	0.399	0.400	0.421	0.319	0.470	0.381	0.747	0.325
19-Jan	0.399	0.398	0.418	0.441	0.224	0.479	0.326	0.867	0.245
2-Feb	0.396	0.394	0.372	0.438	0.318	0.511	0.249	0.683	0.532
Mean	0.467	0.146	0.458	0.473	0.260	0.611	0.309	0.933	0.320
Std Dev	0.132	0.083	0.147	0.117	0.072	0.253	0.091	0.478	0.083
95% CI	0.074	0.000	0.083	0.066	0.041	0.143	0.051	0.297	0.047

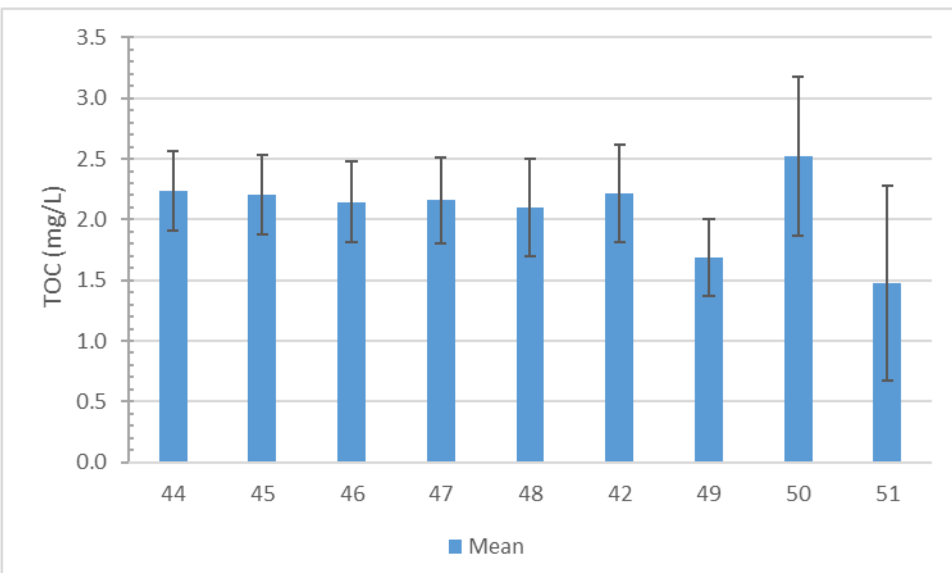
NOTE: ND = No data due to site access restriction on 9/22 and bottle broke at laboratory delivery on 11/16.



Carbon, Total Organic (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	1.91	1.95	1.99	1.93	1.72	1.93	1.37	1.96	0.778
20-Apr	2.39	2.26	2.24	2.13	1.70	2.06	1.17	2.50	0.553
25-May	3.20	3.20	3.14	3.40	2.79	3.74	1.98	4.16	0.755
15-Jun	2.02	2.05	1.97	1.89	1.85	1.80	1.87	1.90	1.38
20-Jul	2.05	2.08	1.98	2.02	2.53	1.87	1.37	2.23	0.973
17-Aug	3.04	3.11	3.09	2.96	3.54	2.96	2.87	4.74	1.85
22-Sep	3.07	2.84	2.85	2.93	3.13	3.21	2.69	ND	5.73
19-Oct	1.89	1.86	1.78	1.74	1.80	1.78	1.33	1.94	1.14
16-Nov	1.98	1.88	2.07	2.12	1.70	2.21	1.45	ND	0.859
14-Dec	1.41	1.43	1.43	1.36	1.47	1.41	1.4	1.62	0.866
19-Jan	1.72	1.51	1.41	1.49	1.38	1.57	1.39	1.83	0.647
2-Feb	2.14	2.26	1.80	1.94	1.62	2.04	1.36	2.30	2.16
Mean	2.24	2.20	2.15	2.16	2.10	2.22	1.69	2.52	1.47
Std Dev	0.57	0.57	0.59	0.62	0.71	0.71	0.56	1.06	1.43
95% CI	0.32	0.33	0.33	0.35	0.40	0.40	0.32	0.66	0.81

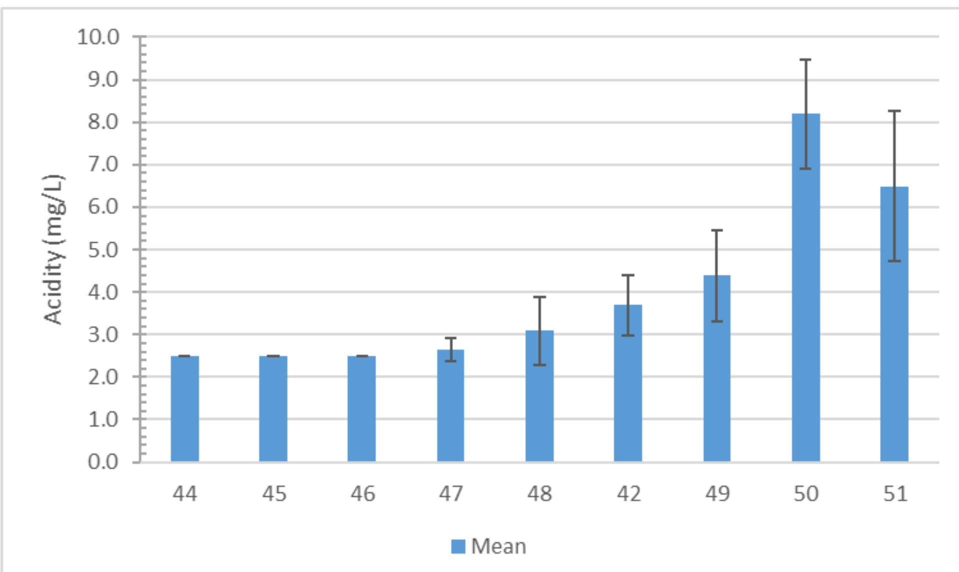
NOTE: ND = No data due to site access restriction on 9/22 and bottle broke at laboratory delivery on 11/16.



Acidity (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar							2.5	4.41	5.53
20-Apr								V	<2.5
25-May						V		V	V
15-Jun				2.59	<2.5	4.63	5.38	10.2	10.7
20-Jul					<2.5	3.23	2.72	6.33	6.14
17-Aug		<2.5	<2.5	3.35	5.47	6.06	7.62	10.6	8.15
22-Sep	<2.5	<2.5	<2.5	<2.5	3	4.03	4.69	ND	11.5
19-Oct						4.25	5.09	9.35	<2.5
16-Nov						2.88	5.19	8.06	4.62
14-Dec				2.5	2.8	4.09	5.5	9.27	8.88
19-Jan	<2.5			<2.5	<2.5	<2.5	2.71	7.35	5.03
2-Feb	<2.5	<2.5	<2.5	<2.5	2.83	<2.5	<2.5	8.17	5.84
Mean	2.50	2.50	2.50	2.66	3.09	3.69	4.39	8.19	6.49
Std Dev	0.00	0.00	0.00	0.34	1.07	1.14	1.72	1.96	3.00
95% CI	0.00	0.00	0.00	0.27	0.79	0.71	1.07	1.28	1.78

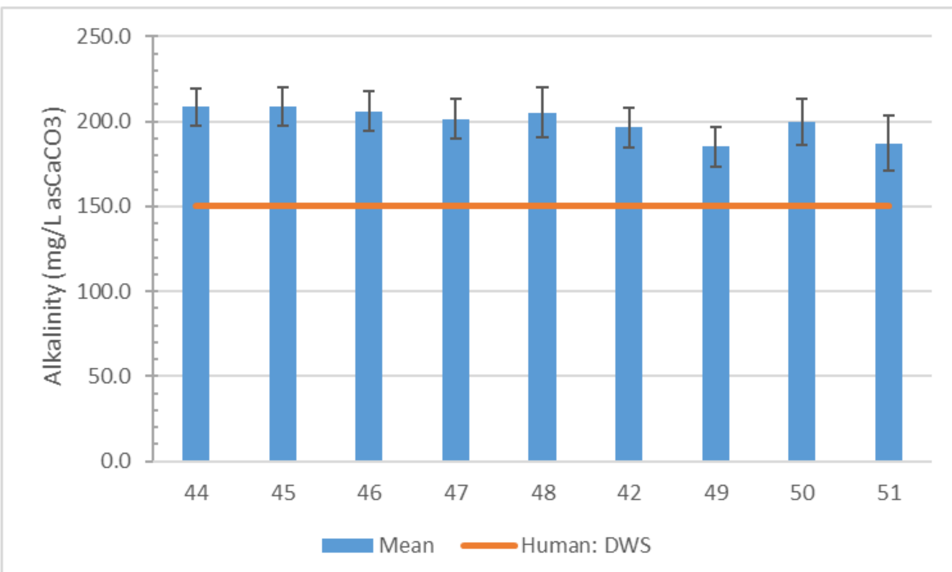
NOTE: ND = No data due to site access restriction on 9/22. V = Data rejected due to calibration verification limit exceedances. Blank cells are due to no acidity being present.



Alkalinity (mg/L as CaCO3)

	44	45	46	47	48	42	49	50	51
16-Mar	182	178	178	182	175	166	160	165	169
20-Apr	191	195	185	184	197	180	174	181	190
25-May	195	197	186	173	163	188	171	181	202
15-Jun	195	196	196	189	197	186	163	193	180
20-Jul	224	225	225	222	208	220	199	214	202
17-Aug	204	203	203	203	193	191	184	192	181
22-Sep	216	219	225	214	226	201	203	ND	144
19-Oct	233	233	229	229	245	227	216	235	216
16-Nov	248	251	245	242	250	234	222	230	225
14-Dec	214	210	208	199	211	199	183	226	212
19-Jan	198	193	193	188	208	181	164	199	194
2-Feb	202	204	201	194	190	186	183	180	129
Mean	208.50	208.67	206.17	201.58	205.25	196.58	185.17	199.64	187.00
StdDev	19.15	20.19	20.68	21.05	25.73	20.63	20.73	23.36	28.67
95% CI	10.83	11.42	11.70	11.91	14.56	11.67	11.73	13.80	16.22

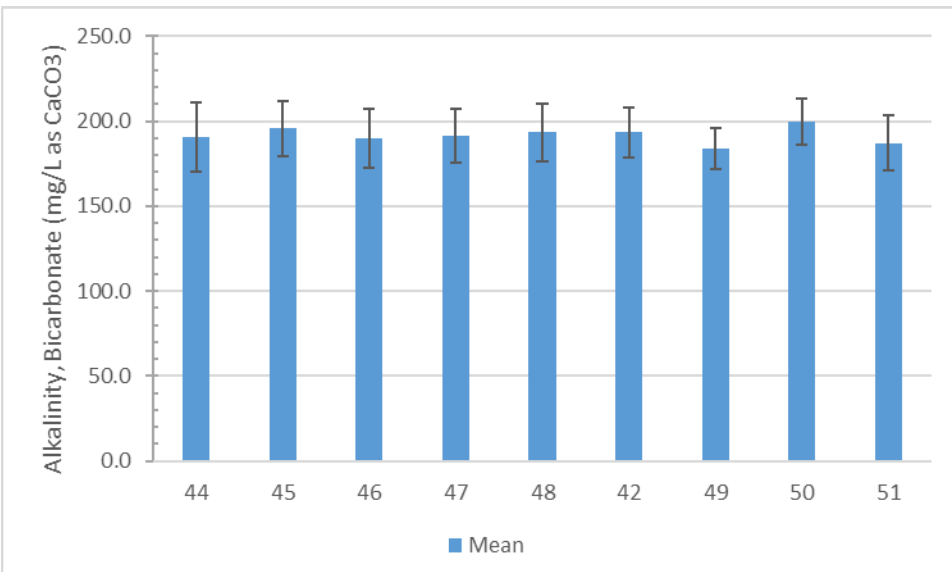
NOTE: ND = No data due to site access restriction on 9/22.



Alkalinity, Bicarbonate (mg/L as CaCO3)

	44	45	46	47	48	42	49	50	51
16-Mar	147	142	137	150	159	138	160	165	169
20-Apr	134	162	138	142	165	171	167	181	190
25-May	130	166	157	157	126	188	162	181	202
15-Jun	181	187	187	189	195	186	163	193	180
20-Jul	209	209	210	216	208	220	199	214	202
17-Aug	200	203	203	203	193	191	184	192	181
22-Sep	216	217	225	214	226	201	203	ND	144
19-Oct	225	224	209	221	213	227	216	235	216
16-Nov	240	241	224	224	227	234	222	230	225
14-Dec	209	205	203	199	211	199	183	226	212
19-Jan	196	188	186	185	208	181	164	199	194
2-Feb	202	204	199	194	190	186	183	180	129
Mean	190.75	195.67	189.83	191.17	193.42	193.50	183.83	199.64	187.00
StdDev	35.75	28.17	30.43	28.02	29.94	26.01	21.84	23.36	28.67
95% CI	20.23	15.94	17.22	15.86	16.94	14.72	12.36	13.80	16.22

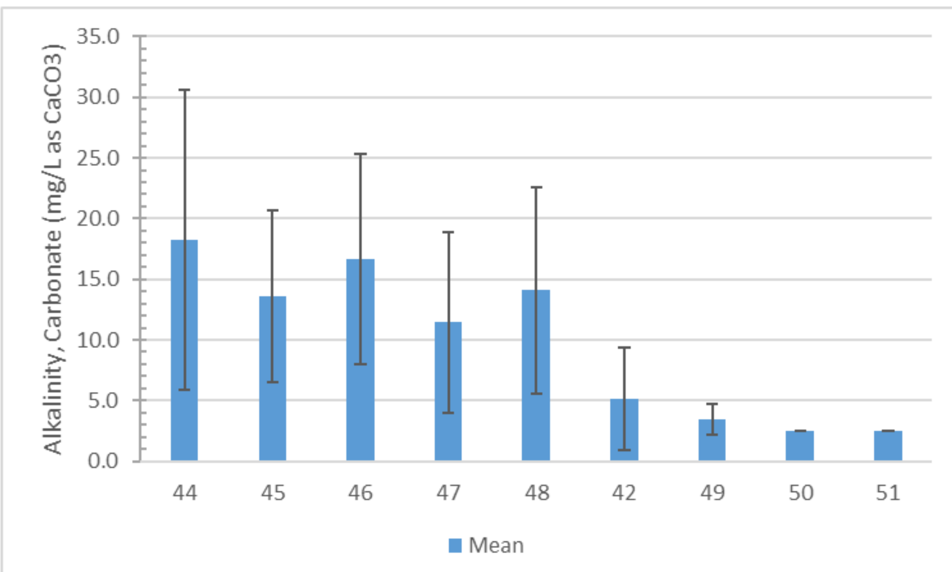
NOTE: ND = No data due to site access restriction on 9/22.



Alkalinity, Carbonate (mg/L as CaCO3)

	44	45	46	47	48	42	49	50	51
16-Mar	34.9	35.4	41.4	31.2	15.7	28.3	<2.5	<2.5	<2.5
20-Apr	56.7	32.6	46.3	42	32.6	8.7	7.36	<2.5	<2.5
25-May	64.9	31.7	29.3	16.2	36.4	<2.5	9.03	<2.5	<2.5
15-Jun	13.9	9.11	8.99	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
20-Jul	14.6	15.9	14.6	6.0		<2.5	<2.5	<2.5	<2.5
17-Aug	4.42	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
22-Sep	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	ND	<2.5
19-Oct	8.45	9.37	19.8	8.08	32.1	<2.5	<2.5	<2.5	<2.5
16-Nov	7.96	10.1	21	17.8	23	<2.5	<2.5	<2.5	<2.5
14-Dec	5.37	5.65	4.78	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
19-Jan	<2.5	5.46	6.74	3.35	<2.5	<2.5	<2.5	<2.5	<2.5
2-Feb	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Mean	18.23	13.57	16.70	11.43	14.07	5.17	3.45	2.50	2.50
StdDev	21.88	12.50	15.32	13.12	14.33	7.50	2.25	0.00	0.00
95% CI	12.38	7.07	8.67	7.42	8.47	4.24	1.27	0.00	0.00

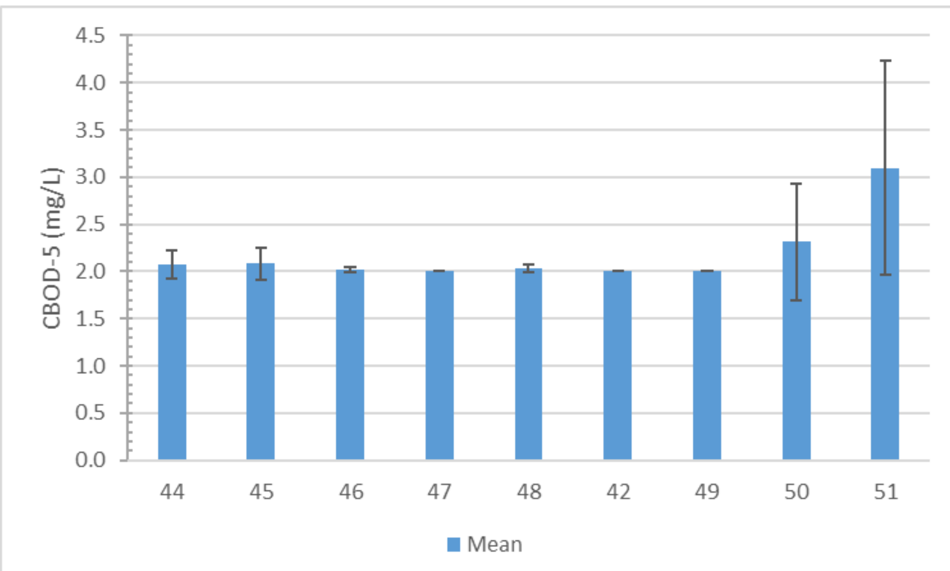
NOTE: ND = No data due to site access restriction on 9/22.



Carbonaceous Biochemical Oxygen Demand, 5-day (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<2	<2	<2	<2	<2	<2	<2	<2	<2
20-Apr	<2	<2	<2	<2	<2	<2	<2	<2	<2
25-May	<2	<2	<2	<2	<2	<2	<2	<2	<2
15-Jun	<2	<2	<2	<2	<2	<2	<2	<2	<2
20-Jul	<2	<2	<2	<2	2.19	<2	<2	<2	<2
17-Aug	<2	<2	<2	<2	<2	<2	<2	5.46	7.19
22-Sep	<2	<2	<2	<2	<2	<2	<2	ND	6.18
19-Oct	<2	<2	<2	<2	<2	<2	<2	<2	<2
16-Nov	<2	<2	<2	<2	<2	<2	<2	<2	<2
14-Dec	<2	<2	<2	<2	<2	<2	<2	<2	<2
19-Jan	<2	<2	<2	<2	<2	<2	<2	<2	<2
2-Feb	2.89	3.04	2.18	<2	2.18	<2	<2	<2	5.8
Mean	2.07	2.09	2.02	2.00	2.03	2.00	2.00	2.31	3.10
StdDev	0.26	0.30	0.05	0.00	0.07	0.00	0.00	1.04	2.01
95% CI	0.15	0.17	0.03	0.00	0.04	0.00	0.00	0.62	1.14

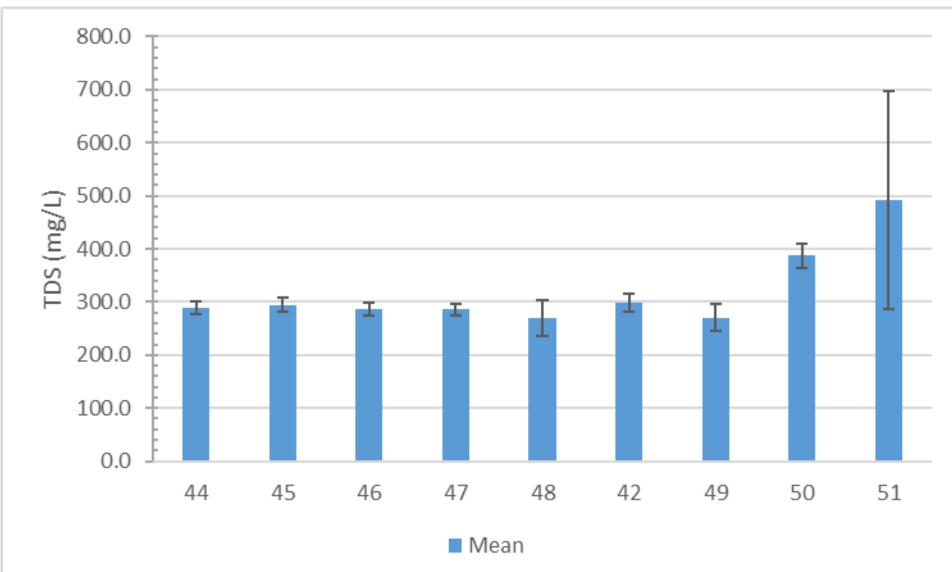
NOTE: ND = No data due to site access restriction on 9/22.



Solids, Total Dissolved (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	253	268	257	261	238	276	223	376	464
20-Apr	289	289	280	290	258	311	258	385	475
25-May	302	317	309	284	202	340	245	419	496
15-Jun	282	282	284	279	261	287	242	354	348
20-Jul	308	303	296	302	256	308	280	397	398
17-Aug	261	257	254	259	233	246	241	320	308
22-Sep	277	293	284	303	270	309	267	ND	242
19-Oct	325	313	311	307	280	324	294	376	349
16-Nov	320	331	326	318	279	332	285	390	384
14-Dec	271	280	263	269	250	267	254	352	355
19-Jan	277	285	282	279	253	279	400	425	469
2-Feb	300	319	296	282	447	305	253	461	1620
Mean	288.75	294.75	286.83	286.08	268.92	298.67	270.17	386.82	492.33
StdDev	22.66	22.26	22.16	18.55	60.02	28.06	45.68	38.86	363.17
95% CI	12.82	12.59	12.54	10.50	33.96	15.88	25.85	22.97	205.48

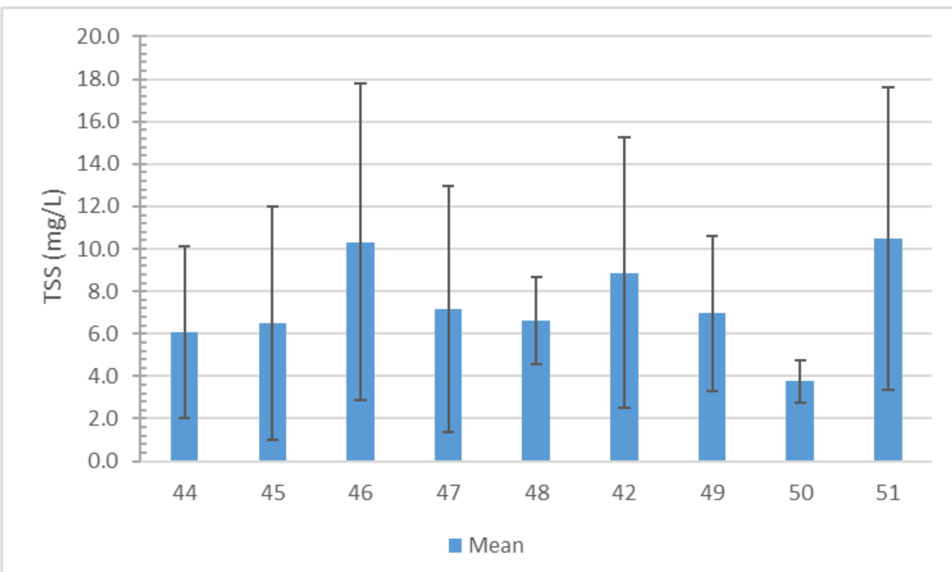
NOTE: ND = No data due to site access restriction on 9/22.



Solids, Total Suspended (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	3	4	4	4.5	4.5	5.5	3	4.5	6
20-Apr	2	3	3	<1.5	7	<1.5	<1.5	<1.5	2
25-May	2	1.5	5	4	3	4	2	<1.5	3
15-Jun	3	4	21	5	5	<1.5	6	6	8
20-Jul	5	4.5	9	7	9	21	2	3	4
17-Aug	28	37	48	39	14	37	24	6	12
22-Sep	8	6	6	3	9	21	11	ND	27
19-Oct	4	<3	<3	<3	<3	<3	<3	4	10
16-Nov	4	<3	16	<3	<3	<3	3	<3	<3
14-Dec	5	3	3	10	8	<3	11	6	4
19-Jan	<3	<3	<3	<3	<3	<3	9	<3	3
2-Feb	6	6	<3	<3	11	<3	8	3	44
Mean	6.08	6.50	10.33	7.17	6.63	8.88	6.96	3.77	10.50
StdDev	7.12	9.69	13.22	10.28	3.65	11.29	6.43	1.68	12.61
95% CI	4.03	5.48	7.48	5.82	2.07	6.39	3.64	0.99	7.13

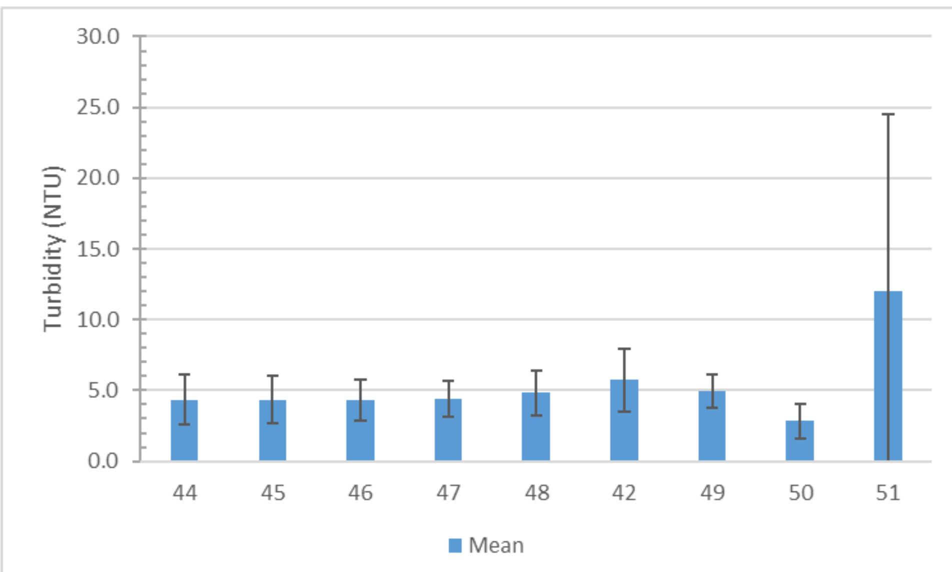
NOTE: ND = No data due to site access restriction on 9/22.



Turbidity (NTU)

	44	45	46	47	48	42	49	50	51
16-Mar	4.31	3.96	3.95	5.11	6.64	6.68	5.37	8.30	3.60
20-Apr	2.65	2.07	3.60	3.06	4.39	2.56	3.48	1.89	1.68
25-May	1.58	2.36	3.58	2.91	1.65	2.55	3.78	1.76	2.56
15-Jun	3.50	4.09	4.80	5.60	2.72	6.21	3.93	3.30	4.88
20-Jul	4.28	4.48	4.20	4.47	5.37	6.15	3.44	1.61	2.19
17-Aug	11.50	11.40	10.90	9.57	4.76	10.00	8.75	4.58	10.60
22-Sep	8.02	8.31	7.23	6.24	7.53	15.6	7.49	ND	35.1
19-Oct	1.38	1.35	1.41	1.64	2.13	2.73	2.59	1.48	2.36
16-Nov	1.23	1.26	1.41	1.49	1.48	2.06	2.84	1.34	1.20
14-Dec	3.38	3.31	4.51	3.87	4.79	4.15	4.06	2.34	2.37
19-Jan	3.16	3.64	3.19	4.72	4.79	4.32	6.03	1.55	1.80
2-Feb	7.08	5.63	3.27	3.99	11.5	5.67	7.68	3.21	75.5
Mean	4.34	4.32	4.34	4.39	4.81	5.72	4.95	2.85	11.99
StdDev	3.08	2.96	2.57	2.19	2.84	3.86	2.07	2.07	22.13
95% CI	1.74	1.68	1.45	1.24	1.61	2.19	1.17	1.22	12.52

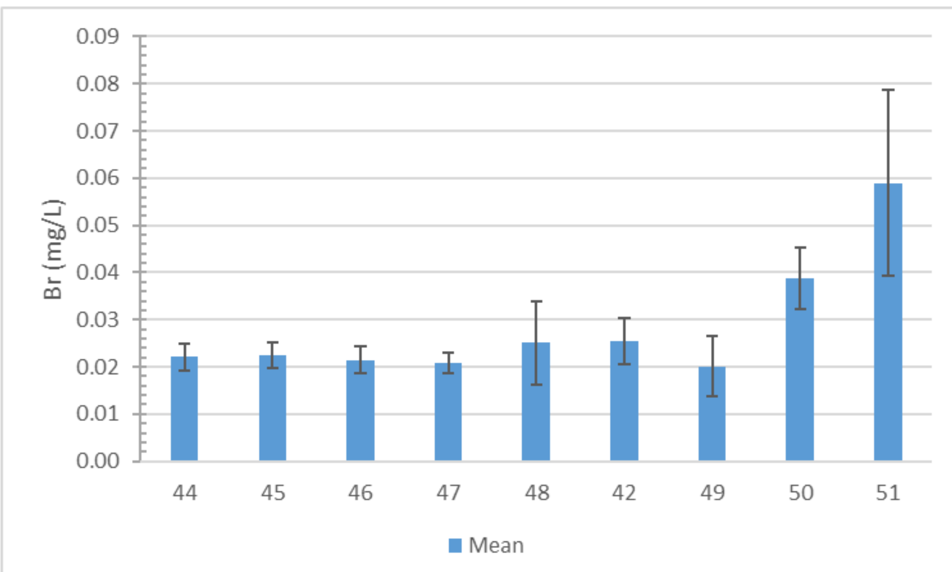
NOTE: ND = No data due to site access restriction on 9/22.



Bromide (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	0.017	<0.015	0.027	0.017	0.021	0.017	<0.015	0.016	0.033
20-Apr	V	V	V	V	V	V	V	V	V
25-May	0.023	0.021	0.019	0.024	0.015	0.025	0.017	0.056	0.069
15-Jun	0.023	0.02	0.023	0.02	0.035	0.044	0.052	0.034	0.095
20-Jul	0.025	0.025	0.031	0.02	0.02	0.026	0.018	0.045	0.06
17-Aug	0.018	0.02	0.02	0.018	0.019	0.018	0.016	0.039	0.042
22-Sep	0.017	0.021	0.015	0.021	<0.015	0.034	0.015	ND	0.023
19-Oct	0.022	0.027	0.018	0.019	0.017	0.023	<0.015	0.033	0.041
16-Nov	0.031	0.032	0.024	0.028	0.029	0.029	0.022	0.044	0.053
14-Dec	0.015	0.019	0.016	0.016	<0.015	0.016	<0.015	0.033	0.038
19-Jan	0.024	0.025	0.024	0.024	0.024	0.024	0.018	0.044	0.055
2-Feb	0.028	0.023	0.019	0.022	0.066	0.024	0.018	0.043	0.14
Mean	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.04	0.06
StdDev	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.03
95% CI	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.02

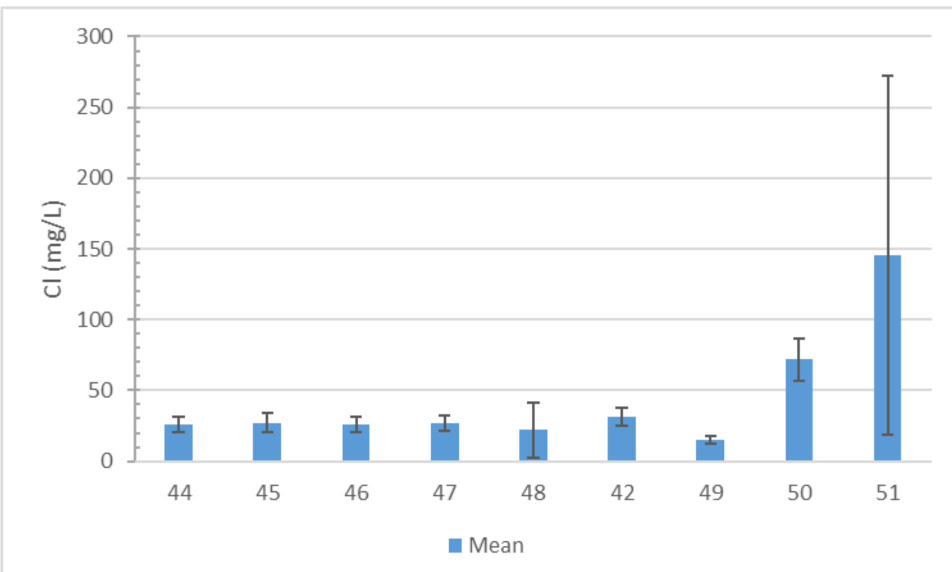
NOTE: ND = No data due to site access restriction on 9/22. V = Data rejected due to calibration verification limit exceedances.



Chloride (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	28.6	29.1	30.1	30.8	22	35.2	17	85.7	120
20-Apr	36.7	35.3	35.9	40.1	18	45.3	22.7	80	119
25-May	45	40.9	41.2	39	12.1	47.5	19.4	74.1	113
15-Jun	25.7	25.5	25.3	25	14.1	26.9	16.1	55.2	65.6
20-Jul	26	25.7	25.5	26.2	13.7	30.2	20	66.3	84.3
17-Aug	13.4	13.4	13.2	12.8	10.7	13.9	7.84	54.4	61.4
22-Sep	18.3	20.2	22.2	24.7	8.86	35.3	14.8	ND	35.3
19-Oct	22.9	22.9	22.7	23.1	8.24	26.8	14.2	53	62.6
16-Nov	20.6	21.3	21.7	24.5	8.66	28.8	12.2	56	68.9
14-Dec	10.6	10.4	10.4	10.5	4.96	12.5	7.63	40.1	48.1
19-Jan	27.6	29.1	28.3	29.1	14	32.6	14.1	101	120
2-Feb	35	52.2	35.1	34.9	131	40.8	14.7	127	851
Mean	25.87	27.17	25.97	26.73	22.19	31.32	15.06	72.07	145.77
StdDev	9.81	11.54	8.97	9.05	34.57	10.81	4.51	25.26	224.09
95% CI	5.55	6.53	5.08	5.12	19.56	6.11	2.55	14.93	126.79

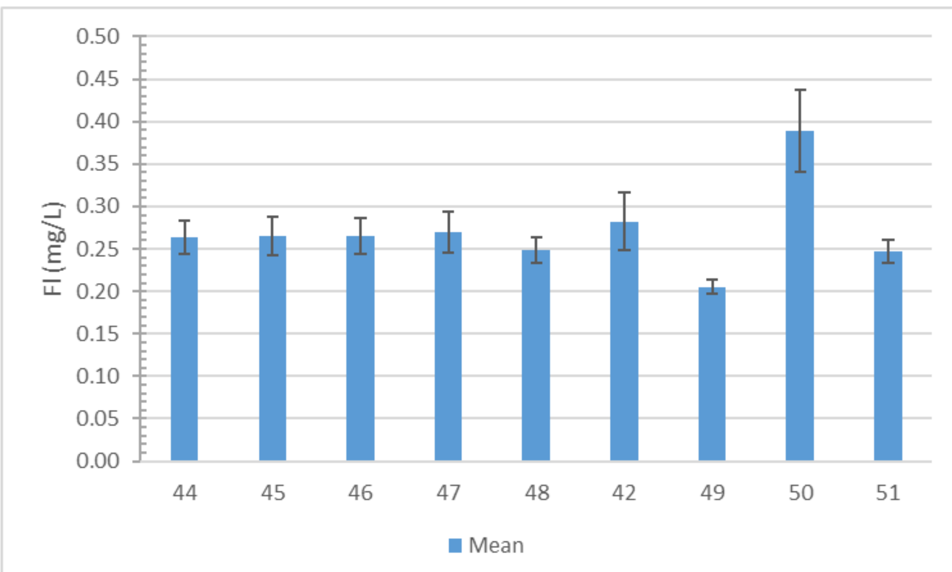
NOTE: ND = No data due to site access restriction on 9/22.



Fluoride (mg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	0.246	0.251	0.258	0.248	0.255	0.244	0.209	0.317	0.231
20-Apr	0.286	0.34	0.292	0.293	0.321	0.31	0.221	0.387	0.264
25-May	0.352	0.342	0.363	0.378	0.252	0.428	0.22	0.596	0.265
15-Jun	0.245	0.241	0.241	0.24	0.248	0.237	0.197	0.311	0.236
20-Jul	0.267	0.268	0.269	0.267	0.252	0.275	0.217	0.374	0.253
17-Aug	0.231	0.228	0.229	0.227	0.251	0.22	0.188	0.383	0.238
22-Sep	0.238	0.243	0.251	0.27	0.219	0.31	0.194	ND	0.186
19-Oct	0.282	0.279	0.277	0.277	0.264	0.289	0.232	0.377	0.271
16-Nov	0.273	0.275	0.278	0.294	0.244	0.32	0.21	0.459	0.276
14-Dec	0.217	0.216	0.22	0.216	0.228	0.214	0.189	0.306	0.248
19-Jan	0.252	0.238	0.239	0.239	0.239	0.238	0.183	0.366	0.255
2-Feb	0.276	0.256	0.27	0.279	0.214	0.302	0.204	0.406	0.244
Mean	0.26	0.26	0.27	0.27	0.25	0.28	0.21	0.39	0.25
StdDev	0.04	0.04	0.04	0.04	0.03	0.06	0.02	0.08	0.02
95% CI	0.02	0.02	0.02	0.02	0.02	0.03	0.01	0.05	0.01

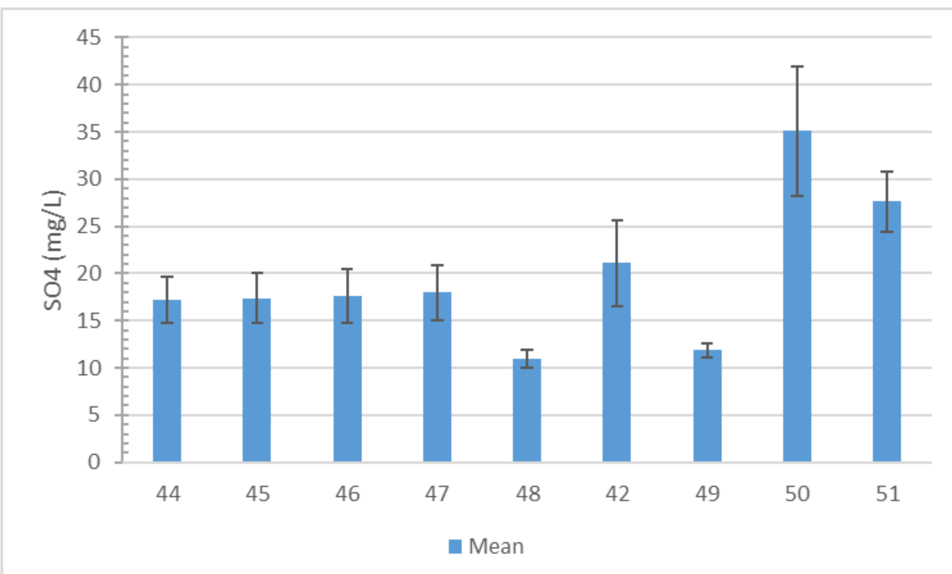
NOTE: ND = No data due to site access restriction on 9/22.



Sulfate (mg/L as S)

	44	45	46	47	48	42	49	50	51
16-Mar	15.8	15.8	15.9	16.0	11.4	17.3	12.1	29.6	26.6
20-Apr	21.4	21.2	21.0	21.9	13.4	28.1	14.1	45.7	32.4
25-May	27.1	28.8	30.8	29.8	9.87	40.9	12.5	62.5	37.0
15-Jun	15.7	15.5	15.4	15.3	10.9	16.1	10.9	27.3	23.6
20-Jul	16.6	16.5	16.5	16.5	10.5	18.9	12.3	32.5	28.0
17-Aug	10.7	10.7	10.6	10.4	8.11	11.4	9.15	25.4	23.7
22-Sep	15	15.8	16.4	18.0	9.64	23.5	10.8	ND	15.4
19-Oct	17.3	17.2	17.0	17.1	10.6	17.8	12.5	27.3	26.5
16-Nov	20.7	20.8	21.4	23.6	11.9	27.2	13.2	45.8	31.7
14-Dec	12.9	12.8	12.7	12.7	9.5	13.7	10.8	26.3	25.8
19-Jan	15.3	15.4	15.4	15.4	11.2	16.2	11.8	29.0	27.5
2-Feb	18.3	18.1	18.2	19.3	14.2	22.2	12.5	34.7	33.7
Mean	17.23	17.38	17.61	18.00	10.94	21.11	11.89	35.10	27.66
StdDev	4.29	4.63	5.13	5.17	1.68	8.05	1.31	11.60	5.65
95% CI	2.43	2.62	2.90	2.93	0.95	4.56	0.74	6.85	3.20

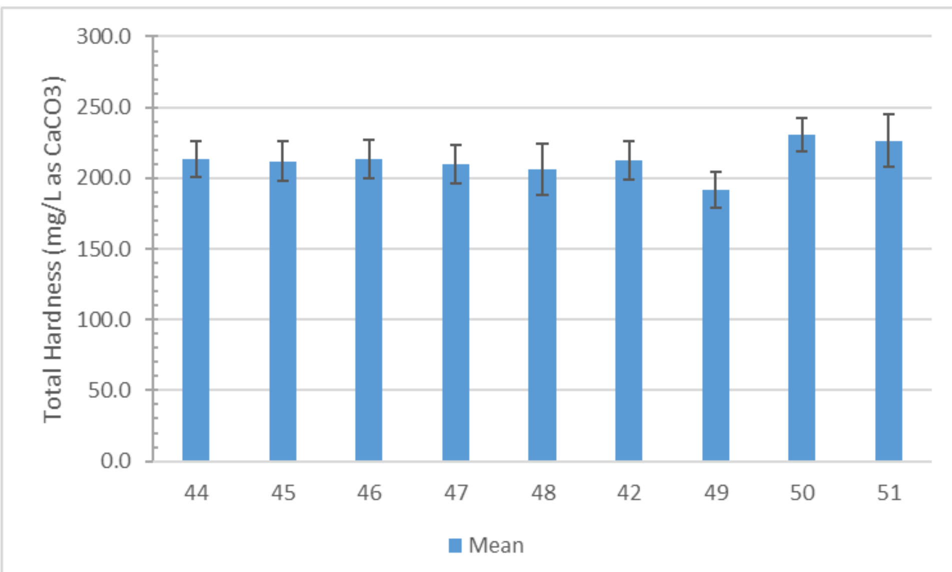
NOTE: ND = No data due to site access restriction on 9/22.



Hardness, Total (mg/L as CaCO3)

	44	45	46	47	48	42	49	50	51
16-Mar	185	178	170	178	161	175	157	197	231
20-Apr	197	190	184	185	189	195	173	215	248
25-May	197	195	206	190	151	210	178	233	284
15-Jun	225	204	226	204	204	196	169	224	207
20-Jul	240	249	244	234	214	243	222	245	226
17-Aug	213	195	212	209	185	199	192	200	201
22-Sep	218	230	224	223	218	216	204	ND	153
19-Oct	221	218	232	222	251	243	213	252	240
16-Nov	255	264	253	264	261	254	230	254	249
14-Dec	225	218	214	214	207	214	199	251	242
19-Jan	210	213	211	212	211	211	176	235	225
2-Feb	176	191	188	183	220	195	191	231	213
Mean	213.50	212.08	213.67	209.83	206.00	212.58	192.00	230.64	226.58
StdDev	22.44	25.57	24.45	24.57	32.00	23.51	22.45	20.02	32.10
95% CI	12.70	14.47	13.83	13.90	18.11	13.30	12.70	11.83	18.16

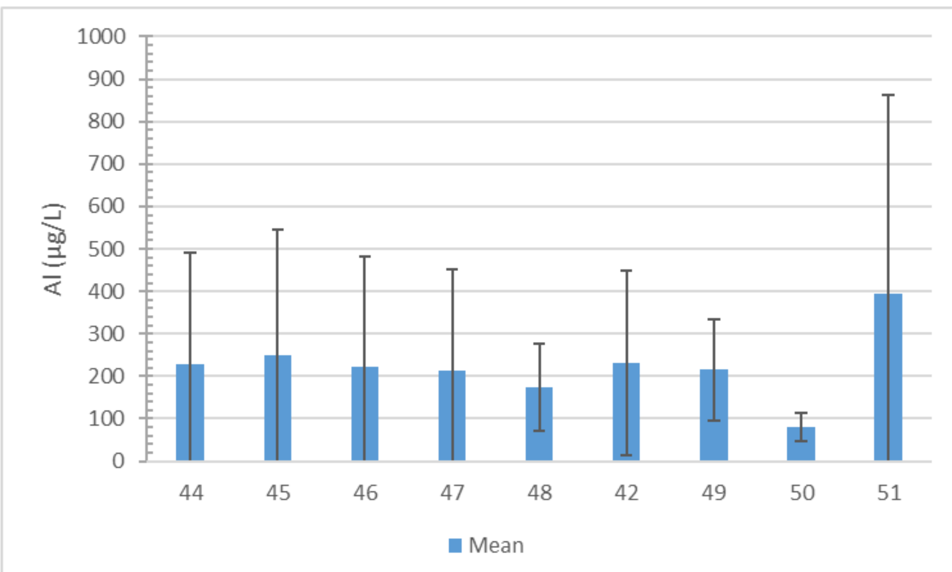
NOTE: ND = No data due to site access restriction on 9/22.



Aluminum (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	Q	Q	Q	Q	Q	Q	Q	Q	Q
20-Apr	Q	Q	Q	Q	Q	Q	Q	Q	Q
25-May	Q	Q	Q	Q	Q	Q	Q	Q	Q
15-Jun	Q	Q	Q	Q	Q	Q	Q	Q	Q
20-Jul	Q	Q	Q	Q	Q	Q	Q	Q	Q
17-Aug	888	997	884	819	272	783	460	158	495
22-Sep	Q	Q	Q	Q	Q	Q	Q	ND	Q
19-Oct	43	80	52.6	47.9	48.1	81.4	80.7	68.9	118
16-Nov	62.6	31.6	52.8	37.6	47.1	62.6	47.8	46.9	51.7
14-Dec	114	141	158	146	148	149	212	66.3	102
19-Jan	97	79.9	99.3	106	149	162	273	50.9	56.6
2-Feb	174	163	80.5	116	376	149	216	89.8	1540
Mean	229.77	248.75	221.20	212.08	173.37	231.17	214.92	80.13	393.88
StdDev	325.65	369.59	327.03	300.20	129.35	273.37	147.91	41.07	585.83
95% CI	260.57	295.73	261.68	240.21	103.50	218.74	118.36	32.86	468.76

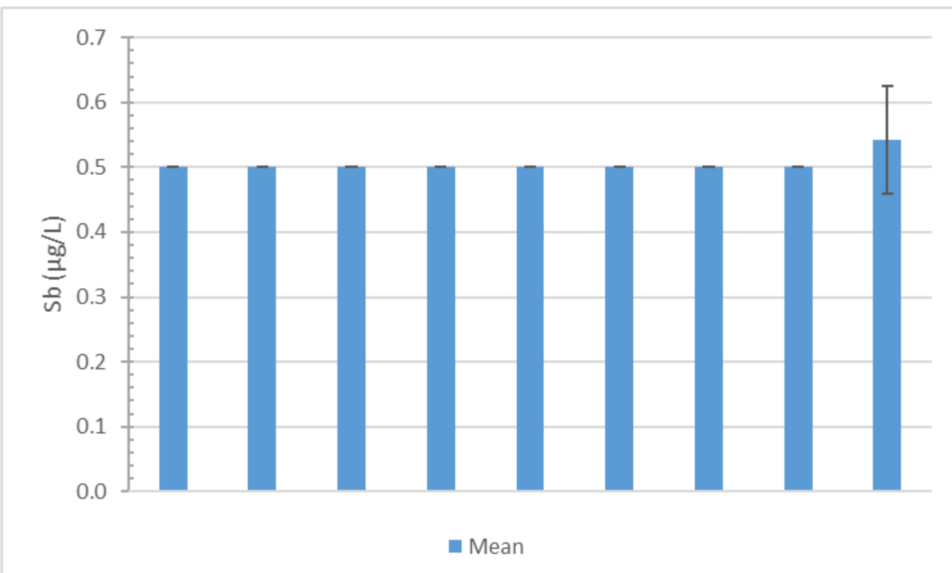
NOTE: ND = No data due to site access restriction on 9/22. Q = Data rejected due to positive blank samples or lack of precision.



Antimony (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Apr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
25-May	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
15-Jun	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Jul	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
17-Aug	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
22-Sep	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5
19-Oct	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
16-Nov	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-Dec	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
19-Jan	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Feb	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.01
Mean	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.54
StdDev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
95% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08

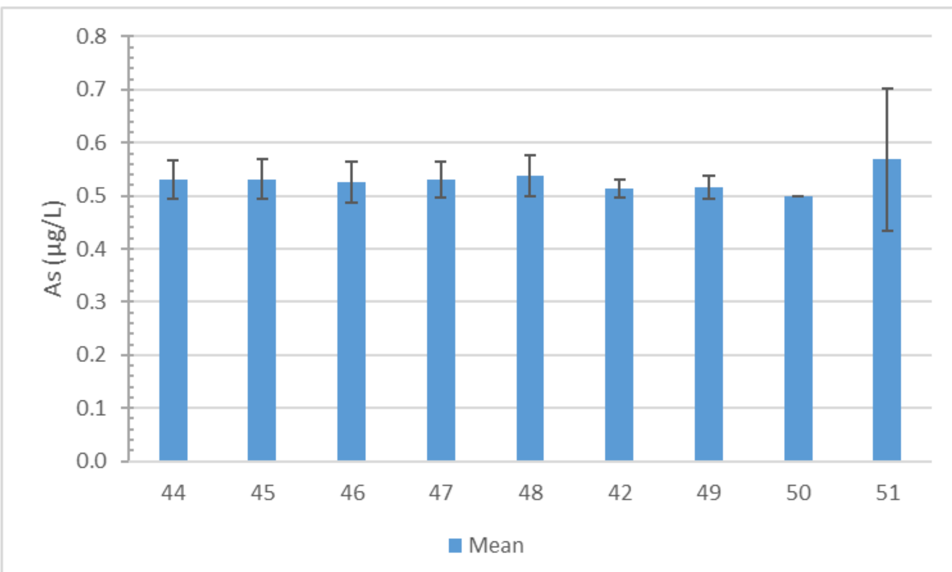
NOTE: ND = No data due to site access restriction on 9/22.



Arsenic (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Apr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
25-May	<0.5	0.55	<0.5	0.52	<0.5	<0.5	<0.5	<0.5	<0.5
15-Jun	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Jul	0.643	0.609	0.589	0.581	0.618	0.532	<0.5	<0.5	<0.5
17-Aug	0.685	0.711	0.726	0.695	0.672	0.592	0.588	<0.5	<0.5
22-Sep	0.545	0.503	<0.5	0.573	0.658	0.55	0.609	ND	<0.5
19-Oct	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
16-Nov	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-Dec	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
19-Jan	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Feb	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.32
Mean	0.53	0.53	0.53	0.53	0.54	0.51	0.52	0.50	0.57
StdDev	0.06	0.07	0.07	0.06	0.07	0.03	0.04	0.00	0.24
95% CI	0.04	0.04	0.04	0.03	0.04	0.02	0.02	0.00	0.13

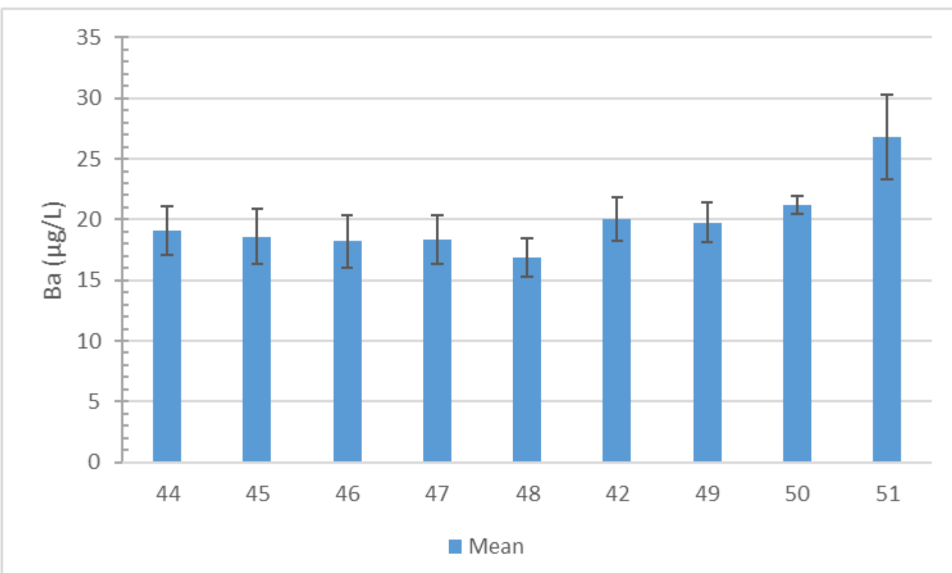
NOTE: ND = No data due to site access restriction on 9/22.



Barium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	14.7	14.1	13.8	13.8	12.6	16.2	16	20.7	23.9
20-Apr	16.4	14	14.4	15.6	15.4	18.6	16.6	19.6	26.8
25-May	18	21.6	18.5	17.5	13.6	20.4	16.4	19.3	28.8
15-Jun	19.4	20.2	19.6	20	17.6	19.2	18.4	21.3	22.3
20-Jul	22.8	22.3	21.6	21.5	20.3	24.2	21.5	23.2	27.8
17-Aug	27.9	27.8	27.8	27.4	17.4	26.8	25.9	22.3	25.2
22-Sep	20.3	20.4	19.4	19	20.7	23.6	23.1	ND	23
19-Oct	19.1	18.4	19	19.3	18	20.1	22.2	23	24.3
16-Nov	20.2	16.2	16.7	17	15.4	18.6	19.6	21.2	24.9
14-Dec	16.6	16	16.7	16.9	14.7	17.4	19.4	20.8	23.2
19-Jan	15.6	15.1	15.6	15.8	15.6	17.9	19	22	26.5
2-Feb	17.8	17	15.6	16.5	21.1	18	19.2	20	45.1
Mean	19.07	18.59	18.23	18.36	16.87	20.08	19.78	21.22	26.82
StdDev	3.59	4.07	3.81	3.55	2.80	3.18	2.96	1.31	6.09
95% CI	2.03	2.30	2.16	2.01	1.58	1.80	1.67	0.77	3.45

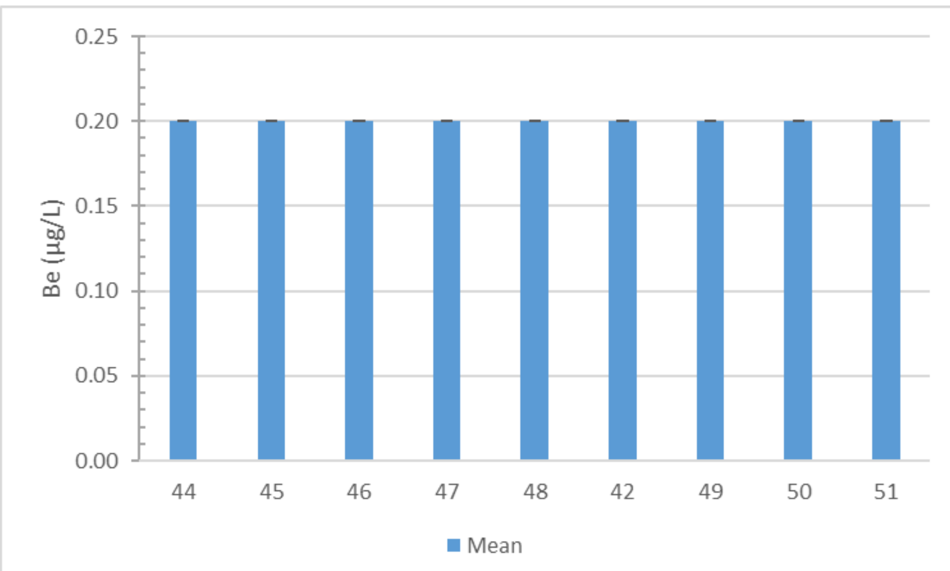
NOTE: ND = No data due to site access restriction on 9/22.



Beryllium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
20-Apr	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
25-May	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
15-Jun	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
20-Jul	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
17-Aug	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
22-Sep	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	ND	<0.2
19-Oct	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
16-Nov	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
14-Dec	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
19-Jan	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-Feb	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mean	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Std Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

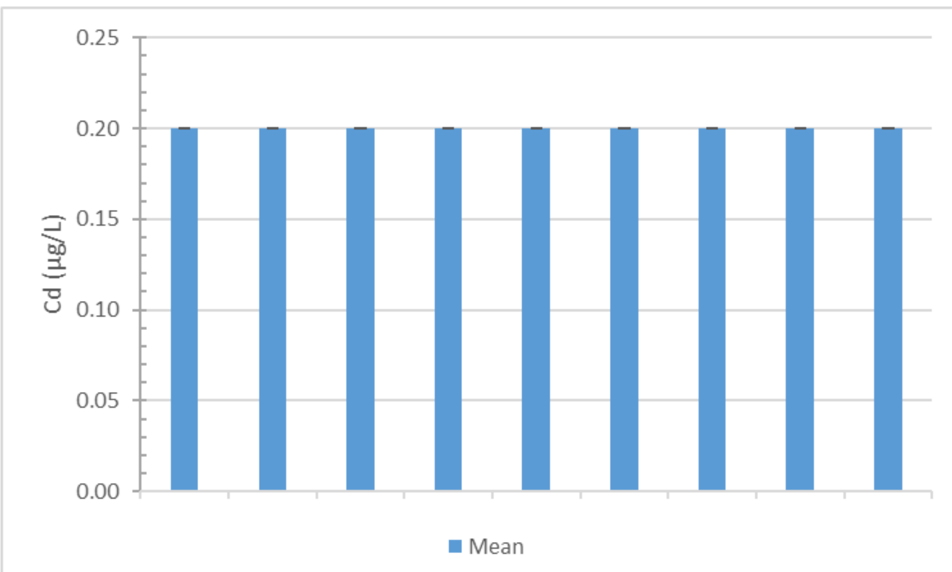
NOTE: ND = No data due to site access restriction on 9/22.



Cadmium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
20-Apr	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
25-May	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
15-Jun	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
20-Jul	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
17-Aug	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
22-Sep	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	ND	<0.2
19-Oct	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
16-Nov	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
14-Dec	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
19-Jan	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-Feb	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mean	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Std Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

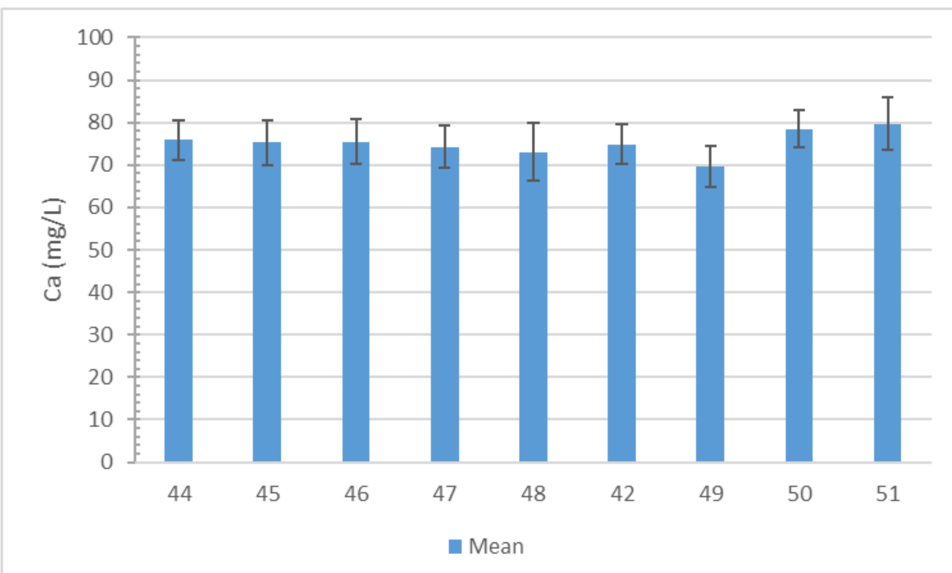
NOTE: ND = No data due to site access restriction on 9/22.



Calcium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	66.3	63.7	60.7	63.4	57.4	62.3	56.8	68.1	81.5
20-Apr	68.9	66.7	60.6	64.4	66.6	67.4	62.3	71.3	86.9
25-May	67.0	66.1	69.6	64.0	50.5	69.3	63.5	72.4	98.4
15-Jun	80.8	73.3	81.3	73.3	72.8	70.4	61.8	78.4	73.4
20-Jul	85.8	88.9	86.9	83.3	75.8	86.5	80.8	84.3	80.0
17-Aug	76.3	70.0	76.0	75.0	65.9	71.5	69.9	68.4	70.8
22-Sep	77.0	81.3	79.2	78.6	77.4	74.8	73.6	ND	53.8
19-Oct	78.9	77.5	82.8	79.0	89.4	86.7	77.5	87.8	85.1
16-Nov	90.2	93.1	89.3	92.8	93.1	88.4	83.8	84.4	87.9
14-Dec	81.0	78.4	76.8	77.2	74.4	77.2	72.2	87.8	85.7
19-Jan	75.4	76.2	75.6	76.0	75.5	75.7	63.8	81.7	79.1
2-Feb	62.5	67.9	66.8	64.8	78.4	68.9	69.6	79.1	74.4
Mean	75.84	75.26	75.47	74.32	73.10	74.93	69.63	78.52	79.75
StdDev	8.33	9.21	9.41	8.99	11.98	8.40	8.32	7.42	11.10
95% CI	4.71	5.21	5.33	5.09	6.78	4.75	4.71	4.39	6.28

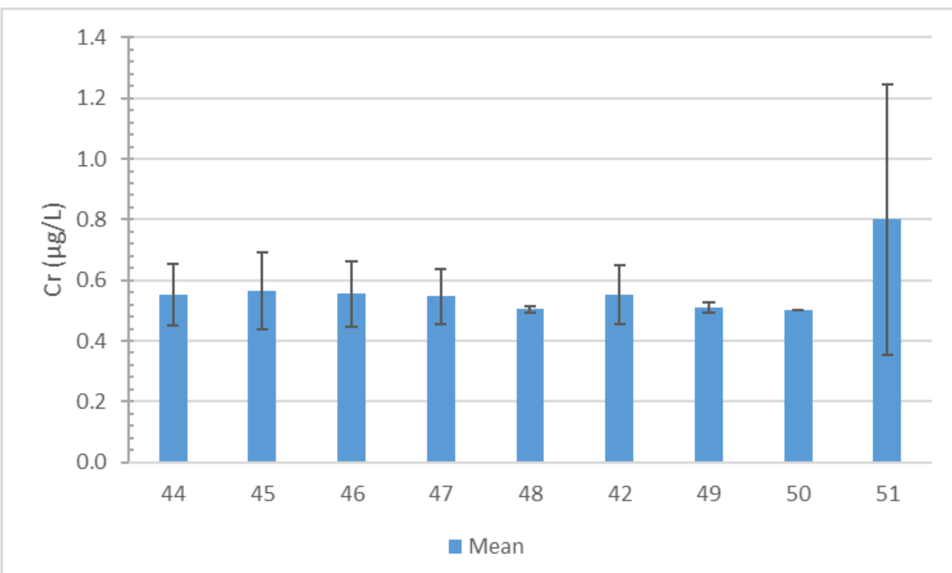
NOTE: ND = No data due to site access restriction on 9/22.



Chromium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Apr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
25-May	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
15-Jun	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.54
20-Jul	<0.5	<0.5	<0.5	<0.5	<0.5	0.526	<0.5	<0.5	<0.5
17-Aug	1.12	1.27	1.16	1.05	<0.5	1.09	0.607	<0.5	0.833
22-Sep	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	0.963
19-Oct	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
16-Nov	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-Dec	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
19-Jan	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Feb	<0.5	<0.5	<0.5	<0.5	0.563	<0.5	<0.5	<0.5	3.26
Mean	0.55	0.56	0.56	0.55	0.51	0.55	0.51	0.50	0.80
StdDev	0.18	0.22	0.19	0.16	0.02	0.17	0.03	0.00	0.79
95% CI	0.10	0.13	0.11	0.09	0.01	0.10	0.02	0.00	0.45

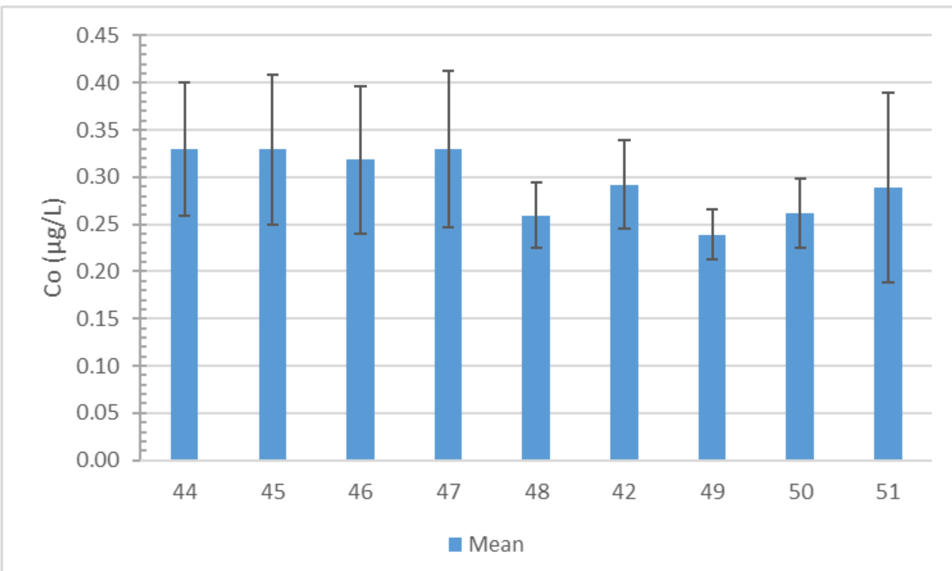
NOTE: ND = No data due to site access restriction on 9/22.



Cobalt (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	0.31	0.29	0.28	0.28	0.3	0.3	0.27	0.36	0.29
20-Apr	0.42	0.37	0.39	0.41	0.33	0.37	0.24	0.33	0.29
25-May	0.63	0.69	0.66	0.72	0.23	0.42	<0.20	0.35	0.24
15-Jun	0.33	0.31	0.33	0.33	0.25	0.29	0.22	0.29	0.27
20-Jul	0.344	0.321	0.335	0.319	0.242	0.365	<0.20	0.266	0.202
17-Aug	0.466	0.492	0.484	0.437	<0.20	0.312	0.246	<0.20	<0.20
22-Sep	0.296	0.305	0.281	0.279	0.246	0.402	0.222	ND	0.328
19-Oct	0.243	0.241	0.255	0.237	0.35	0.232	0.214	0.229	0.211
16-Nov	0.239	<0.20	<0.20	<0.20	<0.20	0.202	<0.20	0.211	<0.20
14-Dec	0.206	0.204	<0.20	<0.20	<0.20	<0.20	0.253	<0.20	<0.20
19-Jan	<0.20	0.207	<0.20	<0.20	<0.20	<0.20	0.232	<0.20	<0.20
2-Feb	0.275	0.321	0.204	0.346	0.368	0.212	0.369	0.248	0.838
Mean	0.33	0.33	0.32	0.33	0.26	0.29	0.24	0.26	0.29
StdDev	0.12	0.14	0.14	0.15	0.06	0.08	0.05	0.06	0.18
95% CI	0.07	0.08	0.08	0.08	0.04	0.05	0.03	0.04	0.10

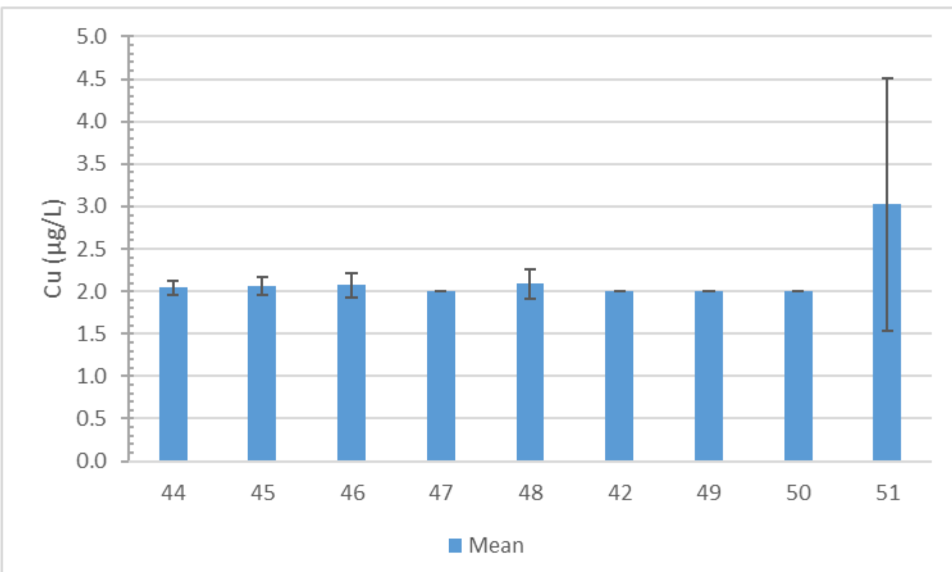
NOTE: ND = No data due to site access restriction on 9/22.



Copper (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<2	<2	<2	<2	<2	<2	<2	<2	<2
20-Apr	<2	<2	<2	<2	<2	<2	<2	<2	<2
25-May	<2	2.12	<2	<2	<2	<2	<2	<2	<2
15-Jun	<2	<2	<2	<2	<2	<2	<2	<2	<2
20-Jul	<2	<2	<2	<2	<2	<2	<2	<2	<2
17-Aug	<2	<2	<2	<2	3.04	<2	<2	<2	<2
22-Sep	<2	<2	<2	<2	<2	<2	<2	ND	5.58
19-Oct	<2	<2	<2	<2	<2	<2	<2	<2	<2
16-Nov	<2	<2	<2	<2	<2	<2	<2	<2	<2
14-Dec	<2	<2	2.88	<2	<2	<2	<2	<2	<2
19-Jan	<2	<2	<2	<2	<2	<2	<2	<2	<2
2-Feb	2.5	2.67	<2	<2	<2	<2	<2	<2	10.7
Mean	2.04	2.07	2.07	2.00	2.09	2.00	2.00	2.00	3.02
StdDev	0.14	0.19	0.25	0.00	0.30	0.00	0.00	0.00	2.63
95% CI	0.08	0.11	0.14	0.00	0.17	0.00	0.00	0.00	1.49

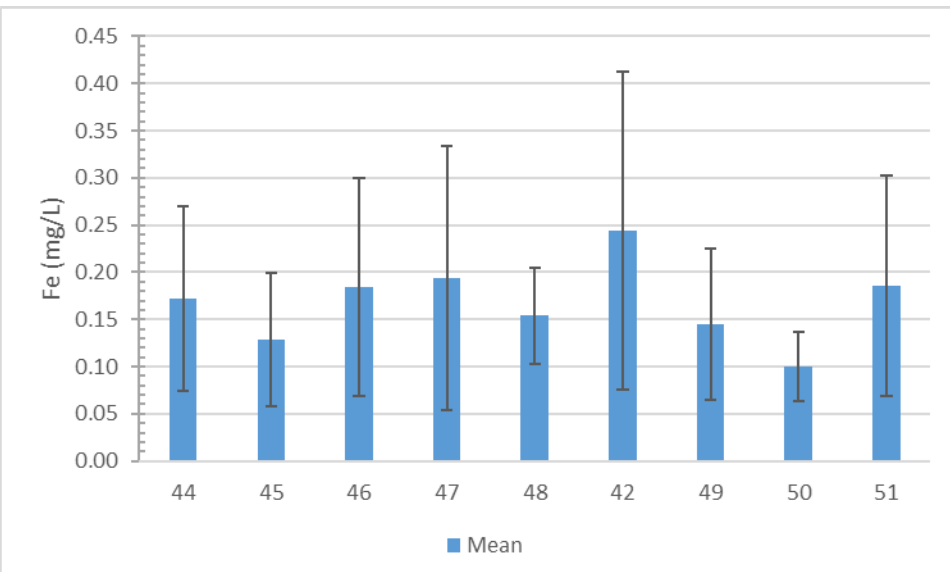
NOTE: ND = No data due to site access restriction on 9/22.



Iron (μg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	0.103	0.102	0.103	0.114	0.173	0.159	0.088	0.198	0.077
20-Apr	0.066	0.051	<0.050	0.064	0.137	0.062	0.055	0.052	0.059
25-May	0.055	0.091	0.078	0.168	0.063	0.093	0.055	0.073	0.083
15-Jun	0.050	0.082	0.081	0.093	<0.050	0.082	<0.050	0.058	0.058
20-Jul	0.612	0.126	0.500	0.229	0.100	0.243	0.071	0.081	0.135
17-Aug	0.396	0.507	0.690	0.947	0.108	1.080	0.518	0.226	0.230
22-Sep	0.232	0.138	0.187	0.220	0.255	0.550	0.234	ND	0.772
19-Oct	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
16-Nov	0.217	0.085	0.108	0.073	0.317	0.131	<0.050	0.064	0.289
14-Dec	0.107	0.172	0.226	0.220	0.264	0.287	0.292	0.156	0.140
19-Jan	0.084	0.082	0.088	0.100	0.109	0.119	0.153	0.070	0.034
2-Feb	0.090	0.051	<0.050	<0.050	0.219	0.079	0.130	0.077	0.299
Mean	0.17	0.13	0.18	0.19	0.15	0.24	0.15	0.10	0.19
StdDev	0.17	0.12	0.20	0.25	0.09	0.30	0.14	0.06	0.21
95% CI	0.10	0.07	0.12	0.14	0.05	0.17	0.08	0.04	0.12

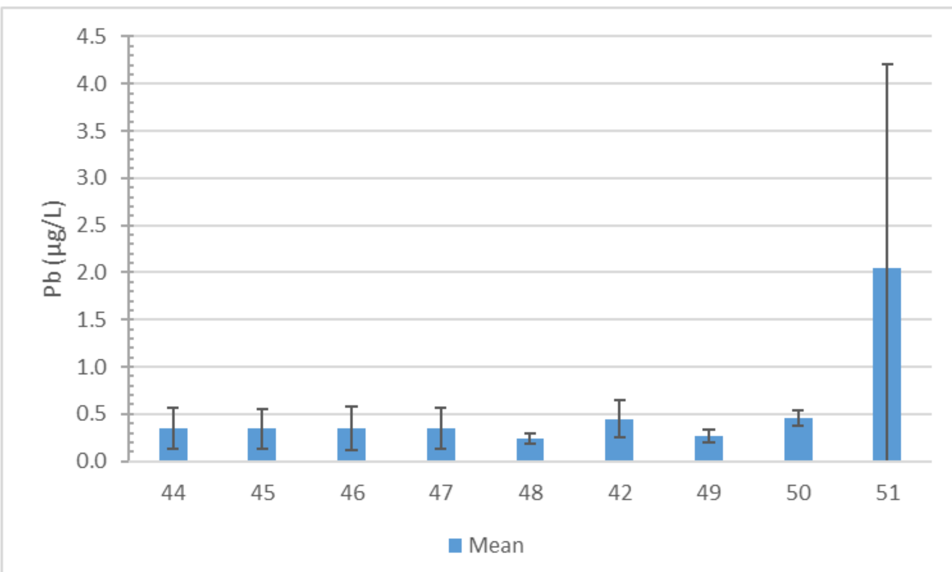
NOTE: ND = No data due to site access restriction on 9/22.



Lead (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	0.22	<0.2	<0.2	<0.2	0.22	0.29	<0.2	0.68	0.53
20-Apr	<0.2	<0.2	<0.2	0.22	<0.2	0.26	<0.2	0.39	0.86
25-May	<0.2	<0.2	<0.2	<0.2	<0.2	0.29	<0.2	0.39	1.17
15-Jun	0.24	0.29	0.33	0.36	<0.2	0.39	<0.2	0.63	0.81
20-Jul	0.333	0.311	0.387	0.381	0.205	0.761	<0.2	0.487	0.887
17-Aug	1.54	1.51	1.64	1.53	0.336	1.37	0.61	0.635	1.37
22-Sep	0.272	0.239	0.21	0.204	0.213	0.732	0.218	ND	2.90
19-Oct	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.355	0.85
16-Nov	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.261	0.377
14-Dec	0.201	0.215	0.231	0.237	0.227	0.276	0.258	0.42	0.431
19-Jan	<0.2	<0.2	<0.2	<0.2	0.204	0.262	0.424	0.297	0.336
2-Feb	0.38	0.401	0.225	0.234	0.511	0.313	0.302	0.46	14
Mean	0.35	0.35	0.35	0.35	0.24	0.45	0.27	0.46	2.04
StdDev	0.38	0.37	0.41	0.38	0.09	0.35	0.13	0.14	3.83
95% CI	0.21	0.21	0.23	0.21	0.05	0.20	0.07	0.08	2.17

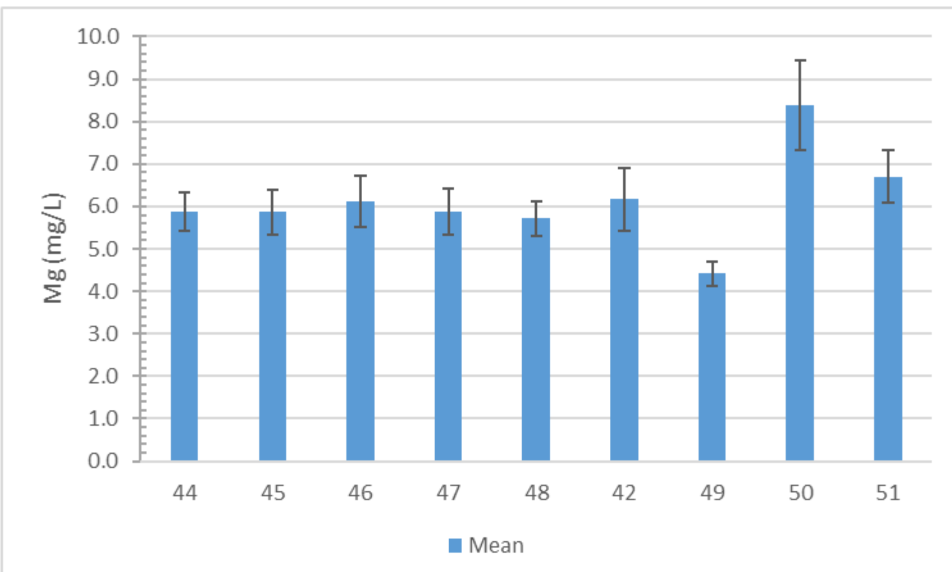
NOTE: ND = No data due to site access restriction on 9/22.



Magnesium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	4.84	4.67	4.51	4.70	4.35	4.63	3.59	6.56	6.77
20-Apr	5.95	5.77	7.87	5.77	5.53	6.58	4.23	9.04	7.51
25-May	7.25	7.32	7.76	7.31	6.08	8.92	4.68	12.6	9.26
15-Jun	5.63	5.09	5.66	5.07	5.29	4.81	3.58	6.75	5.71
20-Jul	6.34	6.59	6.46	6.21	5.97	6.45	4.91	8.29	6.49
17-Aug	5.38	4.95	5.41	5.30	5.07	4.99	4.36	7.05	5.94
22-Sep	6.18	6.52	6.43	6.58	5.93	6.99	4.87	ND	4.63
19-Oct	5.94	5.84	6.18	5.90	6.83	6.45	4.81	8.05	6.8
16-Nov	7.30	7.57	7.29	7.82	7.00	7.98	5.11	10.4	7.28
14-Dec	5.59	5.39	5.31	5.27	5.23	5.21	4.54	7.80	6.89
19-Jan	5.37	5.40	5.40	5.41	5.49	5.37	4.08	7.50	6.56
2-Feb	4.88	5.24	5.17	5.09	5.80	5.63	4.26	8.20	6.63
Mean	5.89	5.86	6.12	5.87	5.71	6.17	4.42	8.39	6.71
StdDev	0.79	0.94	1.08	0.95	0.73	1.32	0.50	1.77	1.11
95% CI	0.45	0.53	0.61	0.54	0.42	0.75	0.28	1.05	0.63

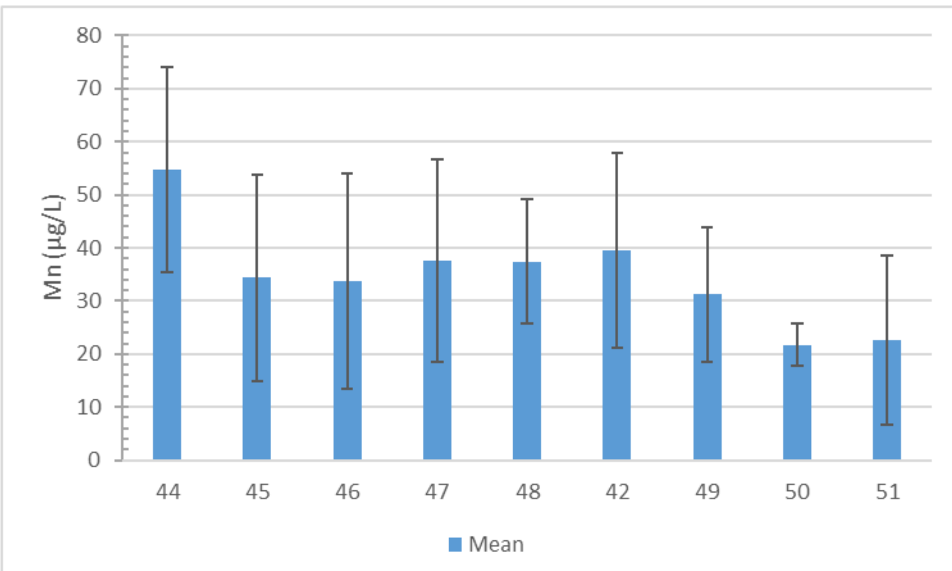
NOTE: ND = No data due to site access restriction on 9/22.



Manganese (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	34.9	16.1	16.1	21.2	27	20	21.5	26.5	7.62
20-Apr	63.6	19.5	18.8	21.8	24.2	13.8	13.9	9.82	8.31
25-May	39.6	27.7	20.7	24.4	17.9	16.2	12	12.2	10.3
15-Jun	51	32.7	33.9	39.1	25	36.8	23.5	26.6	14.6
20-Jul	66.4	46.1	46.6	52.9	62.3	77.2	22.8	26.5	14.4
17-Aug	143	129	133	129	66.6	107	86.6	27.1	22.6
22-Sep	38.5	33.4	30.8	32.4	51.2	69.9	47.6	ND	48.2
19-Oct	Q	Q	Q	Q	Q	Q	Q	Q	Q
16-Nov	44.3	11.7	11.2	12.9	12.1	15.7	13.8	18	8.5
14-Dec	36	23.7	26.5	29.5	35.9	30	33.8	26.3	10
19-Jan	18.5	14.4	15.1	20.7	27.2	22.3	31.9	22.1	8.07
2-Feb	66.2	23.6	18.1	29.4	62.7	24.8	36.1	22	95.7
Mean	54.73	34.35	33.71	37.57	37.46	39.43	31.23	21.71	22.57
StdDev	32.88	32.92	34.47	32.15	19.66	31.08	21.36	6.37	26.98
95% CI	19.43	19.46	20.37	19.00	11.62	18.37	12.63	3.95	15.94

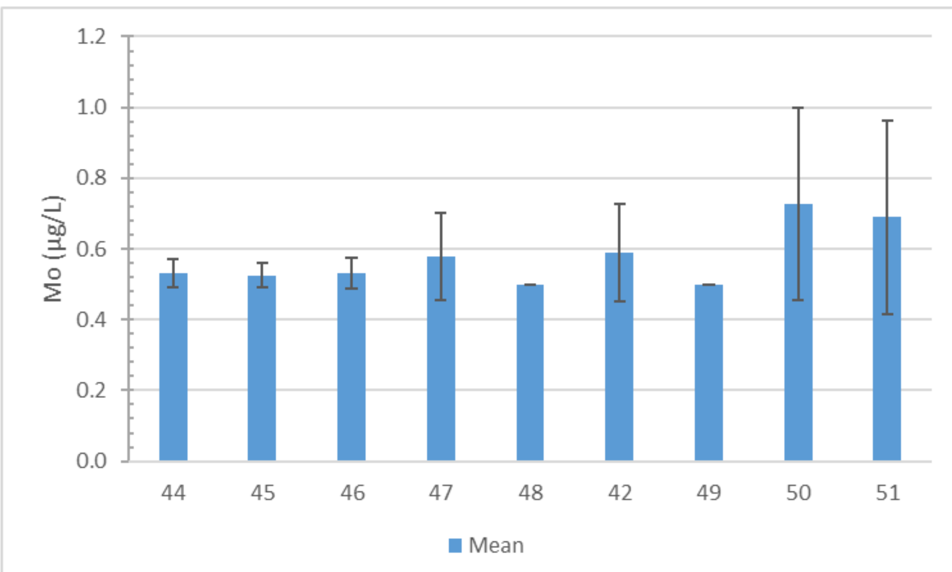
NOTE: ND = No data due to site access restriction on 9/22. Q = Data rejected due to lack of precision.



Molybdenum (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Apr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.59	<0.5
25-May	0.66	<0.7	0.67	0.7	<0.5	0.73	<0.5	1.13	<0.5
15-Jun	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Jul	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
17-Aug	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.749	<0.5
22-Sep	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	0.772
19-Oct	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.553
16-Nov	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.543	0.763
14-Dec	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
19-Jan	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Feb	0.707	0.605	0.722	1.24	<0.5	1.34	<0.5	1.99	2.19
Mean	0.53	0.53	0.53	0.58	0.50	0.59	0.50	0.73	0.69
StdDev	0.07	0.06	0.08	0.22	0.00	0.25	0.00	0.46	0.48
95% CI	0.04	0.04	0.04	0.12	0.00	0.14	0.00	0.27	0.27

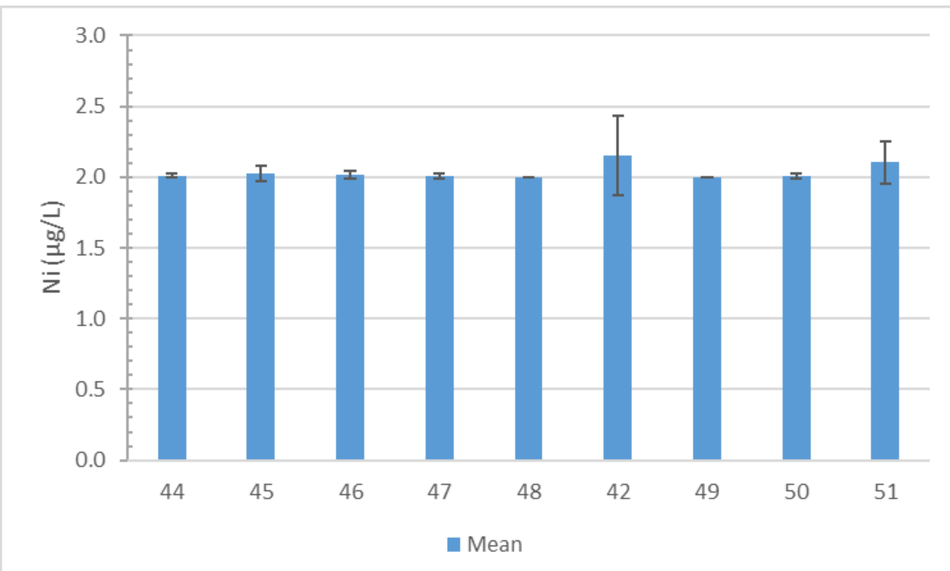
NOTE: ND = No data due to site access restriction on 9/22.



Nickel (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<2	<2	<2	<2	<2	<2	<2	2.08	2.14
20-Apr	2.08	<2	2.13	2.09	<2	2.14	<2	<2	2.21
25-May	2.06	2.31	2.1	<2	<2	<2	<2	<2	<2
15-Jun	<2	<2	<2	<2	<2	<2	<2	<2	<2
20-Jul	<2	<2	<2	<2	<2	<2	<2	<2	<2
17-Aug	<2	<2	<2	<2	<2	<2	<2	<2	<2
22-Sep	<2	<2	<2	<2	<2	<2	<2	ND	<2
19-Oct	<2	<2	<2	<2	<2	<2	<2	<2	<2
16-Nov	<2	<2	<2	<2	<2	<2	<2	<2	<2
14-Dec	<2	<2	<2	<2	<2	<2	<2	<2	<2
19-Jan	<2	<2	<2	<2	<2	<2	<2	<2	<2
2-Feb	<2	<2	<2	<2	<2	3.71	<2	<2	2.9
Mean	2.01	2.03	2.02	2.01	2.00	2.15	2.00	2.01	2.10
StdDev	0.03	0.09	0.05	0.03	0.00	0.49	0.00	0.02	0.26
95% CI	0.02	0.05	0.03	0.01	0.00	0.28	0.00	0.01	0.15

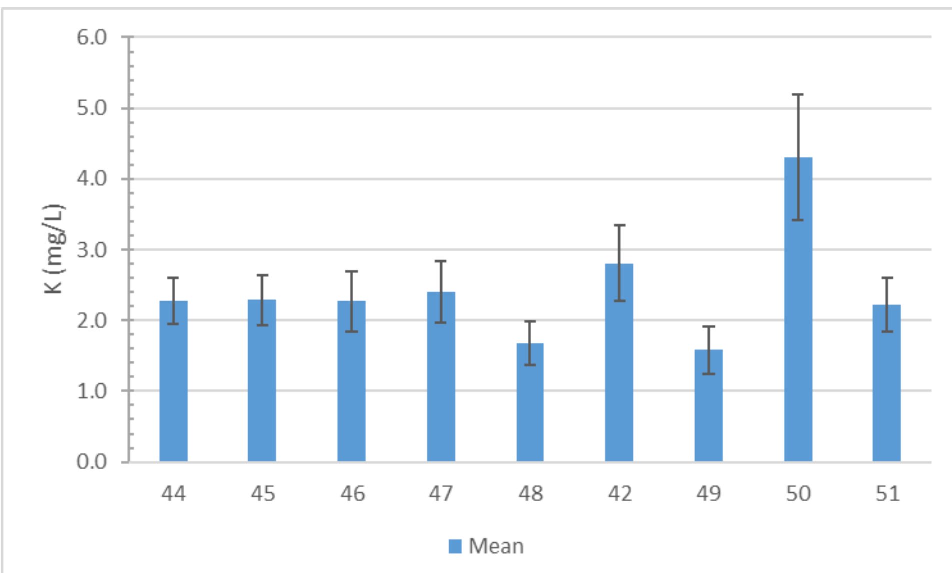
NOTE: ND = No data due to site access restriction on 9/22.



Potassium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	1.63	1.64	1.59	1.66	1.13	1.86	1.17	2.92	1.82
20-Apr	1.85	1.73	1.07	1.69	1.17	2.47	<1	4.76	1.89
25-May	3.09	3.13	3.38	3.74	<1	4.52	<1	7.82	2.57
15-Jun	1.32	1.16	1.27	1.16	<1	1.08	<1	1.88	1.20
20-Jul	2.45	2.60	2.54	2.38	1.83	2.74	1.45	4.01	1.74
17-Aug	3.16	3.05	3.24	3.13	2.14	3.32	2.93	4.81	2.46
22-Sep	2.98	3.13	3.25	3.55	2.77	4.23	2.32	ND	2.92
19-Oct	2.50	2.53	2.59	2.48	2.23	2.82	1.56	3.83	1.99
16-Nov	2.23	2.24	2.01	2.56	1.51	2.99	1.56	5.08	2.11
14-Dec	2.17	2.15	2.07	2.05	1.82	2.22	1.94	3.45	2.18
19-Jan	2.09	2.20	2.23	2.26	1.65	2.45	1.63	4.07	1.99
2-Feb	1.84	1.89	1.97	2.14	1.84	2.99	1.41	4.76	3.78
Mean	2.28	2.29	2.27	2.40	1.67	2.81	1.58	4.31	2.22
StdDev	0.59	0.63	0.76	0.77	0.55	0.94	0.58	1.50	0.66
95% CI	0.33	0.36	0.43	0.43	0.31	0.53	0.33	0.89	0.37

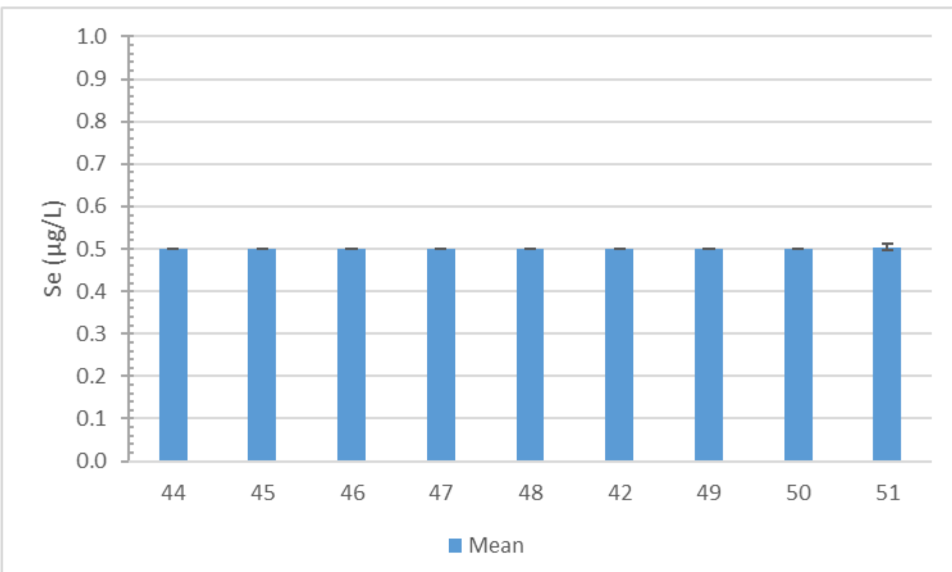
NOTE: ND = No data due to site access restriction on 9/22.



Selenium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Apr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
25-May	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
15-Jun	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Jul	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
17-Aug	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
22-Sep	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5
19-Oct	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
16-Nov	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-Dec	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
19-Jan	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Feb	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.546
Mean	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
StdDev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
95% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

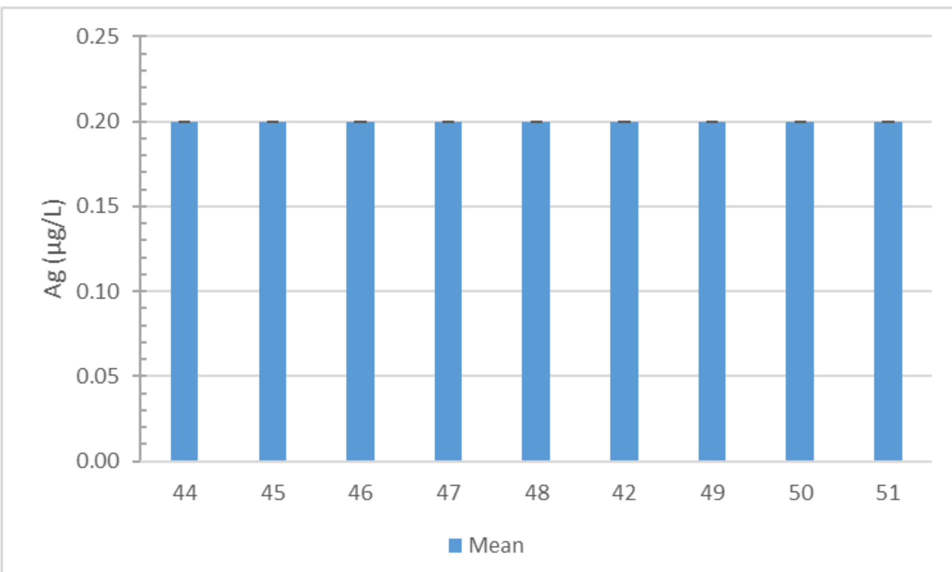
NOTE: ND = No data due to site access restriction on 9/22.



Silver (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
20-Apr	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
25-May	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
15-Jun	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
20-Jul	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
17-Aug	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
22-Sep	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	ND	<0.2
19-Oct	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
16-Nov	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
14-Dec	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
19-Jan	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-Feb	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mean	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Std Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

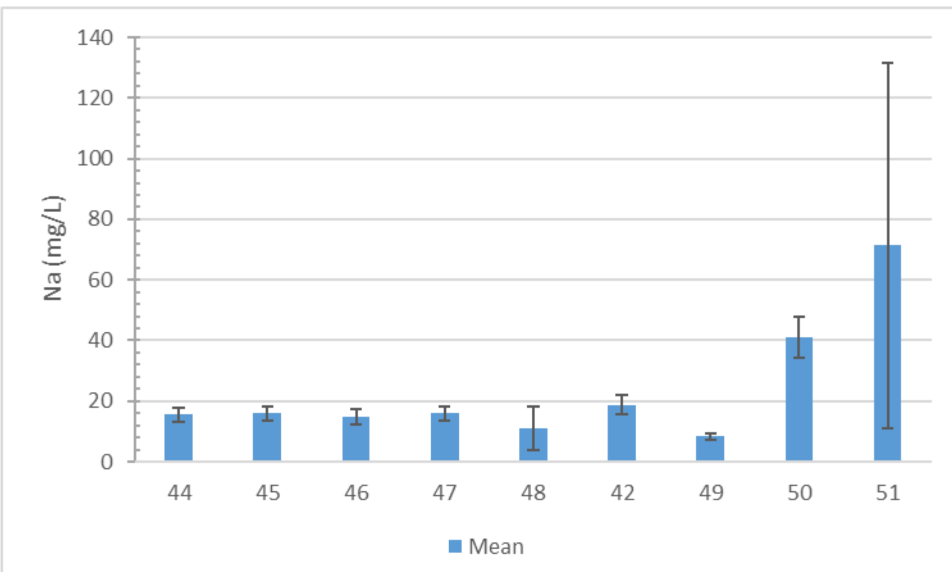
NOTE: ND = No data due to site access restriction on 9/22.



Sodium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	13.9	13.7	13.3	14.5	9.86	16.4	7.4	38.6	49.7
20-Apr	18.5	17.7	8.53	18.5	8.15	22.5	9.78	40.6	49.0
25-May	25.7	23.6	24.3	23.8	6.56	29.1	9.66	46.3	49.9
15-Jun	16	14.7	15.8	14.2	8.28	15.0	8.43	31.2	33.2
20-Jul	16.6	17.4	16.4	16.0	8.85	19.0	11.4	38.9	41.9
17-Aug	9.65	8.95	9.59	9.15	7.33	9.49	5.43	33.7	35.2
22-Sep	14.1	16.2	16.5	18.7	7.5	25.4	9.63	ND	23.9
19-Oct	15.5	15.1	15.6	15.1	6.97	18.2	8.96	34.4	38.4
16-Nov	16.1	17.0	16.0	18.6	7.2	21.2	8.15	38.4	40.8
14-Dec	9.04	8.62	8.35	8.52	4.76	9.79	6.13	29.0	32.4
19-Jan	16.1	16.8	16.2	17.0	7.11	18.9	7.87	52.1	52.1
2-Feb	16.1	21.1	16.4	16.9	51.2	21.2	7.29	69.3	409
Mean	15.61	15.91	14.75	15.91	11.15	18.85	8.34	41.14	71.29
StdDev	4.22	4.29	4.41	4.18	12.68	5.75	1.67	11.43	106.70
95% CI	2.39	2.43	2.49	2.36	7.17	3.25	0.95	6.75	60.37

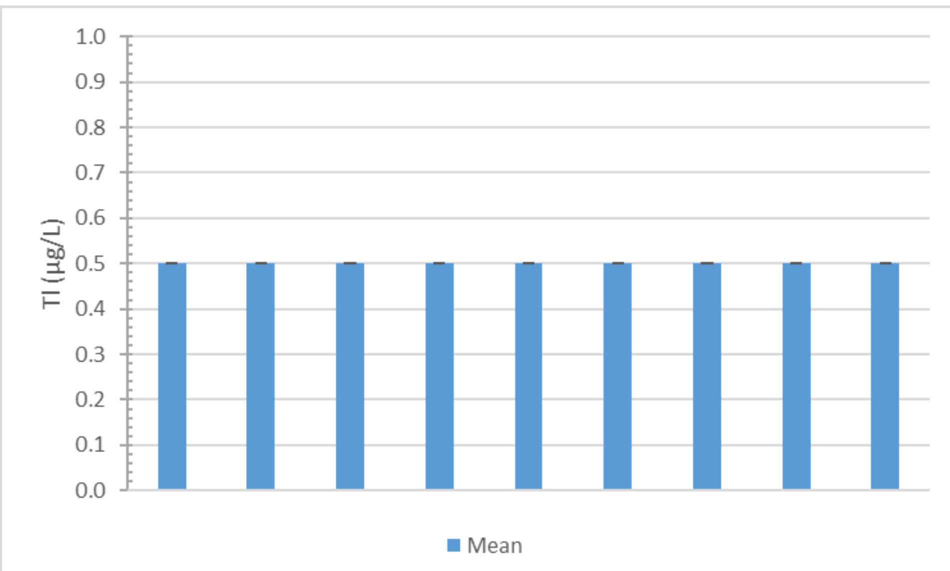
NOTE: ND = No data due to site access restriction on 9/22.



Thallium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Apr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
25-May	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
15-Jun	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-Jul	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
17-Aug	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
22-Sep	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5
19-Oct	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
16-Nov	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-Dec	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
19-Jan	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Feb	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mean	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
StdDev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

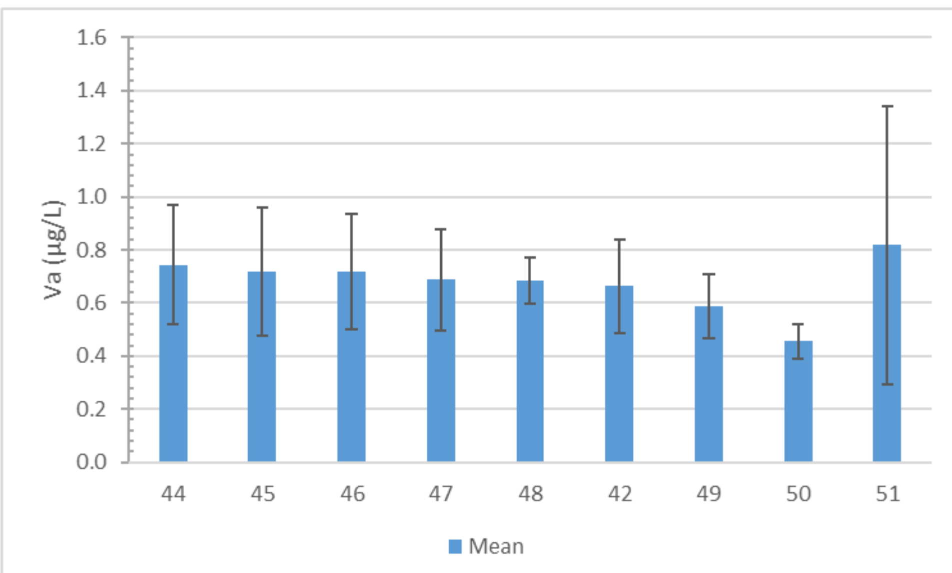
NOTE: ND = No data due to site access restriction on 9/22.



Vanadium (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	0.47	0.44	0.41	0.4	0.55	0.46	0.48	0.45	0.3
20-Apr	0.59	0.51	0.56	0.57	0.62	0.42	0.36	0.29	0.32
25-May	0.97	0.92	0.88	0.9	0.64	0.59	0.51	0.36	0.36
15-Jun	0.71	0.71	0.75	0.74	0.67	0.67	0.57	0.57	0.65
20-Jul	0.99	0.926	0.971	0.838	0.895	0.869	0.523	0.561	0.496
17-Aug	1.84	1.94	1.81	1.64	0.944	1.54	1.18	0.664	1.06
22-Sep	0.796	0.74	0.647	0.633	0.741	0.843	0.665	ND	1.19
19-Oct	0.448	0.486	0.566	0.463	0.553	0.476	0.423	0.403	0.546
16-Nov	0.487	0.392	0.452	0.441	0.486	0.468	0.417	0.446	0.425
14-Dec	0.535	0.543	0.615	0.588	0.625	0.593	0.645	0.486	0.528
19-Jan	0.444	0.414	0.46	0.499	0.567	0.509	0.636	0.352	0.331
2-Feb	0.655	0.595	0.489	0.535	0.914	0.514	0.63	0.428	3.61
Mean	0.74	0.72	0.72	0.69	0.68	0.66	0.59	0.46	0.82
StdDev	0.39	0.43	0.39	0.34	0.16	0.31	0.21	0.11	0.92
95% CI	0.22	0.24	0.22	0.19	0.09	0.18	0.12	0.06	0.52

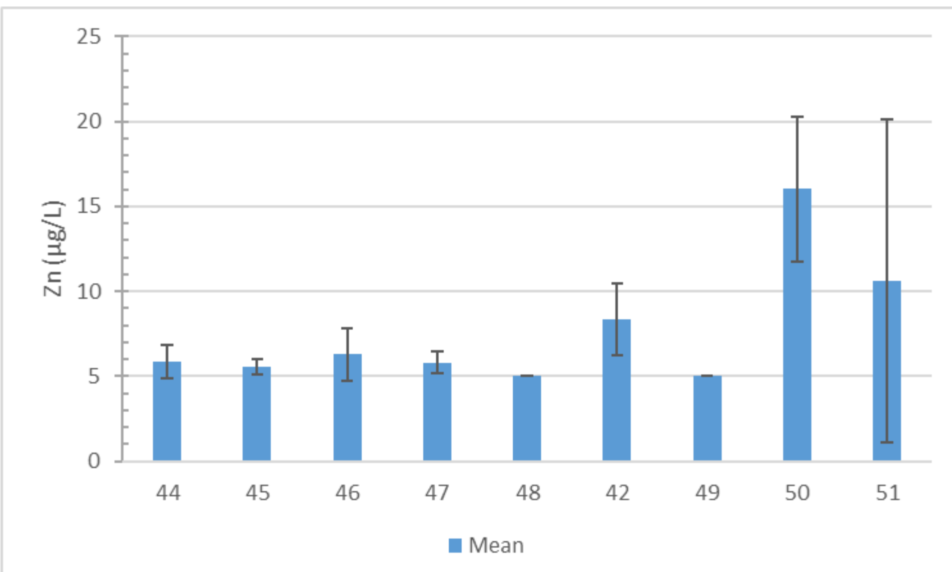
NOTE: ND = No data due to site access restriction on 9/22.



Zinc (µg/L)

	44	45	46	47	48	42	49	50	51
16-Mar	<5	<5	<5	<5	<5	6.4	<5	16.8	<5
20-Apr	6.71	5.51	7.57	7.15	<5	13.8	<5	26.7	<5
25-May	<5	6.61	7.16	6.96	<5	15.5	<5	25.9	<5
15-Jun	<5	<5	<5	<5	<5	6.39	<5	11.4	<5
20-Jul	<5	<5	<5	<5	<5	5.24	<5	11.5	<5
17-Aug	6.38	7.16	14.5	6.84	<5	5.99	<5	8.95	<5
22-Sep	<5	<5	<5	<5	<5	10.3	<5	ND	13.9
19-Oct	<5	<5	<5	<5	<5	<5	<5	8.46	<5
16-Nov	<5	<5	<5	<5	<5	6.88	<5	14.7	<5
14-Dec	<5	<5	<5	<5	<5	<5	<5	6.98	<5
19-Jan	10.9	5.68	5.99	5.57	<5	6.74	<5	21.3	<5
2-Feb	6.06	6.58	5.2	8.02	<5	12.6	<5	23.5	63.4
Mean	5.84	5.55	6.29	5.80	5.00	8.32	5.00	16.02	10.61
StdDev	1.71	0.79	2.74	1.12	0.00	3.73	0.00	7.27	16.82
95% CI	0.97	0.45	1.55	0.63	0.00	2.11	0.00	4.30	9.52

NOTE: ND = No data due to site access restriction on 9/22.



Appendix B: Field Calibration Log

Manufacturer: Hanna Multimeter Waterproof Meter
Model: HI98194
Serial No.: 3110004991
Assigned To: KWRRI

Analyst	Date	Time	Calibration Verification	Specific Conductance µs/cm: Standard Used	Temp	Initial SC	Calibrated SC	SC QA	Conductivity Lot #	Conductivity Expired	pH, SU: Buffer Lot# pH4	Buffer Lot# pH7	Buffer Lot# pH10	Buffer Expired @ Use pH4	Buffer Expired @ Use pH7	Buffer Expired @ Use pH10
SJE	10/16/2020	15:00	Full Calibration	1413	23.0	1561	1408	PASS	1917	NO	2808	1264	2934	NO	NO	YES
SJE	2/23/2021	10:00	Full Calibration	1413	23.0	889	1413	PASS	1917	NO	2808	1264	0GI113	NO	NO	NO
SJE	3/15/2021	14:40	Full Calibration	1413	19.8	1425	1425	PASS	1917	NO	2808	1264	0GI113	NO	NO	NO
SJE	4/19/2021	15:30	Full Calibration	1413	15.2	1578	1419	PASS	1917	NO	2808	1264	0GI113	NO	NO	NO
SJE	5/11/2021	6:19	Full Calibration	1413	19.1	1623	1418	PASS	1917	NO	2808	1264	0GI113	NO	NO	NO
SJE	5/13/2021	6:05	DO Calibration													
SJE	5/18/2021	6:24	Full Calibration	1413	19.5	1478	1413	PASS	1917	NO	2808	1264	0GI113	NO	NO	NO
SJE	5/25/2021	6:16	Full Calibration	1413	20.7	1592	1418	PASS	1917	NO	2808	1264	0GI113	NO	NO	NO
SJE	5/27/2021	6:31	Full Calibration	1413	20.1	1494	1411	PASS	1917	NO	2808	1264	0GI113	NO	NO	NO
SJE	6/15/2021	6:22	Full Calibration	1413	21.1	1441	1441	PASS	1917	NO	2808	1264	0GI113	NO	NO	NO
SJE	7/20/2021	6:45	Full Calibration	1413	22.7	793	1413	PASS	0GI034	NO	2808	0GI113	0GI113	NO	NO	NO
SJE	8/17/2021	6:59	Full Calibration	1413	21.6	1473	1412	PASS	0GI034	NO	0GI001	0GI113	0GI113	NO	NO	NO
SJE	9/21/2021	19:29	Full Calibration	1413	21.3	1507	1414	PASS	0GI034	YES	0GI001	0GI113	0GI113	NO	NO	NO
SJE	10/19/2021	6:09	Full Calibration	1413	20.3	1465	1419	PASS	0GI034	YES	0GI001	0GI113	1GG429	NO	NO	NO
SJE	11/16/2021	6:22	Full Calibration	1413	15.4	1565	1414	PASS	0GI034	YES	0GI001	0GI113	1GG429	NO	NO	NO
SJE	12/14/2021	6:33	Full Calibration	1413	16.3	1538	1414	PASS	1GJ701	NO	0GI001	0GI113	1GG429	NO	NO	NO
SJE	1/19/2022	6:16	Full Calibration	1413	16.2	1676	1414	PASS	1GJ701	NO	0GI001	0GI113	1GG429	NO	NO	NO
SJE	2/2/2022	6:31	Full Calibration	1413	16.4	1584	1418	PASS	1GJ701	NO	0GI001	0GI113	1GG429	NO	NO	NO

Date	pH, SU: Initial pH4	Initial pH7	Initial pH10	Calibrated pH4	Calibrated pH7	Calibrated pH10	pH QA pH4	pH QA pH7	pH QA pH10	Dissolved Oxygen mg/L: Barom. Pressure mmHg	Temp	Initial DO	Initial %DO	Calibrated DO	Calibrated %DO	Batteries Changed	DO Membrane Changed	Date DO Membrane to be Changed Next	Comments, Maintenance Performed
10/16/2020	4.1	7.1	9.9	4.0	7.0	10.0	PASS	PASS	PASS	740.7	17.0		~55		97.5	No	Yes	12/15/20	DO solution replaced, pH 10 solution was expired at time of calibration
2/23/2021	4.1	6.8	10.0	4.0	7.2	10.0	PASS	PASS	PASS	744.3	16.0		194.0		99.2	No	Yes	04/24/21	DO solution replaced
3/15/2021	4.1	7.1	9.9	4.0	7.0	10.0	PASS	PASS	PASS	738.1	18.4		89.0		99.0	No	No		Refilled DO electrolyte solution.
4/19/2021	4.2	7.2	9.9	3.9	6.9	10.1	PASS	PASS	PASS	734.7	15.2		82.0		96.3	No	No		Refilled DO electrolyte solution.
5/11/2021	4.2	7.1	9.9	3.8	7.1	10.1	PASS	PASS	PASS	749.0	19.1		181.7		99.2	No	Yes	07/10/21	Replaced membrane and electorlyte, cleaned probes
5/13/2021										745.2	19.7		112.7		99.2	No	No		None
5/18/2021	4.1	7.1	9.8	3.9	7.0	10.0	PASS	PASS	PASS	743.3	19.5		98.0		99.8	No	No		None
5/25/2021	4.1	7.1	9.8	4.0	7.0	10.0	PASS	PASS	PASS	741.6	20.7		80.4		99.3	No	No		Refilled DO electrolyte solution.
5/27/2021	4.1	7.1	9.8	4.0	7.0	10.0	PASS	PASS	PASS	740.6	20.1		113.2		95.7	No	No		Refilled DO electrolyte solution.
6/15/2021	4.2	7.1	9.8	4.0	7.0	10.0	PASS	PASS	PASS	737.7	21.1		68.1		99.0	No	No		Refilled DO electrolyte solution.
7/20/2021	4.3	7.1	9.7	4.0	7.0	10.0	PASS	PASS	PASS	739.2	22.7		101.1		99.2	No	Yes	09/18/21	Replaced membrane and electorlyte, cleaned probes
8/17/2021	4.2	7.0	9.6	4.0	7.0	10.0	PASS	PASS	PASS	739.4	21.6		116.7		99.9	No	No		Refilled DO electrolyte solution.
9/21/2021	4.1	7.0	9.5	4.0	7.0	10.0	PASS	PASS	PASS	738.0	21.3		118.6		99.4	No	Yes	11/20/21	Replaced membrane and electorlyte, cleaned probes
10/19/2021	4.1	7.1	10.0	4.0	7.0	9.9	PASS	PASS	PASS	742.4	20.3		72.3		99.3	No	No		Refilled DO electrolyte solution.
11/16/2021	4.1	7.0	9.9	3.9	6.9	10.0	PASS	PASS	PASS	738.6	15.4		-		100.1	No	Yes	01/15/22	Replaced membrane and electorlyte, cleaned probes
12/14/2021	4.1	7.0	9.9	4.0	7.0	10.0	PASS	PASS	PASS	747.1	16.3		105.0		98.4	No	No		Refilled DO electrolyte solution.
1/19/2022	4.3	7.3	10.0	3.9	6.9	10.0	PASS	PASS	PASS	735.7	16.2		125.6		99.2	No	Yes	03/20/22	Replaced membrane and electorlyte, cleaned probes
2/2/2022	4.2	7.0	9.8	3.9	7.0	9.8	PASS	PASS	PASS	731.8	16.4		78.0		90.9	No	No		Refilled DO electrolyte solution.