Water Quality and Biological Monitoring Trend Analysis

Missouri-Madison Water Quality Monitoring Program

NorthWestern Energy

December 2021

GEI Consultants
Consulting Engineers and Scientists

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Executive Summary

Water quality has been monitored at 10 stations in the Madison-Missouri River Basin from 1997 through 2020 by NorthWestern Energy (formerly PPL Montana). During this period the monitoring program has been updated with the most recent version being documented in the Water Quality and Biological Monitoring Plan for the Years 2012-2021 established under FERC license 2188. This report presents the data collected from the most recent 10-year period (2011-2020), and the statistical analyses of data based on monitoring objectives outlined in the Plan. Briefly, water quality data included field measured parameters such as specific conductivity, pH, temperature, dissolved oxygen, and turbidity, and analytical laboratory measurements of ionic chemistry (total and dissolved fractions for calcium, magnesium, sodium, chloride, potassium, sulfate, alkalinity/bicarbonate), total suspended/dissolved solids, nutrient chemistry (phosphorus and nitrogen fractions) and a suite of metals data (total fractions for arsenic, cadmium, copper, iron, lead, manganese and zinc). Water quality data were routinely collected on a quarterly basis, except for 2011 when water quality samples were collected on a monthly basis. The 2011 data are included in the data summaries, although for statistical analysis the data were filtered to include only the quarterly results.

In addition to water chemistry, periphyton, macroinvertebrate, and fish tissue samples were collected annually at a subset of 7 biological monitoring stations. Periphyton measures included chlorophyll-a content in addition to identification and enumeration of algae species which provided the basis for diatom metrics used to evaluate the biological integrity of each community. Similarly, macroinvertebrate samples included identification and enumeration of individuals which also provide the basis of the metrics describing community structure. Fish tissue analyses focused on metals and organochlorine compounds including a suite of pesticide and PCB congeners.

The following summary and recommendations are based on analyses of monitoring data from 2011-2020.

ES 1.1 Water Quality

Concentrations of numerous constituents tended to either increase or decrease in the downstream direction throughout the monitoring period. These observations in spatial trends were consistent with previous studies (Land & Water 1999; PBS&J 2011; GEI 2017). The change in water quality conditions in the downstream direction are largely attributed to geologic factors in the headwaters of the Madison River, or source water inputs from the Jefferson, Gallatin, and Sun rivers. For example, elevated concentrations of total arsenic, total sodium, and total chloride observed at Station 1 at the upstream end of the study area are due to the geothermal activity in Yellowstone National Park whereas the increase in total suspended solids downstream at Station 9 is due to watershed/agricultural practices in the Sun River. The longitudinal increase in total calcium, total sulfates, and nutrients are due to shifts in the geological conditions of the various watersheds, anthropogenic influences of treated wastewater, and irrigation return flows, with the largest influence on water quality observed downstream of the Three Forks confluence. The observed differences in concentrations between the two 10-year monitoring periods is largely due to the different hydrological regimes.

Statistically significant changes in concentrations of constituents between monitoring stations was common between upstream stations 1 through 5. These shifts were largely a function of the corresponding dilution of constituents from hydrological gains, losses due to reservoir sinks, and gains due to changing geological sources. Stations lower in the watershed, especially those from immediately downstream of Canyon Ferry Dam and Holter Dam tended to show consistent patterns and stability in water quality concentrations with few significant differences between stations. Few changes in water quality appeared to be directly related to hydroelectric operations, except for total suspended solids/turbidity and dissolved oxygen content. Both Station 4 and Station 6 downstream of reservoirs revealed lower dissolved oxygen content relative to their respective upstream station.

Concentrations of many constituents were strongly correlated with one another. These correlations included geology-related factors (e.g. a strong association of sodium, chloride, and arsenic) and ionic chemistry, specific conductance, and total dissolved solids. Other erosion based watershed parameters such as total suspended solids and metals (e.g. iron) were strongly correlated. Furthermore, many parameter concentrations were strongly correlated to flow via dilution or watershed inputs. These parameters included total alkalinity, total bicarbonate, total calcium, total chloride, dissolved potassium (Madison River only), dissolved sodium, total suspended solids, turbidity, total arsenic, total iron, and specific conductance.

Temporal trends in both field and analytical parameters were analyzed for non-flow adjusted and flow-adjusted data from 2011 to 2020. Statistically significant increasing trends in non-flow adjusted concentrations were observed for multiple parameters. Total sulfate concentrations significantly increased in the Madison River at Station 1 (Hwy 297) and Station 3 (Varney), and total dissolved solids significantly increased over time at Station 1 (Hwy 287) and Station 7 (Hauser) in the Missouri River. Dissolved oxygen data, mg/L and % saturation, increased over time at most stations but was only significant at Station 3 (Varney) and Station 5 (Toston) which represents background conditions for the Missouri River stations. Decreasing trends also existed in the Madison and Missouri Rivers. Total alkalinity exhibited a statistically significant decreasing trend over time at Station 6 (Canyon Ferry). Nitrogen (total nitrate-nitrite and total nitrogen) concentrations did not trend except for a significant decrease in total nitrite-nitrate at Station 3 (Varney). Total phosphorus concentrations decreased at all sites and exhibited significant trends over time at multiple stations in both the Madison and Missouri rivers. Water temperature decreased at most sites and significantly decreased over time at Station 7 (Hauser). Total and dissolved, calcium and potassium exhibited statistically significant trends over time for almost all stations. However, these parameters were collected only either the first or second half of the 10-year period and results should be cautiously interpreted. No significant temporal trends were observed in flow, and in fact, hydrological conditions represented more typical flow conditions from 2011-2020, whereas the flow conditions from 2001-2020 represented extreme dry and wet year type flow conditions.

Of the eleven parameters that showed a strong relationship with flow, only a few exhibited significant trends over time (2011-2020) once the effects of flow were removed. Specific conductance significantly decreased over time at five of the ten monitoring stations, with most of decreasing trends occurring in the Missouri River. Similarly, alkalinity revealed significant decreasing trends over time at many of the Missouri River stations. Of the ten monitoring stations evaluated, Station 4 (Madison) revealed the most significant trends for water quality, with five of the eleven parameters significantly decreasing over time. Most of the trends at Station 4 were related to the ionic condition of the water, although total arsenic significantly decreased over time as well. Overall, the effects of watershed influence or hydroelectric dams had little to no effect on water quality conditions outside of the effects of flow from 2011 to 2020. For the stations that exhibited significant trends over time for alkalinity and conductivity, there was a downstream carry-over effect observed at successive downstream stations.

ES 1.2 Periphyton

From 2011 to 2020, the mean whole-rock chlorophyll-a concentrations were less than 100 mg/m^2 at all stations except for at Station 4 (Madison) and Station B7 (Hauser) where the mean concentrations were higher (126 and 184 mg/m^2, respectively). Wadeable streams with chlorophyll-a concentrations greater than 120 mg/m^2 are often considered nutrient impaired by the State of Montana.

No longitudinal trend (i.e., over river miles) in chlorophyll-a concentrations was apparent among stations. Each station exhibited a high degree of intra/inter annual variability, except for Station B2 (Hebgen). The direction of change (e.g. decrease or increase) in median chlorophyll-a concentrations between paired stations alternated longitudinally between stations. The median concentration was the lowest at Station B2 (Hebgen) and the greatest at Station B7 (Hauser) which experienced nuisance bloom conditions in August 2020. Stations downstream of Holter and Great Falls dams exhibited algal biomass conditions similar to stations in the Madison River, between the Madison Dam and Canyon Ferry Reservoir.

The diatom assemblages typically revealed “Excellent” or “Good” ratings for the Mountain MTM biological index at all stations, except for one “Fair” rating at Station B10 (Morony), which is downstream of Great Falls Reservoir, the city of Great Falls, and Sun and Smith Rivers. Station B2 (Hebgen), exhibited more “Good” ratings for the diatom assemblage than any other station which is reflected in its overall impairment rating of “Severe” in one and “Moderate” in three of the previous ten years of data. The cause of these low ratings were mainly high results for siltation index and abundances of dominant species. The mountain streams siltation index also scored poorly at Station B10 which was rated as “Moderate” impairment in five of the last ten years along with one “Severe” impairment rating. All other stations in all years were rated with a minimal number of “Moderate” impairment and with mostly “Minor” impairment or “None.”

From 2011 to 2020, no longitudinal increasing or decreasing trends in diatom metrics were apparent among the stations except for a decrease in Abnormal Cells (%) in a downstream direction. Many diatom metrics followed similar patterns between stations indicating improving or declining community health from one station to the next. Multiple metrics statistically improved between stations B3 (Varney) and 4 (Madison), and B8 (Holter) and B10 (Morony), indicating an improvement in biological integrity for the diatom communities, while multiple metrics statistically worsened between stations 4 and B5 (Toston) and station B5 and B7 (Hauser), indicating a decline in community health.

Many correlations between metrics at individual stations were observed but few relationships among metrics at all stations occurred indicating that the periphyton communities differ greatly between stations. There were few significant temporal trends in diatom metrics and most represented very minor changes over time. Multiple metrics declined downstream from Hauser and Holter dams which characterize the poorer assemblages in these downstream reaches of the Missouri River; however, little change occurred elsewhere from 2011 to 2020. Overall, the results indicate little change in the diatom community at each station from 2011 to 2020 and little to no direct influence from the hydroelectric facilities.

ES 1.3 Macroinvertebrates

From 2011 to 2020, no longitudinal increasing or decreasing trends in macroinvertebrate metrics were apparent. Most metrics, including the multimetric index, followed a similar pattern of improving or declining macroinvertebrate health from one station to the next station. The biological monitoring stations upstream of Ennis Lake and Canyon Ferry Reservoir revealed the most robust macroinvertebrate assemblages based on the multimetric index. The similar decreasing patterns among the metrics downstream of these locations highlight the negative effects of Ennis Lake and Madison Dam on the community in the Madison River, and the negative effects of Canyon Ferry Reservoir/Dam on community in the Missouri River. Macroinvertebrate community health was poorer for the stations downstream of Hauser and Holter dams, but improved by the last station downstream of Morony Dam.

The abundance of significant correlations within and among stations highlights the descriptive ability of the metrics, especially in the context of the multimetric index. The macroinvertebrate metrics are good descriptors of the biological integrity at each station and reveal consistent improving or declining conditions at successive stations.

Significant temporal trends of macroinvertebrate metrics were limited, and all had relatively shallow slopes. These results indicate little change in the macroinvertebrate community over time at each station from 2011 to 2020.

ES 1.4 Fish Tissue

From 2011 to 2020, fish tissues were collected from seven biological monitoring stations ranging from Hebgen Reservoir to the Great Falls Reservoirs. However, fish tissue sampling did not occur at all stations within the same year, and instead occurred on a rotational basis targeting the upstream-downstream stations in different years. Most fish tissue biocontaminants were not detected in any predator or bottom dwelling fish. No organochlorine pesticides were detected and only one PCB congener was detected in predator and bottom dwelling fish at relatively low levels. Twelve of 13 metals were detected in both fish types while no metal was detected in all samples.

The lack of detectable organochlorine pesticide concentrations in fish tissue samples is consistent with the relatively low number of detectable concentrations in a national fish survey of over 500 lakes and reservoirs sampled in the lower 48 states. Aroclor 1254 (PCB congener) concentrations in both predators and bottom dwelling fish were often greater than the concentrations found in respective fish types for the national survey, while detectable mercury concentrations in both predator and bottom dwelling fish were less than their respective fish tissue concentrations sampled during the national lake survey.

Few patterns were observed in the percent changes between mean fish tissue biocontaminant concentrations and indicates a large variability in the data between years and between feeding styles. Statistical comparisons of fish tissue data between stations were not practicable due to the small number of detectable results, and alternating sampling frequency between stations which limited the number of results for a given station.

1. Introduction

NorthWestern Energy (formerly PPL Montana) filed a Water Quality and Biological Monitoring Plan on June 15, 2001, with the Federal Energy Regulatory Commission (FERC) as required by Article 404 of the Project 2188 License. On January 16, 2002, the FERC approved the plan with the requirement that an updated water quality monitoring plan will be provided to the Montana Department of Environmental Quality for its approval and to other specified agencies for their comments by May 15, 2011, which was extended to December 30, 2011, by FERC order of May 19, 2011.

The Water Quality and Biological Monitoring Plan for the Years 2012 -2021 ([Plan], PPLMT, 2011) incorporated recommendations from the 2011 Water Quality and Biological Monitoring Trend Analysis – Missouri-Madison Water Monitoring Program (PBS&J, 2011) and reviewing agencies. The overall objectives of the monitoring plan include:

1. Identify long-term trends and spatial variation of water quality and biological parameters in the study area.
2. Evaluate the effects of the operation and maintenance of hydroelectric facilities along the Madison and upper Missouri rivers.

The study area covered by the Plan extends from the headwaters of the Madison River in Yellowstone National Park through the upper reaches of the Missouri River, confluence of the Madison, Jefferson, and Gallatin rivers, and downstream of Morony Dam in Great Falls (Figure 1-1). Included in the study area are nine hydroelectric facilities operated by NorthWestern Energy plus one dam operated by the Bureau of Reclamation, Canyon Ferry Dam. The NorthWestern Energy dams include Hebgen and Madison dams on the Madison River, and Hauser, Holter, and the five Great Falls dams (Black Eagle, Rainbow, Cochrane, Ryan, and Morony) on the upper Missouri River. In addition to documenting the water quality and biological conditions for stations that bracket (upstream-downstream) these hydroelectric facilities, the Plan outlined a comprehensive statistical analysis approach to evaluate the downstream effects of these facilities, and other watershed influences, over time.

Monitoring objectives for the study area were previously identified by the Montana Department of Environmental Quality (MDHES 1993), the 2188 Water Quality Technical Committee, and by the terms of the license issued by FERC. These objectives have been combined into the following:

1. Provide a statistical analysis of long-term trends in water quality and biological data.
2. Evaluate the potential influence of dam facilities on water quality and biological parameters with upstream-downstream comparisons.

3. Monitor the effects of operation and maintenance of dam facilities on water quality and biological parameters.
4. Evaluate the behavior of the entire system with respect to water quality and biological parameters.
5. Determine whether the effects measured above indicate an improvement or deterioration of water quality, biological integrity, and ecological health of the Madison and Missouri river system.

The duration of the monitoring program detailed in the Plan is ten years, and per the Water Quality Plan approved by FERC, a comprehensive analysis of water quality and biological data is to be provided at the end of the approved Plan's timeline (2012-2021). The first analysis report summarized the monitoring data and statistical analyses of the data collected from 1997 through 2006 (PBS&J 2011) and the second report from 2006 through 2016 (GEI 2017). In order to align the ten year period with the approved Plan, and to meet the end or reporting requirements for the approved Plan, a 10-year analysis was again performed for 2011 to 2020. The analyses of this recent 10-year period are presented herein.

1.1 Purpose

The purpose of this report is to summarize the monitoring data collected from 2011 through 2020, and to present the results of the comprehensive statistical analyses evaluating whether water quality or biological conditions improved or deteriorated over this period. The statistical approached outlined in the Plan is intended to characterize significant differences among adjacent stations, as well as trends over time for selected water quality, periphyton, macroinvertebrate, and fish tissue parameters. This report has been organized into seven main sections and five appendices:

Section 1 Introduction
Section 2 Monitoring Objectives
Section 3 Data Collection and Sample Analysis
Section 4 Data Management and Analysis Methodology
Section 5 Statistical Analyses
Section 6 Summary
Section 7 References
Appendix A: Monitoring Objectives
Appendix B: Water Quality
Appendix C: Chlorophyll-a
Appendix D: Diatom Metrics
Appendix E: Macroinvertebrate Metrics

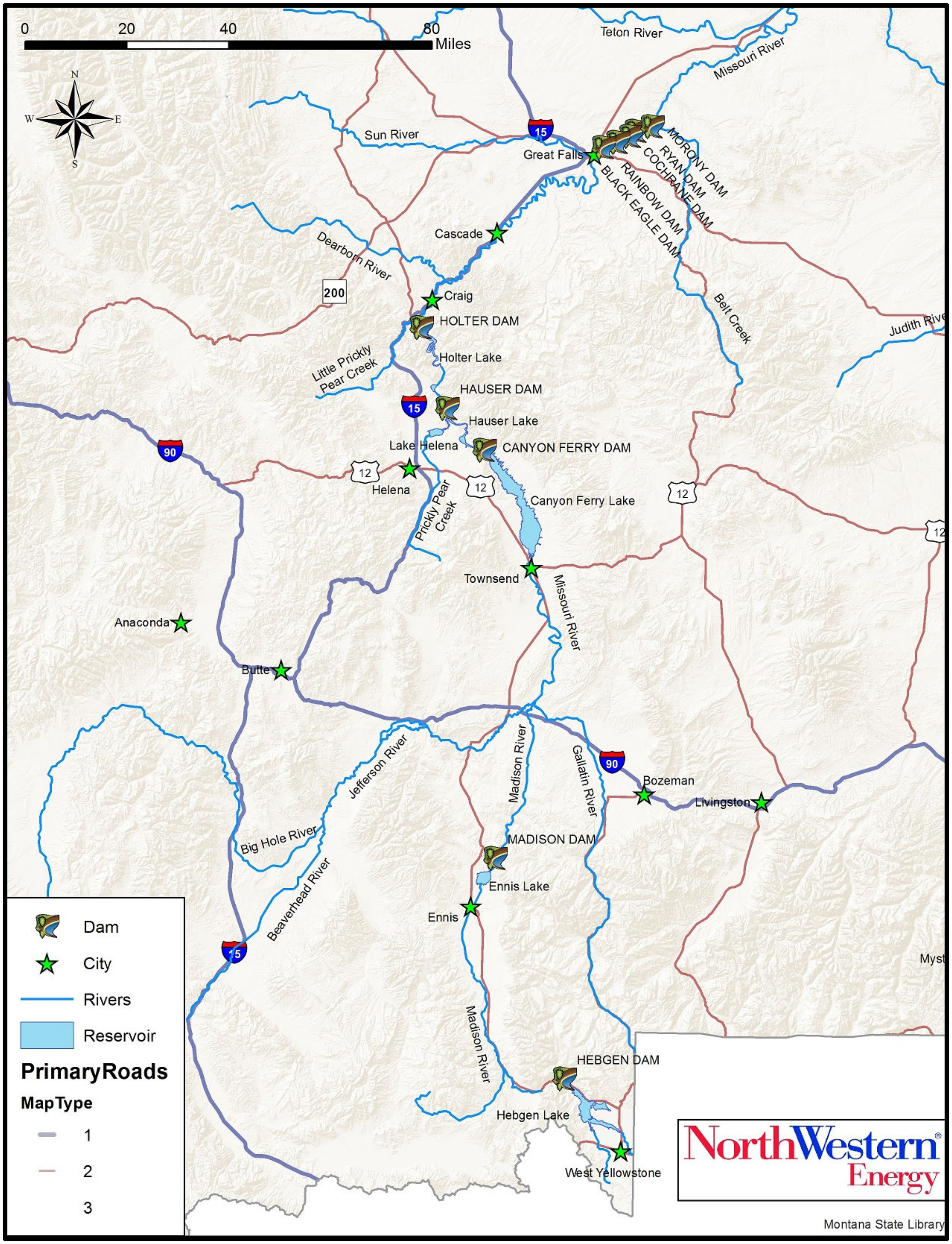

Figure 1-1: Study area from West Yellowstone downstream to Great Falls, Montana.

1.2 Reservoirs and Monitoring Stations

Monitoring stations were selected to evaluate the potential impacts of dams on the Madison and Missouri rivers (Figure 1-2). These stations consist of 10 water quality and 10 biological monitoring stations. The biological monitoring “flushing” stations are part of a separate monitoring program managed by NorthWestern Energy but were included in this report because macroinvertebrate data were available. Water quality and biological monitoring stations often differ slightly due to physical requirements for collecting representative samples. A summary of the monitoring stations is presented in Table 1-1 and a complete description is in Appendix A. Stations 12 and 30 are included in Figure 1-2 but are not discussed because data from these sites were not included in this report.

Table 1-1: Sampling station descriptions. Stations are ordered from upstream to downstream. Macroinvertebrate samples were collecting at “Flushing” stations.

River	Station	Name	Description	Water Quality					Biological					Lat.	Long.
				Ion Chemistry	Solids/Turbidity	Metals	Nutrients	Physicochemical	Chlorophyll-a	Periphyton	Macroinvertebrate	Flushing	Fish Tissue		
Madison	B1	YNP	Yellowstone National Park						X		X			44.65724	-111.06832
Madison	1	HWY 287	Upstream from Hebgen Reservoir	X	X		X	X						44.71564	-111.10260
Madison	2	Hebgen	Downstream from Hebgen Dam	X	X		X	X						44.86653	-111.33844
Madison	B2	Hebgen	Downstream from Hebgen Dam						X	X	X		X	44.86468	-111.35105
Madison	F1	Kirby	Near Kirby									X		44.87058	-111.56497
Madison	3	Varney	Upstream from Madison Reservoir	X	X		X	X						45.23263	-111.75168
Madison	B3	Ennis	Ennis Campground						X	X	X	X	X	45.34368	-111.72511
Madison	4	Madison	Downstream from Madison Dam/ Madison Powerhouse	X	X		X	X	X	X	X		X	45.48891	-111.63438
Madison	F3	Norris	Downstream from Warm Springs FA Site									X		45.60117	-111.57405
Madison	F4	Greycliff	Greycliff FA Site									X		45.71805	-111.51877
Missouri	B5	Toston	Upstream from Canyon Ferry Reservoir						X	X	X			46.14419	-111.41351
Missouri	5	Toston	Upstream from Canyon Ferry Reservoir	X	X		X	X						46.17181	-111.44350
Missouri	6	Canyon Ferry	Downstream from Canyon Ferry Dam	X	X		X	X						46.64909	-111.72813
Missouri	7	Hauser	Downstream from Hauser Dam	X	X		X	X						46.76507	-111.88905
Missouri	B7	Hauser	Downstream from Hauser Dam						X	X	X		X	46.76657	-111.89092
Missouri	8	Holter	Downstream from Holter Dam	X	X		X	X						46.99478	-112.01091
Missouri	B8	Holter	Downstream from Holter Dam						X	X	X		X	46.99989	-112.00498
Missouri	9	Black Eagle/ Central Ave Bridge	Upstream from Great Falls Reservoirs	X	X	X	X	X					X	47.50678	-111.31251
Missouri	10	Morony	Downstream from Great Falls Dams	X	X	X	X	X						47.58168	-111.06024
Missouri	B10	Morony	Downstream from Great Falls Dams							X	X		X	47.58428	-111.06034

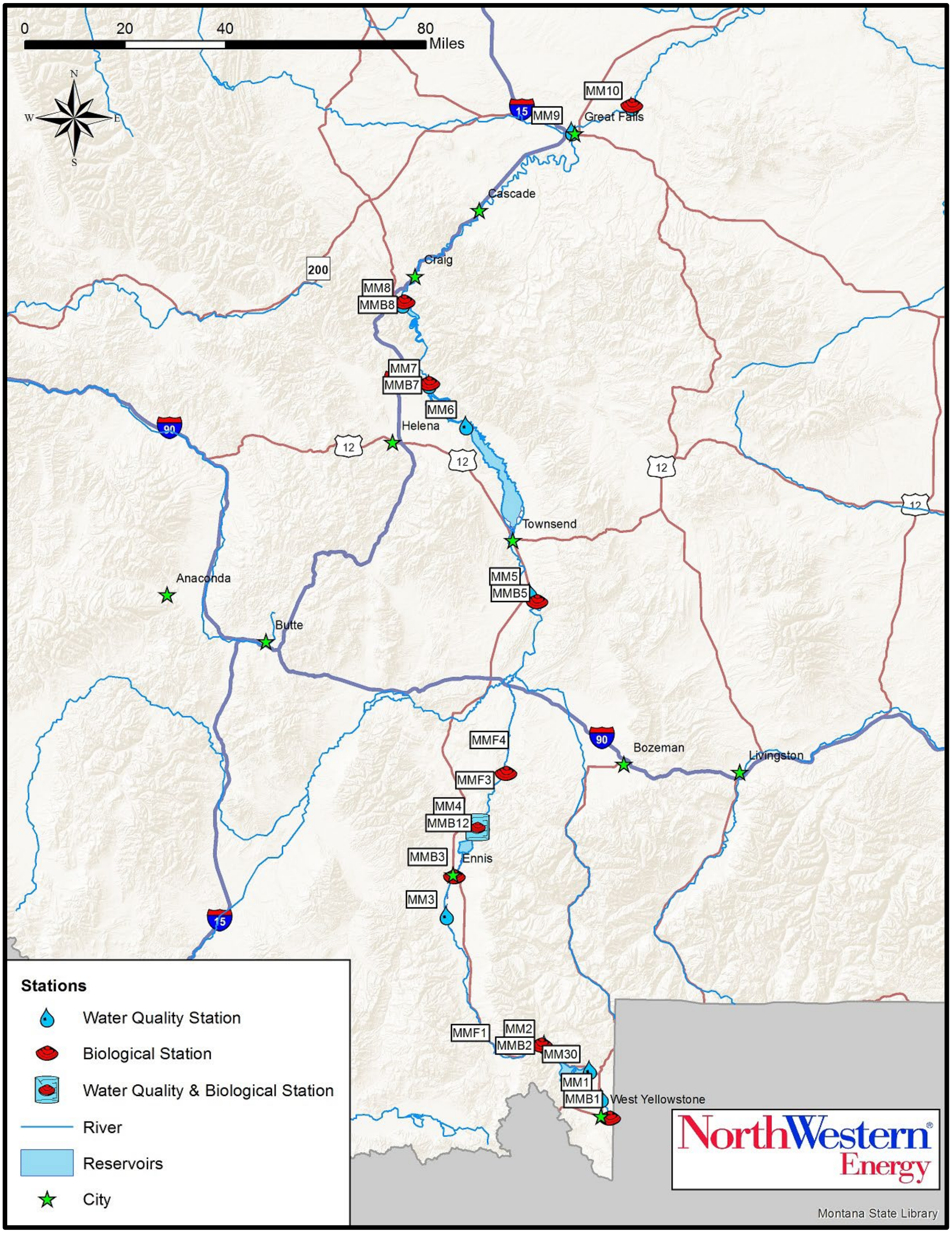

Figure 1-2: Water quality and biology monitoring stations on the Madison and Missouri rivers from 2011 to 2020.

1.2.1 Hebgen Dam on the Madison River

Hebgen Reservoir, formed by the completion of Hebgen Dam in 1915, is located about 22 miles northwest of West Yellowstone, Montana. The reservoir intercepts a drainage area of about 930 square miles. The earth filled dam is 85 feet high and 721 feet long, with a broad crested weir spillway on the right bank that is 50 feet wide. The dam stores 386,000 acre-ft at the normal full pool elevation of 6534.87. Releases from the dam are made through intake gates with a single vertical opening of 10.7 feet in diameter. The depth of the reservoir is 75 feet near the dam and 81 feet maximum (about a mile upstream), with a mean depth of 27 feet. At full pool, the reservoir surface area is 19.8 square miles. The mean water retention time in the reservoir is 172 days.

The biological monitoring station above Hebgen Reservoir (Station B1, YNP) is located approximately 2 miles East of West Yellowstone (Figure 1-3). The water quality monitoring station above the reservoir (Station 1, HWY 287) is located at the Highway 287 bridge (Figure 1-4) and the method used to collect samples at this station is a depth integrated, equal width increment composite. These stations are considered control stations because they are located on a relatively “unregulated” reach of the Madison River and are intended to establish natural background variability in biological and water quality data where no effect from reservoir discharges upstream occurs. The water quality monitoring station below Hebgen Dam (Station 2, Hebgen) is roughly 0.3 miles below the dam, at the United States Geological Survey (USGS) gaging station #6038500 on the right bank (Figure 1-5). Sampling is a depth integrated point sample. The biological monitoring station downstream from Hebgen Dam (Station B2, Hebgen) is located about 1.25 miles downstream of the facility on the right bank (Figure 1-6). A flushing station (Station F1, Kirby) is also located about 16 miles downstream of Hebgen Dam (Figure 1-7).

Figure 1-3: Station B1, YNP on the Madison River.

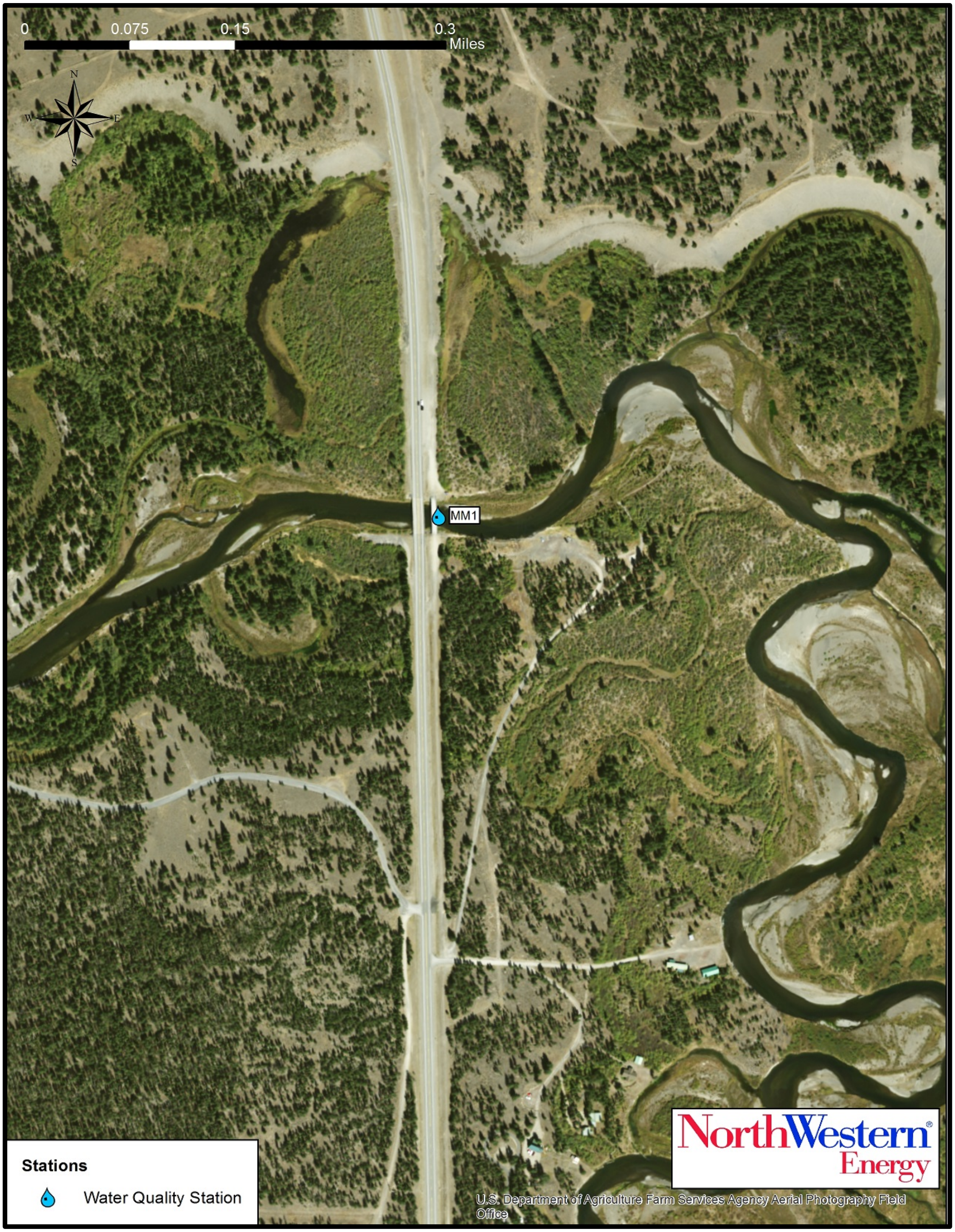

Figure 1-4: Station 1, HWY 287 on the Madison River.

Figure 1-5: Station 2, Hebgen on the Madison River.

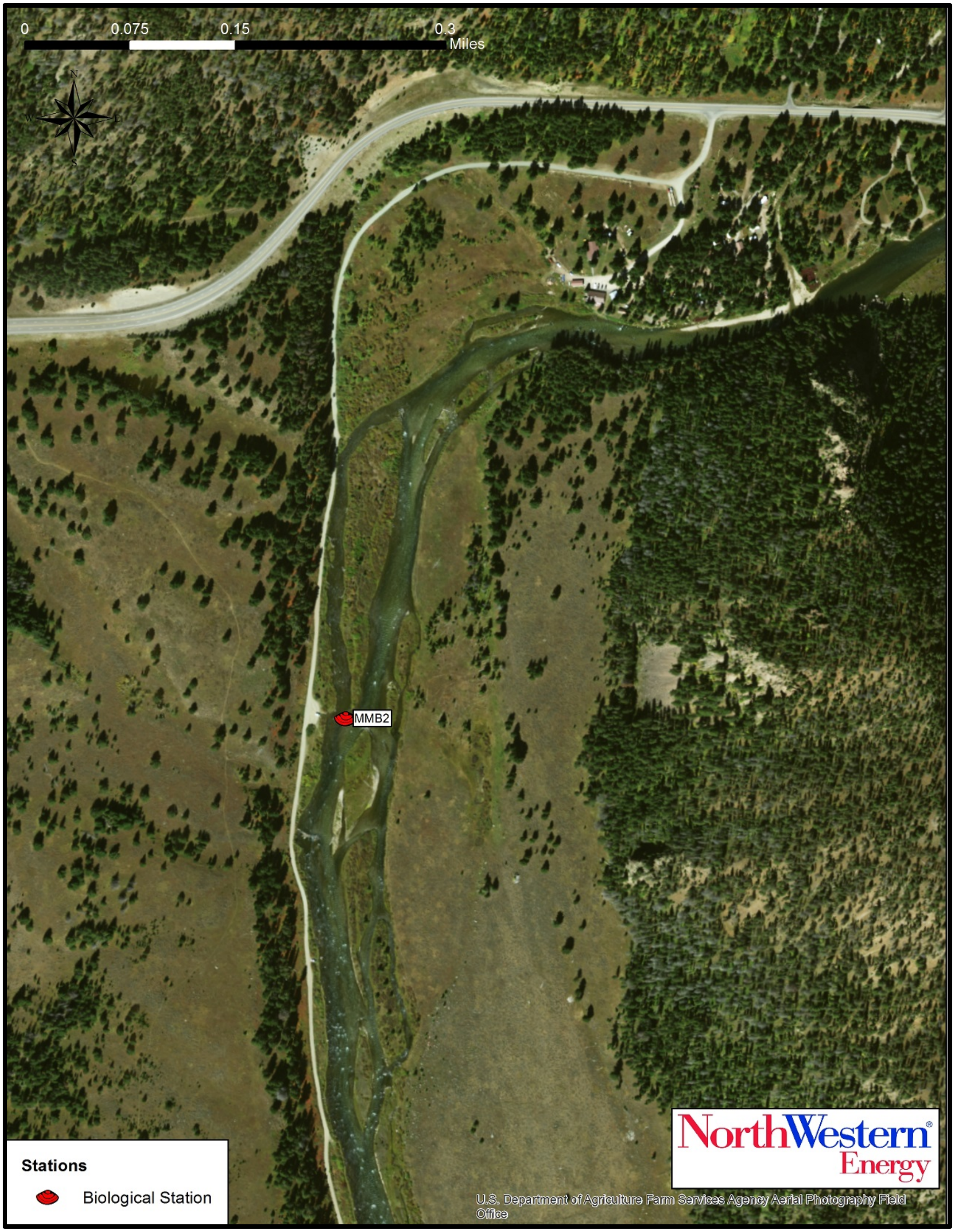

Figure 1-6: Station B2, Hebgen on the Madison River.

Figure 1-7: Station F1, Kirby on the Madison River.

1.2.2 Madison Dam on the Madison River

Ennis Lake is located roughly 5 miles northeast of Ennis, Montana. Madison dam is located 68.8 miles downstream of Hebgen Dam, and 40.2 miles upstream of the Missouri River headwaters at Three Forks, Montana. The reservoir intercepts a drainage area of about 2,181 square miles. The dam is a 38.5-foot high rock-filled crib structure that is operated primarily as a run-of-the river facility. The dam impounds 39,115 acre-feet of useable storage between elevations 4,826 and 4,841 feet.

A concrete intake structure, 26 feet deep in front of the dam, provides water to a 13-foot diameter flow line which extends 7,500 feet down the canyon to the powerhouse. NorthWestern is currently implementing a project to replace all four turbine generator units in the Madison powerhouse which is scheduled to be completed in 2022. The upgraded powerhouse will have a hydraulic capacity of 1,600 cfs. Maximum depth of the reservoir is 32 feet near the dam, with a mean depth of 12 feet. Mean water residence time in the reservoir is 15 days.

The water quality monitoring station (Station 3, Varney) is located at the Varney Bridge and the method used to collect samples is a depth integrated, equal width interval composite (Figure 1-8). The biological monitoring station (Station B3, Ennis) is at Ennis Campground and is also a flushing station (Figure 1-9). The biological and water quality monitoring stations below Ennis Lake (Station 4, Madison) are at the same location (Figure 1-10). Water quality samples are collected using a depth integrated, single point composite method in the bypass channel at the footbridge and the biological monitoring station is located downstream from the junction of the powerhouse and bypass channel. Flushing stations are also located approximately 11 miles (Station F3, Norris; Figure 1-11) and approximately 21 miles (Station F4, Greycliff; Figure 1-12) downstream of the Madison Powerhouse. No additional flushing locations are located downstream.

Figure 1-8: Station 3, Varney on the Madison River.

Figure 1-9: Station B3, Ennis on the Madison River.

Figure 1-10: Station 4, Madison on the Madison River.

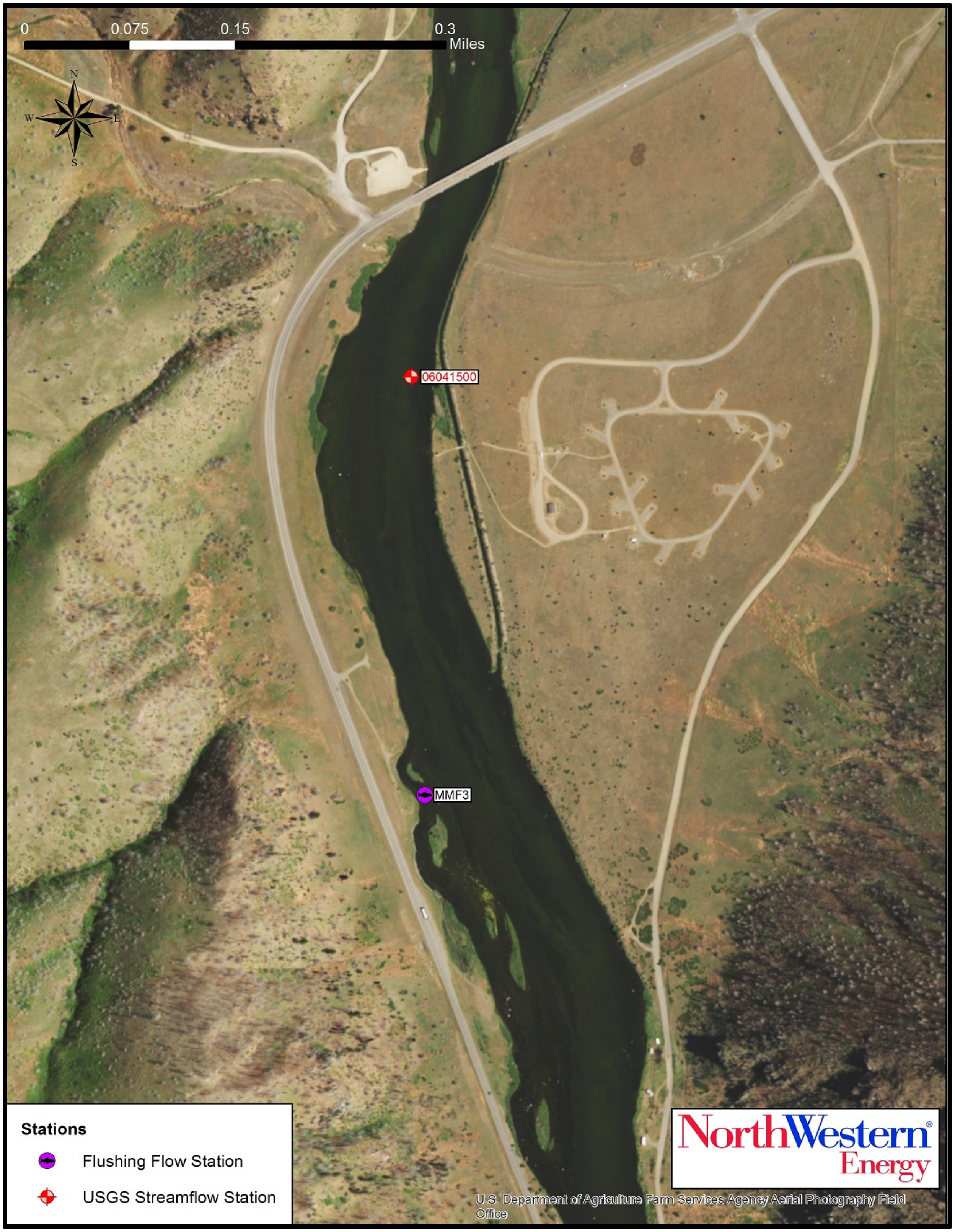

Figure 1-11: Station F3, Norris on the Madison River.

Figure 1-12: Station F4, Greycliff on the Madison River.

1.2.3 Canyon Ferry Dam on the Missouri River

Canyon Ferry Dam is owned and operated by the Bureau of Reclamation and was built between 1949 and 1954. The facility is used for flood control, power generation, irrigation, and recreation. The dam is constructed of concrete and is roughly 1,000 feet long and 225 feet high. The reservoir storage capacity is 2,050,900 acre-feet (at an elevation of 3,800 feet).

The biological monitoring station above Canyon Ferry Lake (Station B5, Toston) is located approximately 3 miles upstream of the Hwy 287 Bypass bridge in Toston on the left bank (Figure 1-13). The water quality monitoring station (Station 5, Toston) is located at the bridge (Figure 1-14), and water samples are collected using is a depth integrated, equal width interval composite method. These stations are considered control stations because they are located in a relatively “unregulated” reach of the Madison River and are intended to establish natural background variability in water quality and biological data where little or no effect from reservoir discharges upstream would be expected. The water quality monitoring station below the dam (Station 6, Canyon Ferry) is located at the penstock discharge, and is sampled as a single point, depth integrated sample (Figure 1-15). It is not possible to proportionally sample spill/turbine flow, and high flow samples are limited to turbine discharge only. No biological monitoring station is located below the dam.

Figure 1-13: Station B5, Toston on the Missouri River.

Figure 1-14: Station 5, Toston on the Missouri River.

Figure 1-15: Station 6, Canyon Ferry on the Missouri River.

1.2.4 Hauser Dam on the Missouri River

Hauser Reservoir is located about 14 miles northeast of Helena, Montana and 14 miles downstream of Canyon Ferry Dam. The reservoir intercepts a drainage area of about 16,876 square miles. The dam is a concrete gravity structure with a 445-foot long overflow spillway and non-overflow sections at each abutment.

The reservoir is comprised of two connected bodies of water. The main water body, Hauser Reservoir, has a useable storage of 52,893 acre-feet. A smaller water body, Lake Helena, has 11,360 acre-feet of useable storage. Mean depth of the reservoir is 25.8 feet at full pool with a mean water residence time of about 9 days.

The monitoring station below Canyon Ferry Dam (Station 6, Canyon Ferry; Figure 1-15) is used to define water quality parameters above Hauser Reservoir. The water quality monitoring station below Hauser Dam (Station 7, Hauser) is approximately 0.1 miles below the power plant on the left bank (Figure 1-16). Water samples are collected using a single point, depth integrated methodology. The biological monitoring station (Station B7, Hauser) is approximately 0.2 miles below the power plant (Figure 1-16).

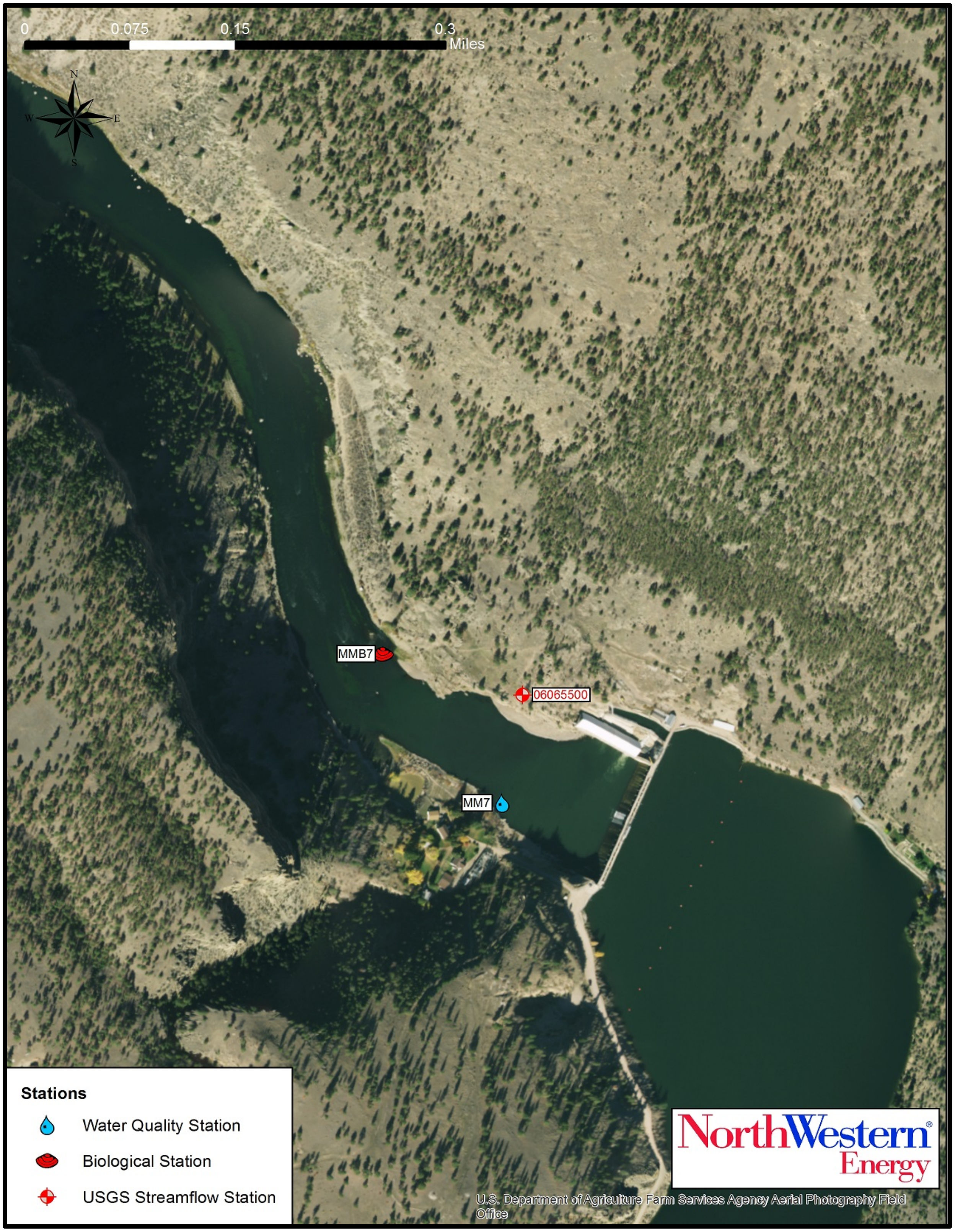

Figure 1-16: Stations 7 and B7, Hauser on the Missouri River.

1.2.5 Holter Dam on the Missouri River

Holter Reservoir is located about 27.7 miles downstream of Hauser Dam, and 43 miles northeast of Helena, Montana. The reservoir intercepts a drainage area of about 17,150 square miles. The dam is a 124-foot high, straight concrete gravity structure with an ogee spillway section that is 682 feet long. The dam impounds 81,920 acre-feet of useable storage with a surface area of 4,550 acres and is operated primarily as a run-of-the river facility. Mean water residence time in the reservoir is 22 days.

The monitoring station below Hauser Dam (Station B7, Hauser; Figure 1-16) is used to define water quality above Holter Reservoir. The water quality monitoring station below Holter Dam (Station 8, Holter) is approximately 0.4 miles below the power plant on the left bank (Figure 1-17), and taken as a single point, depth integrated sample. The biological monitoring station (Station B8, Holter) is approximately 0.9 miles below the power plant (Figure 1-17).

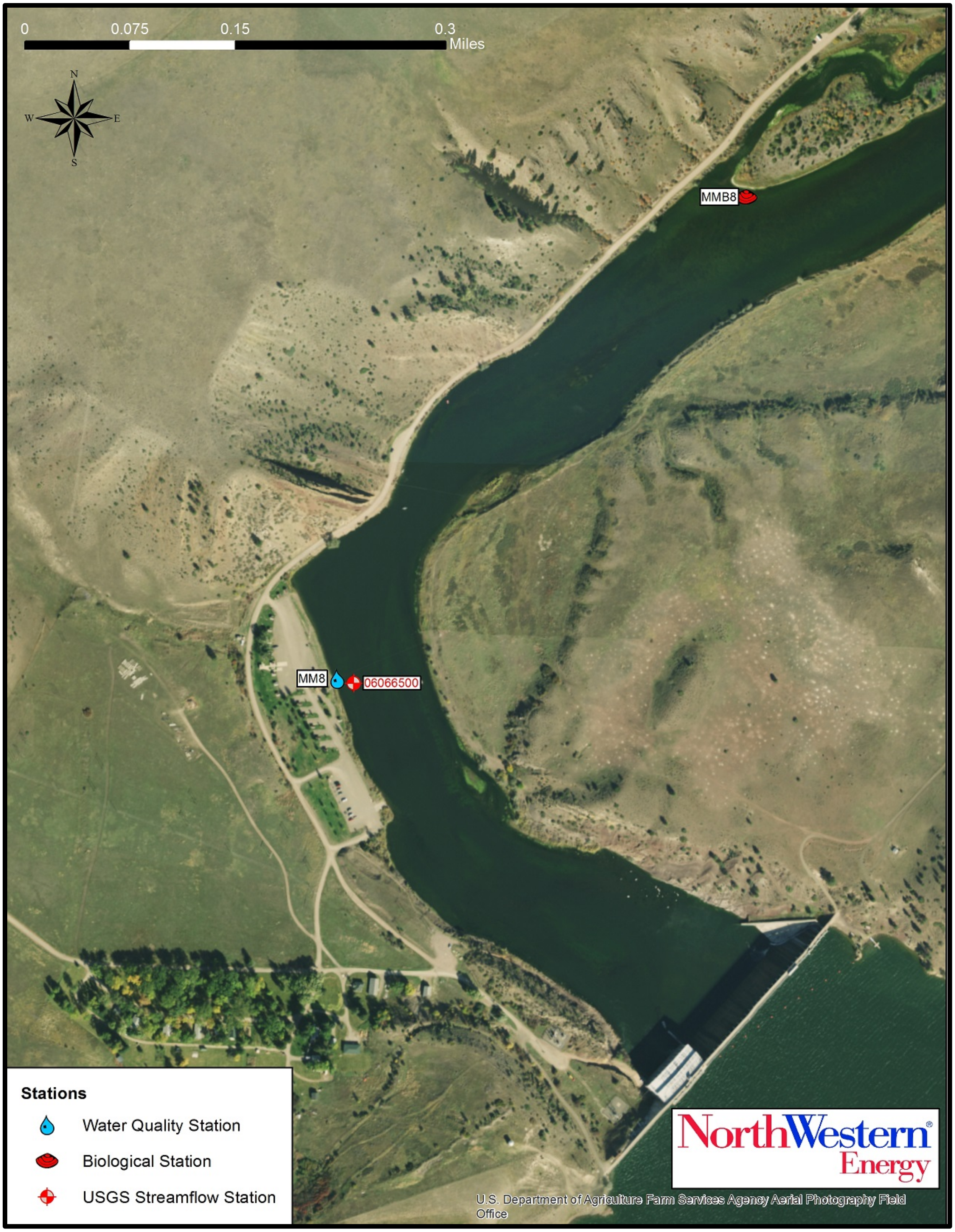

Figure 1-17: Stations 8 and B8, Holter on the Missouri River.

1.2.6 Great Falls Dams on the Missouri River

The Great Falls dams consist of a series of five hydroelectric developments within a 12.1- mile section of the Missouri River. The cumulative effects of the five Great Falls dams (Black Eagle, Rainbow, Cochrane, Ryan, and Morony) are evaluated using monitoring stations above Black Eagle and below the Morony dams. Brief descriptions of each of the dams are presented below, along with a description of the monitoring stations for this study.

Black Eagle Dam is located in Great Falls, 93 miles downstream from Holter Dam. The Sun River empties into Black Eagle Reservoir 3.8 miles upstream from Black Eagle Dam. The reservoir intercepts a drainage area of about 22,100 square miles. The dam is operated as a run-of-the river facility. The dam impounds 1,710 acre-feet of useable storage between elevations 3,279 and 3,290 feet, with a surface area of 402 acres.

The Rainbow Development is located 6 miles northeast of Great Falls, 3.2 miles downstream from Black Eagle Dam. The reservoir intercepts a drainage area of about 22,920 square miles. The dam is operated as a base load, run-of-river project and maintains the elevation of Rainbow Reservoir near its normal full pool elevation of 3,224 feet. The dam impounds 1,170 acre-feet of useable storage, with a surface area of 126 acres.

The Cochrane Development is located northeast of Great Falls, 3.2 miles downstream from Rainbow Dam. The reservoir intercepts a drainage area of about 23,270 square miles. The dam is operated to provide base load generation, short-term generation reserves, load-following generation on a coordinated basis with the Ryan and Morony developments. The dam impounds 4,503 acre-feet of useable storage, with a surface area of 249 acres.

The Ryan Development is located northeast of Great Falls, 1.9 miles downstream from Cochrane Dam. The reservoir intercepts a drainage area of about 23,080 square miles. The dam is operated to provide base load generation, short-term generation reserves, load-following generation on a coordinated basis with the Cochrane and Morony developments. The dam impounds 3,653 acre-feet, of which 2,440 acre-feet is useable storage, with a surface area of 168 acres.

The last of the five dams, Morony Dam, is located northeast of Great Falls, 3.9 miles downstream from Ryan Dam. The reservoir intercepts a drainage area of about 23,292 square miles. The dam is operated as a base load project with outflows approximately equal to inflows into the Great Falls developments upstream. The dam impounds 7,595 acre-feet of useable storage, with a surface area of 304 acres.

The Great Falls dams and reservoirs are treated as one unit for water quality monitoring purposes. The water quality monitoring Station 9 (Black Eagle/ Central Ave Bridge) is located above the dams at the Central Avenue Bridge in Great Falls (Figure 1-18). Water quality samples consist of 12 equal width, depth integrated samples that are composited to create one sample. The water quality monitoring Station 10 (Morony) is located off the penstock discharge structure of the Morony Dam (Figure 1-19) and water samples are collected using a single point depth-integrated methodology. The biological monitoring Station B10 (Morony) is 0.2 miles downstream of Morony Dam on the left bank (Figure 1-19).

Figure 1-18: Station 9, Black Eagle/Central Ave Bridge on the Missouri River.

Figure 1-19: Stations 10 and B10, Morony on the Missouri River.

2. Monitoring Objectives

Monitoring objectives for the study area were previously identified by the Montana Department of Environmental Quality (MDHES 1993), the 2188 Water Quality Technical Committee, and by the terms of the license issued by FERC. These objectives have been combined into the following:

1. Provide a statistical analysis of long-term trends in water quality and biological data.
2. Evaluate the potential influence of dam facilities on water quality and biological parameters with upstream-downstream comparisons.
3. Monitor the effects of operation and maintenance of dam facilities on water quality and biological parameters.
4. Evaluate the behavior of the entire system with respect to water quality and biological parameters.
5. Determine whether the effects measured above indicate an improvement or deterioration of water quality, biological integrity, and ecological health of the Water Quality Monitoring

2.1 Water Quality

Monitoring objectives are outlined in formal structure below and are summarized in Appendix A. Referenced statistical methodologies are outlined in Section 4.2

2.1.1 Long-term Trend Identification

MANAGEMENT GOAL:	Maintain or improve water quality.
MONITORING GOAL:	Detect significant temporal (5 to 10 year) trends in water quality parameters.
DEFINITION OF WATER QUALITY:	Analysis of nutrient, metals, and other parameters defined in Table 3-1.
DEFINITION OF TREND:	Correlation between concentration and time at the 0.05 significance level.
STATISTICAL METHODOLOGY:	Kendall non-parametric test applied to flow and seasonally adjusted data as appropriate.
STATISTICAL HYPOTHESIS:	No trend exists.

DATA ANALYSIS RESULT:	Conclusions regarding presence and nature of trends (statistical significance of +- correlation); provide estimate of trend magnitude (Sen slope estimate).
INFORMATION PRODUCT:	Management goal met when no trend exists, or indicates improvement in water quality (e.g., decreasing trend for nutrient concentration)

2.1.2 Parameter Correlation

MANAGEMENT GOAL:	Optimize monitoring program, define covariate behavior.
MONITORING GOAL:	Detect significant correlations between water quality parameters.
DEFINITION OF WATER QUALITY:	Analysis parameters defined below in Table 3-1.
DEFINITION OF EFFECT:	Correlation between parameters, 0.05 significance level.
STATISTICAL METHODOLOGY:	Spearman's non-parametric correlation applied to paired parameter data.
STATISTICAL HYPOTHESIS:	No correlation exists.
DATA ANALYSIS RESULT:	Conclusions regarding potential use of surrogates to optimize monitoring. Conclusions regarding covariate behavior of parameters.
INFORMATION PRODUCT:	Management goal met when no benefits would result from modifications to monitoring program. Improved understanding of inter-relationships between water quality measures.

2.1.3 Dam Baseline Evaluation, Routine Operations

MANAGEMENT GOAL:	Maintain or improve water quality downstream of dam facilities.
MONITORING GOAL:	Detect and quantify significant differences in parameters upstream-downstream of each dam. Determine if differences suggest dam-related improvement or impact on water quality.

DEFINITION OF WATER QUALITY: Analysis parameters defined below in Table 3-1.

DEFINITION OF EFFECT: Differences in median response, 0.05 significance level.

STATISTICAL METHODOLOGY: Kruskal-Wallis non-parametric test applied to paired parameter data, seasonally stratified as appropriate.

STATISTICAL HYPOTHESIS: No differences in median values exist.

DATA ANALYSIS RESULT: Conclusions regarding presence and nature of facility effects.

INFORMATION PRODUCT: Management goal met when no upstream-downstream differences exist, or results indicate stability or improvement in water quality over time.

2.1.4 Dam Evaluation, Non-Routine Operations

MANAGEMENT GOAL: Minimize any detrimental dam operation effects on water quality.

MONITORING GOAL: Detect significant correlations between dam operations and water quality parameters. Determine if effects vary with magnitude/duration or timing of operation event.

DEFINITION OF WATER QUALITY: Analysis parameters defined below in Table 3-1.

DEFINITION OF EFFECT: Correlation between parameters and dam operations, 0.05 significance level.

STATISTICAL METHODOLOGY: Spearman's non-parametric correlation applied to paired parameter/operation data.

STATISTICAL HYPOTHESIS: No correlation exists.

DATA ANALYSIS RESULT: Conclusions regarding the effect (magnitude/duration) of operation events on water quality. This analysis may employ additional statistical methods such as multivariate analysis to evaluate water quality effects.

INFORMATION PRODUCT: Management goal met if operation effects are not statistically significant, or are deemed to be within acceptable levels.

2.1.5 Site Specific Evaluations

Canyon Ferry/ Madison Powerhouse Dissolved Oxygen

MANAGEMENT GOAL:	Maintain or improve water quality downstream of dam facilities with respect to dissolved oxygen.
MONITORING GOAL:	Detect and quantify significant differences in annual/seasonal dissolved oxygen above and below dam facilities.
DEFINITION OF WATER QUALITY:	Analysis parameters defined below in Table 3-1.
DEFINITION OF TREND:	Differences in median response, 0.05 significance level.
STATISTICAL METHODOLOGY:	Kruskal-Wallis non-parametric test applied to paired parameter data, seasonally or temporally stratified as appropriate.
STATISTICAL HYPOTHESIS:	No differences in median values exist.
DATA ANALYSIS RESULT:	Conclusions regarding presence and nature of facility effects.
INFORMATION PRODUCT:	Management goal met when no differences exist, or analysis indicates stability or improvement in water quality.

2.2 Biological Monitoring

The objectives of the biological monitoring portion of this plan are presented below and follow the format presented in Appendix A.

2.2.1 Periphyton Long-term Trend Identification

MANAGEMENT GOAL:	Maintain or improve periphyton integrity.
MONITORING GOAL:	Detect significant trends in periphyton standing crop. Determine if trends suggest dam related improvement or deterioration of water quality.
DEFINITION OF WATER QUALITY:	Chlorophyll-a, various metrics.
DEFINITION OF TREND:	Correlation between parameter and time to the 0.10 significance level.

STATISTICAL METHODOLOGY:	Kendall non-parametric test applied to seasonal or covariate-adjusted data as necessary.
STATISTICAL HYPOTHESIS:	No trend exists.
DATA ANALYSIS RESULT:	Conclusions regarding presence and nature of trends in periphyton biomass or metrics, and provide estimate of trend magnitude(s).
INFORMATION PRODUCT:	Management goal met when no trend exists, or indicates improvement (i.e., a reduction in biomass for most sites)

2.2.2 *Periphyton Targets*

MANAGEMENT GOAL:	Maintain or improve periphyton integrity.
MONITORING GOAL:	Evaluate annual compliance with site specific targets.
DEFINITION OF WATER QUALITY:	Analysis of metrics defined below in Section 3.1.2.
DEFINITION OF TREND:	Comparison of median values with target limits established by baseline monitoring.
STATISTICAL METHODOLOGY:	Comparison of median values to baseline targets.
STATISTICAL HYPOTHESIS:	Median values are within one standard deviation of baseline.
DATA ANALYSIS RESULT:	Conclusions regarding compliance with respect to periphyton biomass targets.
INFORMATION PRODUCT:	Management goal met when annual periphyton measures are within baseline targets.

2.2.3 *Macroinvertebrate Long-term Trend Identification*

MANAGEMENT GOAL:	Maintain or improve macroinvertebrate integrity.
MONITORING GOAL:	Detect significant trends in composite (“multimetric”) measures of macroinvertebrates. Determine if trends suggest an improvement or deterioration of water quality.
DEFINITION OF WATER QUALITY:	Multimetric scores.

DEFINITION OF TREND:	Correlation between parameter and time to the 0.10 significance level.
STATISTICAL METHODOLOGY:	Kendall non-parametric test applied to seasonal or covariate-adjusted data (as necessary).
STATISTICAL HYPOTHESIS:	No trend exists.
DATA ANALYSIS RESULT:	Conclusions regarding presence and nature of trends. Provide estimate of trend magnitude.
INFORMATION PRODUCT:	Management goal met when no trend exists, or indicates improvement in benthic community integrity

2.2.4 Macroinvertebrate Targets

MANAGEMENT GOAL:	Maintain or improve macroinvertebrate community integrity.
MONITORING GOAL:	Compare annual results with site specific targets established by baseline monitoring.
DEFINITION OF WATER QUALITY:	Analysis of metrics defined below in Section 3.1.2.
DEFINITION OF TREND:	Comparison of annual values with target limits for individual macroinvertebrate metrics.
STATISTICAL METHODOLOGY:	Numerical comparison of annual to baseline targets.
STATISTICAL HYPOTHESIS:	Median values are within one standard deviation of baseline.
DATA ANALYSIS RESULT:	Conclusions regarding achievement of targets with respect to macroinvertebrate metric targets.
INFORMATION PRODUCT:	Management goal met when macroinvertebrate metrics measures are within baseline targets.

2.2.5 Fish Tissue Biocontaminants

MANAGEMENT GOAL:	Maintain or improve (i.e., reduce) biocontaminant levels in fish tissue.
MONITORING GOAL:	Detect significant differences in biocontaminant levels over 4-year period[1].

DEFINITION OF WATER QUALITY:	Analysis of organochlorine and metal parameters defined in Section 3.1.2.
DEFINITION OF TREND:	Detect a 40% difference in mean or median concentrations at 80% power, 90% confidence.
STATISTICAL METHODOLOGY:	Wilcoxon rank sum test (or Kruskal-Wallis), confidence level set at 0.10.
STATISTICAL HYPOTHESIS:	No statistical difference exists between mean or median values.
DATA ANALYSIS RESULT:	Conclusions regarding potential changes in biocontaminant levels in fish tissue.
INFORMATION PRODUCT:	Management goal met when no statistically significant increases occur in biocontaminant levels.

1. Trace metals are sampled every three years; organochlorine compounds every 9 years

3. Data Collection and Sample Analysis

This section outlines the methodology for the collection of water quality and biological samples, sample analysis, and the measurement of dam operation parameters. These components of the monitoring program are discussed separately below.

3.1 Sample Collection

Sample collection methodology for water quality and biological data is summarized below and in Appendix A.

3.1.1 Water Quality

Water quality sampling consisted of either single point depth integrated samples, or depth integrated, equal width increment composites at each monitoring location. Grab samples were collected from the bank in a well-mixed portion of the river. Sample bottles were rinsed with native water (or filtered native water) prior to sampling. Samples were collected in the upstream direction to avoid entrainment of sediment disturbed by wading. During sampling, the sampling device was drawn through the water column once, carefully avoiding any disturbance of bottom sediments.

Samples were transferred to a decontaminated Teflon churn splitter, and sealed in an insulated secure container (wrapped in plastic in a soft cooler) until processing. Processing and splitting of sample aliquots into sample bottles occurred at the end of each day. Filtration with a 0.45µm filter for dissolved parameters was done as a batch process within 8 hours of sampling. All sample bottles were virgin polyethylene bottles supplied by Energy Labs.

Samples were clearly labeled with a waterproof marker or a preprinted label. Label information included the site identification, date and time, sample type, preservative, and sampler's initials. Field notebooks were completed for each location along with appropriate chain-of-custody forms. All samples were immediately placed in a cooler chilled to 4°C for transport to the lab.

Quality control samples were also analyzed for water quality parameters. These samples consisted of one replicate for every ten samples, and one equipment blank for each sampling event. The replicate was a sequential sample taken at one of the locations as a control measure of both field variability, sample processing procedures, and laboratory methodology. The equipment blank was a deionized water sample run through the sampling apparatus after standard decontamination procedures and analyzed for the full suite of water quality parameters. The blank primarily represented a quality control measure of lab methodology, but also integrated procedural aspects such as decontamination and sample handling.

The sampling methodology described above conforms to current standard operating procedures described in the document "*Sample Collection for Chemistry Analysis: Water, Sediment, and Biological Tissue*" (MTDEQ 2019), available online at the Montana Department of Environmental Quality web site.

3.1.2 Biological Monitoring

Chlorophyll samples were collected at seven monitoring stations using the scrape and whole rock methods. The scrape method consisted of selecting a spatially representative set of ten substrate materials and removing material within a template placed on the rocks. This method was performed in August 2011 but was ended because the whole rock method reduced variability and sampler bias inherent with placing the template on the substrate. The whole rock method involved selecting six rocks each August from 2011 to 2020 and submitting the entire rock for analysis. The surface area of the exposed substrate was calculated, and the resulting metrics reflect an integrated measure of chlorophyll-a. Ash free dry weight cannot be determined from whole rock samples and the measurements calculated from the scrape samples are not included in this report.

Separate periphyton samples were also collected at each diatom monitoring station in August from 2011 to 2020. A composite sample from a variety of microhabitats was collected and preserved with Lugol's to provide a representative sample for periphyton species composition analysis.

Macroinvertebrate sampling methods were initially identified in the Biological Monitoring Plan (MDHES 1993). These methods were modified after field testing (McGuire 1997). The modified sampling consisted of collecting five replicate samples enclosing 0.25 m^2 at each site annually in August. The samples were collected using a fine 560 micron mesh kick-net, and the entire sample (macroinvertebrates, vegetation, sediment, and debris) were preserved in 90% ethanol for macroinvertebrate species composition analysis.

Fish tissue biocontaminants were evaluated for both predator species (Brown Trout [*Salmo trutta*], Rainbow Trout [*Oncorhynchus mykiss*], and Walleye [*Sander vitreus*]), and bottom dwellers (Utah Chub [*Gila atraria*] and White Sucker [*Catostomus commersonii*]). An effort was made to obtain a sample of 4 individuals of similar size class (length within 25%) for analysis as filets for "predators" or whole body samples for "bottom dwellers." Approximately 560 grams of tissue was needed for each analysis and required a composite of multiple fish if size classes did not provide enough tissue from individuals. Fish were captured with electrofishing equipment or gill nets, weighed, measured, wrapped in aluminum foil, and placed in double plastic bags. Fish were placed on ice in the field, frozen as soon as practicable, and kept frozen until chemical analyses were performed by the laboratory.

3.2 Sample Analyses

Sample analysis methodologies for the water quality and biological samples are summarized below and in Appendix A.

3.2.1 Water Quality

Water quality samples were analyzed for various parameters both in the field and laboratory (Table 3-1). Ion chemistry, solids/turbidity, nutrients, and physicochemical analysis (sonde) was performed on water samples from each water quality station while metals analysis was routinely performed on samples from stations 9 and 10 (Table 1-1). Laboratory analysis was conducted by Energy Laboratories, in Helena and Billings, MT.

Table 3-1: Water quality parameters analyzed in the laboratory and measured in the field, 2011-2020.

Ion Chemistry	Solids/Turbidity	Metals	Nutrients	Physicochemical (*in situ*)
Alkalinity as CaCO3, Total 2011-2020	Dissolved Solids, Total 2011-2020	Arsenic, Total 2011-2020	Nitrite-Nitrate, Total 2012-2020	Dissolved Oxygen 2011-2020
Bicarbonate as HCO3, Total 2011-2020	Suspended Solids Total 2011-2020	Cadmium, Total 9&10, all in 2011	Nitrite-Nitrate, Dissolved 2011	pH 2011-2020
Calcium, Total 2011-2014	Turbidity (*in situ*) 2011-2020	Copper, Total 9&10, all in 2011	Nitrogen, Total 2011-2020	Specific Conductance 2011-2020
Calcium, Dissolved 2015-2020		Iron, Total 9&10, all in 2011	Phosphorus, Total 2011-2020	Water Temperature 2011-2020
Chloride, Total 2011-2020		Lead, Total 9&10, all in 2011		
Magnesium, Dissolved 2011-2020		Manganese, Total 9&10, all in 2011		
Potassium, Total 2011-2014		Zinc, Total 9&10, all in 2011		
Potassium, Dissolved 2015-2020				
Sodium, Dissolved 2011-2020				
Sulfate, Total 2011-2020				

Note: Turbidity was measured in the field with the other physicochemical parameters while all other parameters were analyzed in the laboratory.

3.2.2 Biological Monitoring

Periphyton sample analysis consisted of chlorophyll-a determination, diatom species count, and identification of soft bodied algae. The methodology for these followed U.S. Environmental protection Agency (EPA) guidance (Barbour et. al. 1999). Chlorophyll-a was measured from samples collected at biological monitoring stations using a spectrophotometer or fluorimeter on samples extracted in acetone. Chlorophyll-a optical density was measured both before and after acidification to correct for the error associated with pheophytin. In addition to the periphyton identification and enumeration, periphyton metrics were calculated by the analyst and provided for statistical analysis described in Section 5.2.1.2.

Sample processing for macroinvertebrates was described by McGuire (1999) and follows the EPA Rapid Bioassessment Protocols (Plafkin et. al.1989) for a 300-count subsample. The entire sample was placed in a US Standard #30 sieve, rinsed with water, and evenly distributed in a gridded pan (9" x 12" or 14" x 20"). All macroinvertebrates in a randomly selected grid were removed. This process was repeated until 270 to 330 macroinvertebrates had been picked. The total number of macroinvertebrates in the sample was estimated from the percentage of sample used to obtain 300 organisms. Rare taxa, which might have been missed by subsampling, were removed from the remainder of the sample to determine taxa richness and EPT richness for the composite sample. Macroinvertebrates in the subsample were then identified to taxonomic levels specified in the document "*Sample Collection, Sorting, Taxonomic Identification, and Analysis of Benthic Macroinvertebrate Communities Standard Operating Procedure*" (MTDEQ 2012b), available online at the Montana Department of Environmental Quality web site.

All fish collected from 2013 to 2015 and from 2017 to 2019 were composited by site and year and then analyzed for biocontaminants. Fish tissue samples were analyzed for a suite of organochlorine pesticides, polychlorinated biphenyl (PCBs, [Aroclor congeners]), and metals as listed in Table 3-2. This list of analytes conforms to reporting requirements of the USFWS. Laboratory analysis was conducted by Energy Laboratories, in Helena and Billings, MT and reported on a wet weight basis.

Table 3-2: Biocontaminants analyzed in fish tissue samples from fish monitoring sites in 2013 to 2015, and 2017 to 2019.

Organochlorine Pesticides	PCBs (Aroclor)	Metals
Aldrin	1016	Aluminum
alpha-BHC	1221	Arsenic
beta-BHC	1232	Cadmium
delta-BHC	1242	Chromium
Chlordane	1248	Copper
DDD	1254	Iron
DDE	1260	Lead
DDT		Manganese
Dieldrin		Mercury
Endosulfan I		Nickel
Endosulfan II		Selenium
Endosulfan Sulfate		Strontium
Endrin		Zinc
Endrin Aldehyde		
Heptachlor		
Heptachlor Epoxide		
Isodrin		
Kepone		
Methoxychlor		
Toxaphene		

Note: Gamma-BHC (Lindane) data was not available and chlordane data was not separated into alpha-chlordane (technical), alpha-chlordane, and gamma-chlordane.

3.3 Sampling and Data Collection Schedule

The schedule for collecting water quality and biological samples is presented in Appendix A. The schedule consisted of routine water quality sampling conducted on a quarterly basis, generally during the third week of February, May, August, and November, and routine biological sampling conducted annually during the second week of August. Fish tissue biocontaminant sampling occurred on a rotational basis (Table 3-3).

Table 3-3: Fish tissue biocontaminant sampling.

Year	Hebgen	Madison	Hauser	Holter	Black Eagle	Morony
2013	X	X				
2014			X	X		
2015					X	X
2017	X	X				
2018			X	X		
2019						X

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4. Data Management and Analysis Methodology

Data quality control, management, and analysis methods are summarized below.

4.1 Data QA/QC

Data quality assurance and quality control (QA/QC) were accomplished per standard QA/QC procedures. These methods included:

- Validation: reviewed analytical laboratory techniques including lab duplicate, matrix spikes, blanks, and surrogate recoveries to determine if the methods were within acceptable limits.
- Replicates: each sampling event included the collection of one replicate per ten samples for water quality, and the collection of replicate samples for the biological monitoring. Replicate variability was analyzed using standard methods with the objective of obtaining Relative Percent Differences within 10% for values greater than 5 times the method detection limit.
- Splits: Splits were collected using a churn splitter to achieve equal aliquots, and samples were analyzed for the full suite of parameters.
- Field methodology: field blanks were collected for each water quality event to monitor field methodology. Methods and field sampling forms were reviewed to assure consistency.
- Individual data which fails to achieve QA/QC objectives were flagged with appropriate qualifiers in the database.
- If QA/QC review suggests widespread problems with QA/QC for a sampling run, the sampling run (or individual samples) was repeated at the discretion of the project manager.

Quality control measures were also employed for the statistical analyses. These measures included:

- Evaluating the data for normality when parametric tests were performed, using transformed data when appropriate, and adjusting for seasonal/flow effects.
- Assigning one-half the detection limit to non-detect water quality and fish tissue, chlorophyll-a, and biocontaminant values and evaluating the methodology/detection limits to assure the analyses were valid.
- Addressing missing values and trend analyses in a consistent manner that avoided biasing the results.

4.2 Data Analysis and Statistical Approach

Statistical analysis differed between water quality and biological data. Methods were designed to meet the objectives described in Section 2, and have been presented in previous data evaluations (Land & Water 1999; Bahls 1999, McGuire 1999). Data observations and statistical analyses are also summarized in Appendices B, C, D, and E.

Statistical analyses evaluated improvements and deteriorations in water quality. Analyses examined changes in water quality and biological conditions at each site, between upstream-downstream pairs at each dam, and for the study area. The methods identified statistically significant temporal and spatial variability. Observed differences were related to dam operations if the change was not accompanied by an equivalent response above the dam. Similar change identified concurrently at multiple sites were considered as indicators of systemic or basin-wide effects.

Inter-correlations of parameters and metrics were also valuable in identifying those factors that behave in a similar fashion (i.e. covariates). This information was useful for interpreting water quality response, and was previously used to streamline the monitoring program and reduce redundant parameters, and analytical costs.

4.2.1 Water Quality

Water quality data were summarized using basic exploratory data analysis approaches for evaluating the central tendency (i.e., mean or median) and variability (standard deviation or inter-quartiles) of the data, including sample size. The percentage of non-detect values for each parameter by station was also calculated to provide information relative to the central tendency value. Non-detect values were substituted with one-half the method detection limit for purposes of statistical analysis. Because non-parametric statistical tests were used to evaluate un-transformed or non-adjusted data relationships, test of normality were not performed. For the few parametric tests, the data was transformed, and the expected normal probability plots and residuals plots of raw data were evaluated to assess whether the distribution of the data affected the results. Data summaries are provided for each station on an annual basis and the 10-year basis (2011-2020).

Graphical summaries of the data are presented using boxplots by station (longitudinal) or by year (temporal) for each station to evaluate patterns in the data. The boxes represent the 25th, 50th, and 75th percentiles of the data and the whiskers represent the upper and lower 90 % confidence intervals for each parameter. Each parameter was analyzed using non-parametric statistical tests to determine whether hydroelectric facilities or major tributary inputs had a significant effect on downstream water quality conditions. In addition, each parameter was statistically analyzed using Seasonal Kendall Trend analysis with year and month (seasonal covariate) to evaluate whether concentrations have increased – decreased – or stayed the same over time. The magnitude of a trend (i.e., slope) that can be detected is a function of inherent data variability and sample size. As sample size increases with continued monitoring, the power to detect trends will improve for long-term analyses (e.g. 1996 to the present). However, if 10-year blocks of data are evaluated, the power to detect trends will remain the same if the sampling frequency remains the same. These analyses helped to determine if there were statistical differences between stations with respect to watershed inputs, reservoirs, or hydroelectric facilities. The water quality statistical analysis methodology is summarized in Appendix A.

4.2.1.1 Flow Adjusted Analysis

Background water quality conditions in the Madison River are largely affected by geothermal activity in Yellowstone National Park (YNP), whereas the background water quality conditions in the Missouri River are largely affected by urbanization in the Gallatin River watershed and agricultural practices in both the Gallatin and Jefferson watersheds. The confluence of these rivers with the Madison River, at Three Forks, MT, establishes the background water quality conditions for the headwaters of the Missouri River. In both the Madison and Missouri rivers, water quantity also affects background water quality conditions. Water quantity is primarily driven by snow-melt runoff and depending on seasonal conditions in each watershed (i.e., dry or wet), stream flow can greatly affect water quality conditions. Unseasonably low flows in the Madison River reduce the dilution potential for geothermal constituents, whereas high flows dilute concentrations. In addition, the various watershed and hydrological inputs along the Madison-Missouri continuum affect concentration – flow relationships. Therefore, removing the effect of flow on water quality provides insight to long-term trends in water quality that may result from influence of reservoirs, operational effects of hydroelectric dams, or other anthropogenic effects.

Mean daily discharge records from January 1, 2001, to December 31, 2020, were downloaded from the USGS Water Data for Montana webpage (https://waterdata.usgs.gov/mt/nwis/nwis) and the Bureau of Land Management HydroMet webpage (https://www.usbr.gov/gp/hydromet/hydromet_arcread.html) for the gage closest to each water quality monitoring station. For each gage dataset, mean daily discharge (cfs) was ranked from the largest value to the smallest value for the period from 2001 through 2020. The Weibull probability value was calculated for each ranked mean daily discharge value to create an exceedance probability value. Exceedance probabilities were converted to a percentile for evaluating the relationship between concentration and flow. For each sampling event at each station, the exceedance probability for the mean daily flow reported on that date was paired with the measured parameter concentration. The data relationships were re-examined to determine the influence of results reported at or near the method detection limits, measured results that exhibit repetitive patterns in the data, as well as other potential non-linear relationships.

Water quality parameters (untransformed) that revealed a strong relationship to flow probability (percentile) across multiple stations were selected for the flow-adjusted analysis. The Kendall-tau correlation test of concentration and flow probability was performed at each station, with a strong relationship being defined by a correlation coefficient > 0.5 and a statistically significant p-value (i.e., <0.1). Selected water quality parameters were transformed (natural logarithm) and regressed (least squares regression) with flow percentile to estimate flow-adjusted concentrations (i.e., residuals). Pearson correlation of flow-adjusted concentration with decimal year was used to determine whether there was a significant increasing or decreasing trend over time. Locally weighted scatterplot smoothing (LOESS) regression was performed on flow-adjusted parameters of interest to evaluate non-monotonic relationships over time. Lastly, percent change between the 2011-2013 mean flow-adjusted concentration and 2018-2020 mean flow-adjusted concentration at each station was calculated to provide some context to the magnitude of change over time for significant and non-significant relationships.

Statistical analysis of water quality data included:

1. Summary Data
    a. Minimum, maximum, and mean values; standard deviations; and percentages of non-detect data for each station and year
    b. Graphical presentation and observations of longitudinal patterns in the data
    c. Kendall-tau correlation analysis between non-adjusted parameters and flow
2. Dam Effect Evaluation
    a. Graphical presentation and evaluation of data patterns
    b. Mann-Whitney U non-parametric test between stations (0.05 significance level)
    c. Mean Rank differences and evaluation of 10-year medians to confirm significant differences between stations
    d. Percent change of 10-year median between stations
3. Long-term Trend Identification
    a. Raw Data
        i. Graphical presentation and evaluation of temporal patterns in the data
        ii. Seasonal Kendall non-parametric test of trend using non-flow-adjusted data over time for each station
        iii. Percent change between 2011-2013 mean water quality concentration and 2018-2020 mean water quality concentration for each station
    b. Flow-adjusted Data
        i. Graphical presentation and evaluation of temporal patterns in the data
        ii. Least Squares Regression analysis and calculation of residuals (flow-adjusted values)
        iii. Pearson correlation analysis of flow-adjusted values with decimal year
        iv. Locally weighted scatterplot smoothing (LOESS) regression
        v. Percent change between 2011-2013 mean flow-adjusted concentration and 2018-2020 mean flow-adjusted concentration at each station
4. Special Studies – Dissolved Oxygen
    a. Graphical presentation and evaluation of data patterns

   b. Mann-Whitney U non-parametric test between stations (0.05 significance level)
   c. Kruskal-Wallis H non-parametric test of seasonal effects within a station (0.05 significance level)

4.2.2 Biological Data

Data analysis methods for evaluating the 2011 to 2020 periphyton and macroinvertebrate data are summarized below.

4.2.2.1 Periphyton Data

Periphyton data included laboratory measured chlorophyll-a that is a surrogate for algal biomass, or standing crop, of a periphyton community. Chlorophyll-a typically ranges from 0.5-2% of total algal biomass, depending on taxonomy, light, and nutrients (Barbour et al. 1999). Generally, streams with concentrations greater than 120 mg/m^2 are considered nutrient impaired (MTDEQ 2011; Suplee and Sada de Suplee 2011).

Statistical analysis of chlorophyll-a data included:

5. Summary Data
   a. Minimum, maximum, and mean values; standard deviations; and percentages of non-detect data were calculated for each station and year
   b. Graphical presentation and observations of longitudinal patterns in the data
   c. Results were compared to guidelines established by Montana Department of Water quality
   d. Concentrations at potentially impacted stations were compared to background control stations (B1 and B5)
6. Dam Effect Evaluation
   a. Mann-Whitney U non-parametric statistical comparisons of data between paired stations upstream-downstream of reservoirs and dams
   b. Graphical presentation and observations of longitudinal patterns in the data
   c. Percent change in median concentrations were calculated between paired stations upstream-downstream of reservoirs and dams
7. Long-term Trend Identification
   a. Mann-Kendall non-parametric trend analysis of temporal data for each station
   b. Graphical presentation and observations of longitudinal patterns in the data

Periphyton data also included various diatom metrics calculated from taxa and species counts. The metrics used generally follow EPA guidance (EPA 1998; Barbour et al. 1999) and include:

- Shannon Diversity. Measurement of diversity calculated using taxa richness and distribution (evenness) of individuals among taxa (Weber 1973). It is a measure of the effects of stress on invertebrate communities. Diversity is expected to be higher in unimpacted sites.

- Pollution Tolerance Index (PTI). Resembles the Hilsenhoff Biotic Index (described below for macroinvertebrates) and categorizes diatoms according to their tolerance to increased pollution (Bahls 1993). PTI is a sum of values assigned to three categories of diatoms where a value of 1 is assigned to the most pollution-tolerant taxa, 2 to less tolerant taxa, and 3 to sensitive taxa. This metric is expected to be higher in degraded streams.
- Siltation Index (%). Percentage of motile species that live in the sediment and are capable of holding their position on unstable substrates (Bahls 1993). The percentage is expected to increase with sedimentation.
- Disturbance Index (%). Percentage of generalist diatom species that are often pioneer species at scour or polluted locations (Barbour et al. 1999). This metric is expected to be higher in area of increased natural or anthropogenic disturbance.
- Species Richness. Number of species counted per sample is indicative of water quality. This metric increases with number of species.
- Abundance of Dominant Species (%). Percentage of the dominant (i.e., tolerant) species. This metric increases with stress to the environment.
- Abnormal Cells (%). Percent of diatoms that have anomalies in striae patterns or frustule shape. This metric has been positively correlated with heavy metals contamination (Barbour et al. 1999) and increases with pollution.

Note: Individual taxonomic count data that is required for the calculation of percent community similarity was not available.

Mean diatom metric data by station were scored and rated per biological integrity thresholds used for Montana mountain and plain stream ecoregions (Table 4-1, Bahls 1993; Teply and Bahls 2005). These thresholds correspond to a 1 to 4 score, “Poor” to “Excellent” rating of the score, and a “None” to “Severe” impairment evaluation of the diatom community. In addition, the lowest scoring metric at each station in a year was considered the overall rating and impairment assessments of that station in that year.

Data observations and statistical analysis of diatom metric data included:

8. Summary Data
    a. Minimum, maximum, and mean values and standard deviations by metric were calculated for each station and year
    b. Graphical presentation and observations of longitudinal patterns in the data Biological integrity ratings for each metric and impairment ratings for each station and year were determined
    c. Concentrations at potentially impacted stations were compared to background control stations (B1 and B5)

9. Dam Effect Evaluation
   a. Mann-Whitney U non-parametric statistical comparisons of data between paired stations upstream-downstream of reservoirs and dams.
   b. Percent change in in median metric values were calculated between paired stations upstream-downstream of reservoirs and dams.
10. Metric Relationships
    a. Scatter plot matrices were used to evaluate metric relationships
    b. Kendall-tau non-parametric correlation analysis between metrics was performed for each station
11. Long-term Trend Identification
    a. Least Squares Regression analysis for trends in each metric at each station

Table 4-1: Diatom metrics biological integrity thresholds and ratings used for Montana stream ecoregions.

Metric	Mountains				Plains			
	Thresholds	Score	Rating	Impairment	Thresholds	Score	Rating	Impairment
Shannon Diversity[a]	< 1	1	Poor	Severe	< 1.5	1	Poor	Severe
	1 - 1.75	2	Fair	Moderate	1.5 - 2.5	2	Fair	Moderate
	1.75 - 2.5	3	Good	Minor	2.5 - 3.5	3	Good	Minor
	≥ 2.5	4	Excellent	None	≥ 3.5	4	Excellent	None
Pollution Tolerance Index[a]	< 1.5	1	Poor	Severe	< 1	1	Poor	Severe
	1.5 - 2	2	Fair	Moderate	1 - 1.5	2	Fair	Moderate
	2 - 2.5	3	Good	Minor	1.5 - 2	3	Good	Minor
	≥ 2.5	4	Excellent	None	≥ 2	4	Excellent	None
Siltation Index (%)[a]	< 20	4	Excellent	None	< 60	4	Excellent	None
	20 - 40	3	Good	Minor	60 - 70	3	Good	Minor
	40 - 60	2	Fair	Moderate	70 - 80	2	Fair	Moderate
	≥ 60	1	Poor	Severe	≥ 80	1	Poor	Severe
Disturbance Index (%)[b]	< 25	4	Excellent	None	< 25	4	Excellent	None
	25 - 50	3	Good	Minor	25 - 50	3	Good	Minor
	50 - 75	2	Fair	Moderate	50 - 75	2	Fair	Moderate
	≥ 75	1	Poor	Severe	≥ 75	1	Poor	Severe
Species Richness[b]	< 10	1	Poor	Severe	< 20	1	Poor	Severe
	10 - 20	2	Fair	Moderate	20 - 30	2	Fair	Moderate
	20 - 30	3	Good	Minor	30 - 40	3	Good	Minor
	≥ 30	4	Excellent	None	≥ 40	4	Excellent	None
Abundance of Dominant Species (%)[b]	< 25	4	Excellent	None	< 25	4	Excellent	None
	25 - 50	3	Good	Minor	25 - 50	3	Good	Minor
	50 - 75	2	Fair	Moderate	50 - 75	2	Fair	Moderate
	≥ 75	1	Poor	Severe	≥ 75	1	Poor	Severe
Abnormal Cells (%)[b]	0	4	Excellent	None	Not assessed			
	> 0 - 3	3	Good	Minor				
	3 - 10	2	Fair	Moderate				
	≥ 10	1	Poor	Severe				

[a]Bahls 1993
[b]Teply and Bahls 2005

4.2.2.2 Macroinvertebrate Data

Various metrics associated with water quality and flow regimes below dams were calculated from median macroinvertebrate taxa and species count data. These metrics generally follow EPA guidance (Plafkin et al. 1989) and include:

- Taxa Richness. Number of taxa counted per sample is indicative of water quality. Loss of most sensitive species to any stress affects index. This metric increases with number of taxa.
- Shannon Diversity. Measurement of diversity and stress of invertebrate communities and is calculated using taxa richness and distribution (evenness) of individuals among taxa (Weber 1973). Diversity is expected to be higher in unimpacted sites.
- Biotic Index (Hilsenhoff 1988; tolerance values from Bukantis 1996). Community index that uses tolerance values to weight abundance in an estimate of overall pollution. It is also known as the Modified Family Biotic Index. The index on a scale of 0-10, with higher values indicating more eutrophic conditions.
- EPT Richness Index. Total number of distinct taxa in EPT taxa (Ephemeroptera [mayfly], Plecoptera [stonefly], and Trichoptera [caddisfly]) which are primarily intolerant species divided by the total number of taxa. It is also known as an EPT Index. The index increases with improving water quality.
- Relative Abundance of EPT (%). Percent of population consisting of EPT taxa. Percent increases with improving water quality.
- Relative Abundance of Chironomidae (%). Percent of population consisting of chironomid (midge) larvae which are a very pollution tolerant species. Increased abundance is indicative of stress.
- Ratio of Amphipoda to Isopoda. Ratio of Amphipods, which require high oxygen concentrations, to Isopods, which are tolerant of low oxygen levels. Ratio ranges from 0 to 1, with lower values indicating more eutrophic/reduced oxygen conditions.
- Community Density. Number of organisms assessed per 0.25 m^2 sample and not by subsample of 300. Density increases in response to organic and/or nutrient enrichment and can be used as measure of trophic status.
- Multimetric Assessment (Total). Composite (multimetric) assessment of benthic macroinvertebrate assemblage composition and structure. Scores ranging from 0 to 5 are assigned to metric results according to predefined threshold and added together for total multimeric score (Table 4-2).
- Multimetric Assessment (% of possible). Multimetric Assessment (Total) score divided by highest potential score.

Note: Data required to calculate ordinal relative abundance and percent community similarity was not available.

Table 4-2: Benthic macroinvertebrate assemblages scoring thresholds.

Metric	Score					
	0	1	2	3	4	5
Taxa Richness	< 13	17 - 13	22 - 18	27 - 23	32 - 28	> 32
Shannon Diversity	< 2.2	2.4 - 2.2	2.7 - 2.5	3.0 - 2.8	3.3 - 3.1	> 3.3
Biotic Index	> 6.4	5.9 - 6.4	5.3 - 5.8	4.7 - 5.2	4.1 - 4.6	< 4.1
EPT Richness	0	4 - 1	8 - 5	12 - 9	16 - 13	> 16
Relative Abundance of EPT (%)	< 31	40 - 31	50 - 41	60 - 51	70 - 61	> 70
Relative Abundance of Chironomidae (%)	> 40	36 - 40	31 - 35	26 - 30	21 - 25	< 21
Ratio of Amphipoda to Isopoda*	0.0	0.13 - 0.01	0.26 - 0.14	0.39 - 0.27	0.52 - 0.40	> 0.52

*Not calculated when crustaceans represent less than one percent of the fauna.

Data observations and statistical analysis of macroinvertebrate metric data included:

12. Summary Data
    a. Minimum, maximum, and mean values and standard deviations by metric were calculated for each station and year
    b. Graphical presentation and observations of longitudinal patterns in the data
    c. Concentrations at potentially impacted stations were compared to control stations (B1 and B5)
13. Dam effect Evaluation
    a. Mann-Whitney U non-parametric test of comparison for metric data between stations paired upstream-downstream of reservoirs and dams
    b. Percent change in 10-year median metric values were calculated between paired stations upstream-downstream of reservoirs and dams
14. Metric Relationships
    a. Relationship observations were made using a scatter plot matrix of metrics
    b. Kendall-tau non-parametric correlation analysis between metrics was conducted for each station
15. Long-term Trend Identification
    a. Least Squares Regression analysis for trends in each metric at each station

4.2.2.3 Fish Tissue Biocontaminant Data

Data observations and statistical analysis of fish tissue biocontaminant data included:

16. Summary Data
    a. Minimum, maximum, mean values and standard deviations for fish length and weight were calculated for Predator and Bottom fish for each station and year
    b. Number of fish tissue biocontaminant concentration detections above the detection limit, number or non-detects, and percentage of non-detects and mean

biocontaminant concentrations were calculated for Predator and Bottom fish for each station.

   c. Results compared to national median concentrations and Montana and EPA fish consumption guidelines
   d. Observations of differences between Predator and Bottom fish concentrations and longitudinal patterns by metric were made

17. Dam Effect Evaluation
   a. Percent changes in mean Predator and Bottom concentrations above detection limit were calculated between paired stations upstream-downstream of reservoirs and dams
   b. Mann-Whitney U non-parametric statistical comparisons of biocontaminant data between paired stations upstream-downstream of reservoirs and dams were made for Predator and Bottom fish
   c. Percent change in in median Predator and Bottom concentrations were calculated between paired stations upstream-downstream of reservoirs and dams

Note: Metric relationships and long-term trend analysis could not be performed due to the small sample size.

5. Statistical Analyses

Spatial and temporal analyses of water quality, periphyton and macroinvertebrates are presented in the following sections. The first step in the analyses was to perform the basic summary statistics and graphical display of parameters for the period of record (2011-2020), followed by statistical comparisons of stations that bracket (upstream-downstream) the hydroelectric facilities. The last component was the temporal trend and flow-adjusted analyses for selected water quality parameters.

Many of the graphical displays are presented in a format that sequentially represents Station 1 through Station 10, a river mile distance of nearly 350 miles. However, the stations are not represented on a river mile scale, and instead bracket the hydroelectric facilities from Hebgen Dam downstream to Morony Dam. The following schematic (Figure 5-1) provides some context to the water quality and biological stations that bracket hydroelectric facilities and other important hydrologic inputs.

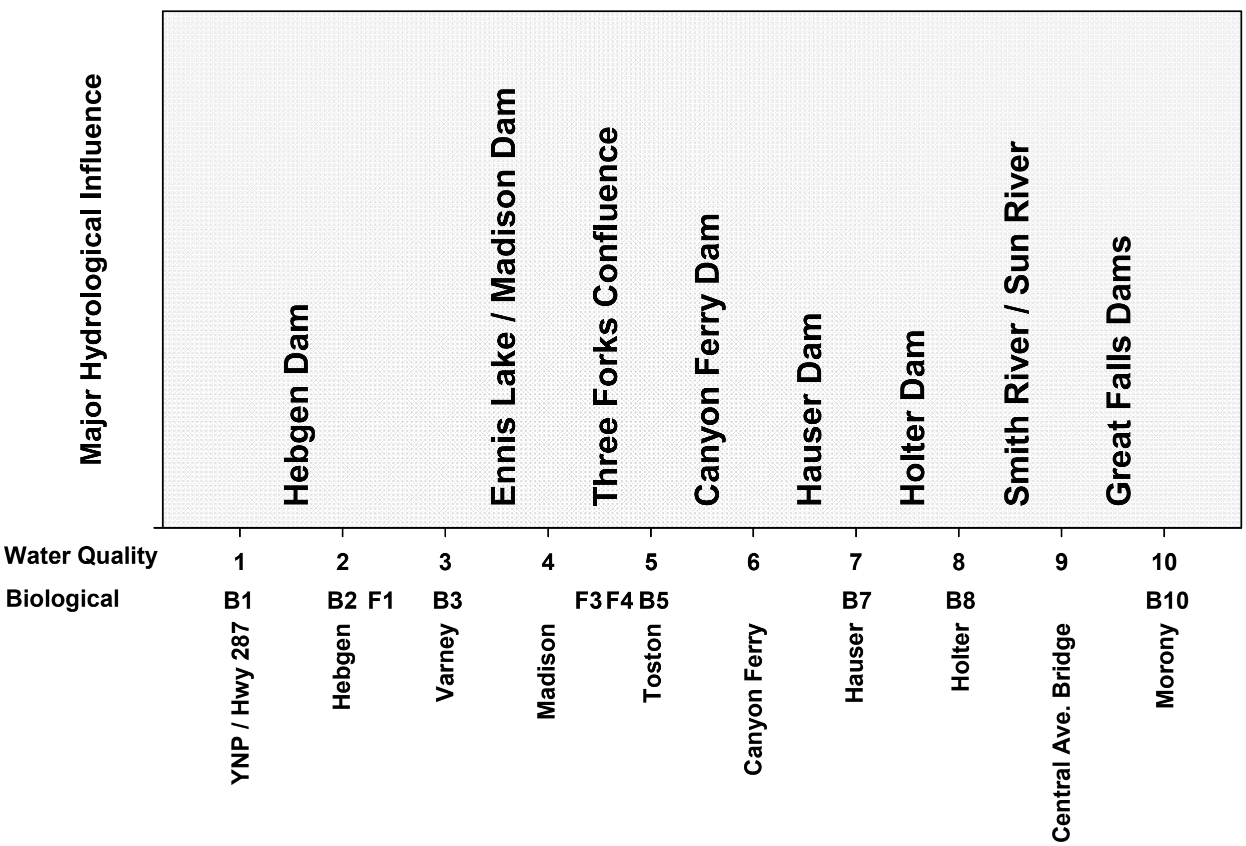


Figure 5-1: Schematic of water quality and biological monitoring stations that bracket hydroelectric facilities and dominant watershed inputs. Note: stations F3 and F4 are upstream of the Three Forks Confluence.

5.1 Water Quality Analyses

5.1.1 Spatial Analyte Summary

Water quality parameters were generally collected on a quarterly basis with sampling occurring during the third week of February, May, August, and November for each year. The notable exception to the sampling frequency was in 2011 when monthly samples were collected at each site. This sampling routine resulted in up to a total of 48 samples per station. In general, the ion chemistry, solids/turbidity, nutrients, and *in situ* physicochemical (e.g., pH, specific conductance) measurements were performed at all stations each year, whereas the metals analyses were only performed at stations 9 and 10. Again, the notable exception for most metal parameters was in 2011 when monthly samples were collected from all sites for a total of 12 samples. Additionally, total arsenic was measured for each station for each year. A summary of water quality results is presented below in Table 5-1. These data represent the sample size, mean values, and percentage of the results that were non-detects for each parameter by station over the 10-year monitoring period from 2011 to 2020. A high percentage of the results (i.e., > 50%) were less than detection limits for dissolved magnesium, total suspended solids, total cadmium, total lead, and total zinc. Complete descriptive statistics can be found in Appendix B, including summary annual statistics by station and parameter.

Table 5-1: Water quality parameter descriptive statistics from 2011 to 2020 at all stations. N = sample size and % ND = percent of non-detect results.

Parameter	Station 1			Station 2			Station 3			Station 4			Station 5		
	N	Mean	% ND	N	Mean	% ND	N	Mean	% ND	N	Mean	% ND	N	Mean	% ND
Ion Chemistry															
Alkalinity as CaCO3, Total (mg/L)	48	98.4	0	48	82.6	0	48	89.1	0	48	101.1	0	48	124.9	0
Bicarbonate as HCO3, Total (mg/L)	48	119.9	0	48	100.5	0	48	108.2	0	48	122.0	0	48	150.3	0
Calcium, Total (mg/L)	24	5.9	0	24	10.2	0	24	15.4	0	24	20.3	0	24	34.7	0
Calcium, Dissolved (mg/L)	24	6.1	0	24	10.5	0	24	16.5	0	24	21.2	0	24	34.4	0
Chloride, Total (mg/L)	48	50.2	0	48	28.2	0	48	20.5	0	48	18.0	0	48	10.9	0
Magnesium, Dissolved (mg/L)	48	0.5	100	48	2.2	0	48	4.1	0	48	5.6	0	48	10.3	0
Potassium, Total (mg/L)	48	7.5	0	24	5.0	0	24	4.0	0	24	3.9	0	24	3.7	0
Potassium, Dissolved (mg/L)	48	7.6	0	24	5.1	0	24	4.0	0	24	3.7	0	24	3.3	0
Sodium, Dissolved (mg/L)	48	76.0	0	48	45.2	0	48	33.8	0	48	30.5	0	48	19.4	0
Sulfate, Total (mg/L)	48	12.0	0	48	9.1	0	48	10.2	0	48	13.2	0	48	30.0	0
Solids/Turbidity															
Dissolved Solids, Total (mg/L)	48	289.2	0	48	194.6	0	48	176.5	0	48	183.5	0	48	206.8	0
Suspended Solids Total (mg/L)	48	9.6	73	48	5.0	100	48	10.1	81	48	6.7	83	48	31.4	40
Turbidity (NTU)	48	3.6	--	48	1.1	--	48	6.2	--	48	5.8	--	48	17.1	--
Metals															
Arsenic, Total (mg/L)	48	0.234	0	48	0.129	0	48	0.090	0	48	0.076	0	48	0.032	0
Cadmium, Total (mg/L)	12	<0.001	100	12	<0.001	100	12	<0.001	100	12	<0.001	92	12	<0.001	83
Copper, Total (mg/L)	12	0.001	33	12	0.001	92	12	0.002	50	12	0.001	58	12	0.004	0
Iron, Total (mg/L)	12	0.222	0	12	0.081	0	12	0.240	0	12	0.249	0	12	0.948	0
Lead, Total (mg/L)	12	0.001	92	12	0.001	100	12	0.001	92	12	0.001	100	12	0.003	67
Manganese, Total (mg/L)	12	0.034	25	12	0.027	42	12	0.022	83	12	0.036	8	12	0.057	0
Zinc, Total (mg/L)	12	0.005	100	12	0.005	100	12	0.005	100	12	0.005	100	12	0.008	83
Nutrients															
Nitrite-Nitrate, Total (mg/L)	36	0.030	3	36	0.019	42	36	0.031	25	36	0.025	39	36	0.124	3
Nitrite-Nitrate, Dissolved (mg/L)	12	0.040	0	12	0.032	33	12	0.068	0	12	0.050	33	12	0.138	0
Nitrogen, Total (mg/L)	48	0.147	8	48	0.170	4	48	0.186	6	48	0.214	2	48	0.389	0
Phosphorus, Total (mg/L)	48	0.024	0	48	0.025	0	48	0.029	0	48	0.026	0	48	0.054	0
Physicochemical															
Dissolved Oxygen (mg/L)	42	7.7	--	42	8.5	--	42	9.5	--	42	8.8	--	41	8.9	--
Dissolved Oxygen (% Sat)	42	83.3	--	42	91.3	--	42	92.6	--	42	88.6	--	41	85.6	--
pH (s.u.)	48	7.7	--	48	7.9	--	48	8.1	--	48	8.1	--	48	8.1	--
Specific Conductance (µS/cm)	48	387	--	48	268	--	48	257	--	48	277	--	48	320	--
Water Temperature (°C)	48	8.6	--	48	8.1	--	48	6.6	--	48	8.8	--	48	8.8	--

Table 5-1 (cont.): Water quality parameter descriptive statistics from 2011 to 2020 at all stations. N = sample size and % ND = percent of non-detect results.

Parameter	Station 6			Station 7			Station 8			Station 9			Station 10		
	N	Mean	% ND	N	Mean	% ND	N	Mean	% ND	N	Mean	% ND	N	Mean	% ND
Ion Chemistry															
Alkalinity as CaCO3, Total (mg/L)	48	126.3	0	48	126.8	0	48	129.7	0	47	138.6	0	48	139.8	0
Bicarbonate as HCO3, Total (mg/L)	48	152.5	0	48	153.8	0	48	156.0	0	47	166.3	0	48	167.8	0
Calcium, Total (mg/L)	24	35.3	0	24	36.0	0	24	36.3	0	24	38.4	0	23	41.0	0
Calcium, Dissolved (mg/L)	24	35.5	0	24	36.2	0	24	36.5	0	23	39.1	0	25	41.7	0
Chloride, Total (mg/L)	48	9.3	0	48	9.4	0	48	9.4	0	47	8.0	0	48	8.0	0
Magnesium, Dissolved (mg/L)	48	10.4	0	48	10.5	0	48	10.8	0	47	12.9	0	48	13.9	0
Potassium, Total (mg/L)	24	3.3	0	24	3.2	0	24	3.3	0	24	3.1	0	23	3.1	0
Potassium, Dissolved (mg/L)	24	3.3	0	24	3.3	0	24	3.3	0	23	3.0	0	25	3.0	0
Sodium, Dissolved (mg/L)	48	17.6	0	48	17.7	0	48	17.7	0	47	17.9	0	48	17.1	0
Sulfate, Total (mg/L)	48	29.3	0	48	30.3	0	48	31.2	0	47	40.1	0	48	48.3	0
Solids/Turbidity															
Dissolved Solids, Total (mg/L)	48	202.3	0	48	204.5	0	48	206.5	0	47	220.0	0	48	231.3	0
Suspended Solids Total (mg/L)	48	5.0	100	48	5.0	100	48	5.0	100	47	23.2	36	48	18.0	46
Turbidity (NTU)	48	2.6	--	48	3.0	--	48	2.0	--	48	14.6	--	48	13.0	--
Metals															
Arsenic, Total (mg/L)	48	0.024	0	48	0.024	0	48	0.023	0	47	0.019	0	48	0.017	0
Cadmium, Total (mg/L)	12	<0.001	100	12	<0.001	83	12	<0.001	92	44	<0.001	98	45	<0.001	87
Copper, Total (mg/L)	12	0.003	0	12	0.002	0	12	0.002	8	44	0.003	5	45	0.002	4
Iron, Total (mg/L)	12	0.137	25	12	0.133	0	12	0.076	8	44	0.430	0	45	0.362	0
Lead, Total (mg/L)	12	0.002	75	12	0.001	100	12	0.001	100	44	0.003	43	45	0.002	44
Manganese, Total (mg/L)	12	0.033	8	12	0.032	8	12	0.021	54	44	0.028	5	45	0.025	9
Zinc, Total (mg/L)	12	0.005	100	12	0.005	100	12	0.005	100	44	0.005	98	45	0.005	98
Nutrients															
Nitrite-Nitrate, Total (mg/L)	36	0.176	0	36	0.149	3	36	0.118	19	35	0.126	9	36	0.154	0
Nitrite-Nitrate, Dissolved (mg/L)	12	0.205	0	12	0.187	0	12	0.166	14	12	0.185	0	12	0.191	8
Nitrogen, Total (mg/L)	48	0.407	0	48	0.428	0	48	0.395	0	47	0.383	0	48	0.418	0
Phosphorus, Total (mg/L)	48	0.036	0	48	0.037	0	48	0.039	2	47	0.049	0	48	0.045	0
Physicochemical															
Dissolved Oxygen (mg/L)	41	7.4	--	41	8.8	--	41	9.0	--	40	8.9	--	41	9.0	--
Dissolved Oxygen (% Sat)	41	69.7	--	41	84.6	--	41	87.7	--	40	85.1	--	41	85.3	--
pH (s.u.)	48	7.9	--	48	8.1	--	48	8.2	--	47	8.1	--	48	8.2	--
Specific Conductance (µS/cm)	48	316	--	48	320	--	48	323	--	47	346	--	48	367	--
Temperature (°C)	48	8.2	--	48	8.6	--	48	9.2	--	47	9.1	--	48	9.5	--

Longitudinal patterns in water quality conditions are presented in the following box plots that identify the median concentration for each parameter (center bar) and data distribution (25th & 75th percentiles [box], and the 10th & 90th percentiles [whiskers]). These figures illustrate the spatial distributions of data from Station 1 (Upstream of Hebgen Lake) to Station 10 (Downstream of Great Falls Dams) for each 10-year period.

5.1.1.1 Ion Chemistry

The carbonate and bicarbonate concentrations at Station 1 have been approximately 110 mg/L and 130 mg/L, respectively, over the long-term and as streamflow passes through Hebgen Lake concentrations decrease by approximately -16 % (Figure 5-2, Figure 5-3). The lake acts as a sink for inorganic carbon, although concentrations gradually increase between Station 2 and Station 5 due to watershed sources. At Station 5, downstream of the Three Forks confluence reach, the carbonate and bicarbonate concentrations increase by roughly +23 % as compared to Station 4 due to the influence of the other source waters. From Station 5 downstream to Station 10, concentrations remain relatively constant with little change between sites that bracket hydroelectric facilities. Carbonate and bicarbonate concentrations in both the Madison and Missouri rivers (all stations) have shown little decrease between the two 10-year periods, ranging between -8 % to -2 % change.

Calcium and magnesium concentrations are the lowest at Station 1, near detection limits, and increase through Station 5, downstream of the Three Forks confluence reach (Figure 5-4, Figure 5-5, Figure 5-6), by roughly +470 % for calcium and +1,967 % for magnesium. The stream flows change from soft waters at Station 1 to hard water downstream of Three Forks. Concentrations remain relatively constant from Station 5 through Station 10, with the last station exhibiting the highest concentration (~41 mg/L for total and dissolved calcium and 14 mg/L for dissolved magnesium). Calcium and magnesium concentrations at all stations have shown minor change between the two 10-year periods, -16 to +3 % and -6 to +5 %, respectively.

Chloride, potassium, and sodium all exhibit the highest concentration at Station 1 and gradually decrease by Station 4 (by roughly -64 %, -50 %, and -60 %, respectively), at which point the streamflow concentrations remain relatively constant, near the detection limits (Figure 5-7, Figure 5-8, Figure 5-9, Figure 5-10). Chloride, potassium, and sodium concentrations have shown a decrease between the 10-year periods with a greater magnitude in change observed for the Missouri River (-10 to -8 %, -21 to -3 %, and -2 to 0 %, respectively) as compared to the Madison River (-20 to -12 %, -19 to -3 %, and -14 to -7 %, respectively).

These results differ from the previous Water Quality and Biological Monitoring Trend Analysis report (GEI 2017) where an increase in chloride and sodium concentrations were observed in the Madison River and attributed to increased road salting. In fact, chloride, potassium, and sodium concentrations from 1997 to 2020 at all sample stations were lowest in 1997, increased to their highest values in the early 2000s (roughly 2001 to 2004), and overall, gradually decreased through 2020 (Appendix B). The relatively low concentrations of these parameters in the late

1990s resulted in the mean values for 1996 to 2006 being lower than 2007 to 2016. The 1997 to 2000 data are not included in this report and, as a result, the mean values for 2001 to 2010 are greater than 2011 to 2020.

The pattern of increase in chloride, potassium, and sodium through the early 2000s may be attributed to changes in highway management practices and the increase in road salting that has been in observed many regions of the U.S. (Corsi et al. 2015, GEI 2015, Fallon and Chaplin). This trend was also documented in a Colorado Department of Transportation Report that attributed the increasing chloride concentrations in many front-range Colorado watersheds to the use of road de-icing agents. The USGS study (Corsi et al. 2015) noted that chloride concentrations have outpaced the urbanization rate in many watersheds and that the de-icing agents used in wintertime are likely stored in the shallow alluvium and slowly released throughout the year.

Sulfate concentrations are relatively low (~11 mg/L) in Madison River, and notably increase downstream of the Three Forks confluence at Station 5 by +127 % (Figure 5-11). Sulfate concentrations remain relatively constant at 30 mg/L downstream to Station 8, and begin to gradually increase at stations 9 and 10 where the typical concentration is approximately 44 mg/L. Total sulfate concentrations in both the Madison and Missouri rivers have shown a decrease between the two periods, ranging between -7 to -1 % change.

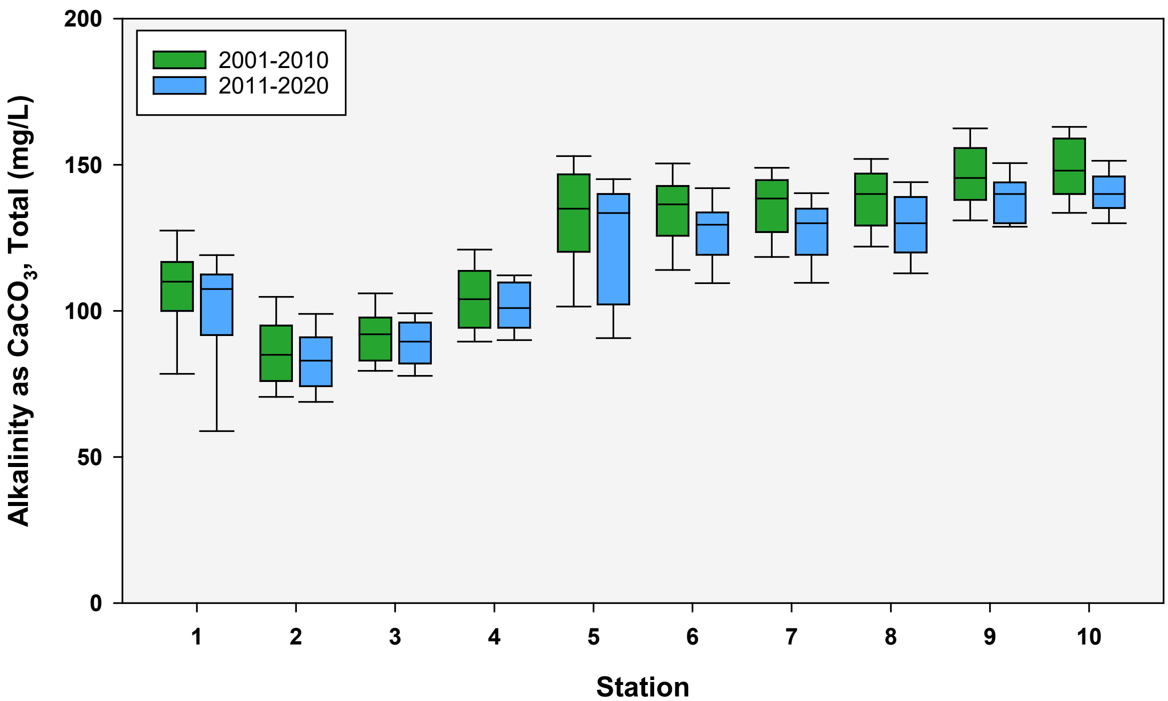


Figure 5-2: Longitudinal pattern for total alkalinity grouped by 10-year periods for each station.

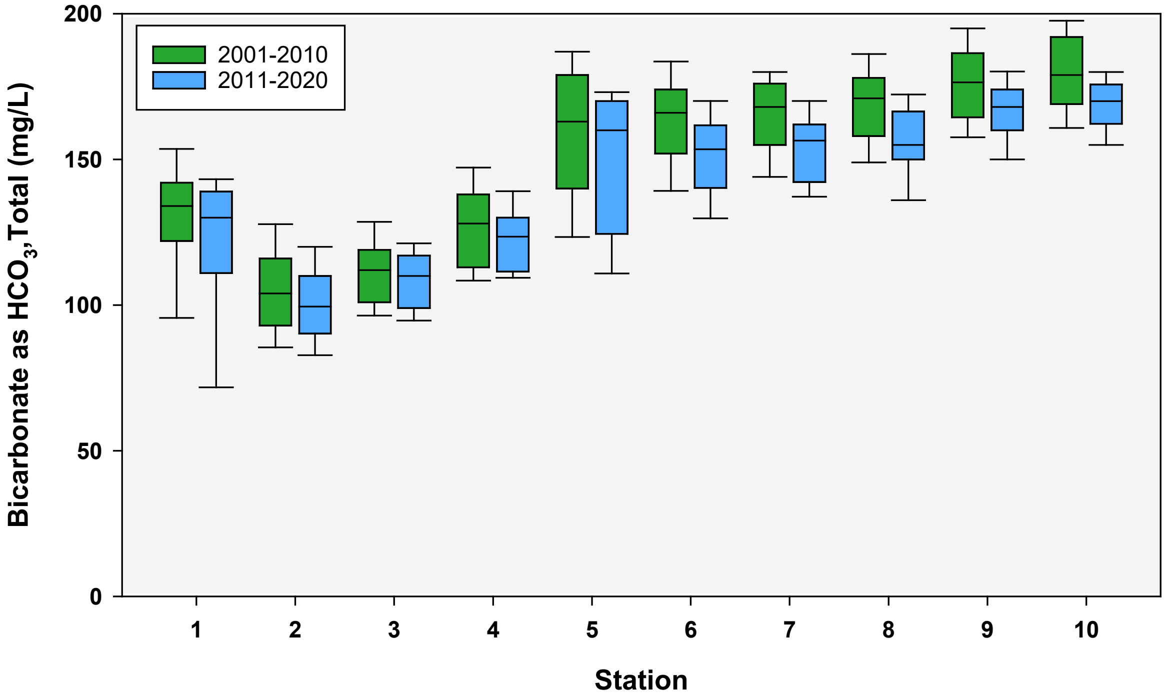


Figure 5-3: Longitudinal pattern for total bicarbonate grouped by 10-year periods for each station.

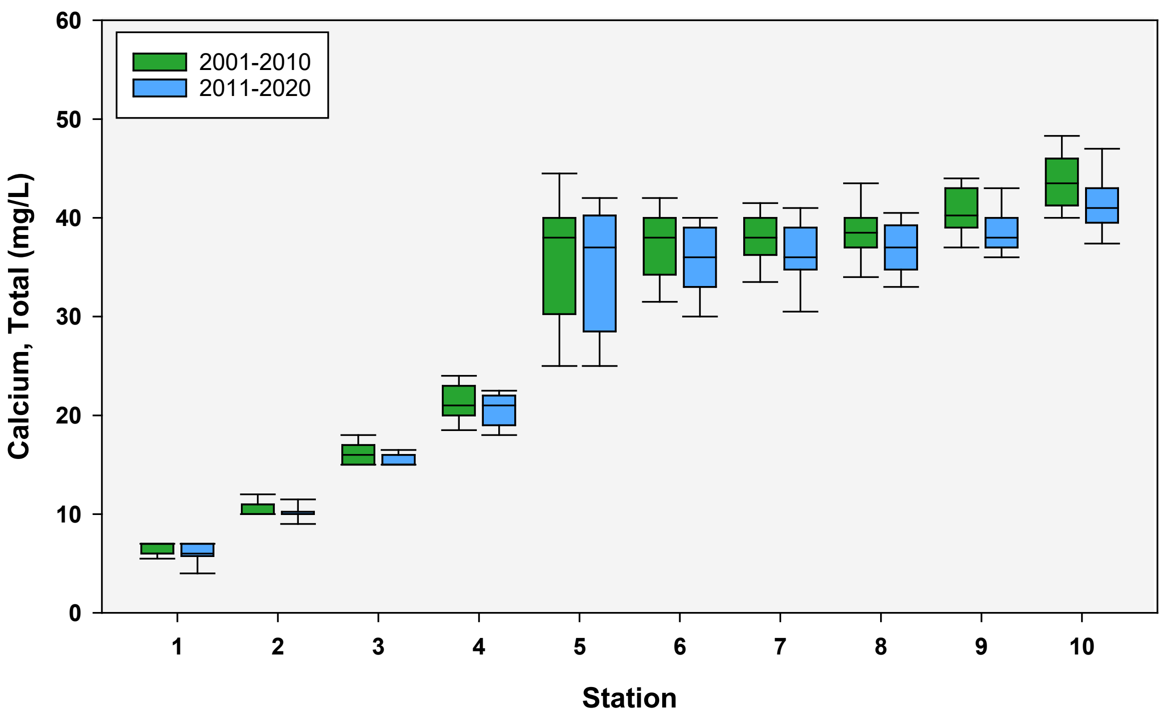


Figure 5-4: Longitudinal pattern for total calcium grouped by 10-year periods for each station.

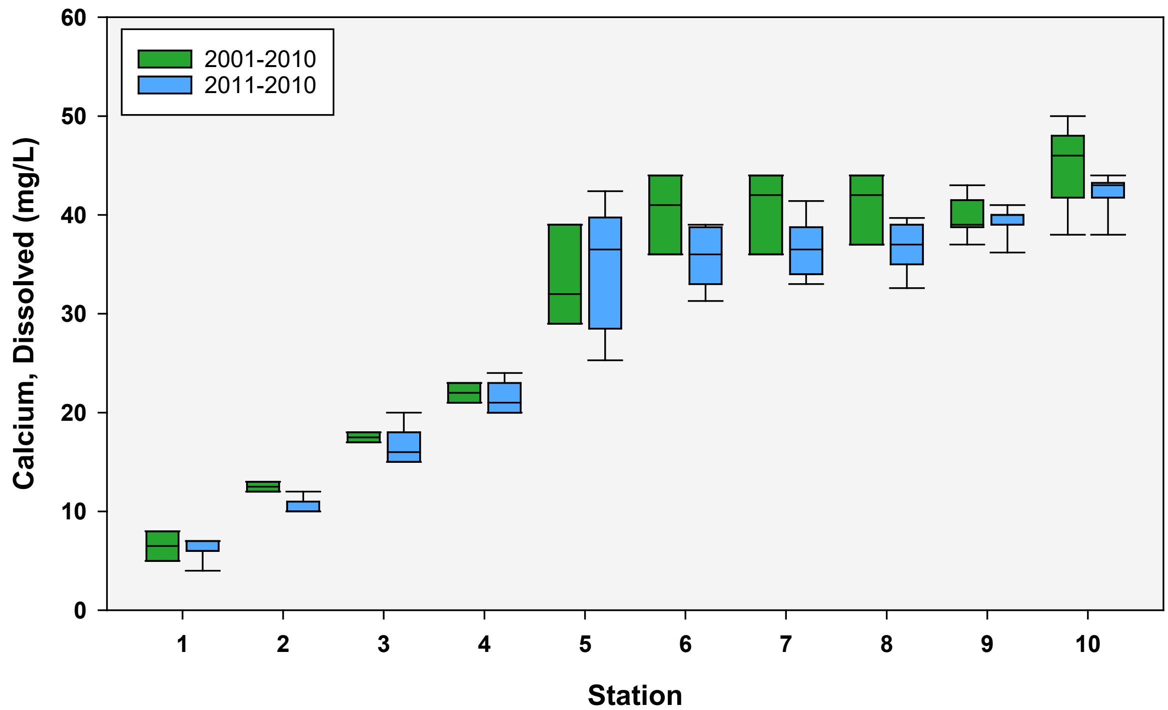


Figure 5-5: Longitudinal pattern for dissolved calcium grouped by 10-year periods for each station.

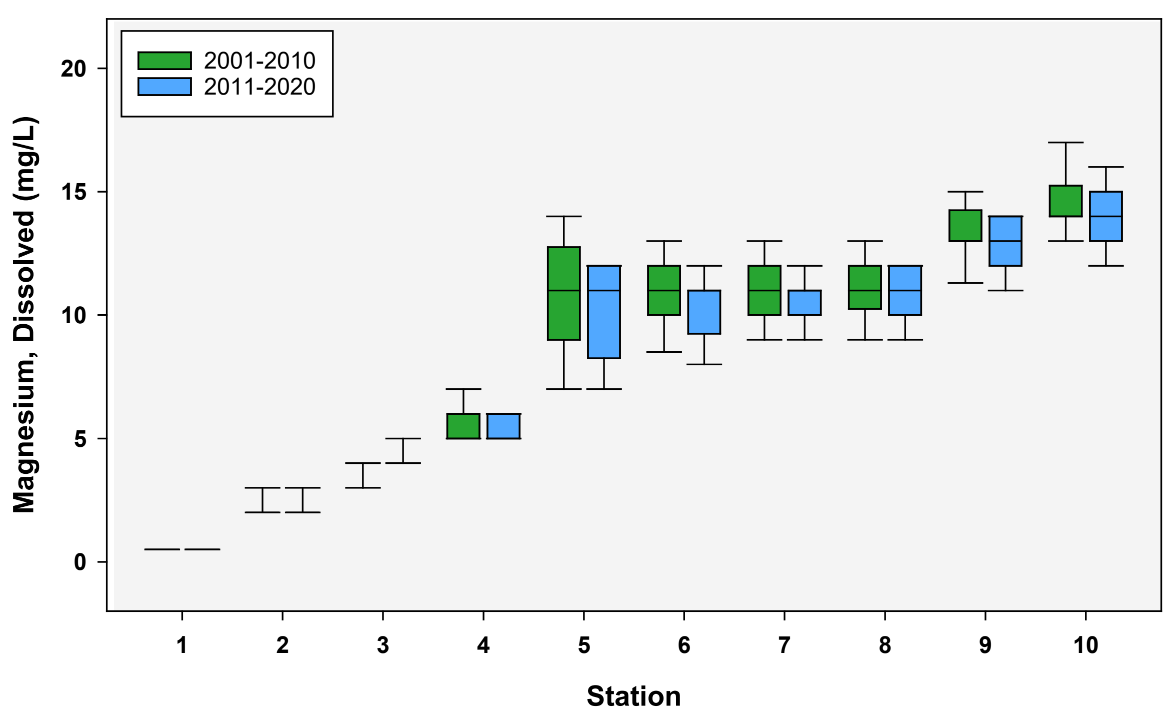


Figure 5-6: Longitudinal pattern for dissolved magnesium grouped by 10-year periods for each station.

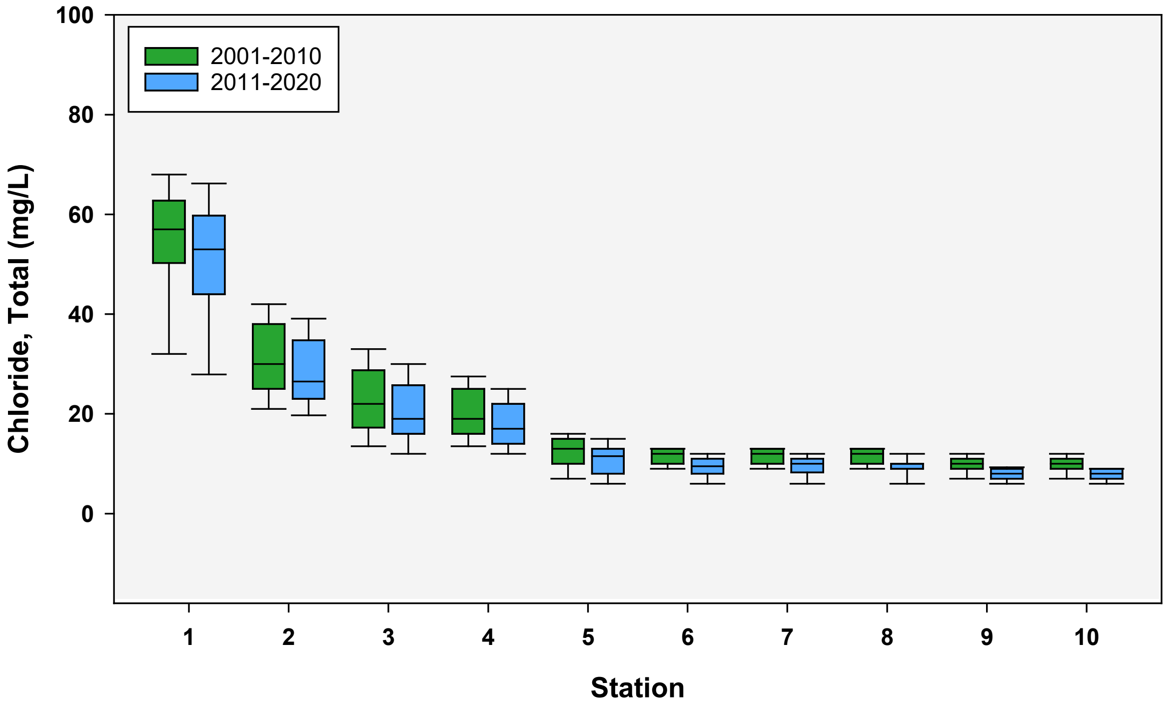


Figure 5-7: Longitudinal pattern for total chloride grouped by 10-year periods for each station.

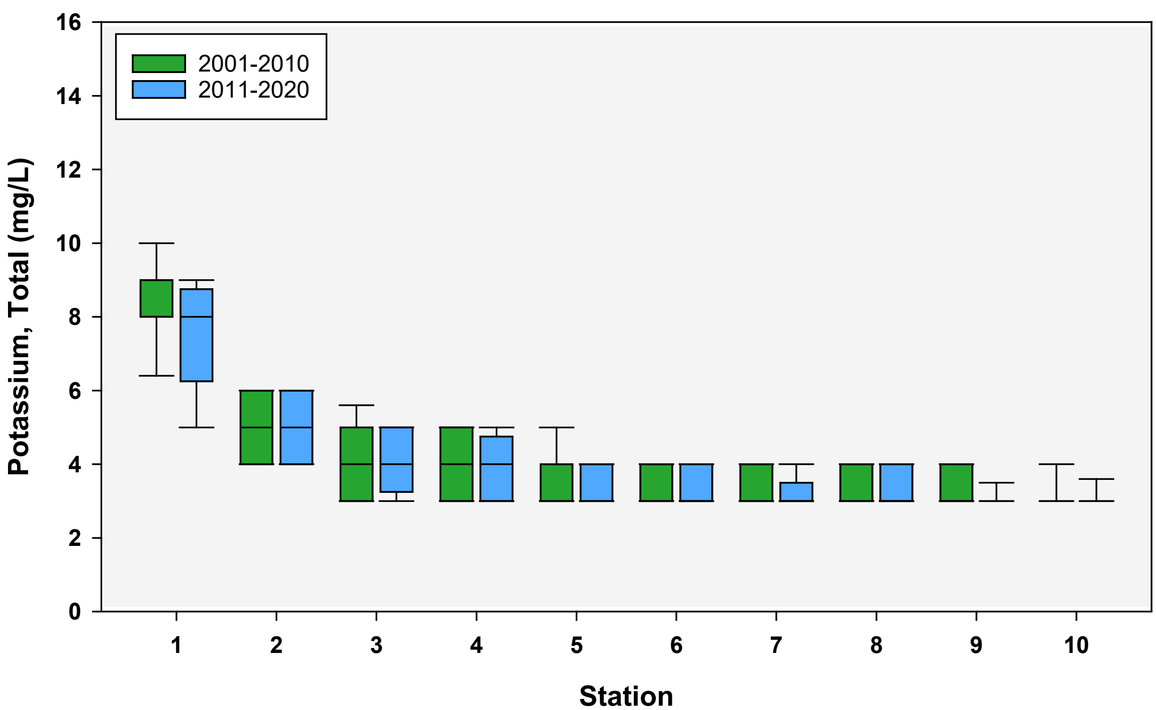


Figure 5-8: Longitudinal pattern for total potassium grouped by 10-year periods for each station.

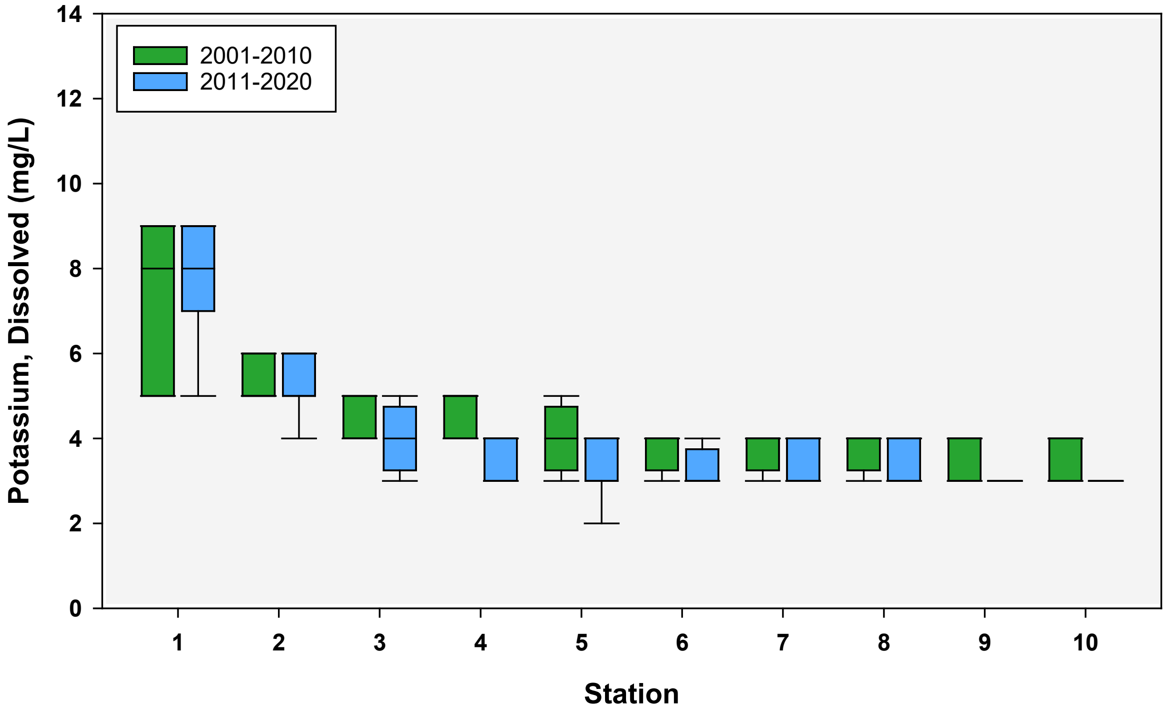


Figure 5-9: Longitudinal pattern for dissolved potassium grouped by 10-year periods for each station.

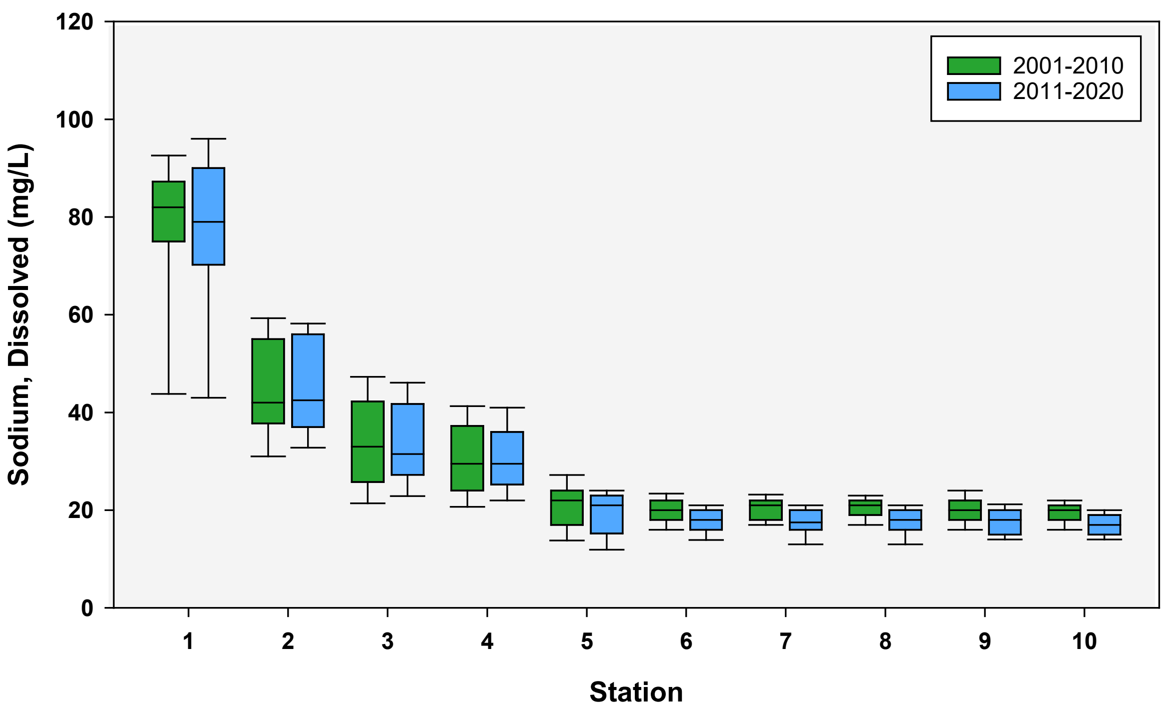


Figure 5-10: Longitudinal pattern for dissolved sodium grouped by 10-year periods for each station.

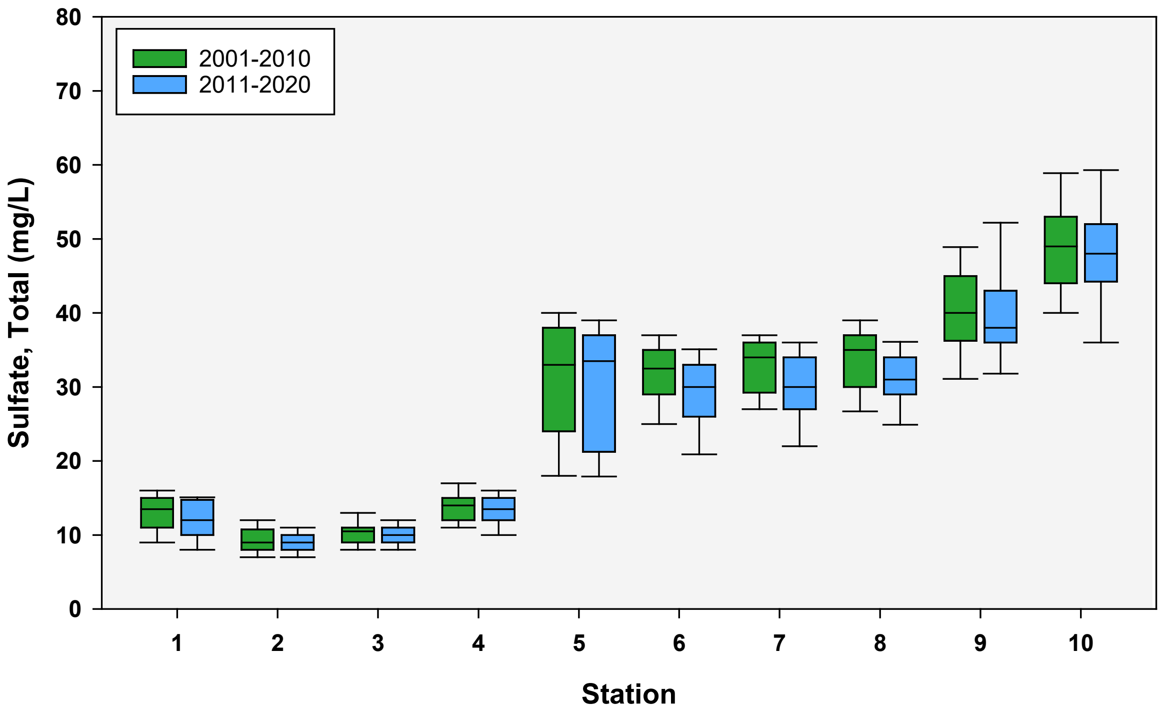


Figure 5-11: Longitudinal pattern for total sulfate grouped by 10-year periods for each station.

5.1.1.2 Solids/Turbidity

The total dissolved solids concentrations are the highest at Station 1 (289 mg/L) and reflect the geothermal influence on ion chemistry as noted above for certain parameters. As streamflow passes through Hebgen Lake, the dissolved solids concentration is reduced by -33 % and remains relatively constant through the Madison River sites (Figure 5-12). A +13 % increase in total dissolved solids is observed at Station 5, downstream of the Three Forks confluences, followed by relatively constant concentrations (~212 mg/L) through Station 10. Total dissolved solids at all sites were the lowest in 1997 and increased through the early 2000s, and have remained slightly lower, albeit variable through the present (Appendix B). At all stations, total dissolved solids concentrations showed a slight decrease over the last 10-year period (-7 to -3 %).

Measurable amounts of total suspended solids are typically reported for stations 1, 5, 9, and 10 while results are typically less than the detection limits for the remaining stations (Figure 5-13). Hebgen Lake and Canyon Ferry greatly reduce the solids content in streamflow which is also evident in the water clarity (turbidity) measurements for stations 2 and 6 (Figure 5-14). Turbidity generally increases in the Madison River in a downstream fashion and peaks at Station 5 (~17 NTU, Station 1 to 5 increase of +382 %). Turbidity decreases from stations 5 to 6 by -85 %, remains relatively low through stations 7 and 8 (~3 NTU), and notably increases by +618 % in streamflow upstream of the Great Falls (~14 NTU). Turbidity was also greater in 2019 and 2020 at all stations than in previous years (Appendix B). Between the two 10-year periods, total suspended solids have decreased in the Madison River (-16 to -4 %) and total suspended solids and turbidity have predominantly increased in the Missouri (-2 to +51 % and +24 to +43 %, respectively).

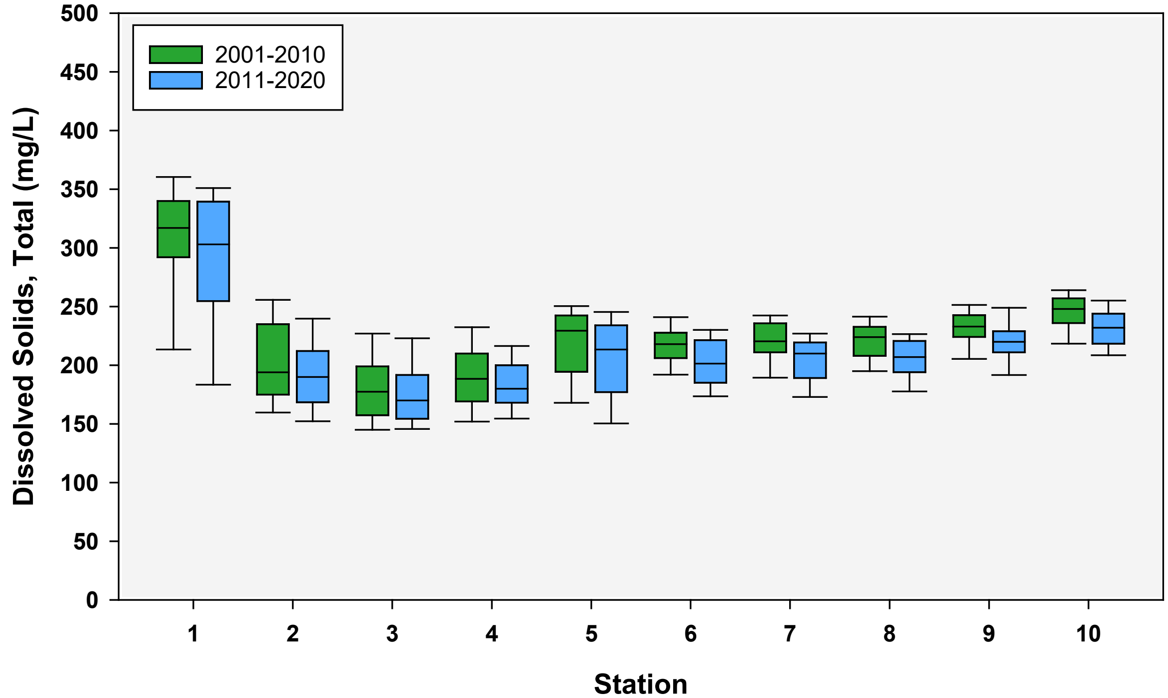


Figure 5-12: Longitudinal pattern for total dissolved solids grouped by 10-year periods for each station.

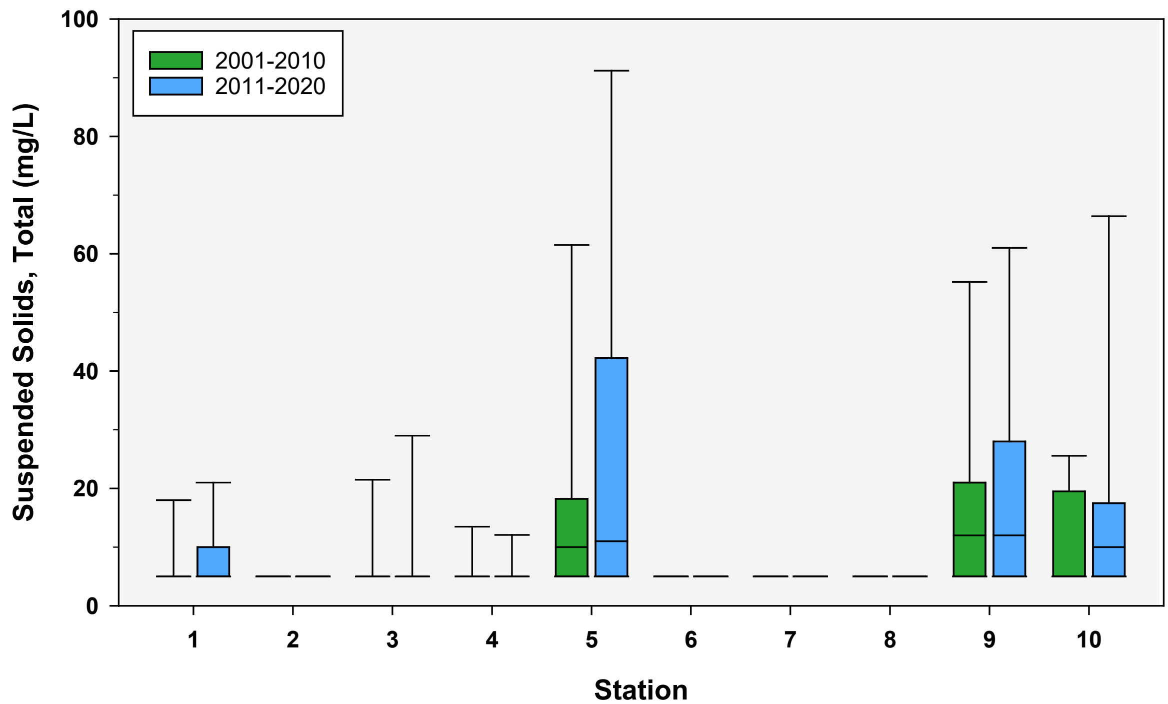


Figure 5-13: Longitudinal pattern for total suspended solids grouped by 10-year periods for each station.

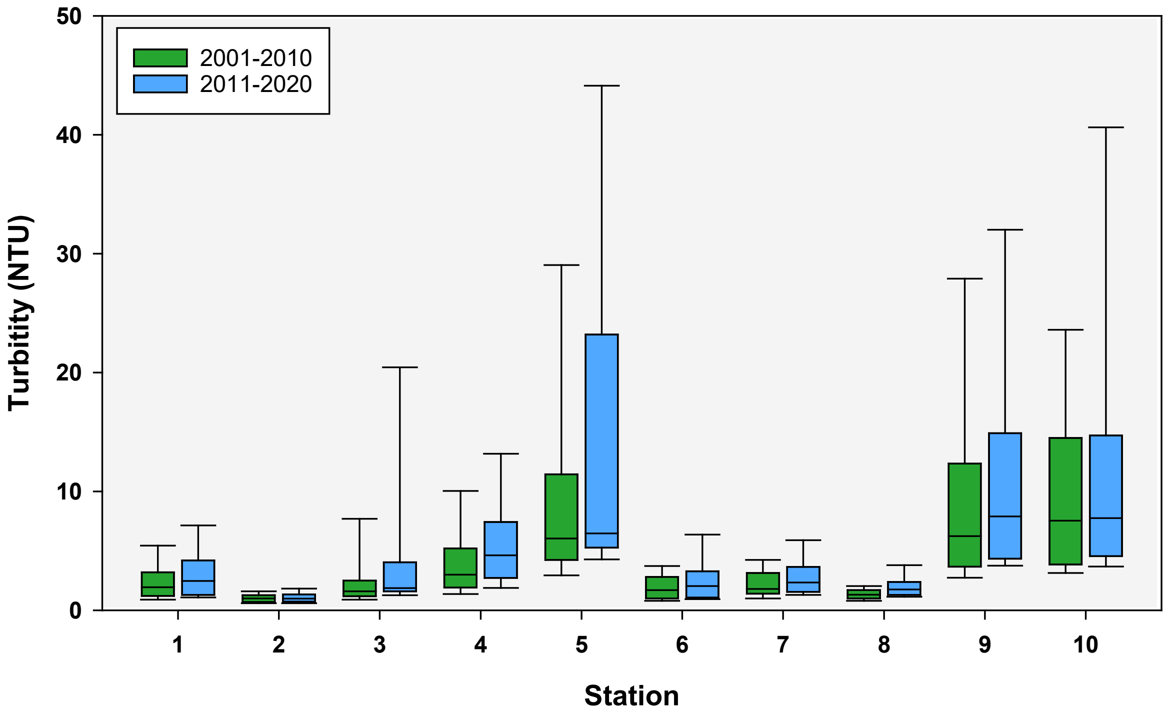


Figure 5-14: Longitudinal pattern for turbidity grouped by 10-year periods for each station.

5.1.1.3 Metals

Arsenic is routinely measured at all sites due to the geothermal influence from the headwaters of the Madison River. Mean arsenic concentrations are the highest at Station 1 (0.24 mg/L) and exhibit a decreasing pattern in concentrations through the Madison River Stations (-87 %; Figure 5-15). This decreasing pattern is attributed to the sorption potential with suspended solids that converts arsenic from an aqueous phase to solid phase (Nimick et al. 1998). Arsenic concentrations notably decrease downstream of the Three Forks confluence (-59 %) due to the increased dilution potential that the Jefferson and Gallatin rivers provide. Arsenic concentrations are further reduced downstream of Canyon Ferry (-22 %) and remain relatively constant through Station 10 where concentrations represent a 10-fold decrease from Station 1. Arsenic concentrations in the Madison River, and upstream of Canyon Ferry, have changed little (-5 to -2 %) between the 10-year periods, while concentrations in the Missouri River, downstream of Canyon Ferry, have decreased by -18 to -10 %.

These results differ from the previous Water Quality and Biological Monitoring Trend Analysis report (GEI 2017) where an increase in arsenic concentrations were observed during the second 10-year period in the Madison River. In fact, arsenic concentrations from 1997 to 2020 at all sample stations were lowest in 1997, increased to their highest values in the early 2000s (roughly 2002 to 2005), and overall, gradually decreased through 2020 (Appendix B). The low concentrations in the late 1990s resulted in the mean values for 1996 to 2006 being lower than

2007 to 2016. The 1997 to 2000 data are not included in this report and, as a result, the mean values for 2001 to 2010 are greater than 2011 to 2020.

Total copper, total iron, and total manganese were the only other metal parameters that generally exhibited detectable concentrations at multiple stations along the Madison and Missouri Rivers (Figure 5-17, Figure 5-18, Figure 5-20). Notably, stations 9 and 10 are the only stations currently sampled under the 2011 SAP, although all stations were sampled in 2011. Measured concentrations for these parameters were slightly above detection limits. Concentrations for total cadmium, total lead, and total zinc were generally less than detection limits (Figure 5-16, Figure 5-19, Figure 5-21).

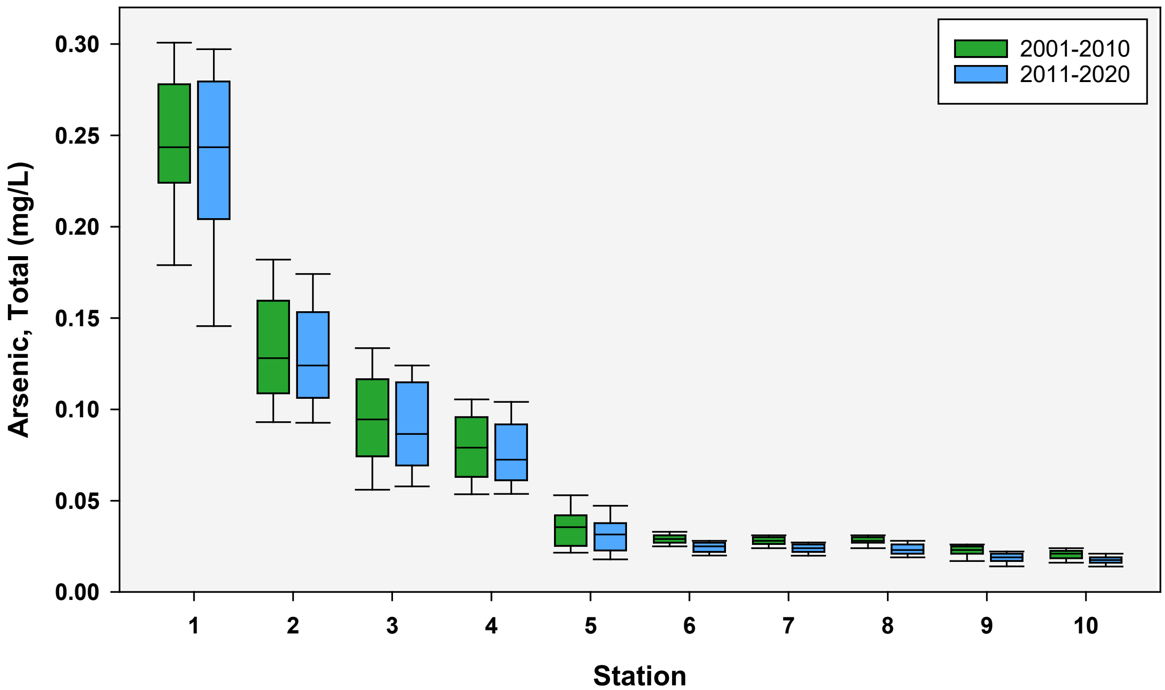


Figure 5-15: Longitudinal pattern for total arsenic grouped by 10-year periods for each station.

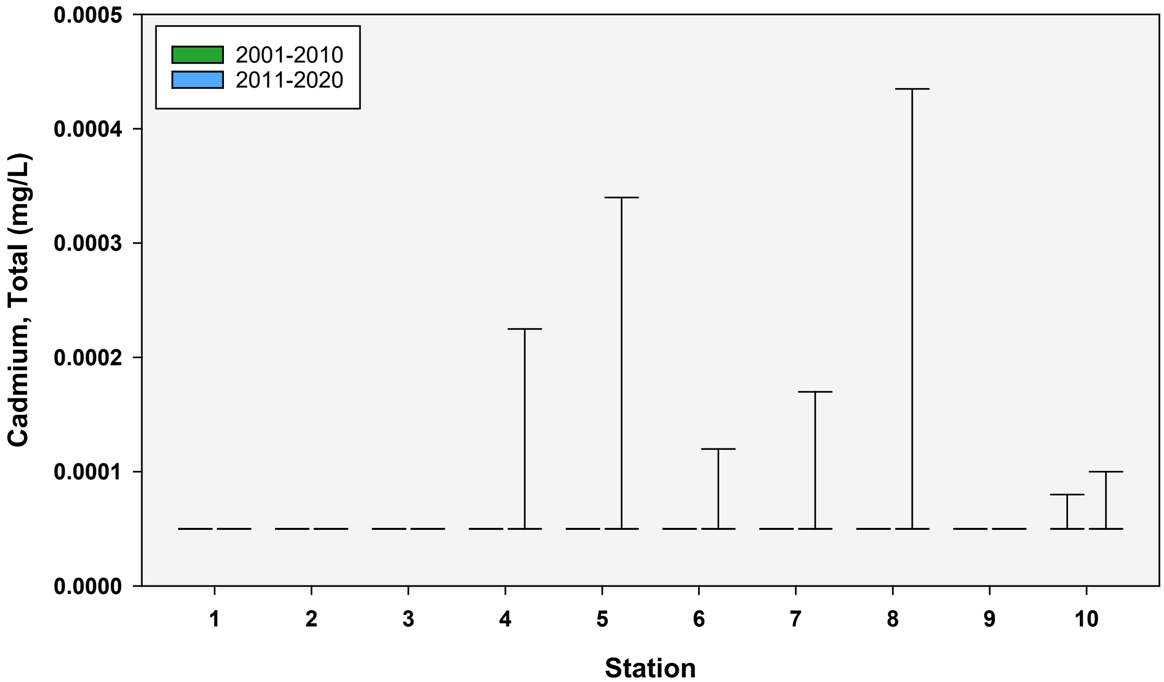


Figure 5-16: Longitudinal pattern for total cadmium grouped by 10-year periods for each station.

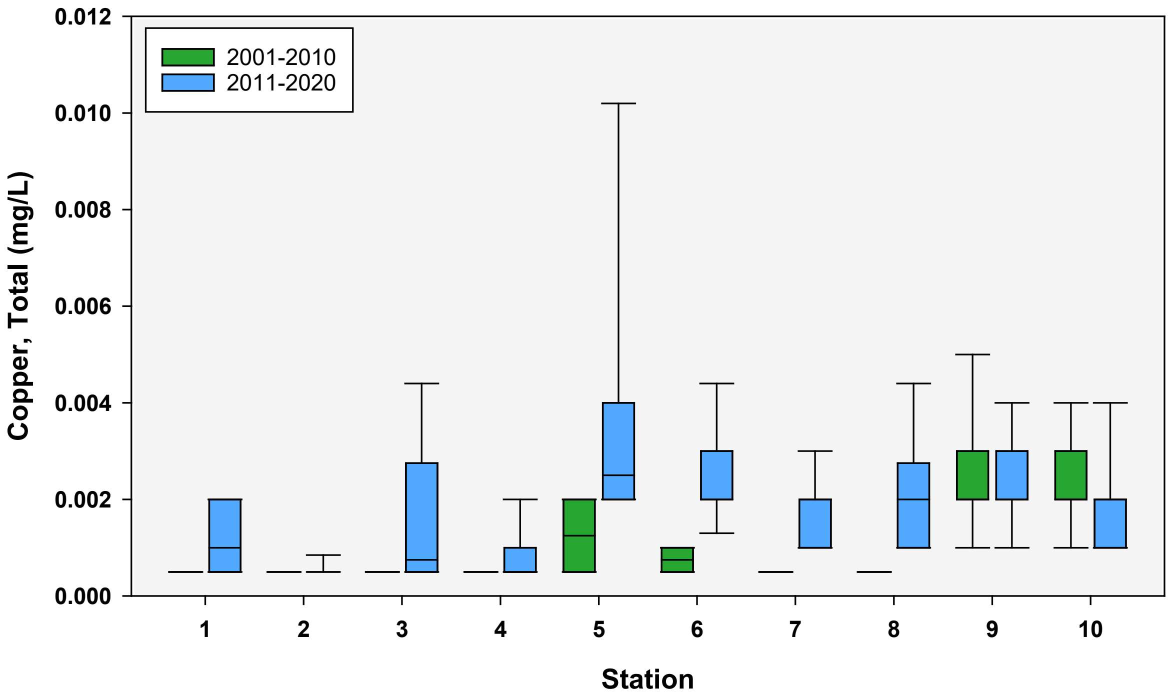


Figure 5-17: Longitudinal pattern for total copper grouped by 10-year periods for each station.

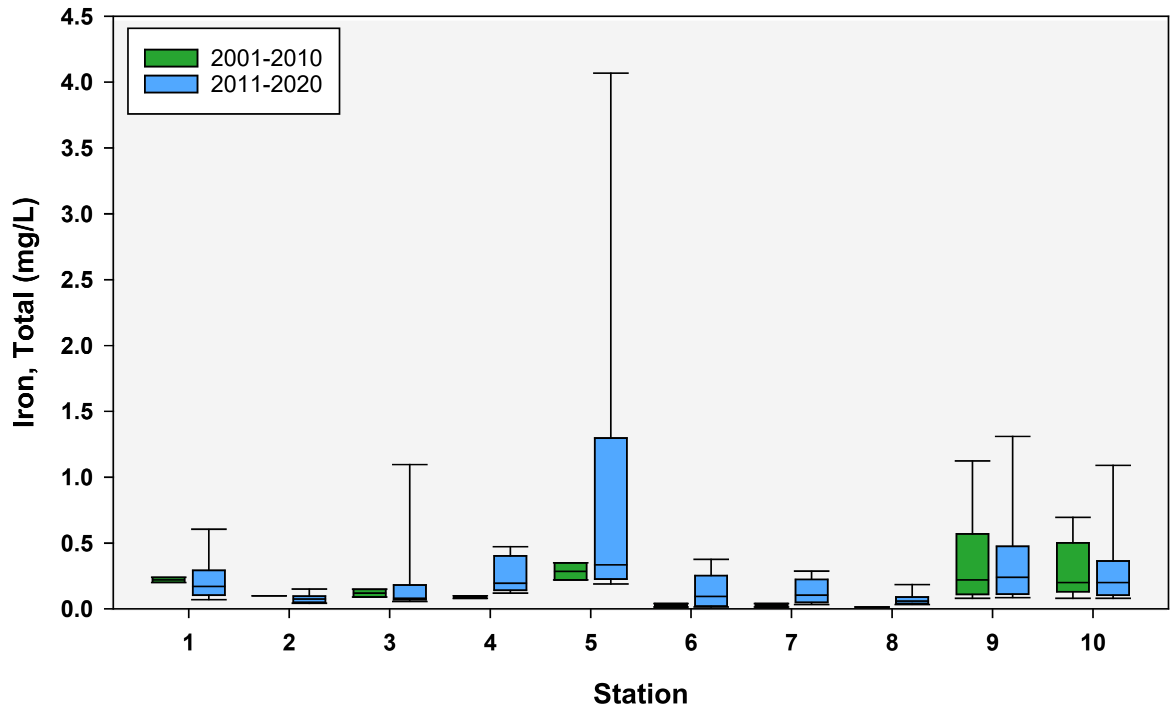


Figure 5-18: Longitudinal pattern for total iron grouped by 10-year periods for each station.

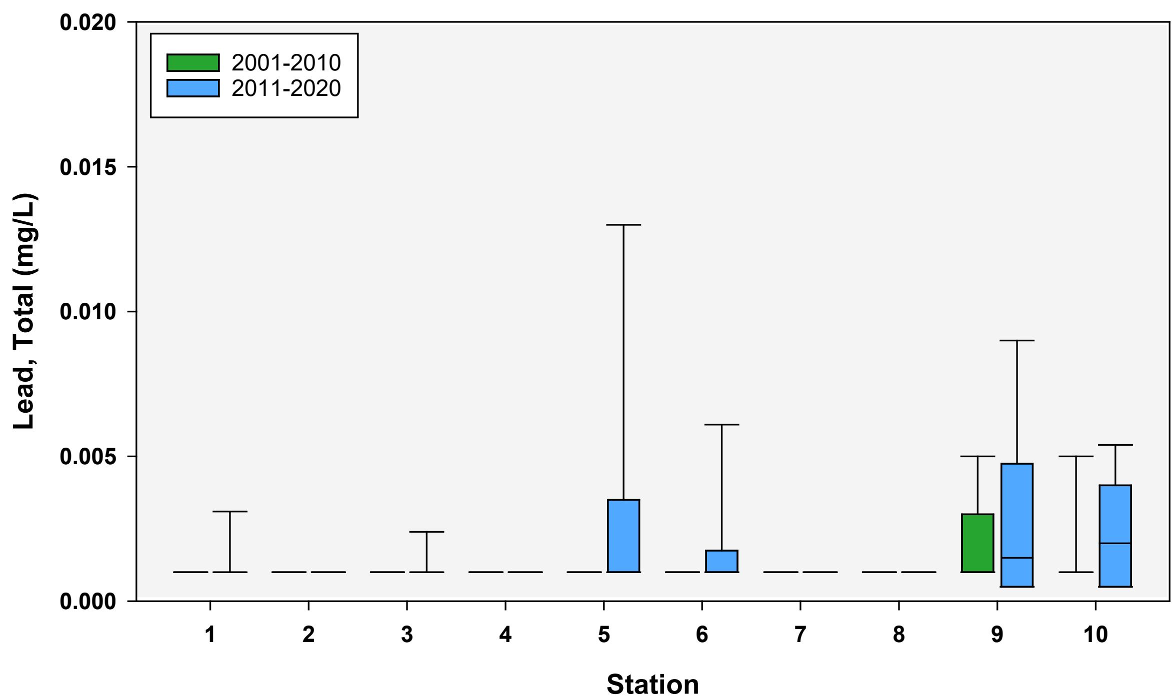


Figure 5-19: Longitudinal pattern for total lead grouped by 10-year periods for each station.

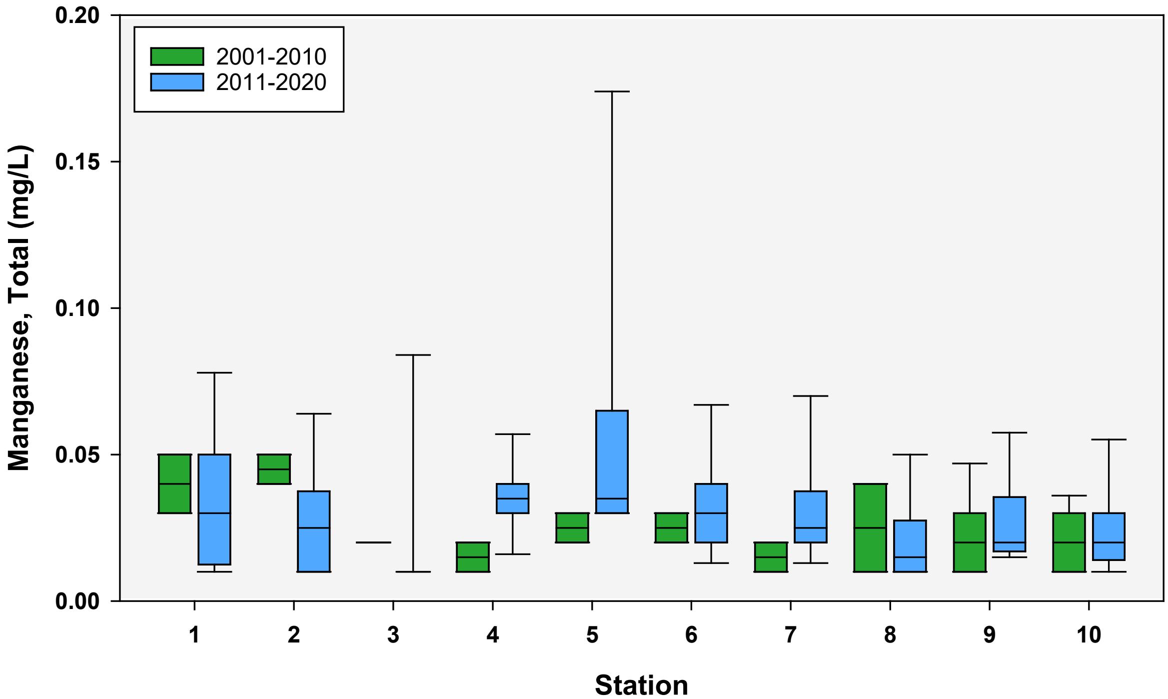


Figure 5-20: Longitudinal pattern for total manganese grouped by 10-year periods for each station.

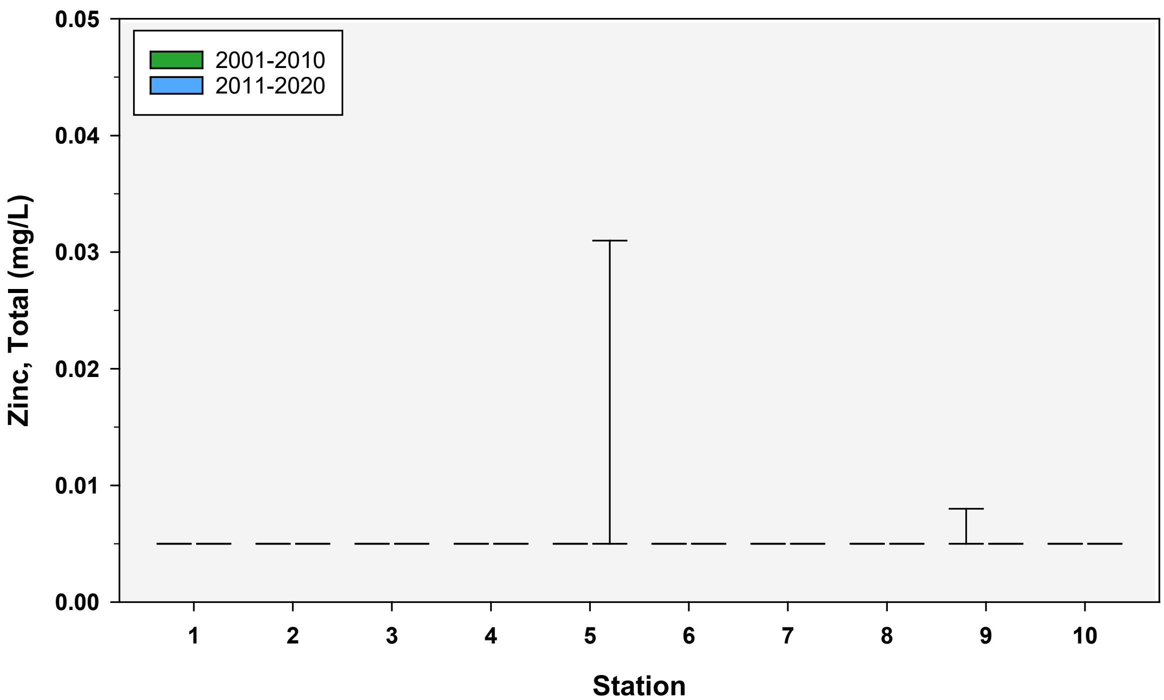


Figure 5-21: Longitudinal pattern for total zinc grouped by 10-year periods for each station.

5.1.1.4 Nutrients

The mean total nitrogen concentration typically ranged from 0.1 to 0.2 mg/L in the Madison River and increased +82 % in the Missouri River, downstream of Three Forks confluences, remaining relatively consistent at 0.4 mg/L from Station 5 through Station 10 (Figure 5-22). Total nitrogen concentrations in the Madison and Missouri rivers tend to be lower in the early 2000s and have indicated a +16 to +40 % increase between the current two 10-year periods. Nitrite-nitrate concentrations revealed similar patterns in concentrations for both the Madison and Missouri river stations with a +396 % increase between stations 4 and 5 (Figure 5-23, Figure 5-24. However, nitrite-nitrate concentrations decreased in the Madison River (-39 to -5 %) while they increased in the Missouri River (+9 to +31 %). The mean total phosphorus concentration was approximately 0.03 mg/L in the Madison River, and 0.04 mg/L in the Missouri River (Figure 5-25). On average, total phosphorus concentrations decreased by -28 % in the Madison River sites between the two 10-year periods, while increasing 6 % in the Missouri River sites.

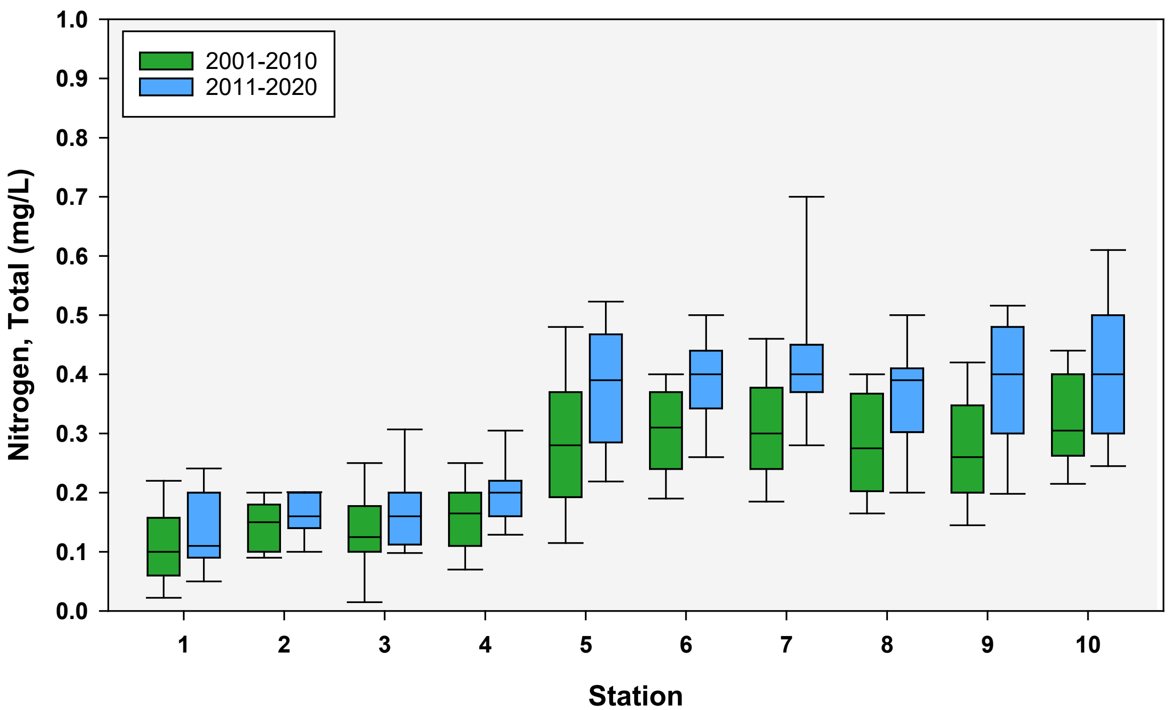


Figure 5-22: Longitudinal pattern for total nitrogen grouped by 10-year periods for each station.

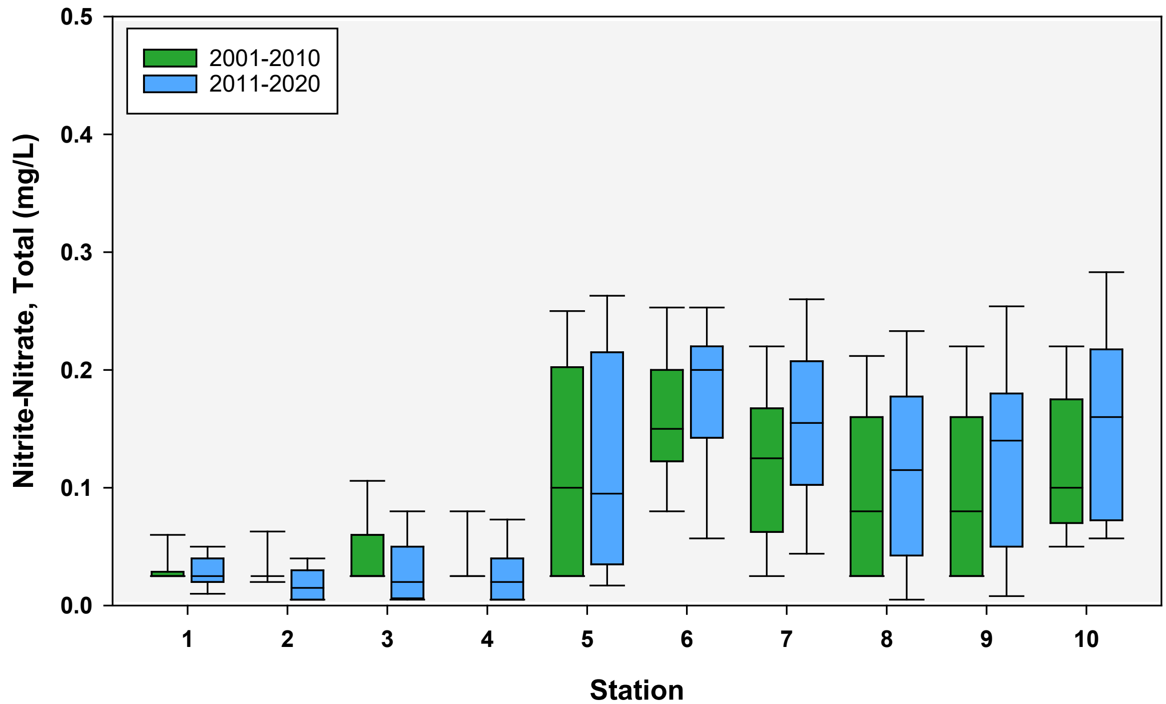


Figure 5-23: Longitudinal pattern for total nitrite-nitrate grouped by 10-year periods for each station.

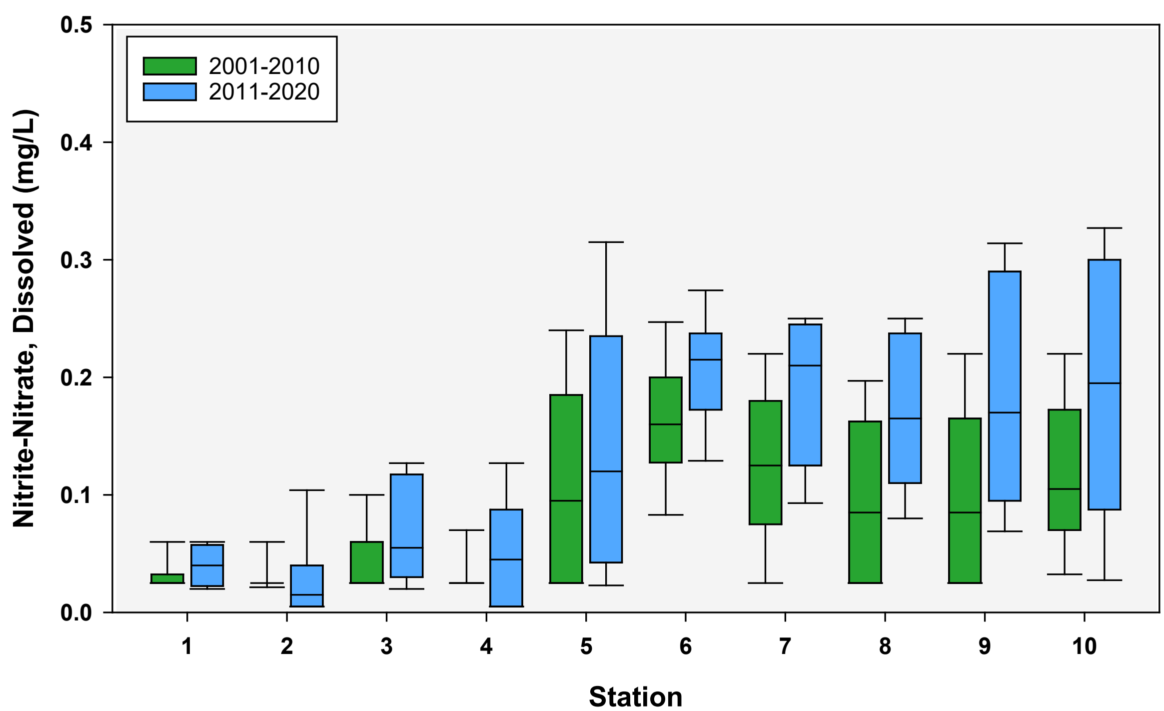


Figure 5-24: Longitudinal pattern for dissolved nitrite-nitrate grouped by 10-year periods for each station.

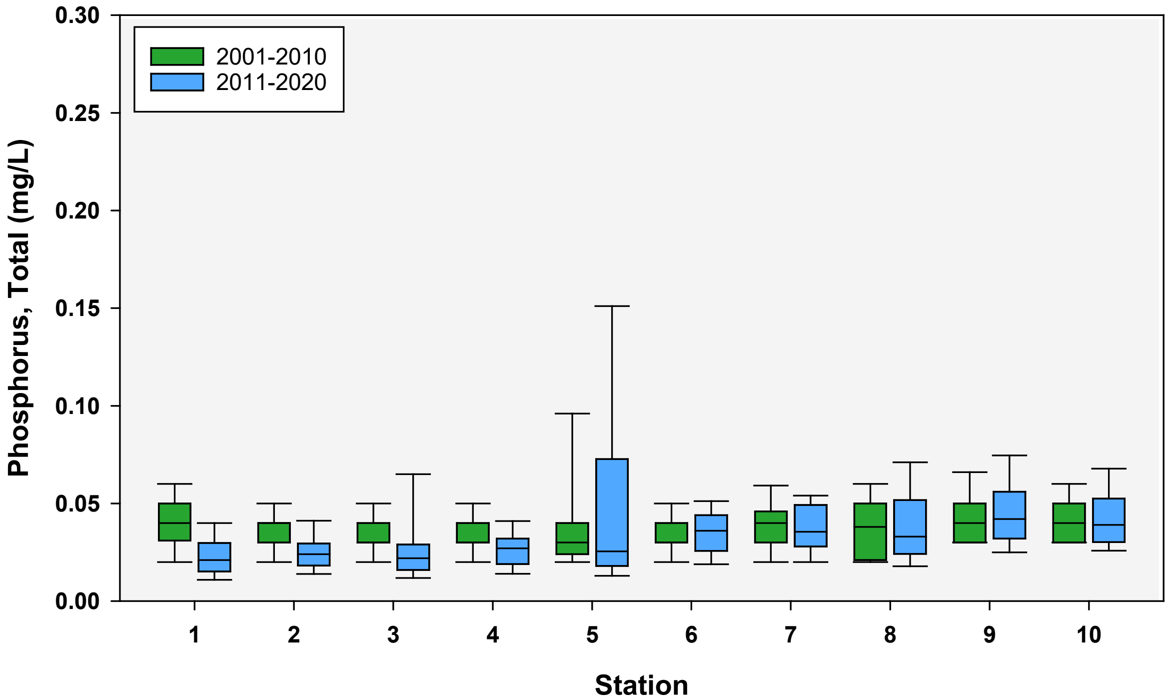


Figure 5-25: Longitudinal pattern for total phosphorus grouped by 10-year periods for each station.

5.1.1.5 Physicochemical

Dissolved oxygen concentrations were typically the lowest at Station 6 (7.4 mg/L and +69.7 % sat.) and highest at Station 3 (9.5 mg/L and +92.6 % sat.) as compared to the other stations (Figure 5-26; Figure 5-27). Dissolved oxygen data is only available from 2011 to the present, and when examined on an annual basis, the concentrations were greater in 2019 and 2020 at all stations as compared to previous years (Appendix B). Overall, dissolved oxygen content is generally higher in the Madison River than in the Missouri River. The dissolved oxygen conditions in both the Madison and Missouri rivers are discussed in more detail in Section 5.1.7.

The mean hydrogen ion concentrations (pH) varied throughout the study reach and were the lowest at Station 1 (7.7 s.u.) and the highest at Station 10 (8.24 s.u.; Figure 5-28). Notably, little change occurred between the two 10-year periods (-3 to 0 %) and the mean pH was relatively consistent between stations, specifically stations 4 and 5 that bracket the Three Forks confluence reach.

The mean specific conductance was greatest at Station 1 (387 µS/cm) and decreased notably (-31 %) as flows passed through Hebgen Lake (Figure 5-29). Specific conductance levels remained relatively consistent through Station 4 and increased by +16 % downstream of the Three Forks confluence reach. Specific conductance levels remained relatively consistent through Stations 6, 7, and 8, and slightly increased at stations 9 and 10, near Great Falls (+7 and +6 %, respectively). Specific conductance at all stations has decreased by approximately -9 to -5 % between the two 10-year periods.

These results differ from the previous Water Quality and Biological Monitoring Trend Analysis report (GEI 2017) where an increase in specific conductance was observed in the Madison River. In fact, specific conductance from 1997 to 2020 at all sample stations were lowest in 1997, increased to their highest values in the early 2000s (roughly 2001 to 2005), and overall, gradually decreased through 2020 (Appendix B). The low concentrations in the late 1990s resulted in the mean values for 1996 to 2006 being lower than 2007 to 2016. The 1997 to 2000 data are not included in this report and, as a result, the mean values for 2001 to 2010 are greater than 2011 to 2020.

Mean water temperature varied little throughout the study reach and were the lowest at Station 3 (6.6 °C) and a maximum at Station 10 (9.5 °C; Figure 5-30). Notably, little change occurred between the two 10-year periods (-4 to +9 %). Although the relative change in water temperature between stations was more variable with the largest percent decrease occurring between stations 2 and 3 (-18 %) while the largest increase occurred between stations 3 and 4 (+34 %).

Many of the patterns in the water quality data are closely associated with flow conditions. For example, the decrease in specific conductance, as noted for the both the Madison and Missouri River stations, is closely tied to the increase in flow conditions observed between the two 10-year periods which have a diluting effect on this parameter. As to be expected, based on the increasing watershed size upstream of each station, daily median flows from 2011 to 2020 increased from Station 1 (436 cfs) to Station 10 (5,850 cfs) with the Jefferson and Gallatin rivers providing the largest step increase in flow (2,240 cfs) between stations (Figure 5-31). At the Madison River stations, the median flow conditions between the two 10-year periods increased by +10 to +14 %, whereas the median flow conditions in the Missouri River stations have increased by +14 to +25 %. The influence of Jefferson, Gallatin, and Sun River watersheds have provided more flow during the last 10-year period as compared to the upper Madison watershed.

These results differ from the previous Water Quality and Biological Monitoring Trend Analysis report (GEI 2017) where a decrease in median flow between the two 10-year periods was observed in the Madison River. In fact, the 1996 to 1999 hydrological conditions represented wet-year conditions at all sample stations, with annual flow conditions decreasing to some of their lowest values in the early 2000s (roughly 2001 to 2004), then flows have gradually increased through 2020 (Appendix B).

The variability in flow conditions (2011-2020) at each station have been greater than observed during the 2001-2010 period which exhibited less extreme low and high flow conditions. The median annual flow was calculated for stations 1 and 5 (2011-2020), and ranked from lowest to highest to evaluate the relative flow conditions based on the commonly used wet year type (i.e., >75th percentile flow), dry year type (<25th percentile flow) and the typical flow conditions that range from the 25th to the 75th percentile flow. Based on Station 1's median annual flow condition for each year of the monitoring program (2001-2020), the first 10-year period contained zero of the five wet-year types, three of the five dry-year types, and seven of the 10 years that would be characterized as typical flow conditions (Table 5-2). Whereas the last

10-year period contained all five wet-year types, two of the five dry-year types, and three of the 10 typical flow years. Similarly, at Station 5, the first 10-year period contained zero of the five wet-year types, all 5 dry-year types, and five of the 10 typical flow years, while the last 10-year period contained all five wet-year types, zero dry-year types, and five of 10 typical flow years.

Table 5-2: Median annual flow conditions at stations 1 and 5.

Year	Station 1			Station 5		
	Median Flow (cfs)	Median Flow Rank	Year Type	Median Flow (cfs)	Median Flow Rank	Year Type
2001	406	10	Typical	3,020	16	Dry
2002	385	16	Dry	2,740	20	Dry
2003	373	19	Dry	2,830	19	Dry
2004	389	14	Typical	2,925	18	Dry
2005	388	15	Typical	2,970	17	Dry
2006	405	11	Typical	3,420	13	Typical
2007	375	18	Dry	3,120	15	Typical
2008	411	9	Typical	3,460	11	Typical
2009	417	7	Typical	3,740	7	Typical
2010	390	13	Typical	3,720	8	Typical
2011	457	3	Wet	4,670	1	Wet
2012	437	5	Wet	3,990	4	Wet
2013	400	12	Typical	3,320	14	Typical
2014	427	6	Typical	3,830	5	Wet
2015	383	17	Dry	3,500	10	Typical
2016	369	20	Dry	3,450	12	Typical
2017	469	2	Wet	3,780	6	Typical
2018	472	1	Wet	4,330	2	Wet
2019	455	4	Wet	4,180	3	Wet
2020	417	7	Typical	3,670	9	Typical

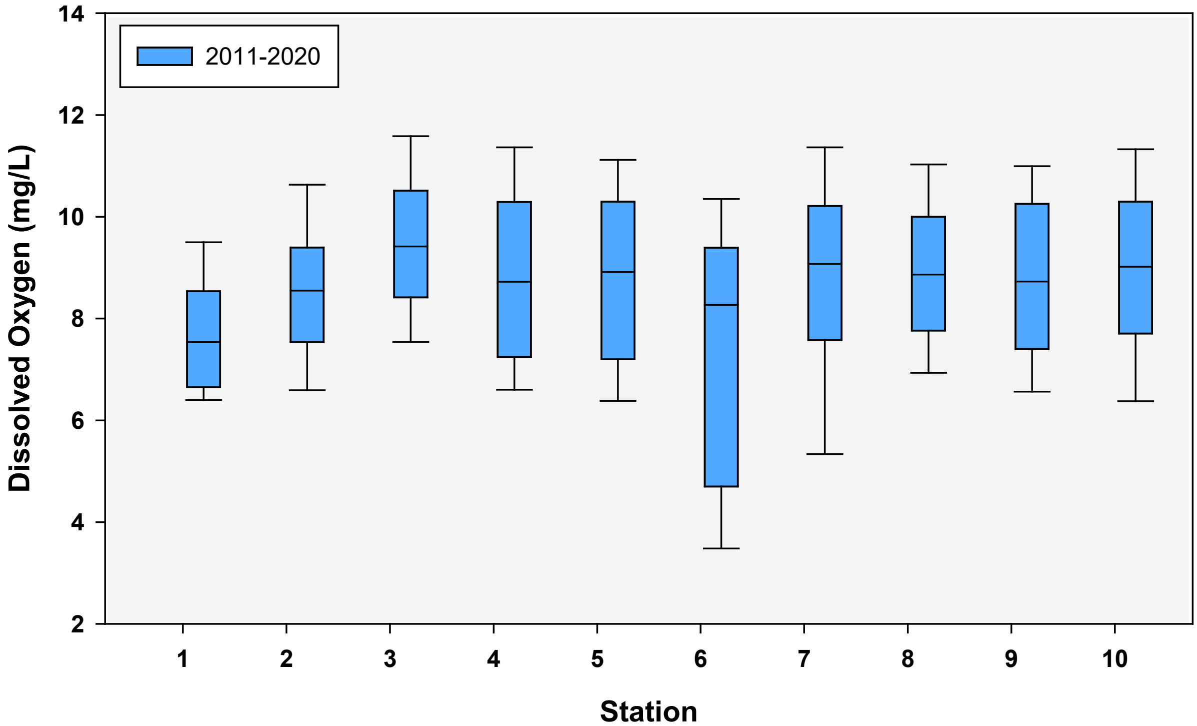


Figure 5-26: Longitudinal pattern for dissolved oxygen for each station.

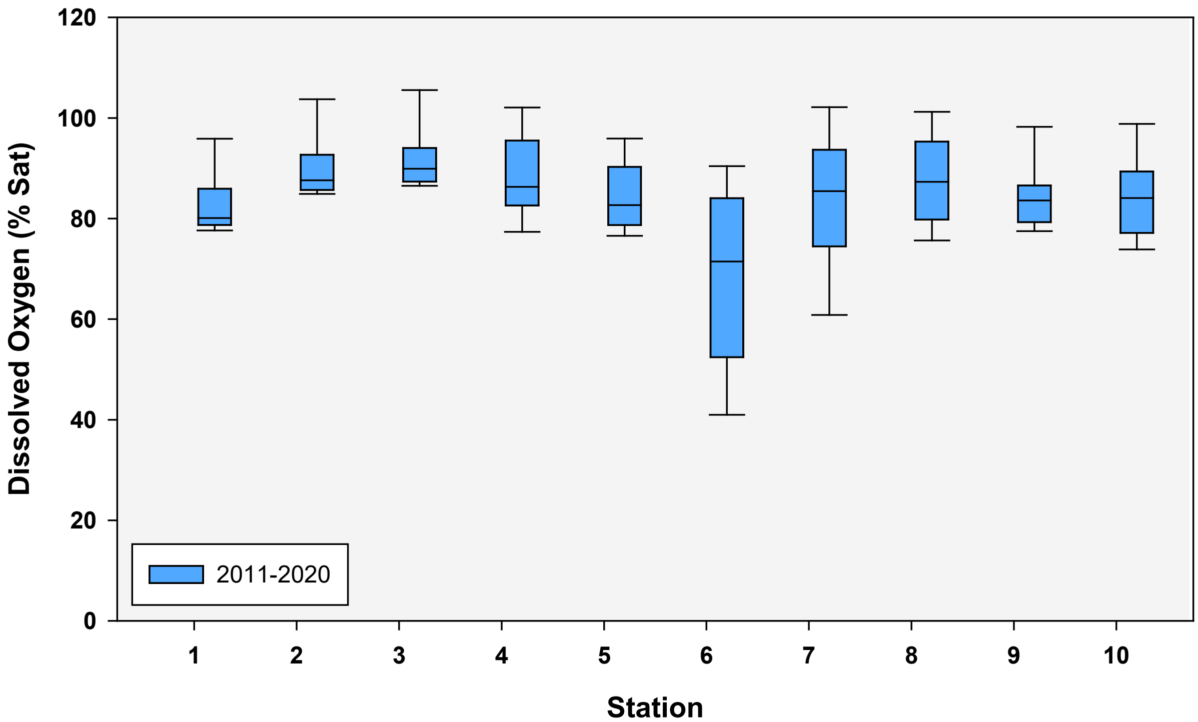


Figure 5-27: Longitudinal pattern for percent saturated dissolved oxygen for each station.

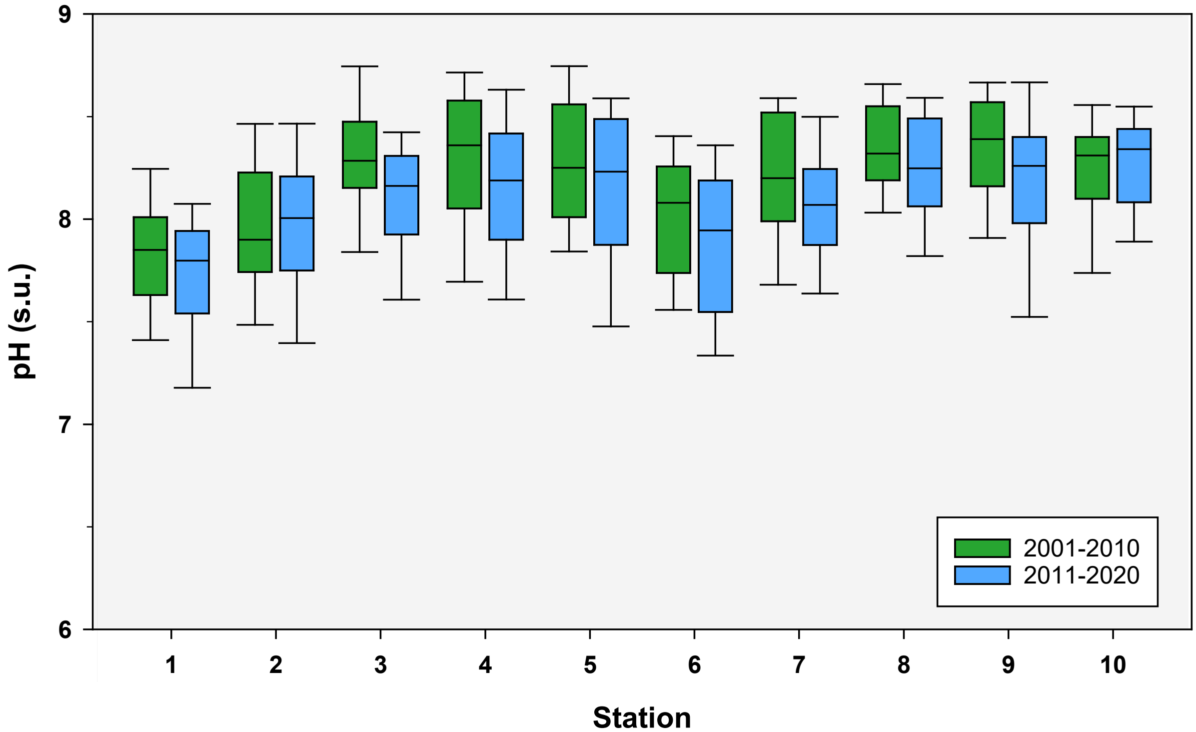


Figure 5-28: Longitudinal pattern for pH grouped by 10-year periods for each station.

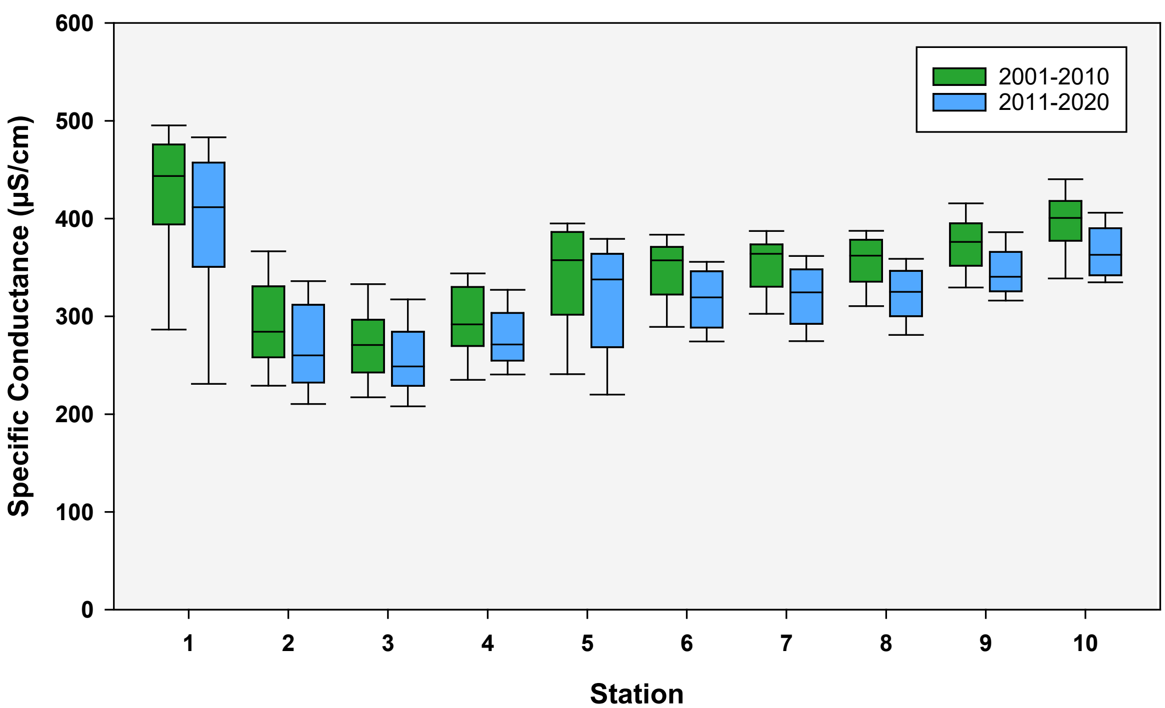


Figure 5-29: Longitudinal pattern for specific conductance grouped by 10-year periods for each station.

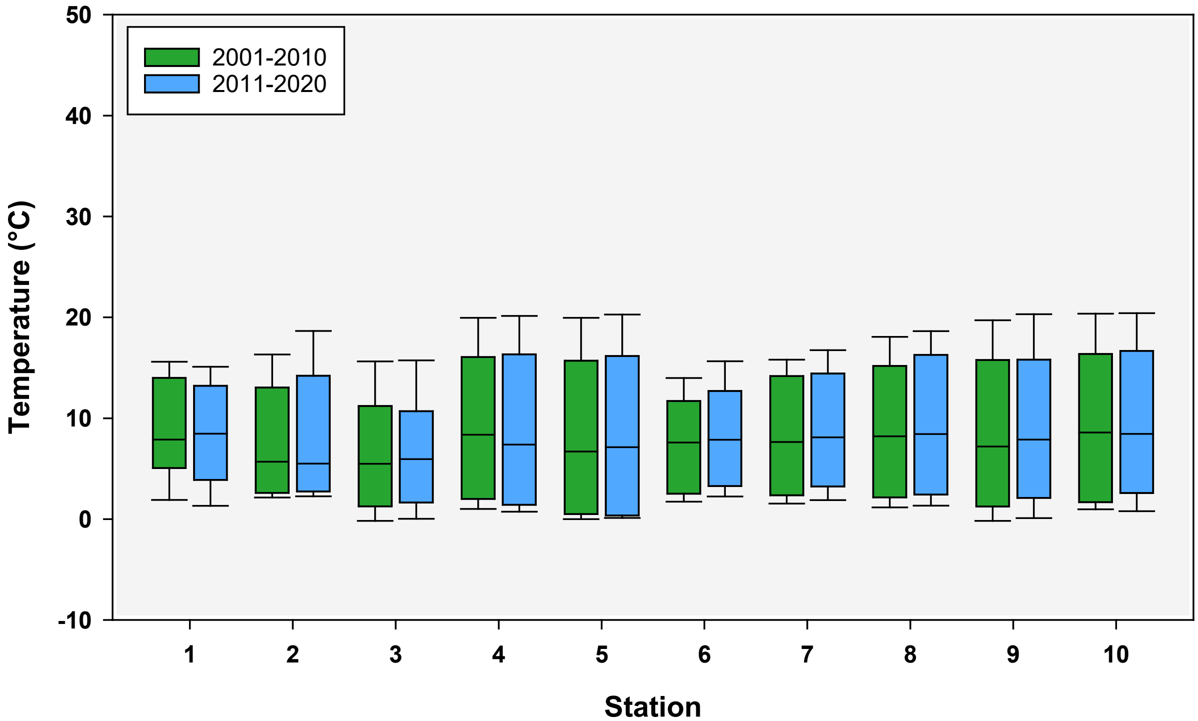


Figure 5-30: Longitudinal pattern for temperature grouped by 10-year periods for each station.

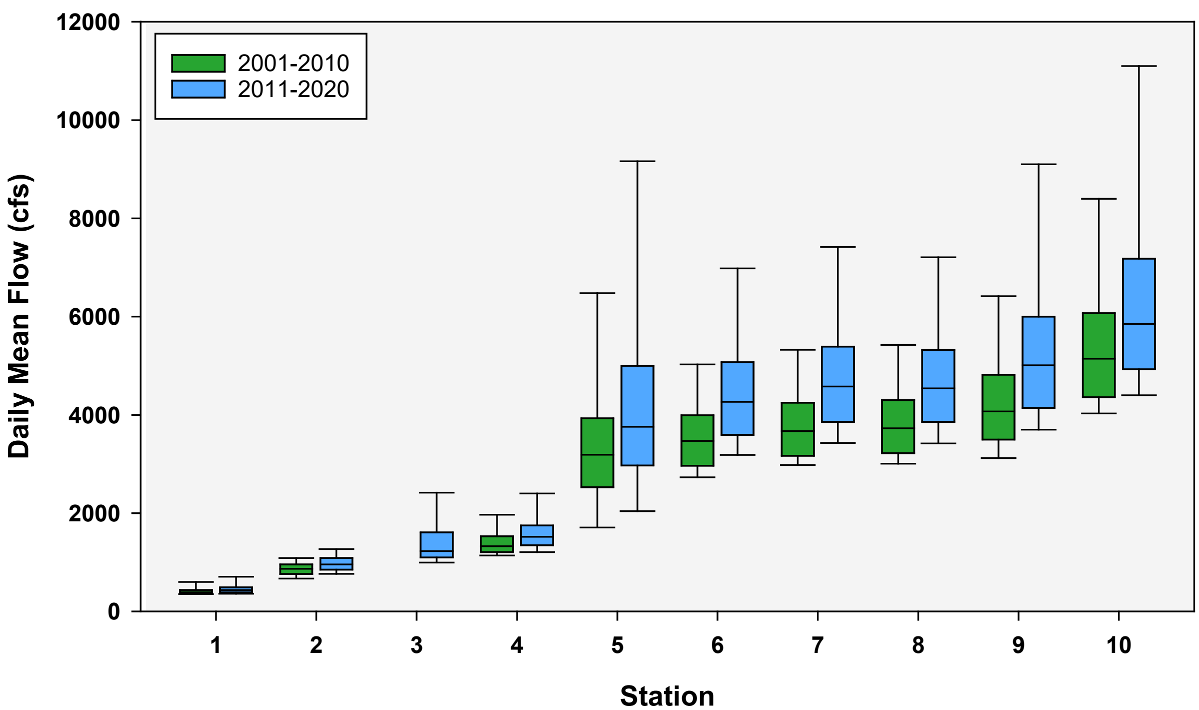


Figure 5-31: Longitudinal pattern for daily mean flow grouped by 10-year periods for each station.

5.1.2 Upstream-Downstream Comparisons

Comparisons of adjacent station pairs (upstream/downstream) were made using the non-parametric Mann-Whitney test for each parameter to identify significant differences between the median values for water quality data collected from 2011 to 2020. The percent change for each parameter between station pairs was calculated to quantify the magnitude and direction of change (Table 5-3). Percent change was calculated by subtracting the median value for the downstream station from the upstream station, divided by the upstream value. Those values highlighted in the table indicate statistically significant differences between stations for a given parameter. Complete test statistics for each comparison (e.g., sample size, Mean Rank and Sum of Rank) are presented in Appendix B. Notably, parameters that contain a large percentage of non-detect values, including parameters for which the median value is near the non-detect limits, may result in spurious statistical results when comparing station pairs. For example, stations that exhibit the same median value (i.e., zero percent change in Table 5-3) even though the distribution characteristics are different (see figures above) may result in a statistical difference based on the non-parametric ranking of values. In these cases, where the percent change in the median values was zero, yet a statistical difference was noted, the significance was removed from Table 5-3. This occurred 5 times among the analyses (dissolved potassium station pair 8/9; total suspended solids station pairs 1/2, 2/3; and total lead station pair 4/5). A graphical representation of the station comparisons discussed below is shown on box plots presented above, and note the comparisons are only for the 2011-2020 box plot data. Overall, results for 2011 to 2020 for all parameters were very similar to that observed in 2007 to 2016 (GEI 2017).

5.1.2.1 Ion Chemistry

Total alkalinity and bicarbonate were statistically different between station pairs 1/2, 2/3, 3/4, 4/5 and 8/9. The largest decrease in concentration was for stations 1/2 at -23 %, whereas the largest increase was observed for and stations 4/5 at +30 %. The median calcium (total and dissolved) and magnesium (dissolved) concentrations exhibited a similar pattern of statistical differences, with the addition of station pair 9/10. However, both calcium and magnesium concentrations increased in all the downstream station pairs. Total calcium increased +67 % for station pairs 1/2, +50 % between stations 2/3, +40 % between 3/4, and +76 % between 4/5. Dissolved magnesium concentrations were very low near detection limits for stations in the Madison River, thus large percent changes (i.e., statistical differences) were noted for the station pairs, including the stations that bracket the Three Forks confluence reach.

Total chloride, dissolved sodium, and potassium (total and dissolved) concentrations generally revealed statistically significant decreases for station pairs 1/2, 2/3, 4/5, and 5/6. The differences observed between stations 5/6 were the only statistically significant changes for ion concentrations. Notably, the differences observed between stations 3/4 were not statistically significant.

Total sulfate generally exhibited a pattern similar to alkalinity and bicarbonate with respect to statistical differences observed between upper station pairs. A significant decrease (-25 %) in concentrations was observed for stations pairs 1/2, while statistically significant increases in concentrations were observed for station pairs 2/3, 3/4, 4/5, 8/9, and 9/10. The largest increase in concentration (+148 %) occurred between the stations that bracket the Three Forks confluence reach. Notably, there were no statistically significant differences noted between station pairs 6/7 and 7/8 for anion/cation parameters which are the stations that bracket Hauser and Holter dams. It is worthwhile to note that alkalinity, calcium, chloride, magnesium, potassium, sodium, and sulfate and total dissolved solids were not generally influenced by the Canyon Ferry, Hauser, Holter, or Morony hydro facilities. Shifts in these parameters were generally observed at Central Ave (8/9 pair) and were related to the influence of the Sun River.

5.1.2.2 Solids/Turbidity

Total dissolved solids concentrations exhibited a similar pattern in statistical differences between station pairs that was observed for alkalinity and bicarbonate. The largest significant decrease was observed between station pair 1/2 at -37 % and concentrations continued to decrease between station pair 2/3 (Table 5-3). The largest significant increase in concentration (+19 %) was observed for stations pair 4/5 that bracket the Three Forks confluence reach. Total suspended solids exhibited significant differences between station pairs 4/5 (+120 %), 5/6 (-55 %), and 8/9 (+140 %). The increase is suspended solids at stations 5 and 9 are due to the tributary inputs from the Three Forks confluence reach and the Sun River/Muddy Creek, respectively. The significant decrease between stations 5/6 is due to the storage effects of Canyon Ferry.

Turbidity was statistically different between all station pairs with the exception of 6/7 and 9/10. The percent change in median values between stations ranged from -68 to +348 %. Turbidity was the most highly variable analyte between stations. Turbidity decreased by -61 % downstream of Hebgen Lake, and increased +90 % and +146 % at Varney and the Madison Ennis stations, respectively. Turbidity increased +41 % at Toston, and decreased -68 % downstream of Canyon Ferry. A decrease was also observed downstream of Holter Dam (-25 %). The largest increase (+348 %) was noted at Station 9 due to the influence of the Sun River and Muddy Creek.

5.1.2.3 Metals

Total arsenic concentrations exhibited statistically significant decreases between all station pairs except 6/7 and 7/8. The largest decrease (-57 %) occurred between stations 4/5 that bracket the Three Forks confluence reach (Table 5-3). This decrease primarily related to the increased dilution potential from the tributary inputs. The second largest decrease (-49 %) was observed downstream of Hebgen Lake. Additional decreases of -21 % and -17 % were apparent downstream of Canyon Ferry and Central Avenue, respectively. The decreases downstream of Hebgen Lake, Canyon Ferry, and Central Avenue likely reflected the additional loss due to the sorption of arsenic with suspended solids. Remaining metals (not shown for brevity) showed no statistical differences between stations 9 and 10.

While total copper, total iron, and total manganese were the only other parameters that generally exhibited detectable concentrations at multiple stations along the Madison and Missouri rivers, only stations 9 and 10 contained a sufficient sample size to evaluate the change in median concentrations. Only total iron exhibited a statistically significant increase in concentration between station pair 8/9, although concentrations remain relatively low, near detection limits.

5.1.2.4 Nutrients

Total nitrite-nitrate was statistically different between station pairs 1/2, 4/5, and 5/6, while dissolved nitrite-nitrate was statistically different between pairs 2/3, 4/5, and 5/6 (Table 5-3). The noted differences between the Madison River stations are largely due to very low concentrations, often near the detection limits, whereas the significant differences noted between stations 4/5 reflect the nitrogen inputs from the Jefferson and Gallatin rivers. These inputs increased the total and dissolved nitrite-nitrate by +375 and +167 %, respectively at Toston. Total and dissolved nitrite-nitrate nitrogen also increased +110 to +79 % downstream of Canyon Ferry, respectively. These increases likely reflect the influence of reservoir nutrient cycling, as well as watershed point and non-point sources.

Total nitrogen was variable between station pairs upstream of Toston with statistical differences between station pairs 3/4 (+25 %), 4/5 (+95 %), and 7/8 (-3 %). Notably, unlike nitrite-nitrate, total nitrogen did not show a significant increase downstream of Canyon Ferry and in fact, only a minimal change at one station pair was observed in the median concentrations further downstream. In addition, the change in concentrations between total nitrogen and nitrite-nitrate was typically in the opposite direction for stations upstream of Madison. The only statistical difference between station pairs for total phosphorus occurred between 8/9, with an increase of +27 %.

5.1.2.5 Physicochemical

The field measured hydrogen ion concentrations (pH) exhibited statistical differences between station pairs 1/2, 5/6, 6/7, and 7/8. These pH differences were generally small, ranging from -3 to +3 % (Table 5-3). Specific conductance exhibited statistical differences between station pairs 1/2, 3/4, 4/5, 8/9, and 9/10, with the only decrease in conductivity occurring between stations 1/2 (-36 %) and reflect the influence of Hebgen Lake on the ionic concentrations and total dissolved solids. Conductivity increased +24 % between stations 4/5 and reflected the influence from the major tributaries at the Three Forks confluence reach.

Dissolved oxygen (mg/L and percent saturation) concentrations were statistically different between station pairs 1/2, 5/6, and 6/7, whereas one or the other parameter was statistically different between station pairs 2/3 and 3/4 (Table 5-3). Dissolved oxygen concentrations decreased significantly between station pair 5/6 revealing the effect of Canyon Ferry Dam on these parameters. Decreased concentrations were also observed downstream of Madison Dam, although the significant effects were mixed as noted above. The annual and seasonal effects of these dams are discussed in greater detail in Section 5.1.7. Dissolved oxygen concentrations increased downstream at Hauser Dam (+10 %) with no significant change occurring further downstream.

Flow was statistically different between station pairs 1/2, 2/3, 3/4, 4/5, and 9/10 which reflected the influence of increasing watershed area. The increase in flow was especially notable between station pair 4/5 (+163 %) which is downstream of the Jefferson, Madison and Gallatin rivers confluence reach.

Table 5-3: Change (%) in median water quality analyte values between stations upstream and downstream of dams from 2011 to 2020. Grey cells indicate a significant ($p < 0.05$) difference in mean ranks as determined by Mann–Whitney U tests.

Analyte	1 and 2	2 and 3	3 and 4	4 and 5	5 and 6	6 and 7	7 and 8	8 and 9	9 and 10
Ion Chemistry									
Alkalinity as CaCO3, Total (mg/L)	-22.8	7.8	12.8	32.2	-3.0	0.4	0.0	7.7	0.0
Bicarbonate as HCO3, Total (mg/L)	-23.5	10.6	12.3	29.6	-4.1	2.0	-1.0	8.4	1.2
Calcium, Total (mg/L)	66.7	50.0	40.0	76.2	-4.1	1.4	1.4	4.1	5.3
Calcium, Dissolved (mg/L)	66.7	60.0	31.3	73.8	-1.4	1.4	1.4	8.1	7.5
Chloride, Total (mg/L)	-50.0	-28.3	-10.5	-32.4	-17.4	5.3	0.0	-20.0	0.0
Magnesium, Dissolved (mg/L)	300.0	100.0	50.0	83.3	0.0	0.0	0.0	18.2	7.7
Potassium, Total (mg/L)	-37.5	-20.0	0.0	0.0	-25.0	0.0	0.0	0.0	0.0
Potassium, Dissolved (mg/L)	-37.5	-20.0	0.0	-25.0	0.0	0.0	0.0	0.0	0.0
Sodium, Dissolved (mg/L)	-46.2	-25.9	-6.3	-28.8	-14.3	-2.8	2.9	0.0	-5.6
Sulfate, Total (mg/L)	-25.0	11.1	35.0	148.1	-10.4	0.0	3.3	22.6	26.3
Solids/Turbidity									
Dissolved Solids, Total (mg/L)	-37.3	-10.5	5.9	18.6	-5.6	4.2	-1.4	6.3	5.5
Suspended Solids, Total (mg/L)	0.0	0.0	0.0	120.0	-54.5	0.0	0.0	140.0	-16.7
Turbidity (NTU)	-60.5	90.5	146.4	40.7	-68.4	15.2	-25.1	348.0	-1.7
Metals									
Arsenic, Total (mg/L)	-49.1	-30.2	-16.2	-56.6	-20.6	-4.0	-4.2	-17.4	-7.9
Cadmium, Total (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper, Total (mg/L)	-50.0	50.0	-33.3	400.0	-20.0	0.0	0.0	0.0	0.0
Iron, Total (mg/L)	-55.9	6.7	143.8	71.8	-71.6	10.5	-42.9	300.0	-16.7
Lead, Total (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	33.3
Manganese, Total (mg/L)	-16.7	-60.0	250.0	0.0	-14.3	-16.7	-40.0	33.3	0.0
Zinc, Total (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nutrients									
Nitrite Nitrate, Total (mg/L)	-40.0	33.3	0.0	375.0	110.5	-22.5	-25.8	21.7	14.3
Nitrite Nitrate, Dissolved (mg/L)	-62.5	266.7	-18.2	166.7	79.2	-2.3	-21.4	3.0	14.7
Nitrogen, Total (mg/L)	45.5	0.0	25.0	95.0	2.6	0.0	-2.5	2.6	0.0
Phosphorus, Total (mg/L)	14.3	-8.3	22.7	-5.6	41.2	-1.4	-7.0	27.3	-7.1
Physicochemical									
Dissolved Oxygen (mg/L)	15.1	9.7	-4.6	-1.8	-7.3	9.7	-2.3	-1.5	3.3
Dissolved Oxygen (% Sat.)	8.9	2.9	-4.2	-3.9	-13.6	19.6	2.2	-4.2	0.6
pH, Field (s.u.)	2.6	2.0	0.3	0.6	-3.5	1.6	2.2	0.1	1.0
Specific Conductance (µS/cm)	-36.4	-4.7	9.2	23.9	-5.4	1.6	0.2	4.7	6.6
Water Temperature (ºC)	-35.1	8.0	17.5	2.2	10.4	3.0	4.1	-6.7	7.3
Hydrology									
Flow (CFS)	122.7	36.2	21.7	163.4	4.6	12.0	-1.7	14.1	12.2
Flow (probability)	3.6	-4.8	16.7	0.3	0.5	5.1	-1.1	0.7	-7.8

5.1.3 Parameter Correlations

Correlation between individual parameters by station was evaluated using the non-parametric Kendall-tau statistic. This provided an assessment establishing which parameters were statistically associated. A combination of a strong relationship (i.e., correlation coefficient > 0.5) and a statistically significant p-value (i.e., <0.1) between concentration and flow and flow percentile provided the rationale for "flow adjustment" of selected trend analyses. The 2011-2020 data record was used to evaluate data relationships among parameters.

The water quality matrices of cross-correlations are quite extensive and are not detailed in narrative form. Suffice to say that significant correlations between ionic chemistry, specific conductance and total dissolved solids; metals and total suspended solids; or dissolved oxygen and water temperature were expected based on their physicochemical or thermodynamic relationships. There were many other inter-parameter correlations that indicated relationships such as dissolved nitrite-nitrate and dissolved oxygen. The complete results of cross-correlations (e.g., correlation coefficient, significance, and sample size) for individual stations and parameters are presented in Appendix B.

Parameters that were strongly correlated to flow across multiple stations include:

- Total alkalinity as CACO3
- Total bicarbonate as HCO3
- Total calcium
- Total chloride
- Dissolved potassium (Madison River only)
- Dissolved sodium
- Total suspended solids
- Turbidity
- Total arsenic
- Total iron, and
- Specific conductance

Other parameters such as dissolved magnesium, total sulfate, total nitrogen, total phosphorus, dissolved oxygen (% sat.), and pH exhibited significant relationships to flow, but the correlation coefficients indicated a high degree of variability in the relationship; therefore, these parameters were not included in the flow-adjusted analyses. Other parameters that exhibited a significant but weak relationship to flow included dissolved calcium, total potassium, total dissolved solids, total copper, total manganese, total nitrite nitrate, dissolved nitrite nitrate, dissolved oxygen (mg/l), and water temperature. However, these relationships were only apparent for a few sites and most all parameters were strongly correlated to the selected parameters above or a small sample size affected the relationship; therefore, these parameters were not included for flow-adjustment either.

5.1.4 Trend Analysis Non-Flow-Adjusted Parameters

Trend analysis for the Missouri-Madison monitoring Stations 1-10 was conducted using the Seasonal Kendall nonparametric test of correlation between date and analyte result. Results less than the detection limits were substituted with a value equal to one-half of the detection limit for trend analyses. The "seasonal" covariate for the trend analysis was based on the raw quarterly data, and in the case of the 2011 monthly data, only the data from February, May, August, and November were selected to minimize sample size bias. No adjustments were made for potential influence of autocorrelation. Autocorrelation is the tendency for sequential data points to be related and not fully independent. e.g. high values tend to follow highs. Autocorrelation can lead to a tendency to identify trends more frequently, and some of these apparent trends may be an artifact of autocorrelation. Seasonal adjustment is a common approach to address this issue if the sampling frequency is relatively high (i.e., weekly or bi-monthly). However, for analyses using less than ten years of quarterly data, the seasonally adjustment is generally not beneficial due to the small sample size. On the other hand, because the hydrological cycle is driven by snowmelt runoff and corresponds roughly to the seasonal component, the flow-adjustment will help minimize the effect of autocorrelation, although the sampling frequency reduces that effect too. The results for trend tests not adjusted for flow are summarized in Table 5-4. Box plots for parameter/station combinations over time show the trends graphically and are presented in Appendix B. Notably, the Seasonal Kendall Trend analysis evaluates the relationship sequentially over time (year) and season (month) rather than combining data by year as presented in the boxplots. Therefore, trend lines are not included on the box plots as parameters did not necessarily show uniform monotonic trends in concentration over time (2011 – 2020).

To provide some context to the relative change in concentrations over time, the mean concentration for the first three-years was compared to the mean concentration for last three-years for each parameter and station. Note that the reported magnitude of change may have suggested a large change but was not statistically significant using the time series analysis. This resulted in part from underlying high variability in the data and number of non-detect data that provided little variability in the data for some parameters. Notably, the magnitude of change was calculated using the average of three-year endpoints and excluded four years of data in the middle of the monitoring cycle that was greatly affected by flow conditions.

5.1.4.1 Ion Chemistry

Total alkalinity exhibited a statistically significant decreasing trend ($p < 0.05$) over time for Station 6 (Table 5-4). In addition, the percent change in the median total alkalinity concentration from the first three years compared to the last three years of the 10-year period also decreased (-3.5 %, Table 5-5). Bicarbonate exhibited no significant trends at any stations. Total and dissolved, calcium and potassium exhibited statistically significant trends over time for all stations except for dissolved calcium at Station 5 (Table 5-4). Total calcium and potassium trends tended to increase, dissolved calcium decreased, and dissolved potassium was variable. However, these parameters were analyzed only either the first or second half of the 10-year period because of the analytical method change from unfiltered (total) to filtered (dissolved) samples; thus, the results should be interpreted carefully. Total sulfate significantly increased at Stations 1 and 3 (Table 5-4) and increased between the first and last three years (+6.1 and +8.6 %, respectively; Table 5-5). Total chloride, dissolved magnesium, and dissolved sodium concentrations did not indicate any trends over time at any of the Madison-Missouri stations. Overall, little consistency was observed among the significant trends and again the switch in analytical methods influenced the analyses.

Ion chemistry trends were different in 2011 to 2020 than in 2007 to 2016 (GEI 2017). During the previous 10-year period, total alkalinity and total bicarbonate concentrations exhibited statistically significant increasing trends over time for Stations 1, 2, and 3 in the Madison River. Dissolved magnesium and total potassium each exhibited statistically significant trends over time for only a select few stations. Total sulfate concentrations did not indicate any trends over time at any of the Madison-Missouri stations.

5.1.4.2 Solids/Turbidity

Total dissolved solids concentrations exhibited a significantly increasing trend over time at Stations 1 and 7 (Table 5-4) and increased by +3.7 and +4.1 %, respectively (Table 5-5), between the first three years and last three years of the 10-year period. Total dissolved solids also increased at all other stations, but the slope of the trend was not significantly from zero. No significant trends for total suspended solids and turbidity measurements over time were observed for any Madison-Missouri stations. Total and dissolved solids and turbidity all increased from the first three-year period to the last three-year period more at Station 9 than any other station (+8, +91, and +102 %, respectively). Overall, solids and turbidity exhibited few trends and remained relatively consistent throughout the monitoring network from 2011 through 2020. For the 2007 to 2016 data, total dissolved solids significantly increased at only Station 1 (GEI 2017).

5.1.4.3 Metals

No metals revealed a significant trend from 2011 to 2020 at any station (Table 5-4). The small sample size for metal analyses throughout the monitoring network hindered the analyses for stations upstream of Great Falls. From 2007 to 2016, total manganese revealed a significant increasing trend at Station 10 (GEI 2017).

5.1.4.4 Nutrients

Patterns in nutrient concentrations were generally decreasing over time with some significant trends existing in the data (Table 5-4). Total nitrite-nitrate concentrations indicate a significant decreasing trend at Station 3 with a -32 % decrease from the first three-year period to the last three-year period (Table 5-5). Total nitrogen concentrations did not significantly trend over time at any station (Table 5-4) while total phosphorus concentrations exhibited significant decreasing trends over time at Stations 1 through 7 ranging from a -47 to -12 % decrease from the first three-year period to the last three-year period (Table 5-5). Phosphorus also decreased at the remaining stations but not significantly. Overall, nitrogen and phosphorus concentrations exhibited decreasing patterns over time; however, the nitrite-nitrate nitrogen concentration was significant at only the one station.

Nutrient data from 2007 to 2016 also indicated an overall decreasing pattern (GEI 2017). However, dissimilar to 2011 to 2020, significant decreasing trends were observed at Stations 9 and 10 for dissolved nitrite-nitrate, Station 9 for total nitrogen, and Stations 1, 3, 5, and 9 for total phosphorus.

5.1.4.5 Physicochemical

A few stations also revealed significant trends in dissolved oxygen and water temperature. Dissolved oxygen data, mg/L and % saturation, revealed statistically significant increasing trends at Stations 3 and 5, respectively (Table 5-4), with both increasing roughly +13 % from the first three-year period to the last three-year period (Table 5-5). Dissolved oxygen conditions improved at the other sites too, but not significantly. There were no significant trends in field pH (Table 5-4), although there was a general decrease in pH with percent changes ranging from -3.8 % to -3.0 %. Water temperature significantly decreased over time at Station 7, downstream of the Hauser Dam (Table 5-4), with the largest percent change in water temperature of any station at -9.8 % (Table 5-5). The stations downstream of Holter Dam also exhibited a large, but not significant, percent decrease in temperature (-8.0 %). Temperature at most other stations and specific conductance at most stations decreased, but not significantly.

The occurrence and direction of significant trends from 2011 to 2020 are different from that in 2007 to 2016. Dissolved oxygen data (mg/L and % saturation) from 2007 to 2016 revealed statistically significant decreasing trends at all stations, except Stations 3 and 5 (GEI 2017). Significant decreasing trends in pH were observed at Stations 6, 7, and 8 and water temperature significantly increased over time at Stations 2, 5, 6, and 8. Flow did not significantly trend but did increase at all stations.

Table 5-4: Seasonal Kendall trends analyses for non-flow adjusted concentrations from 2011 to 2020 at all stations. Grey cells indicate a significant (p <0.05).

Parameter	Statistic	1	2	3	4	5	6	7	8	9	10
Ion Chemistry											
Alkalinity as CaCO3, Total (mg/L)	Tau Correlation Coefficient	0.033	0.022	0.094	-0.178	0.011	-0.261	-0.172	-0.106	-0.058	0.017
	Sig.	0.822	0.893	0.468	0.159	0.963	0.035	0.173	0.409	0.672	0.926
	Slope	0.000	0.000	0.250	-0.388	0.000	-0.333	-0.500	-0.143	0.000	0.000
	N	40	40	40	40	40	40	40	40	39	40
Bicarbonate as HCO3, Total (mg/L)	Tau Correlation Coefficient	0.083	0.056	0.050	-0.122	0.022	-0.206	-0.106	-0.139	-0.064	0.050
	Sig.	0.527	0.685	0.716	0.333	0.887	0.104	0.413	0.279	0.637	0.716
	Slope	0.243	0.268	0.000	-0.056	0.000	-1.056	-0.208	-0.708	0.000	0.000
	N	40	40	40	40	40	40	40	40	39	40
Calcium, Total (mg/L)	Tau Correlation Coefficient	0.784	0.824	0.775	0.794	0.775	0.833	0.853	0.843	0.691	0.848
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Slope	1.000	1.000	1.000	2.000	2.500	-1.750	4.500	3.250	247.900	4.000
	N	16	16	16	16	16	16	16	16	16	15
Calcium, Dissolved (mg/L)	Tau Correlation Coefficient	-0.433	-0.333	-0.400	-0.383	-0.283	-0.425	-0.475	-0.458	-0.333	-0.474
	Sig.	0.002	0.016	0.006	0.009	0.057	0.004	0.001	0.002	0.028	0.001
	Slope	-0.500	-0.500	-1.000	-1.000	-1.000	-1.750	-2.000	-2.000	-1.500	-2.000
	N	24	24	24	24	24	24	24	24	23	25
Chloride, Total (mg/L)	Tau Correlation Coefficient	-0.061	0.0500	-0.094	-0.117	-0.033	-0.011	-0.056	0.000	0.000	-0.056
	Sig.	0.649	0.716	0.468	0.3621	0.817	0.962	0.673	1.000	1.000	0.6718
	Slope	0.000	0.000	-0.155	-0.167	0.000	0.000	0.000	0.000	0.000	0.000
	N	40	40	40	40	40	40	40	40	39	40
Magnesium, Dissolved (mg/L)	Tau Correlation Coefficient	--	0.011	0.028	-0.006	-0.139	-0.117	-0.067	-0.072	-0.047	-0.150
	Sig.	--	0.949	0.770	1.000	0.219	0.300	0.594	0.546	0.733	0.222
	Slope	--	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	40	40	40	40	40	40	40	40	39	40
Potassium, Total (mg/L)	Tau Correlation Coefficient	0.794	0.814	0.843	0.843	0.794	0.804	0.732	0.833	0.667	0.798
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Slope	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	252.100	1.000
	N	16	16	16	16	16	16	17	16	16	15
Potassium, Dissolved (mg/L)	Tau Correlation Coefficient	-0.517	-0.500	-0.258	-0.358	-0.325	-0.317	-0.304	-0.342	-0.342	-0.439
	Sig.	0.000	0.000	0.047	0.010	0.011	0.015	0.025	0.010	0.010	0.000
	Slope	-0.667	-0.500	0.000	-0.333	0.000	0.000	0.000	-0.225	0.000	-0.100
	N	24	24	24	24	24	24	24	24	23	25
Sodium, Dissolved (mg/L)	Tau Correlation Coefficient	0.072	0.022	-0.058	-0.106	-0.083	0.033	0.017	0.050	0.076	0.011
	Sig.	0.587	0.892	0.684	0.412	0.517	0.816	0.927	0.713	0.568	0.963
	Slope	0.156	0.000	-0.083	-0.143	0.000	0.000	0.000	0.000	0.000	0.000
	N	40	40	40	40	40	40	40	40	39	40
Sulfate, Total (mg/L)	Tau Correlation Coefficient	0.272	0.183	0.267	0.172	0.067	0.083	0.039	0.022	0.082	-0.006
	Sig.	0.025	0.127	0.024	0.161	0.608	0.523	0.785	0.892	0.544	1.000
	Slope	0.167	0.000	0.118	0.056	0.000	0.000	0.000	0.000	0.250	0.000
	N	40	40	40	40	40	40	40	40	39	40
Solids/Turbidity											
Dissolved Solids, Total (mg/L)	Tau Correlation Coefficient	0.311	0.044	0.183	0.139	0.206	0.233	0.256	0.122	0.222	0.156
	Sig.	0.014	0.753	0.152	0.281	0.106	0.066	0.043	0.347	0.087	0.226
	Slope	3.125	0.514	1.000	0.929	1.167	1.500	1.071	0.833	2.143	1.062
	N	40	40	40	40	40	40	40	40	39	40
Suspended Solids, Total (mg/L)	Tau Correlation Coefficient	--	--	--	--	-0.211	--	--	--	0.035	-0.083
	Sig.	--	--	--	--	0.071	--	--	--	0.788	0.446
	Slope	--	--	--	--	0.000	--	--	--	0.000	0.000
	N	40	40	40	40	40	40	40	40	39	40
Turbidity (NTU)	Tau Correlation Coefficient	0.172	0.161	0.156	-0.056	-0.167	-0.183	-0.217	-0.122	0.012	-0.006
	Sig.	0.179	0.210	0.226	0.687	0.195	0.152	0.089	0.348	0.963	1.000
	Slope	0.047	0.023	0.033	-0.041	-0.171	-0.037	-0.040	-0.013	0.007	-0.013
	N	40	40	40	40	40	40	40	40	39	40
Metals											
Arsenic, Total (mg/L)	Tau Correlation Coefficient	0.011	0.083	-0.028	-0.061	-0.111	0.006	-0.022	0.044	-0.0818	0.044
	Sig.	0.964	0.531	0.857	0.654	0.388	1.000	0.890	0.751	0.925	0.748
	Slope	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	40	40	40	40	40	40	40	40	39	40

Parameter	Statistic	1	2	3	4	5	6	7	8	9	10
Copper, Total (mg/L)	Tau Correlation Coefficient	--	--	--	--	--	--	--	--	-0.111	-0.173
	Sig.	--	--	--	--	--	--	--	--	0.372	0.144
	Slope	--	--	--	--	--	--	--	--	0.000	0.000
	N	4	4	4	4	4	4	4	4	36	37
Iron, Total (mg/L)	Tau Correlation Coefficient	--	--	--	--	--	--	--	--	-0.144	-0.179
	Sig.	--	--	--	--	--	--	--	--	0.291	0.173
	Slope	--	--	--	--	--	--	--	--	-0.005	-0.008
	N	4	4	4	4	4	4	4	4	36	37
Lead, Total (mg/L)	Tau Correlation Coefficient	--	--	--	--	--	--	--	--	-0.039	-0.185
	Sig.	--	--	--	--	--	--	--	--	0.795	0.140
	Slope	--	--	--	--	--	--	--	--	0.000	0.000
	N	4	4	4	4	4	4	4	4	36	37
Manganese, Total (mg/L)	Tau Correlation Coefficient	--	--	--	--	--	--	--	--	-0.157	-0.117
	Sig.	--	--	--	--	--	--	--	--	0.244	0.382
	Slope	--	--	--	--	--	--	--	--	0.000	0.000
	N	4	4	4	4	4	4	4	4	36	37
Nutrients											
Nitrate Nitrite, Total (mg/L)	Tau Correlation Coefficient	-0.080	-0.136	-0.272	-0.173	0.130	-0.111	-0.154	-0.056	-0.013	-0.099
	Sig.	0.527	0.271	0.032	0.138	0.329	0.406	0.244	0.693	0.960	0.466
	Slope	0.000	0.000	-0.002	0.000	0.003	-0.002	-0.006	0.000	0.000	-0.003
	N	36	36	36	36	36	36	36	36	35	36
Nitrogen, Total (mg/L)	Tau Correlation Coefficient	0.239	-0.233	0.061	-0.139	0.022	-0.161	-0.128	-0.144	0.000	-0.094
	Sig.	0.058	0.063	0.650	0.280	0.893	0.207	0.317	0.262	1.000	0.467
	Slope	0.007	-0.004	0.000	-0.004	0.000	-0.007	-0.003	-0.007	0.000	-0.002
	N	40	40	40	40	40	40	40	40	39	40
Phosphorus, Total (mg/L)	Tau Correlation Coefficient	-0.433	-0.361	-0.356	-0.406	-0.372	-0.328	-0.328	-0.228	-0.246	-0.211
	Sig.	0.001	0.004	0.005	0.001	0.003	0.009	0.008	0.073	0.056	0.096
	Slope	-0.002	-0.001	-0.001	-0.002	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001
	N	40	40	40	40	40	40	40	40	39	40
Physicochemical											
Dissolved Oxygen (mg/L)	Tau Correlation Coefficient	0.187	0.170	0.298	0.123	0.210	0.086	0.148	0.222	0.085	0.235
	Sig.	0.151	0.195	0.021	0.355	0.113	0.533	0.270	0.093	0.549	0.076
	Slope	0.086	0.075	0.132	0.090	0.170	0.074	0.193	0.120	0.052	0.192
	N	40	40	40	40	39	39	39	39	38	39
Dissolved Oxygen (% Sat)	Tau Correlation Coefficient	0.047	0.135	0.228	0.099	0.272	0.074	0.136	0.235	-0.020	0.148
	Sig.	0.746	0.309	0.079	0.459	0.039	0.598	0.313	0.076	0.920	0.270
	Slope	0.158	0.200	0.960	0.711	1.423	0.673	1.943	1.212	-0.073	0.868
	N	40	40	40	40	39	39	39	39	38	39
pH field (s.u.)	Tau Correlation Coefficient	-0.067	-0.189	-0.044	-0.150	-0.078	-0.144	-0.094	0.144	0.012	-0.133
	Sig.	0.623	0.140	0.754	0.245	0.561	0.264	0.474	0.264	0.963	0.304
	Slope	-0.013	-0.026	-0.007	-0.026	-0.010	-0.023	-0.011	0.014	0.000	-0.016
	N	40	40	40	40	40	40	40	40	39	40
Specific Conductance (µS/cm)	Tau Correlation Coefficient	0.056	-0.056	-0.111	-0.167	-0.039	-0.122	-0.178	-0.211	-0.029	-0.200
	Sig.	0.687	0.687	0.396	0.195	0.788	0.348	0.166	0.098	0.853	0.118
	Slope	0.522	-1.307	-2.280	-1.818	-0.407	-2.167	-2.433	-2.553	-0.046	-2.535
	N	40	40	40	40	40	40	40	40	39	40
Temperature, Water (°C)	Tau Correlation Coefficient	0.000	-0.067	0.011	-0.067	0.122	-0.200	-0.344	-0.244	-0.006	0.000
	Sig.	1.000	0.623	0.964	0.623	0.348	0.118	0.006	0.055	1.000	1.000
	Slope	0.001	-0.012	-0.008	-0.059	0.034	-0.081	-0.125	-0.106	-0.010	-0.001
	N	40	40	40	40	40	40	40	40	39	40
Hydrology											
Flow (CFS)	Tau Correlation Coefficient	0.083	0.072	0.225	0.067	0.028	0.111	0.139	0.100	0.094	0.078
	Sig.	0.531	0.591	0.132	0.622	0.858	0.396	0.283	0.446	0.487	0.561
	Slope	2.286	8.333	1.000	12.670	12.000	31.050	60.000	30.000	53.750	45.000
	N	40	40	26	40	40	40	40	40	39	40
Flow (probability)	Tau Correlation Coefficient	0.083	0.072	0.225	0.067	0.028	0.111	0.139	0.100	0.094	0.078
	Sig.	0.531	0.591	0.132	0.622	0.858	0.396	0.283	0.446	0.487	0.561
	Slope	0.004	0.007	0.024	0.006	0.001	0.009	0.015	0.008	0.011	0.007
	N	40	40	26	40	40	40	40	40	39	40

-- Not calculated due to low number of samples or high number of not detected analysis results.
Total cadmium and total zinc not calculated due a high number of not detected analysis results.

Table 5-5: Percent change (%) between the 2011-2013 mean water quality concentration and the 2018-2020 mean water quality concentration at each station. -- = Not part of the 2011 SAP data collection effort.

Parameter	1	2	3	4	5	6	7	8	9	10
Ion Chemistry										
Alkalinity as CaCO3, Total (mg/L)	-1.8	-4.2	0.5	-2.6	-1.3	-3.5	-3.7	-4.4	-0.3	-0.2
Bicarbonate as HCO3, Total (mg/L)	-0.4	-3.7	-0.3	-1.6	-0.5	-5.0	-2.3	-3.7	-0.9	1.2
Chloride, Total (mg/L)	-6.0	-3.3	-6.9	-7.6	0.0	0.6	0.4	3.9	-0.8	0.6
Magnesium, Dissolved (mg/L)	0.0	-3.1	0.0	1.5	-3.5	-5.6	-3.5	-3.1	2.0	-3.7
Sodium, Dissolved (mg/L)	-1.1	-2.0	-2.8	-4.3	1.3	0.0	1.1	3.2	6.4	1.9
Sulfate, Total (mg/L)	6.1	6.3	8.6	6.2	2.5	0.3	1.3	1.3	11.7	-3.5
Solids/Turbidity										
Dissolved Solids, Total (mg/L)	3.7	0.9	0.6	2.0	4.2	2.3	4.1	2.6	8.2	4.3
Suspended Solids, Total (mg/L)	-23.2	0.0	22.8	-20.3	-1.7	0.0	0.0	0.0	90.7	54.1
Turbidity (NTU)	-17.6	23.0	62.7	-20.2	1.8	-39.6	-27.2	-21.9	101.6	29.8
Metals										
Arsenic, Total (mg/L)	-3.7	-0.9	-3.4	-4.2	6.3	4.3	2.3	4.9	-1.4	2.5
Copper, Total (mg/L)	--	--	--	--	--	--	--	--	-30.1	-23.6
Iron, Total (mg/L)	--	--	--	--	--	--	--	--	14.9	-5.3
Lead, Total (mg/L)	--	--	--	--	--	--	--	--	-62.1	-41.7
Manganese, Total (mg/L)	--	--	--	--	--	--	--	--	12.7	0.1
Nutrients										
Nitrite-Nitrate, Total (mg/L)	5.8	18.5	-32.2	-21.5	30.3	4.2	-1.6	20.0	22.3	6.5
Nitrogen, Total (mg/L)	29.1	-11.3	-7.9	-14.2	3.1	-11.3	-7.0	-18.8	5.8	-11.0
Phosphorus, Total (mg/L)	-46.7	-36.8	-12.2	-34.1	-17.7	-20.8	-22.3	-25.8	14.5	-3.9
Physicochemical										
Dissolved Oxygen (mg/L)	12.8	12.4	13.4	9.7	16.5	25.2	23.0	20.9	11.1	16.4
Dissolved Oxygen (% Sat)	9.4	9.1	11.0	7.6	12.7	19.2	15.1	12.5	7.8	8.7
pH (s.u.)	-1.5	-4.1	-3.4	-1.1	-1.8	-1.7	-2.2	0.4	-3.8	-3.0
Specific Conductance (µS/cm)	-1.1	-0.3	-4.6	-4.9	0.4	-3.9	-2.8	-3.4	-1.5	-2.4
Water Temperature (°C)	-7.1	4.0	1.6	-1.9	-1.3	-5.6	-9.8	-8.0	7.0	-2.4

Dissolved and total, calcium and potassium; dissolved nitrite nitrate; and dissolved oxygen were not included in the analysis because sampling did not occur one or both three year time period.
Total cadmium and total zinc not calculated due a high number of not detected analysis results.

5.1.5 Concentration and Flow Relationships

The initial correlation analyses (Appendix B) indicated that parameters including alkalinity, bicarbonate, total calcium, total chloride, dissolved potassium (Madison River only), dissolved sodium, total suspended solids, turbidity, total arsenic, total iron, and specific conductance were generally correlated with flow for most stations in the monitoring network (Section 5.1.3). These 11 parameters were examined more closely in the context of flow conditions observed over time from 2001 to 2020. The initial subset of analytes included five analytes that overlapped with the previous analysis from 1996 to 2016 - total calcium, total chloride, dissolved sodium, total arsenic, total iron, total suspended solids, and specific conductance (GEI 2017).

The following figures display the relationships between the selected parameters and percentile flow conditions for the complete data record 2001 to 2020, by station. For each station, the 20-year percentile flow figure is depicted in the upper left panel, such that the smallest mean daily flow value is assigned a value that approaches zero (0.0) and the largest daily flow value is assigned a value that approaches one (1.0). The upper left panel is a flow exceedance probability figure, except that the exceedance value has been translated to a percentile value. The flow percentile value normalizes the range of flow conditions and removes the effect of magnitude on the relationship during the trend analyses. This approach of evaluating water quality – flow duration relationships is commonly used in the development of total maximum daily loads (EPA 2007, EPA 2008) and estimating flow-adjusted concentrations (USGS 2012). Patterns observed in the figures for the overlapping parameters between the 1996 to 2016 and 2001 to 2020 were very similar (GEI 2017).

5.1.5.1 Station 1 YNP / HWY 287

Alkalinity, bicarbonate, and total arsenic exhibit a decreasing pattern in concentration as flows increase. Similarly, total chloride, dissolved sodium, and the surrogate measurement – specific conductance – all reveal a decreasing pattern in concentration as flow increases.

Despite significant correlations between total calcium and percentile flow, and dissolved potassium and percentile flow, these analytes highlight some of the issues with significant data correlations with flow or flow percentile. At Station 1, total calcium and dissolved potassium concentrations exhibit a repetitive pattern of results (6 and 7 mg/L and 8 and 9 mg/L, respectively) across the range of flow conditions that skews the flow relationship (Figure 5-32). Total calcium and dissolved potassium concentrations vary little from a range of flow conditions and it's not until flow reaches approximately the 90th percentile level (651 cfs) before concentrations begin to decrease due to dilution potential from discharge.

Total suspended solids and turbidity also vary little over the range of flow conditions observed at Station 1, and it's not until flow reached the 80th percentile condition (499 cfs) before concentrations begin to increase due to flow. The total iron data reveals no relationship with flow at Station 1, although significant relationships were observed further downstream.

5.1.5.2 Station 2 Downstream from Hebgen Lake

The effects of Hebgen Lake on the relationships between concentrations and flow is more apparent with the scatter of data being more variable across the range of flow conditions (Figure 5-33). Alkalinity, bicarbonate, total chloride, dissolved sodium, turbidity, total arsenic, and specific conductance data all exhibit variability across the range of flow conditions, and the strength of the relationships with flow are poor.

No relationship between total calcium and percentile flow or dissolved potassium and percentile flow exists, even at the highest flow levels at Station 2. Like Station 1, there is a repetitive pattern of concentrations across the full range of flow conditions. The total suspended solids, turbidity, and total iron data reveal no relationships with flow at Station 2, although significant relationships were observed further downstream.

5.1.5.3 Station 3 Upstream from Ennis Lake

Insufficient flow data exists for Station 3 to fully evaluate the relationships between selected parameters and flow (Figure 5-34). Regardless, the relationships for the available data are presented in Figure 5-34. The limited data does provide some indication that total suspended solids, turbidity, and total iron concentrations increase when flow conditions are greater than the 80th percentile level (1,770 cfs), yet remain relatively consistent for lower flow conditions.

5.1.5.4 Station 4 Downstream from Madison Dam

The effects of Ennis Lake/Madison Dam on the relationships between concentrations and flow is apparent with the scatter of data being variable across the range of flow conditions (Figure 5-35). A threshold level for alkalinity, bicarbonate, and total chloride is apparent with these parameters exhibiting significant decreasing wedge shape relationships with increasing flow. Dissolved sodium, total arsenic, and specific conductance concentrations also exhibit this trend, but the strength of the relationship is less apparent.

No relationship between percentile flow and total calcium, dissolved potassium, or total suspended solids exists, even at the highest flow levels at Station 4. Like upstream stations, a repetitive pattern of concentrations exists across the full range of flow conditions for some of the parameters. Turbidity and total iron concentrations vary little over a range of flow conditions until flow reaches approximately the 80th (1,735 cfs) and 70th (1,595 cfs) percentile level, respectively, when concentrations begin to increase due to flow.

5.1.5.5 Station 5 Upstream from Canyon Ferry

The patterns in the concentration-flow relationships begin to change downstream of the Three Forks confluence reach with some parameters exhibiting a unimodal relationship with flow (Figure 5-36). These relationships are likely due to the influence of one of the major tributaries under a certain range of flow conditions that were not apparent in the Madison River stations. Alkalinity, bicarbonate, total calcium, and specific conductance data reveal this pattern such that concentrations are relatively lower at low flow conditions and increase at mid-range flow conditions (i.e., 50th percentile, 3,450 cfs) then begin to decrease with flow conditions greater than the 50th percentile.

Total chloride and dissolved sodium concentrations are variable across the range of flow conditions until the 70th percentile (4,170 cfs) after which the concentrations decrease with increasing flow. Total iron, turbidity, and total suspended solids concentrations exhibit no relationship to flow conditions less than the 80th percentile level (4,990 cfs), which is also supported by the large number of non-detect values for total suspended solids. However, as flow increases beyond the 80th percentile condition, concentrations rapidly increase. Arsenic expresses a strong linear shape in the data in which concentrations decrease with increased flow, indicating a dilution of the background arsenic concentrations observed in the Madison River.

Dissolved potassium did not generally correlate to flow for most stations and is not displayed graphically or discussed for the Missouri River stations.

5.1.5.6 Station 6 Downstream of Canyon Ferry Dam

A wedge shape relationship becomes more apparent in the concentration-flow relationships downstream of Canyon Ferry Dam. Generally, there is a threshold level in concentration, depending on the parameter, when flow conditions are less than the 60th percentile level

(4,022 cfs). Seven of the 11 parameters exhibit the wedge relationship indicating other watershed conditions or reservoir storage conditions are affecting the relationship in addition to flow (Figure 5-37). Total suspended solids, turbidity, and total iron concentrations exhibit no relationship to flow conditions downstream of Canyon Ferry Dam, and, again, many non-detect values across the full range of flow conditions exist for total suspended solids. This relationship highlights the sediment accumulation affect (i.e., sink) that the reservoir and dam have on flows.

5.1.5.7 Station 7 Downstream of Hauser Dam

The concentration-flow relationships downstream of Hauser Dam are nearly identical to relationships observed downstream of Canyon Ferry Dam (Figure 5-38). Again, there is a threshold level in concentration, depending on the parameter, when flow conditions are less than the 70th percentile level (4,700 cfs). Total suspended solids, turbidity, and total iron concentrations exhibit no relationship to flow conditions downstream of Hauser Dam, and, again, many non-detect values across the full range of flow conditions exist for total suspended solids.

5.1.5.8 Station 8 Downstream of Holter Dam

The concentration-flow relationships downstream of Holter Dam are nearly identical to relationships observed for downstream of Canyon Ferry and Hauser dams (Figure 5-39). Again, a threshold level exists for concentration, depending on the parameter, when flow conditions are less than the 70th percentile level (4,700 cfs). Total suspended solids, turbidity, and total iron concentrations exhibit no relationship to flow conditions downstream of Canyon Ferry Dam, and, again, many non-detect values across the full range of flow conditions exist for total suspended solids.

5.1.5.9 Station 9 Upstream from Great Falls

The patterns in the concentration-flow relationships change downstream of the three dams and indicate less variability in the data across the full range of flow conditions (Figure 5-40). The ionic parameters including total arsenic and specific conductance all reveal a significant decreasing relationship with increasing flow conditions. The strength of the relationships for these parameters (i.e., correlation coefficient) is similar to conditions observed at Station 1. Total suspended solids, turbidity, and total iron concentrations exhibit a significant increasing relationship to flow and concentrations begin to increase when flow conditions are greater than the 60th percentile level (4,830 cfs). The greater percentage of measurable values indicates new sources (i.e., tributary inflows) of suspended sediment as compared to conditions further upstream on the Missouri.

5.1.5.10 Station 10 Downstream from Great Falls

The patterns in the concentration-flow relationships downstream of Great Falls is very similar to conditions observed at Station 9. The water quality conditions at Station 10 exhibit less variability and the strongest relationships across the full range of flow conditions as compared to the other stations (Figure 5-41). The ionic parameters including total arsenic and specific conductance all reveal a significant decreasing relationship with increasing flow conditions. Total suspended solids, turbidity, and total iron concentrations exhibit a significant increasing relationship to flow conditions and concentrations begin to increase when flow conditions are greater than the 80th percentile level (7,130 cfs). Again, the greater percentage of measurable suspended solids concentrations across the full range of flow conditions indicates a source of suspended sediment further upstream (Sun River/Muddy Creek).

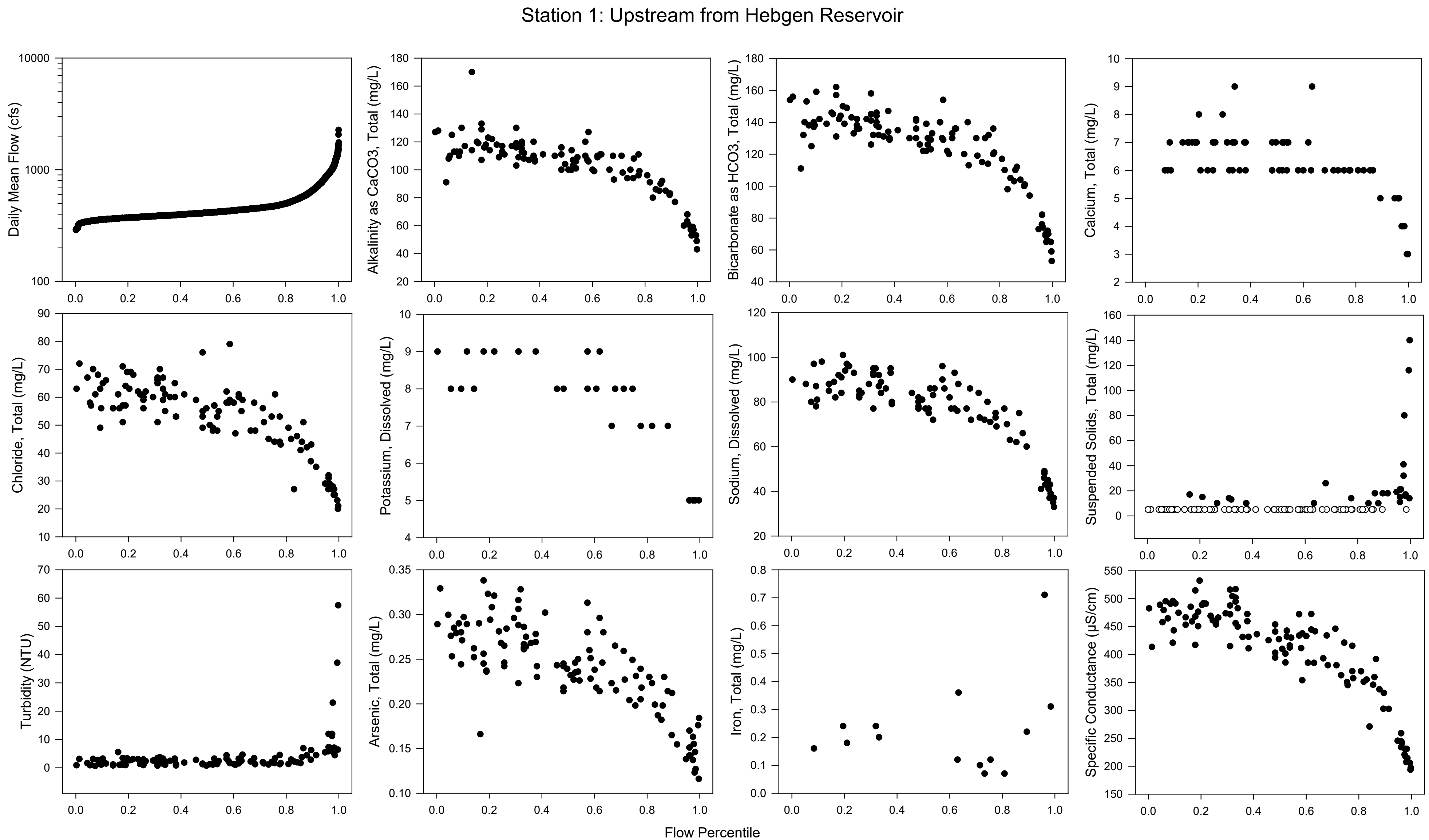


Figure 5-32: Relationships between selected parameters and percentile flow conditions at Station 1 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

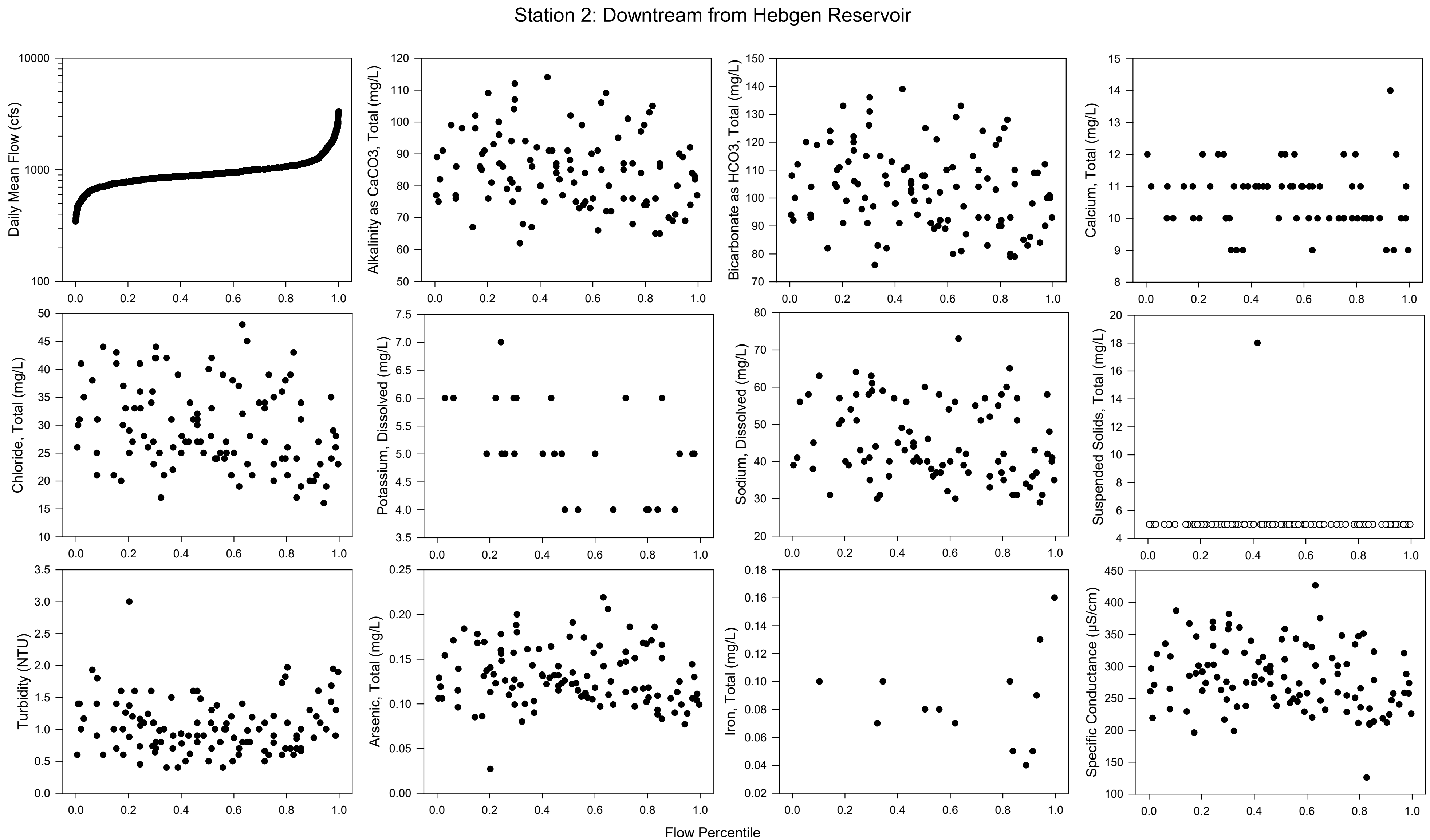


Figure 5-33: Relationships between selected parameters and percentile flow conditions at Station 2 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

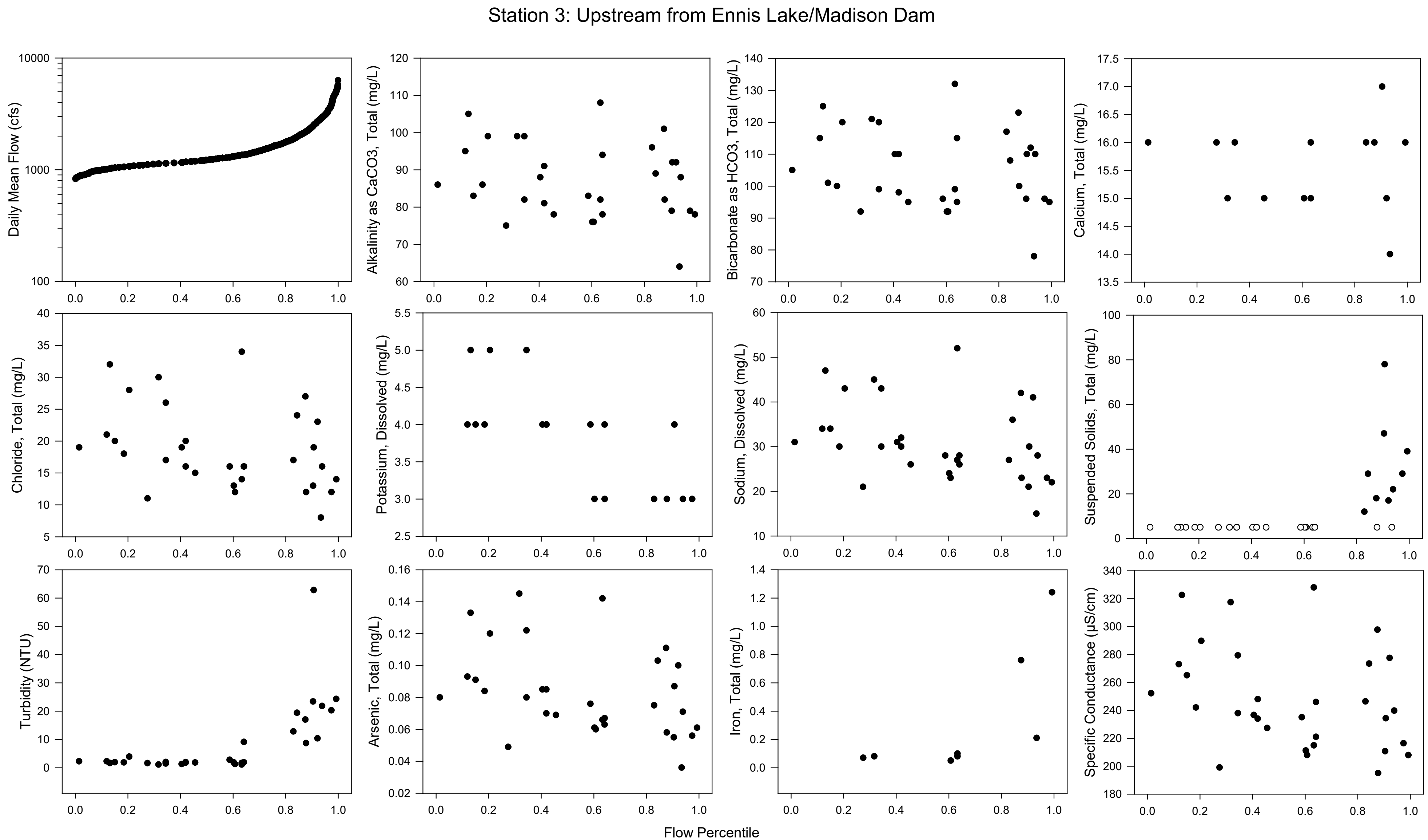


Figure 5-34: Relationships between selected parameters and percentile flow conditions at Station 3 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

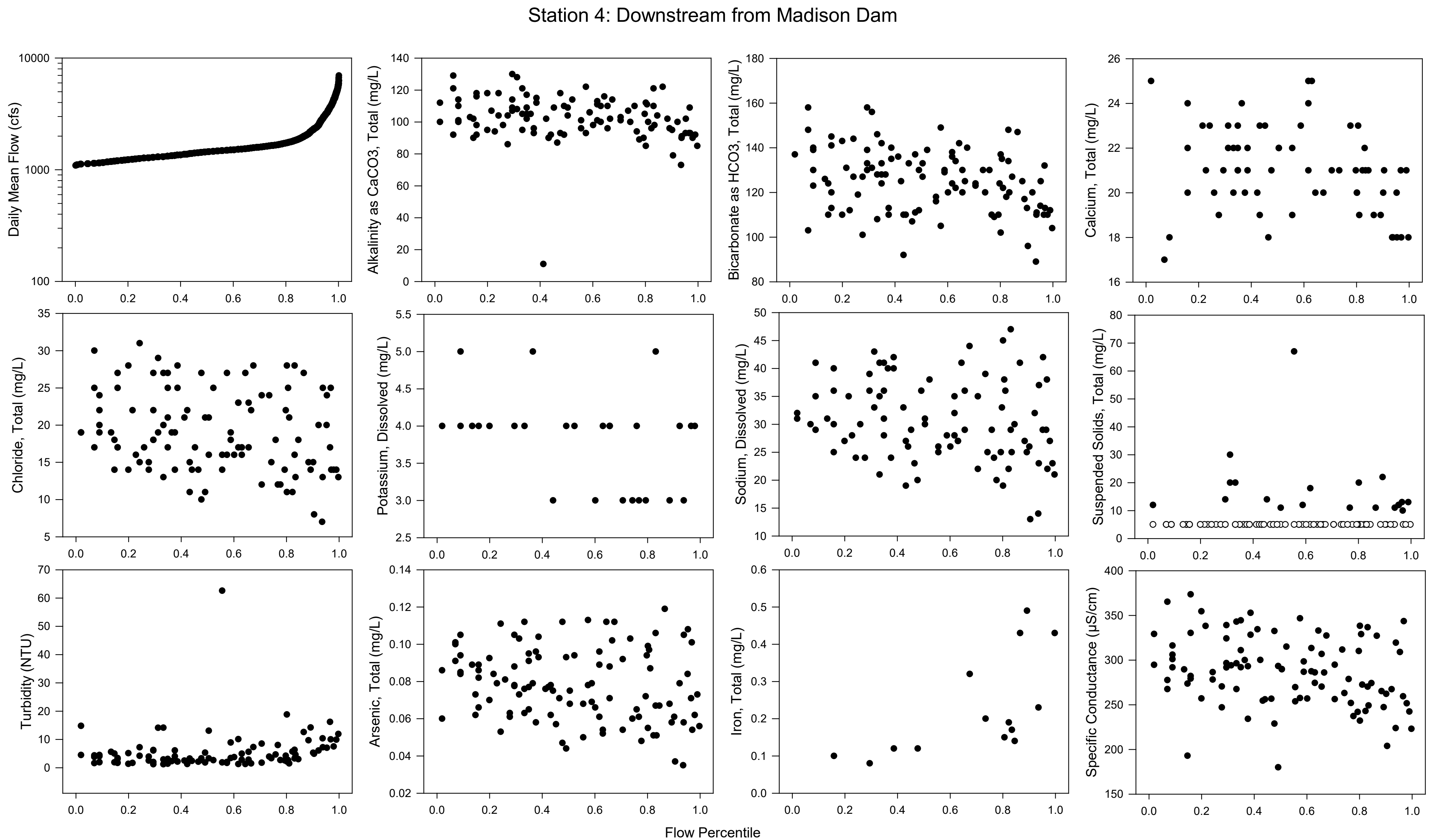


Figure 5-35: Relationships between selected parameters and percentile flow conditions at Station 4 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

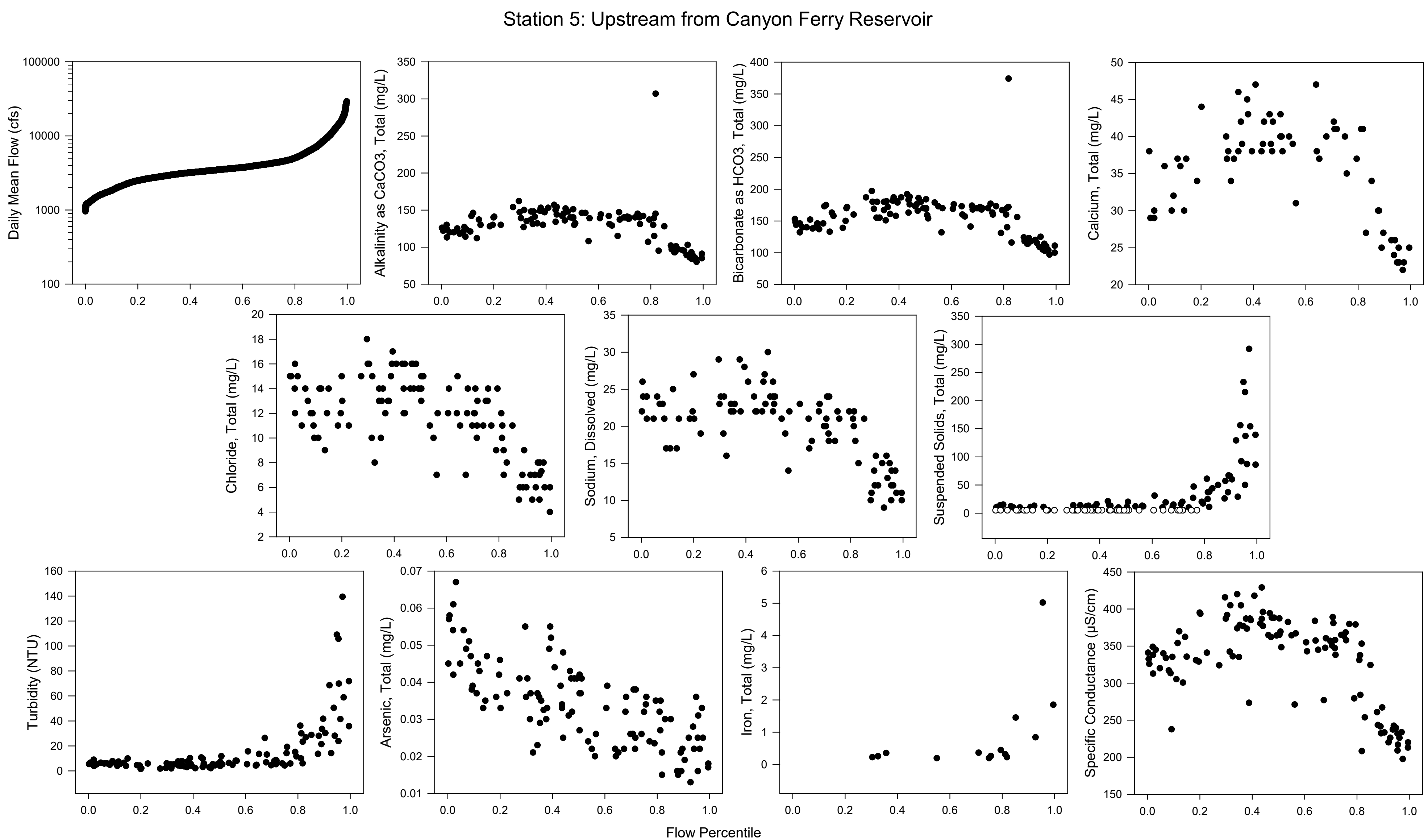


Figure 5-36: Relationships between selected parameters and percentile flow conditions at Station 5 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

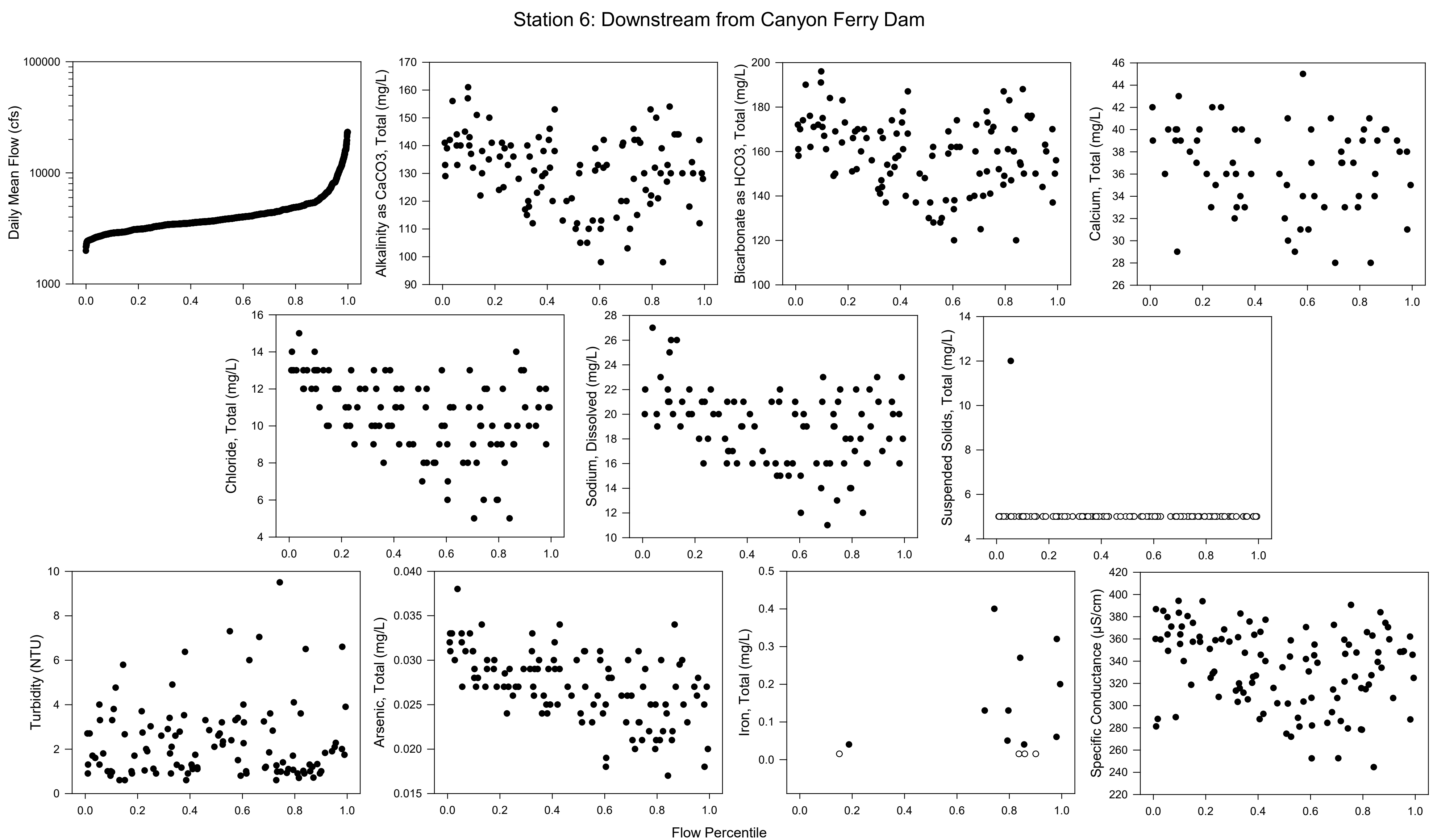


Figure 5-37: Relationships between selected parameters and percentile flow conditions at Station 6 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

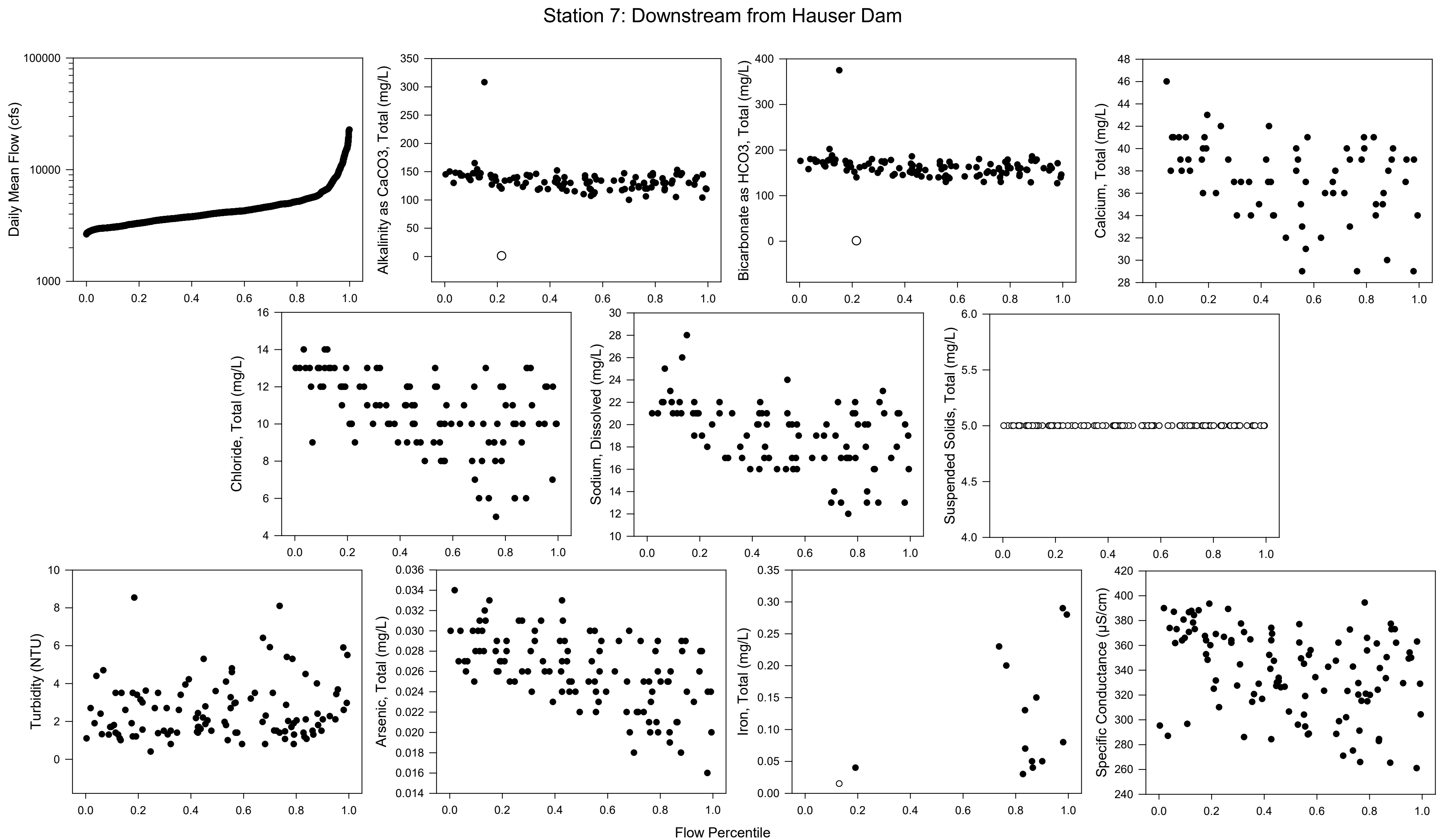


Figure 5-38: Relationships between selected parameters and percentile flow conditions at Station 7 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

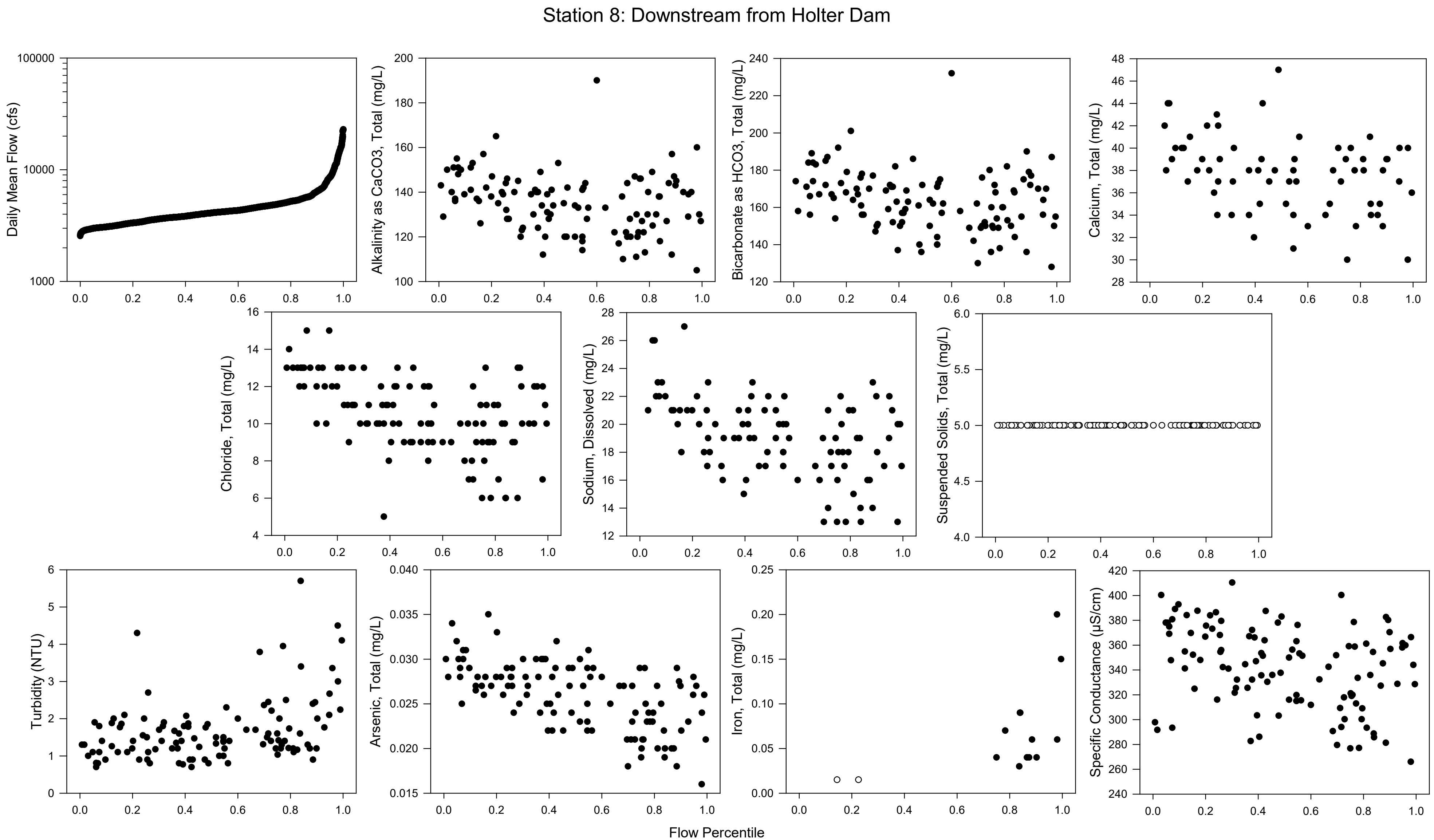


Figure 5-39: Relationships between selected parameters and percentile flow conditions at Station 8 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

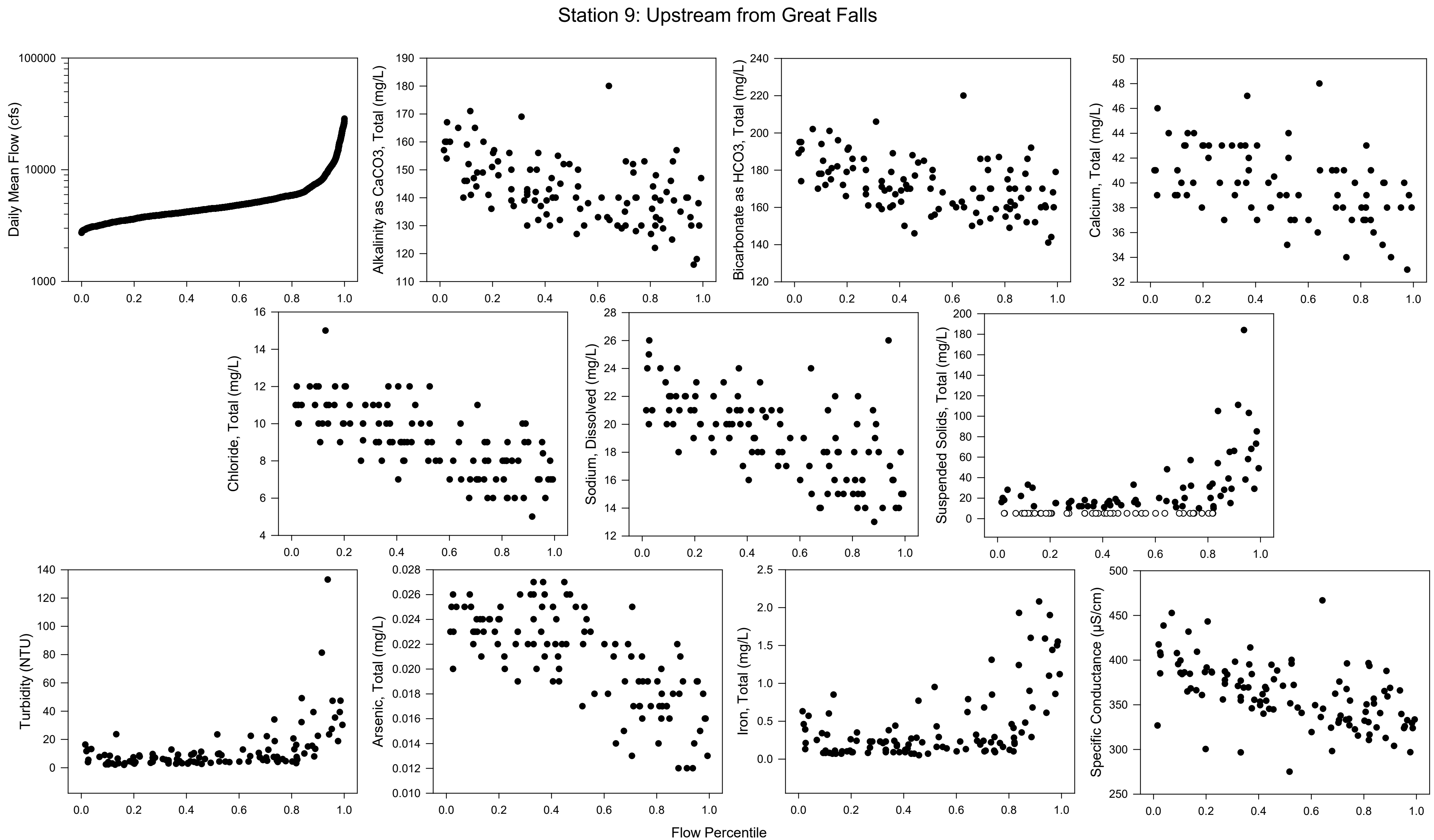


Figure 5-40: Relationships between selected parameters and percentile flow conditions at Station 9 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

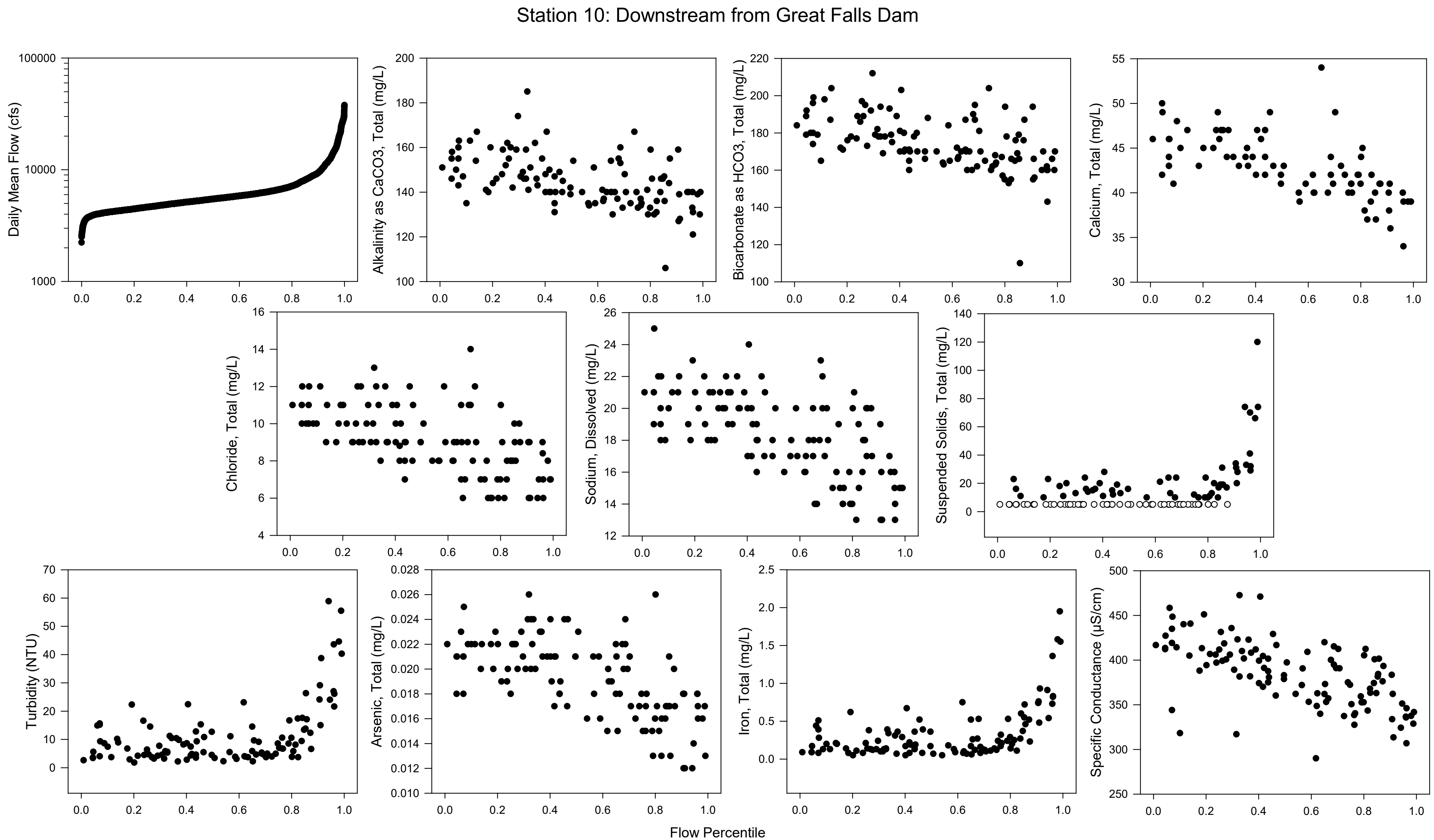


Figure 5-41: Relationships between selected parameters and percentile flow conditions at Station 10 from 2001 to 2020. Open circles represent non-detects which were replaced with values half of the MDL.

5.1.6 Flow Adjusted Trends

The figures presented above provide the basis for the flow-adjustment approach and addresses the objective of whether a trend exists over time for the last 10-year period of record (2011-2020). Total suspended solids, turbidity, and total iron tend to increase with streamflow, while alkalinity, bicarbonate, total calcium, total chloride, dissolved sodium, total arsenic and specific conductance tend to decrease with flow (i.e. dilution). These data relationships were filtered to only include the last ten years of data as depicted in Figure 5-42 (i.e., open red circles), keeping the concentrations and flow percentiles paired. The filtered data pairs revealed that measured concentrations spanned the entire flow range for each station, and that there were no gaps in the relationships used to evaluate the effects of flow on each parameter.

Due to the patterns in the data such as the alkalinity, bicarbonate, calcium, and specific conductance relationships at Station 5 and turbidity and total suspended solids at Station 9, the chemistry data were transformed (natural logarithm) for the flow-adjusted analysis. This transformation also paired well with the normalized flow data, and ordinary least squares (OLS) regression analysis was performed on each data pair for each station. This analysis yielded pairs of estimated and measured concentrations (ln transformed) from which the residual values (i.e., difference) were calculated. These residual values represent the flow-adjusted data that were plotted over time (decimal year) to evaluate temporal trends (Figure 5-43 through Figure 5-58). Pearson Correlation analysis was performed to evaluate the strength of the relationship and to determine whether a significant increasing or decreasing trend existed over time (2011-2020). For parameters that showed a significant trend at a station, non-flow and flow adjusted parameter concentration were plotted over time. Locally weighted scatterplot smoothing (LOESS) regression was performed on these flow-adjusted parameters to identify non-linear patterns in the data and to corroborate the results. The flow-adjusted analyses removed the effect due to dilution, and allowed for testing of trends independent of flow that may result from other physical watershed processes. To provide some context to the relative change in concentrations over time, the mean flow-adjusted concentrations for the first three-years was compared to the mean flow-adjusted concentrations for last three-years. The flow-adjusted data were back-transformed to remove the effects of the natural logarithm for the percent change analysis which introduces a source or error in the analyses and increases the magnitude of change which remains relative to the parameter of interest. Again, the results depend on the endpoints selected rather than an averaging or smoothing function, the calculated magnitude of change can be misleading and does not incorporate information about specific years in between the three year.

Parameter concentrations did not show uniform, linear monotonic trends over the monitoring period (Figure 5-43 through Figure 5-58). Instead, non-adjusted alkalinity concentration at stations 4, 7, and 8 and bicarbonate at Station 8 decreased from 2011 to 2020; total chloride at Station 4 has been decreasing since 2016; dissolved sodium and total arsenic at Station 4 and specific conductance at stations 4, 6, 7, 8 and 10 has been decreasing since 2014. These data patterns remain evident in the flow-adjusted data.

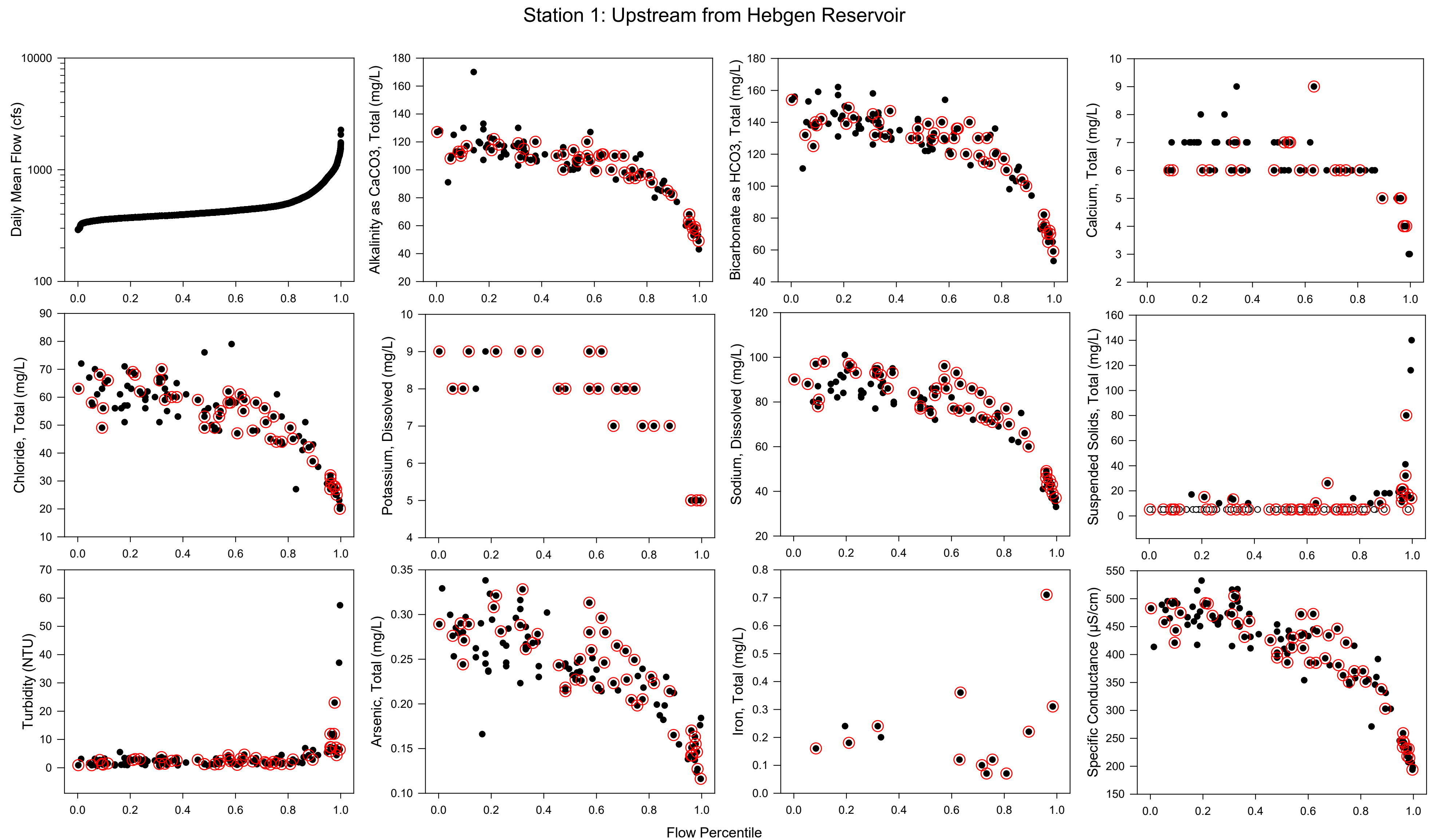


Figure 5-42: Filtered data used to calculate the flow-adjusted concentrations for Station 1. Closed black circles identify 2001-2020 data; open red circles identify 2011-2020 data; open black circles represent non-detects that were replaced with values one-half of the MDL.

Results of the flow adjusted trend analysis identified that alkalinity at stations 4, 7, 8, and 9; bicarbonate at Station 8; total chloride, dissolved sodium, and total arsenic at Station 4; and specific conductance at stations 4, 6, 7, 8, and 10 exhibited significantly decreasing trends over time (Table 5-6, Figure 5-43 through Figure 5-58). The percent change over time in these flow-adjusted parameters ranged from -62.5 to -25.3 % except for alkalinity at Station 9 which decreased by 9.9 % (Table 5-7). Only bicarbonate at Station 1 exhibited a significant increasing trend (Figure 5-47) and a +108 % change over time (Table 5-7). All other flow-adjusted parameters that were strongly correlated to flow did not exhibit statistically significant trends over time.

The presence of these significant trends is different than those found from 2007 to 2016 (GEI 2017). The only significant trends observed during that time were increasing dissolved sodium concentrations at stations 9 and 10. While not significant from 2011 to 2020 (Table 5-6), concentrations did increase (Figure 5-57, Figure 5-58).

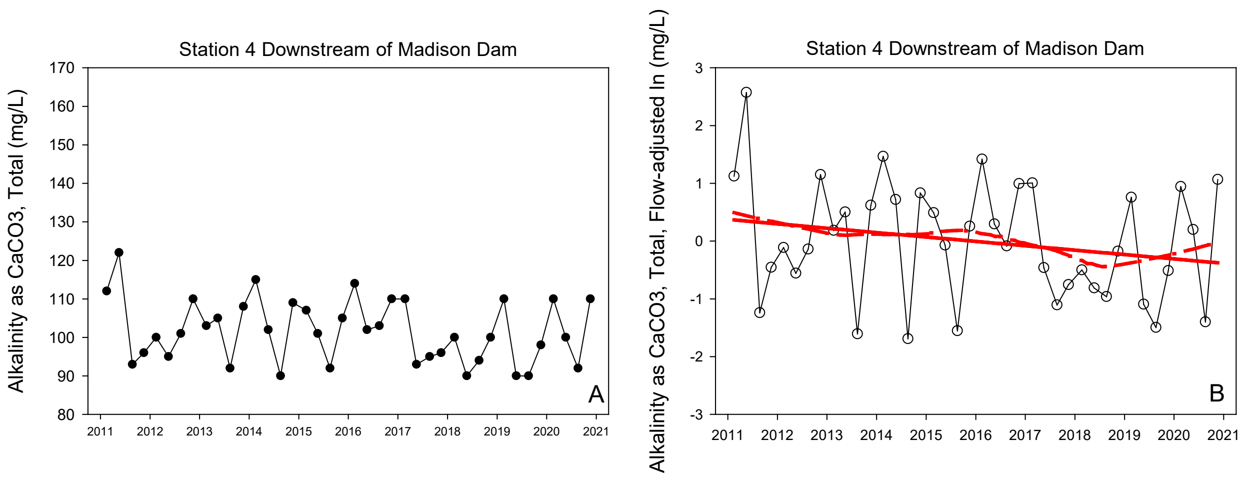


Figure 5-43: Alkalinity concentrations (A) and the flow-adjusted alkalinity concentrations (B) over time at Station 4. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

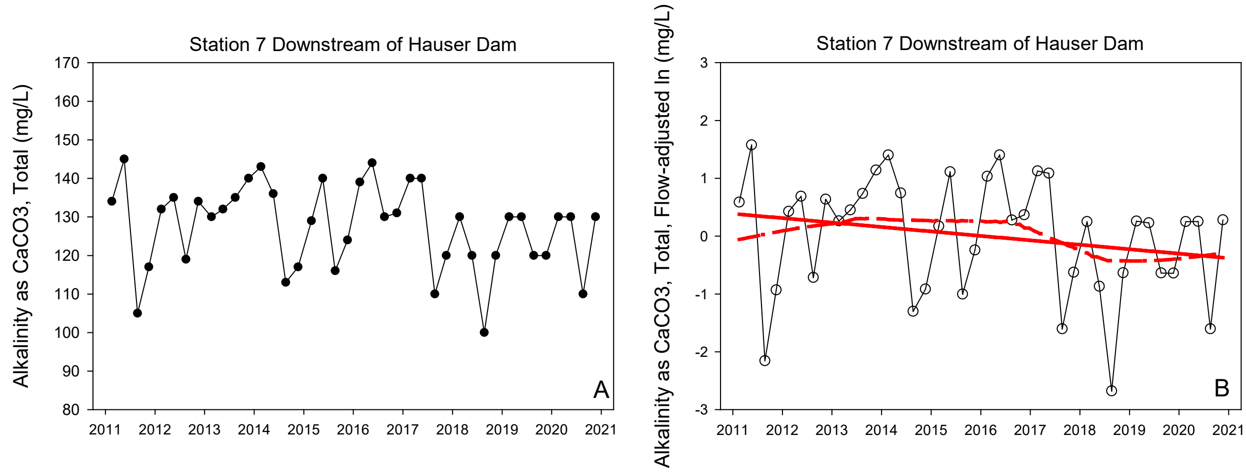


Figure 5-44: Alkalinity concentrations (A) and the flow-adjusted alkalinity concentrations (B) over time at Station 7. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

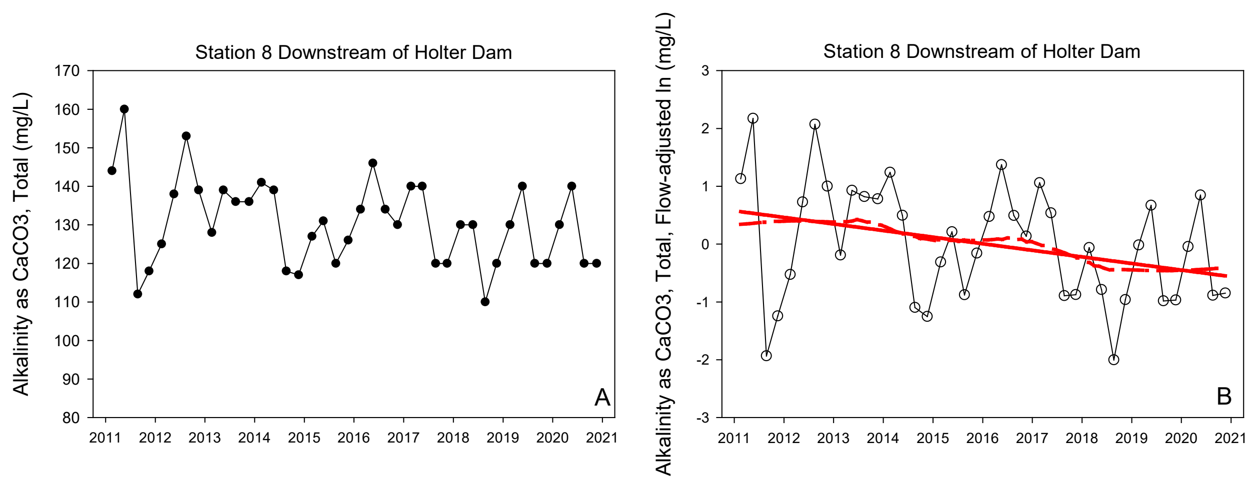


Figure 5-45: Alkalinity concentrations (A) and the flow-adjusted alkalinity concentrations (B) over time at Station 8. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

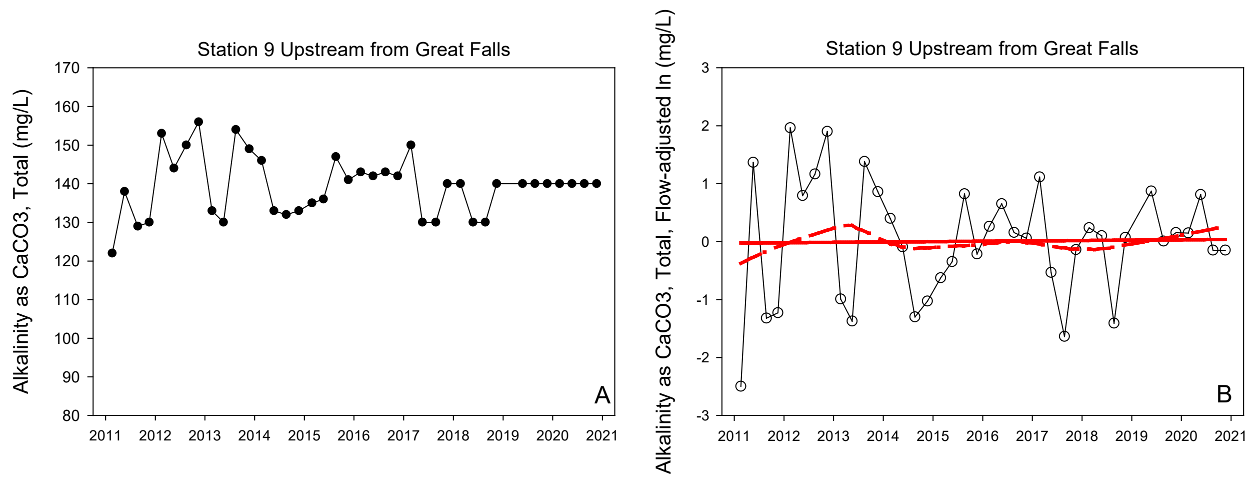


Figure 5-46: Alkalinity concentrations (A) and the flow-adjusted alkalinity concentrations (B) over time at Station 9. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

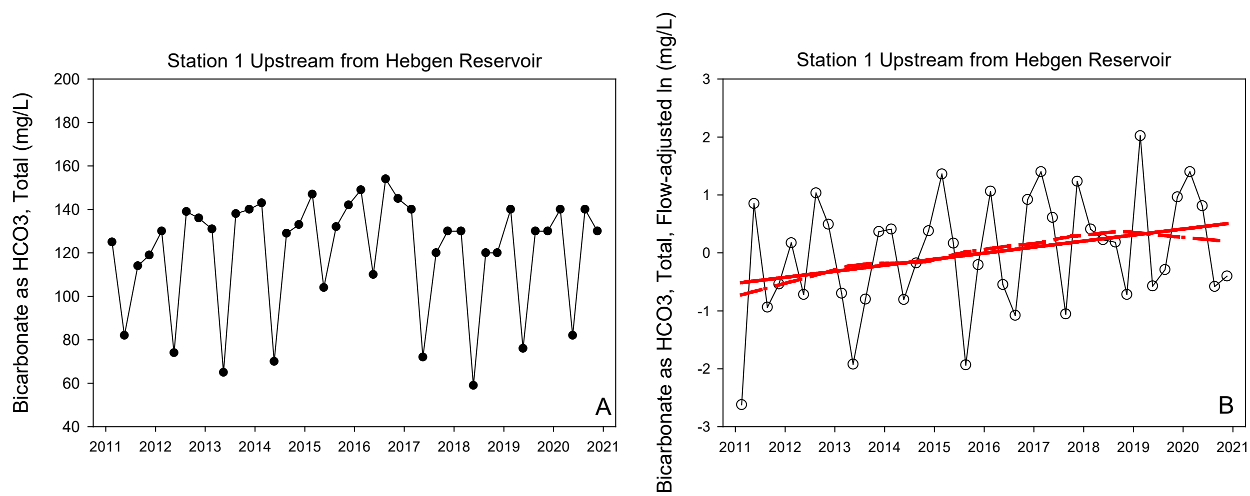


Figure 5-47: Bicarbonate concentrations (A) and the flow-adjusted bicarbonate concentrations (B) over time at Station 1. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

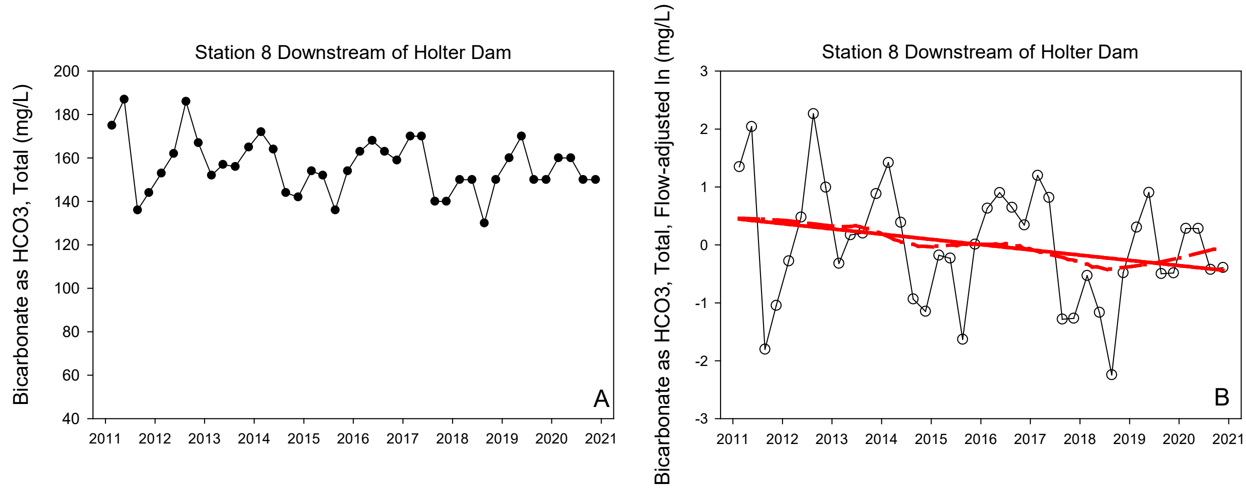


Figure 5-48: Bicarbonate concentrations (A) and the flow-adjusted bicarbonate concentrations (B) over time at Station 8. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

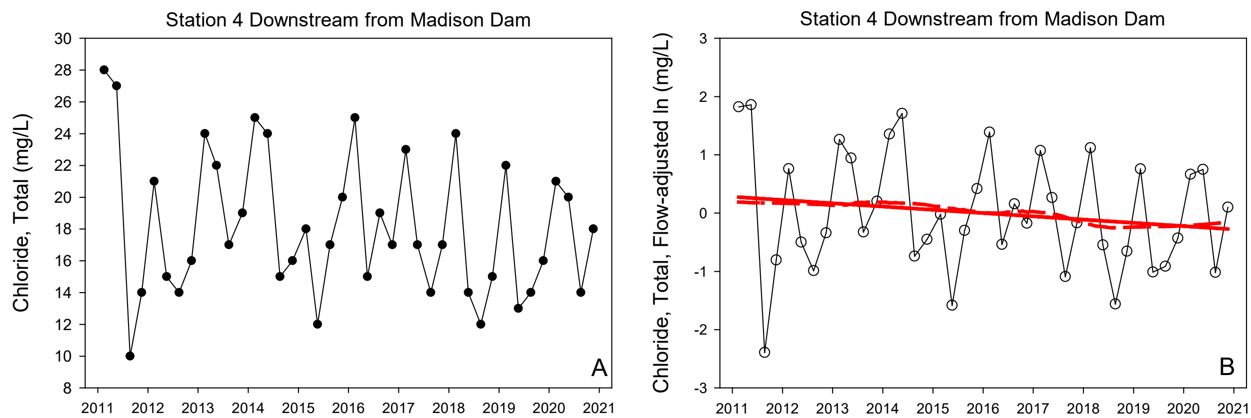


Figure 5-49: Total chloride concentrations (A) and the flow-adjusted total chloride concentrations (B) over time at Station 4. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

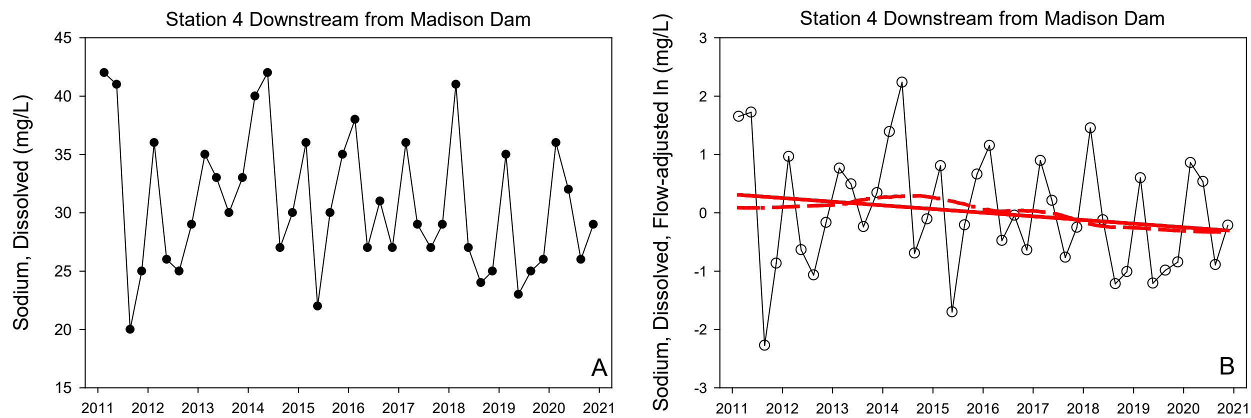


Figure 5-50: Dissolved sodium concentrations (A) and the flow-adjusted dissolved sodium concentrations (B) over time at Station 4. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

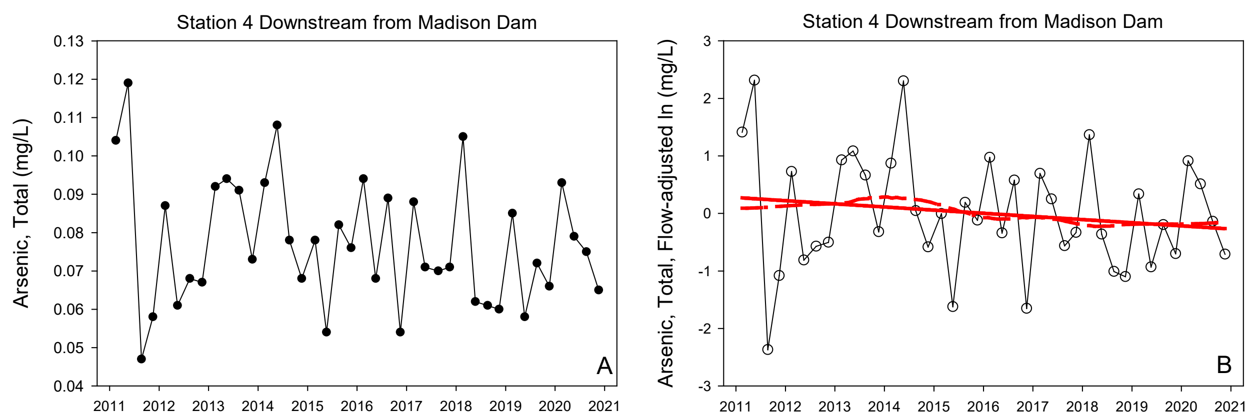


Figure 5-51: Total arsenic concentrations (A) and the flow-adjusted total arsenic concentrations (B) over time at Station 4. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

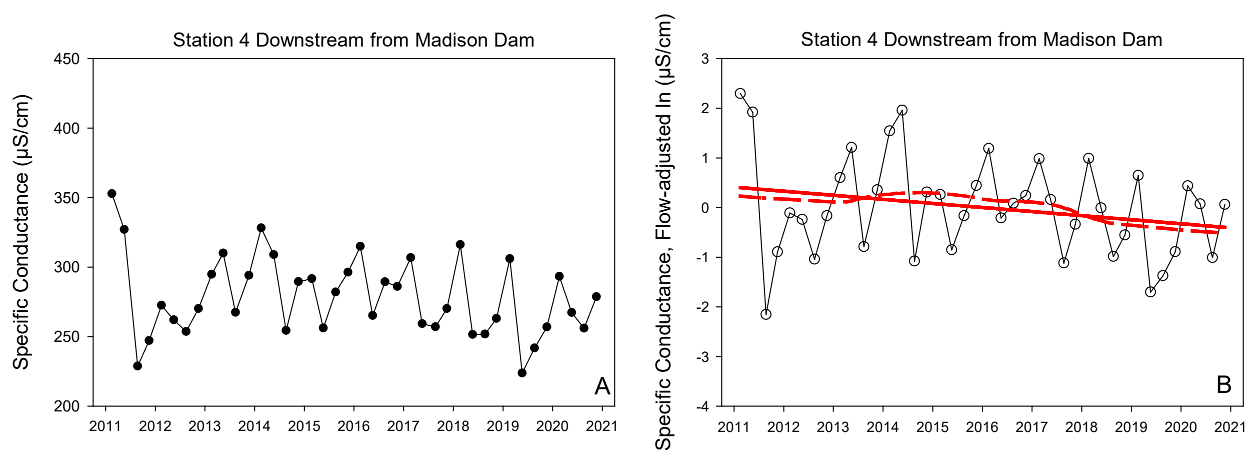


Figure 5-52: Specific conductance concentrations (A) and the flow-adjusted specific conductance concentrations (B) over time at Station 4. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

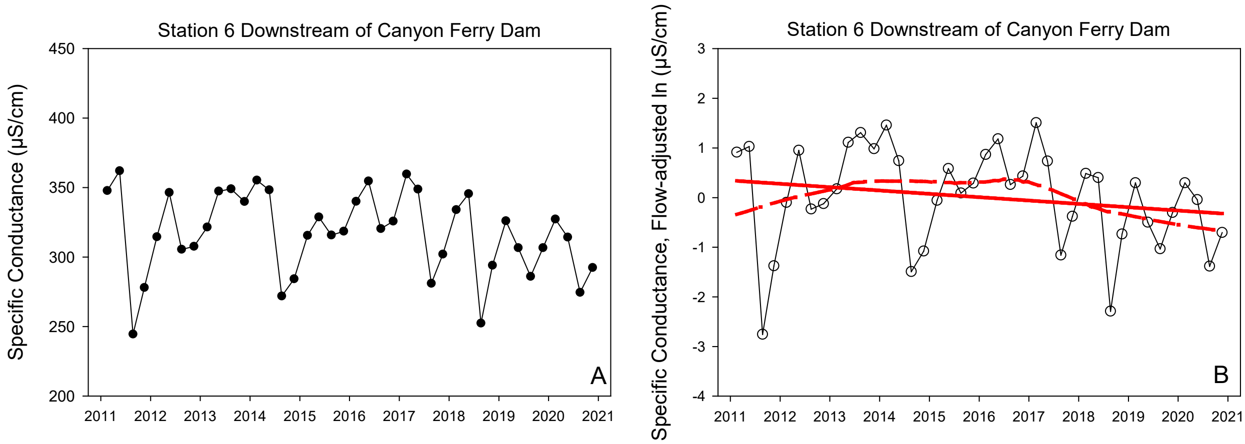


Figure 5-53: Specific conductance concentrations (A) and the flow-adjusted specific conductance concentrations (B) over time at Station 6. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

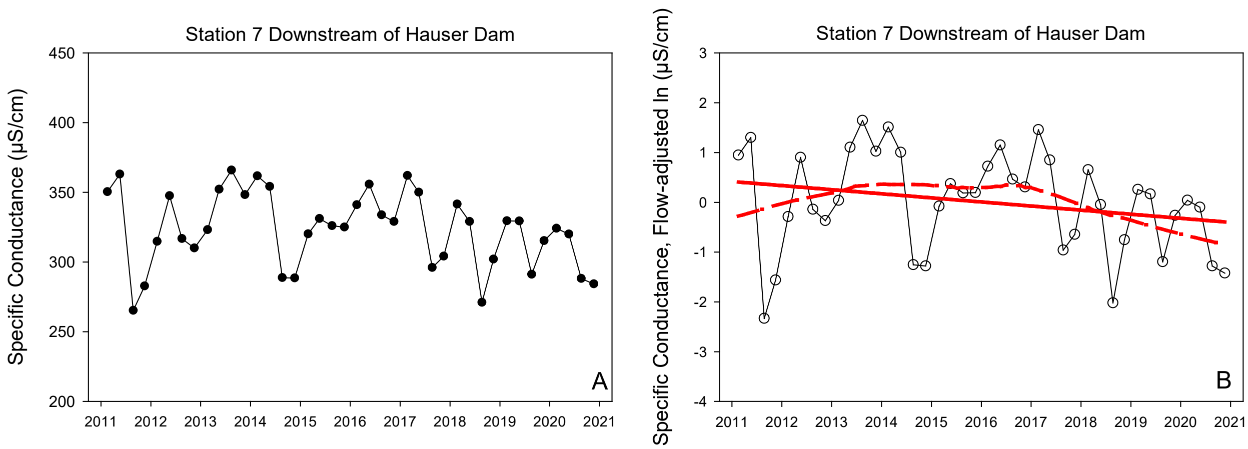


Figure 5-54: Specific conductance concentrations (A) and the flow-adjusted specific conductance concentrations (B) over time at Station 7. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

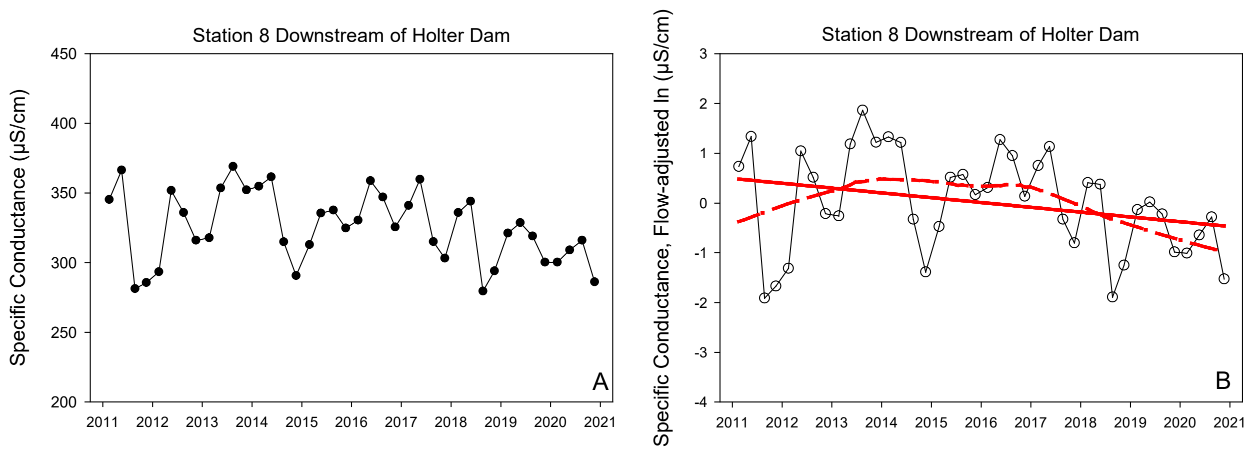


Figure 5-55: Specific conductance concentrations (A) and the flow-adjusted specific conductance concentrations (B) over time at Station 8. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

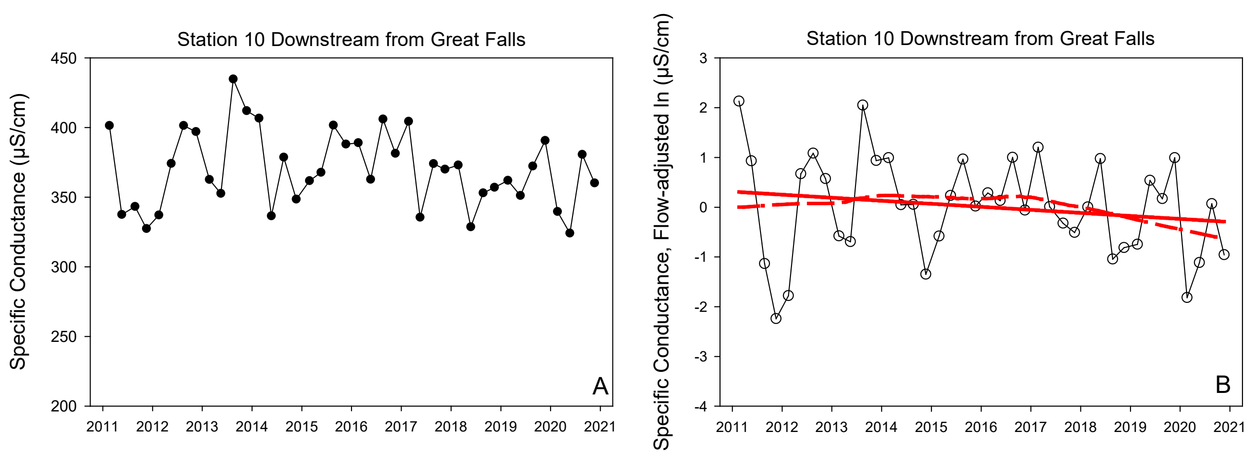


Figure 5-56: Specific conductance concentrations (A) and the flow-adjusted specific conductance concentrations (B) over time at Station 10. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (significant trend).

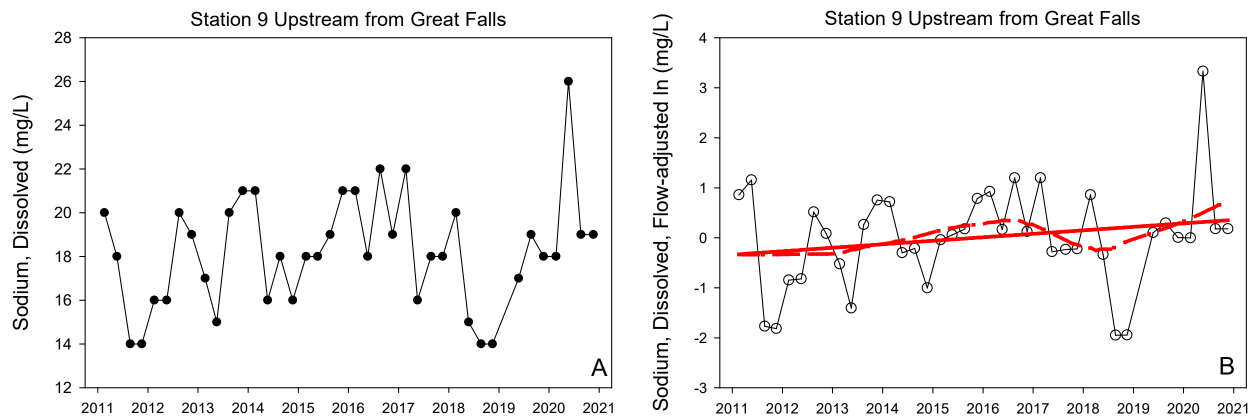


Figure 5-57: Dissolved sodium concentrations (A) and the flow-adjusted dissolved sodium concentrations (B) over time at Station 9. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (non-significant trend).

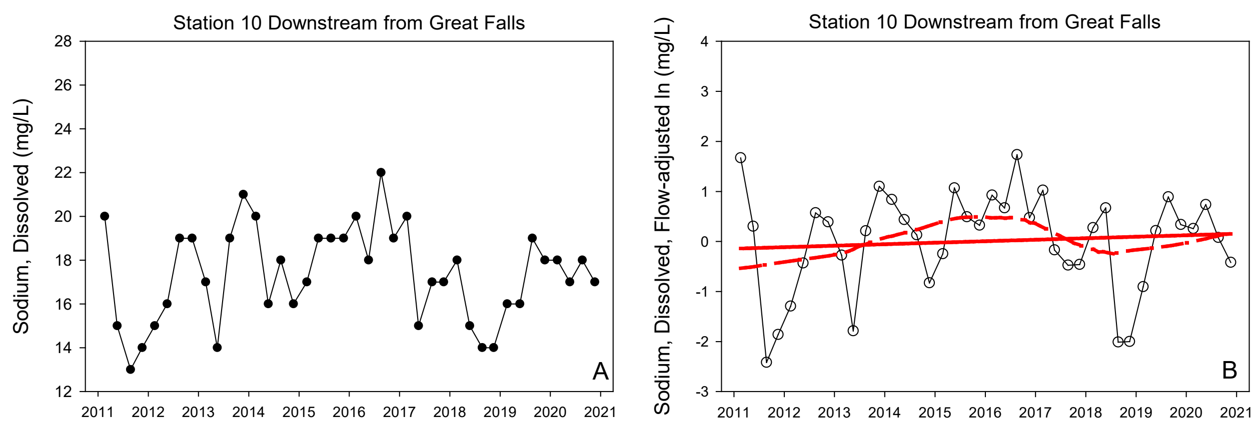


Figure 5-58: Dissolved sodium concentrations (A) and the flow-adjusted dissolved sodium concentrations (B) over time at Station 10. Solid red line represents linear regression and red dashed line represents LOESS regression at 50% smoothing (non-significant trend).

Table 5-6: Pearson's correlation trend analyses of flow adjusted concentrations from 2011 to 2020 at all stations. Grey cells indicate a significant (p <0.10 level, 2-tailed).

Parameter	Statistic	1	2	3	4	5	6	7	8	9	10
Ion Chemistry											
Alkalinity as CaCO3, Total (mg/L)	Pearson Coefficient	0.176	-0.108	-0.046	-0.28	-0.06	-0.219	-0.29	-0.412	-0.279	-0.14
	Significance (2-tailed)	0.278	0.508	0.824	0.080	0.715	0.174	0.070	0.008	0.086	0.39
	N	40	40	26	40	40	40	40	40	39	40
Bicarbonate as HCO3, Total (mg/L)	Pearson Coefficient	0.269	-0.092	-0.057	-0.247	0.001	-0.238	-0.189	-0.372	-0.235	0.028
	Significance (2-tailed)	0.094	0.572	0.783	0.125	0.995	0.138	0.243	0.018	0.150	0.862
	N	40	40	26	40	40	40	40	40	39	40
Calcium, Total (mg/L)	Pearson Coefficient	0.207	-0.307	-0.248	0.253	0.022	0.100	0.125	0.151	-0.021	0.101
	Significance (2-tailed)	0.443	0.247	0.554	0.344	0.936	0.711	0.643	0.576	0.938	0.72
	N	16	16	8	16	16	16	16	16	16	15
Chloride, Total (mg/L)	Pearson Coefficient	0.122	-0.091	-0.166	-0.322	-0.141	-0.136	-0.193	-0.165	-0.116	-0.117
	Significance (2-tailed)	0.452	0.575	0.417	0.043	0.387	0.402	0.232	0.310	0.483	0.472
	N	40	40	26	40	40	40	40	40	39	40
Potassium, Dissolved (mg/L)	Pearson Coefficient	-0.205	-0.227	0.331	-0.057	-0.067	-0.182	-0.246	-0.243	-0.120	-0.122
	Significance (2-tailed)	0.338	0.286	0.180	0.790	0.754	0.393	0.258	0.253	0.587	0.561
	N	24	24	18	24	24	24	23	24	23	25
Sodium, Dissolved (mg/L)	Pearson Coefficient	0.222	-0.078	-0.158	-0.271	-0.159	-0.042	-0.114	-0.086	0.241	-0.059
	Significance (2-tailed)	0.168	0.634	0.442	0.090	0.327	0.795	0.483	0.598	0.140	0.719
	N	40	40	26	40	40	40	40	40	39	40
Solids/Turbidity											
Suspended Solids, Total (mg/L)	Pearson Coefficient	-0.007		0.050	-0.220	-0.186				0.095	-0.017
	Significance (2-tailed)	0.967	--	0.806	0.172	0.251	--	--	--	0.566	0.917
	N	40		26	40	40				39	40
Turbidity (NTU)	Pearson Coefficient	-0.156	0.226	0.030	-0.166	-0.131	-0.201	-0.136	-0.121	0.163	-0.029
	Significance (2-tailed)	0.337	0.162	0.883	0.305	0.420	0.214	0.404	0.457	0.322	0.859
	N	40	40	26	40	40	40	40	40	39	40
Metals											
Arsenic, Total (mg/L)	Pearson Coefficient	0.101	-0.040	-0.077	-0.292	-0.139	0.005	-0.042	-0.005	0.037	0.112
	Significance (2-tailed)	0.534	0.808	0.708	0.067	0.391	0.978	0.795	0.976	0.822	0.493
	N	40	40	26	40	40	40	40	40	39	40
Iron, Total (mg/L)	Pearson Coefficient									-0.163	-0.228
	Significance (2-tailed)	--	--	--	--	--	--	--	--	0.342	0.175
	N									36	37
Physicochemical											
Specific Conductance (µS/cm)	Pearson Coefficient	0.247	-0.087	-0.248	-0.369	0.038	-0.297	-0.326	-0.368	-0.167	-0.315
	Significance (2-tailed)	0.124	0.592	0.222	0.019	0.818	0.063	0.040	0.020	0.308	0.048
	N	40	40	26	40	40	40	40	40	39	40

-- Not calculated due to low number of samples

Table 5-7: Relative percent change (%) between the 2011-2013 mean flow-adjusted concentration and the 2018-2020 mean flow-adjusted concentration at each station. -- = Not part of the 2011 SAP data collection.

Parameter	1	2	3	4	5	6	7	8	9	10
Ion Chemistry										
Alkalinity as $CaCO_3$, Total (mg/L)	62.4	-4.1	28.8	-39.5	8.7	-44.6	-49.7	-62.5	-9.9	13.4
Bicarbonate as HCO_3, Total (mg/L)	107.7	0.6	14.3	-18.3	16.3	-49.1	-36.3	-54.2	-12.4	63.0
Chloride, Total (mg/L)	-7.2	7.4	2.4	-29.8	-13.0	-13.6	-26.6	-6.0	-9.6	-8.7
Sodium, Dissolved (mg/L)	93.4	5.8	21.4	-26.7	0.7	-23.4	-20.3	-14.1	43.4	17.6
Solids/Turbidity										
Suspended Solids, Total (mg/L)	-38.9	--	-62.5	-46.2	-50.4	--	--	--	-13.9	-20.3
Turbidity (NTU)	-19.4	26.0	-55.0	-25.0	-55.2	-30.8	-28.7	-11.7	-12.7	-38.0
Metals										
Arsenic, Total (mg/L)	9.9	21.5	27.3	-25.3	-2.6	5.4	0.7	11.3	1.3	20.7
Iron, Total (mg/L)	--	--	--	--	--	--	--	--	-43.6	-62.3
Physicochemical										
Specific Conductance (µS/cm)	82.4	-10.2	-17.7	-35.7	19.3	-46.0	-49.6	-55.3	-17.7	-37.7

5.1.7 Site Specific Evaluations – Madison Dam and Canyon Ferry Dam

Site-specific dissolved oxygen conditions were examined in greater detail to evaluate the seasonal effects of the Madison Dam/Powerhouse and the Canyon Ferry Dam. As previously noted in the upstream-downstream comparisons, the change in dissolved oxygen content between stations 3 and 4 for the last 10-year period was not statistically significant with respect to the concentration (mg/L), even though concentrations were less downstream. However, once the effects of water temperature and atmospheric pressure are considered, the relative percent saturation was significantly less downstream of the Madison Dam at Station 4 (Table 5-3). The upstream-downstream comparisons between stations 5 and 6 revealed that both dissolved oxygen concentration and percent saturation were statistically different over the last 10-year period.

When examined on a seasonal basis using the four quarterly sampling periods at each station, the Kruskal-Wallis test indicates a significant difference among the four seasonal quarters with respect to dissolved oxygen concentrations for all stations (Table 5-8). However, when the effects of water temperature and atmospheric pressure are considered on dissolved oxygen, the Kruskal-Wallis test revealed only a significant difference at Station 6, downstream of Canyon Ferry Dam.

At stations 3 and 4, mean dissolved oxygen concentrations decreased from winter (Jan-Mar) through summer (Jul-Sep) and increased in autumn (Oct-Dec), although concentrations remain greater than 6 mg/L. The mean dissolved oxygen concentrations by season are always less at Station 4 as compared to Station 3. Mean dissolved oxygen percent saturation values follow an opposite pattern where saturation increases through summer and decrease in autumn. Saturation is not consistently greater at one station over the other. Percent saturation values generally remain greater than +85% downstream of the Madison Dam.

At the stations that bracket the Canyon Ferry Dam, a significant seasonal effect exists as well as a downstream effect, albeit not a consistent negative impact on dissolved oxygen concentrations (Figure 5-59). During the spring season (Apr-Jun), dissolved oxygen concentrations are greater downstream of the dam which is a result of spilling surface flows that mitigate deep water releases. During the summer season, the deep-water releases significantly reduce both dissolved oxygen concentrations and percent saturation downstream of the dam, with a mean concentration of 3.9 mg/L and percent saturation of +43%. The cooler fall water temperatures along with fall turnover, improve dissolved oxygen content with a median concentration of 7.7 mg/L (+74 % saturation).

Overall, the Madison Dam/Powerhouse has a negligible effect on dissolved oxygen content with concentrations exhibiting a similar seasonal pattern that is observed for the upstream station. Percent saturation remains greater than +80% at Station 4 for all seasons. In contrast, the Canyon Ferry Dam significantly effects dissolved oxygen content downstream of the dam, albeit mixed effects. Even though conditions improved during the spring due to reservoir spilling, the summer and fall reservoir/operating conditions significantly reduce dissolved oxygen content downstream of the dam.

Table 5-8: Kruskal-Wallis seasonal analysis of dissolved oxygen content upstream and downstream of Madison Dam and Canyon Ferry Dam for 2011-2020.

Parameter	Statistic	3	4	5	6
Dissolved Oxygen (mg/L)	Chi-Square	27.298	27.953	25.165	28.009
	df	3	3	3	3
	Asymp. Sig.	.000	.000	.000	.000
Dissolved Oxygen (% Saturation)	Chi-Square	2.290	.175	3.467	26.756
	df	3	3	3	3
	Asymp. Sig.	.514	.982	.325	.000

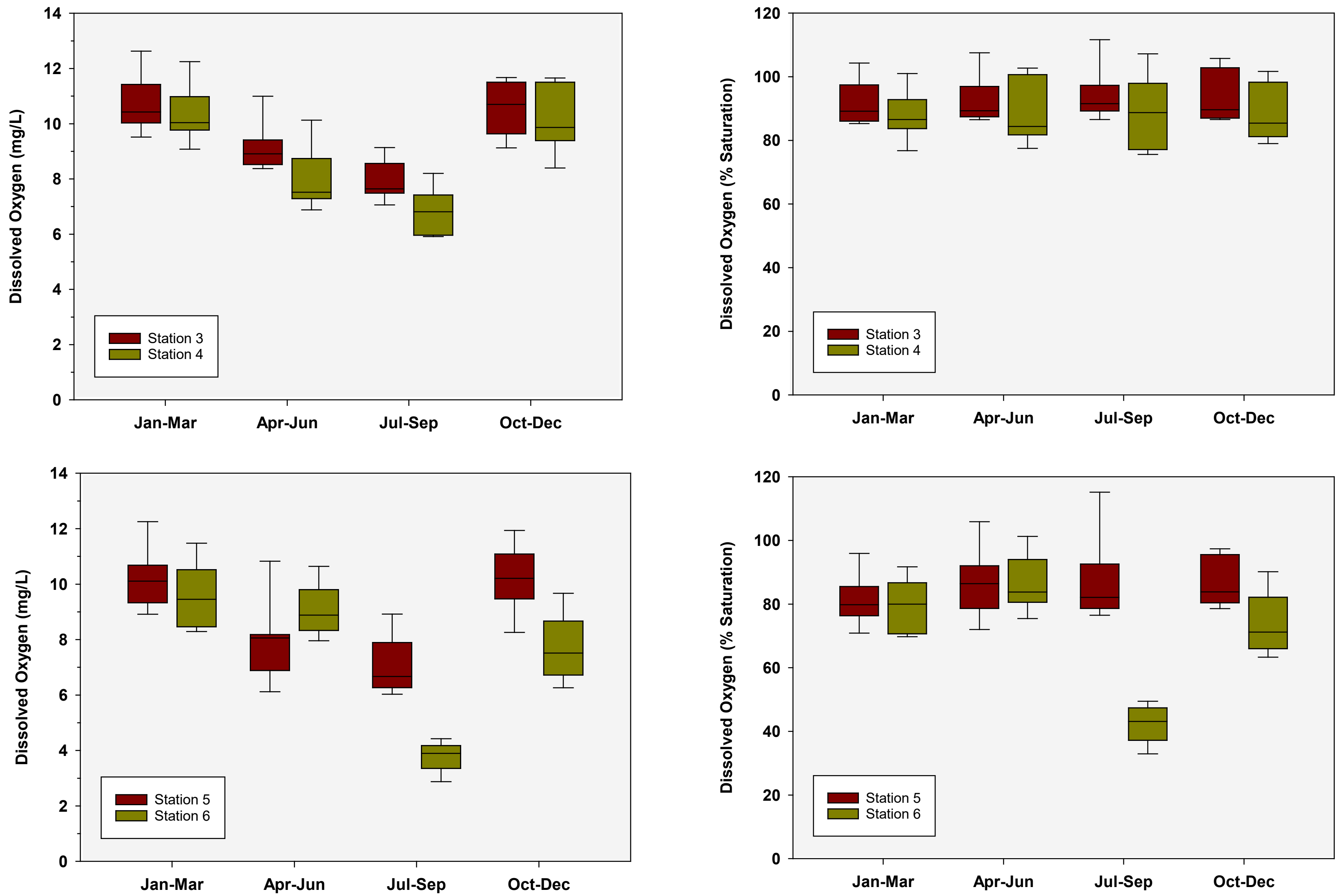


Figure 5-59: Dissolved oxygen conditions upstream and downstream of Madison Dam (stations 3 and 4) and Canyon Ferry Dam (stations 5 and 6) for 2011-2020.

5.2 Biological Analyses

5.2.1 *2017 Trend Analysis Report Root Cause Analysis of Chlorophyll Error*

During the data compilation effort for this report, GEI and NorthWestern Energy determined that the previous Water Quality and Biological Monitoring Trend Analysis Report (GEI 2017) contained an error that resulted in the erroneous reporting of chlorophyll-a data for Station B1 (Yellowstone National Park) and no reporting of data for Station B10 (Morony). In fact, Station B1 was only sampled for chlorophyll-a in 1995 and 1996 while Station B10 had been sampled for chlorophyll-a from 2007 to 2016. As a result, these observations precipitated a Root Cause Analysis (RCA, GEI 2021a) to identify the root causes of the data discrepancies or decision-making process that resulted in the data analysis error and to develop corrective actions. The review of the data compilation process found that the error originated when Station IDs were incorrectly applied to the Station Name, resulting in a shift of the Station IDs to the next downstream Station Name. As a result, the Station B1 identifier was applied to data collected from Hebgen while Station B8 identifier was applied to Morony. This error was limited to the chlorophyll-a and ash free dry weight data and did not affect periphyton metric or other water quality data. The chlorophyll-a and ash free dry weight data (1995-2016) were recompiled and the reanalysis of 2007-2016 chlorophyll-a data confirmed that the descriptive statistics/graphics, upstream-downstream comparisons, and trend analysis statistics for the 2017 Report remained the same, except for the Station ID (GEI 2021a).

5.2.2 *Periphyton*

5.2.2.1 Chlorophyll-a

Excessive periphyton biomass can be determined through analysis of chlorophyll-a content in periphyton samples. The Missouri-Madison water quality monitoring program initially used a scrape method of a known area early in the period of record; however, switched to a whole-rock method to reduce variability in the data. In 2011, ten replicate “scrape” samples were collected at each of the seven monitoring stations and analyzed for chlorophyll-a content. Results from these analyses are included in data tables and figures but will not be discussed further as the method was discontinued in 2011. From 2012 to the present, replicate whole-rock chlorophyll-a samples have been collected at each of the seven monitoring stations. Measurements below the detection limit were substituted with values one-half of the detection limit for statistical analysis.

5.2.2.1.1 Spatial Summary

A summary of chlorophyll-a concentration results is presented in Table 5-9 and complete descriptive statistics are provided in Appendix C. Mean whole rock chlorophyll-a concentrations (2011-2020) were generally ranged from 14 to 92 mg/m^2 for many of the stations, except for stations 4 and B7, where the mean concentrations were 126 and 185 mg/m^2, respectively (Table 5-9). The higher algal biomass at these two sites is likely due to increased nutrient concentrations, specifically nitrogen, from source waters in Ennis and Hauser lakes, as well as other environmental factors such as stream flow and water temperature.

Table 5-9: Chlorophyll-a (mg/m^2) descriptive statistics of replicate samples grouped by sampling method at all chlorophyll-a monitoring stations in August, 2011 to 2020. N = sample size and % ND = percent of non-detect results.

Station	Sample Type	N	Mean	Standard Deviation	% ND
B2	Scrape	10	13.3	11.8	20.0
	Whole Rock	60	51.9	38.8	1.7
B3	Scrape	10	3.0	4.5	20.0
	Whole Rock	60	14.1	8.4	0.0
4	Scrape	10	93.7	149.2	10.0
	Whole Rock	60	126.1	59.5	0.0
B5	Scrape	10	38.3	45.3	0.0
	Whole Rock	60	67.2	31.1	1.7
B7	Scrape	10	165.1	235.6	10.0
	Whole Rock	60	184.8	140.6	0.0
B8	Scrape	10	97.9	98.9	0.0
	Whole Rock	60	71.7	40.6	0.0
B10	Scrape	10	39.2	39.7	0.0
	Whole Rock	60	91.8	38.0	0.0

Longitudinal patterns of median chlorophyll-a concentrations are presented in Figure 5-60 and illustrate the range of concentrations observed for Station B2 (Downstream from Hebgen Dam) to Station B10 (Downstream from Great Falls Dams) for the 2011 to 2020 period. No longitudinal trend was apparent for the whole rock method (Figure 5-60) with each station exhibiting a high degree of intra/inter annual variability, except for Station B3. The median concentration was the lowest at Station B3, which is approximately 5 miles upstream of Ennis Lake, and the greatest at Station B7, which is approximately 0.25 miles downstream from Hauser Dam.

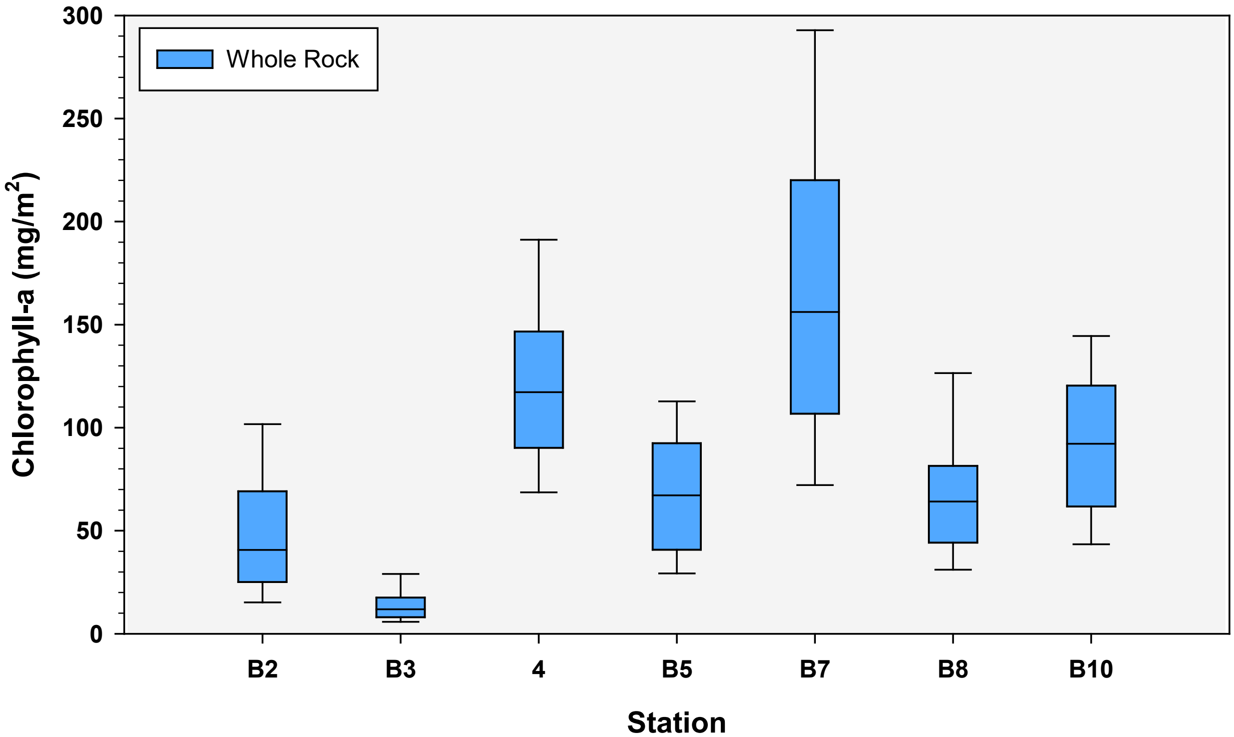


Figure 5-60: Chlorophyll-a (mg/m²) boxplots of replicate samples grouped by sampling method for each station in August, 2011 to 2020.

5.2.2.1.2 Upstream-Downstream Comparisons

Comparisons of median chlorophyll-a concentrations for paired stations upstream-downstream of the reservoirs and dams were made using the non-parametric Mann-Whitney *U* test. This analysis was performed to identify persistent statistical differences from 2011 to 2020. A summary of significance and percent change is presented in Table 5-10 and complete statistical results are found in Appendix C.

Median whole rock method chlorophyll-a concentrations were significantly different at all of the upstream-downstream paired stations ($p < 0.001$; Table 5-10). Direction of change in concentrations between paired stations alternated longitudinally between decreasing and increasing nitrogen concentrations. The largest and significant increase in median chlorophyll-a concentration occurred between stations B3 and 4, which is a section of the Madison River that brackets Ennis Lake and the Madison Dam. This increase corresponds with a slight increase in total nitrogen and phosphorus, water temperature, and smallest change in flow between the two stations, and was strongly influenced by the low algal biomass content at Station B3. Decreases in median chlorophyll-a concentration occurred between stations B2, downstream from Hebgen Dam, and B3, Ennis Campground, (-71 %); between stations 4 and B5 which bracket the Three Forks area, (-43 %), and between stations B7, downstream from Hauser Dam, and B8, downstream from Holter Dam, (-59 %) which consists primarily of riverine habitat. In general, portions of the Madison River are affected by nutrients and more favorable growing conditions (e.g. water temperature, consistent flow, light availability) in reaches where reservoirs/lakes are as compared to riverine reaches.

Table 5-10: Change (%) in median chlorophyll-a (mg/m^2) values between chlorophyll-a monitoring stations upstream-downstream of reservoirs and dams from 2011 to 2020. Grey cells indicate a statistically significant ($p < 0.05$) difference in mean ranks as determined by Mann–Whitney U tests.

Sample Type	B2 and B3	B3 and 4	4 and B5	B5 and B7	B7 and B8	B8 and B10
Scrape	-90	2,526	-43	159	-10	-60
Whole Rock	-71	889	-43	132	-59	44

5.2.2.1.3 Trend Analysis

Temporal trends in whole rock method chlorophyll-a replicate concentrations for each station were determined using the Mann-Kendall non-parametric trend analysis on data from 2011 to 2020. This analysis evaluated the monotonic trend (increasing or decreasing) over time and the Tau correlation coefficient provides information relative to the strength of the relationship between data pairs (Helsel et al. 2005; McBride 2005). Summary of chlorophyll-a concentration trends are presented in Table 5-11. Results from the scrape methodology were not analyzed for trends. Bar graphs of Station B2 (Downstream from Hebgen Dam) to Station B10 (Downstream from Great Falls Dams) illustrating the temporal distributions of data for the 2011 to 2020 are found in Appendix C.

Chlorophyll-a concentrations significantly increased by 4.62 mg/L per year at Station B2, downstream from Hebgen Dam, and by 0.70 mg/L per year at Station B3 upstream of Ennis Lake. The only significant decrease in concentrations occurred at Station B8 (-4.62 mg/L per year), downstream from Holter Dam between 2011 and 2020 (Table 5-11). No statistically significant trends occurred at the remaining stations.

Table 5-11: Trends analyses of whole rock method mean chlorophyll-a (mg/m^2) replicate samples in August, 2011 to 2020 at all chlorophyll-a monitoring stations. Grey cells indicate statistically significant ($p < 0.05$) trends as determined by the Mann-Kendall trend analyses.

Statistic	B2	B3	4	B5	B7	B8	B10
Tau Correlation Coefficient	0.388	0.298	-0.126	-0.090	-0.005	-0.363	0.072
Significance	<0.001	0.001	0.154	0.308	0.964	<0.001	0.415
Slope	4.62	0.70	-1.02	-0.14	0.00	-4.62	0.00
N	60	60	60	60	60	60	60

5.2.2.2 Diatoms

Excessive periphyton growth often indicates impairment of the aquatic ecosystem and can be evaluated through analysis of diatom metrics. Replicate periphyton samples were collected and composited to create one sample in August from 2011 to 2020 at the biological monitoring stations. Species were identified and enumerated, metrics were calculated, and biological integrity and impairment for mountain and plains streams were assessed.

5.2.2.2.1 Spatial Metrics Summary

A summary of biological integrity ratings and descriptive statistics by diatom metrics is presented in Table 5-12. Overall biological integrity and impairment ratings by diatom monitoring station and year from 2011 to 2020 are also provided in Appendix D.

Throughout the study period, the biological integrity rating for the diatom metrics for the Mountains and Plains Streams – Shannon diversity, pollution tolerance index, disturbance index, species richness and abundance of dominant species – at all stations has been categorized as "Excellent", as well as the siltation index in Plains Streams has been "Excellent" (Table 5-12). The exception to this was at Station B2, downstream from Hebgen Lake, where the pollution tolerance index for the Mountain Streams, the abundance of dominant species in both Mountain and Plains streams, and the abundance of dominant species was "Good". Percent abnormal cells was "Good" at all stations in Mountain streams, except at Station B7 where it was "Excellent", while siltation index was "Good" at all stations except for "Fair" at B10, downstream from Great Falls reservoir, the city of Great Falls, and Sun and Smith Rivers.

Table 5-12: Biological integrity ratings descriptive statistics by diatom metrics at all diatom monitoring stations in August, 2011 to 2020.

Station	Metric	N	Min.	Max.	Mean	Stand. Dev.	Mountain Streams	Plains Streams
B2	Shannon Diversity	10	2.40	4.82	4.13	0.77	Excellent	Excellent
	Pollution Tolerance Index	10	2.1	2.6	2.4	0.1	Good	Excellent
	Siltation Index (%)	10	9	64	28	18	Good	Excellent
	Disturbance Index (%)	10	1	18	6	5	Excellent	Excellent
	Species Richness	10	40	66	52	8	Excellent	Excellent
	Abundance of Dominant Species (%)	10	12	68	30	18	Good	Good
	Abnormal Cells (%)[a]	10	0	1.5	0.6	0.6	Good	--
B3	Shannon Diversity	10	3.35	4.92	4.39	0.47	Excellent	Excellent
	Pollution Tolerance Index	10	2.6	2.8	2.7	0.1	Excellent	Excellent
	Siltation Index (%)	10	17	45	31	10	Good	Excellent
	Disturbance Index (%)	10	4	24	9	6	Excellent	Excellent
	Species Richness	10	38	66	56	8	Excellent	Excellent
	Abundance of Dominant Species (%)	10	12	34	20	7	Excellent	Excellent
	Abnormal Cells (%)[a]	10	0	0.5	0.2	0.2	Good	--
4	Shannon Diversity	10	4.78	5.43	5.21	0.21	Excellent	Excellent
	Pollution Tolerance Index	10	2.4	2.8	2.6	0.1	Excellent	Excellent
	Siltation Index (%)	10	12	51	33	11	Good	Excellent
	Disturbance Index (%)	10	2	8	5	2	Excellent	Excellent
	Species Richness	10	65	94	79	10	Excellent	Excellent
	Abundance of Dominant Species (%)	10	8	14	11	2	Excellent	Excellent
	Abnormal Cells (%)[a]	10	0	0.3	0.0	0.1	Good	--
B5	Shannon Diversity	10	4.20	5.21	4.83	0.30	Excellent	Excellent
	Pollution Tolerance Index	10	2.5	2.7	2.6	0.1	Excellent	Excellent
	Siltation Index (%)	10	13	49	28	12	Good	Excellent
	Disturbance Index (%)	10	1	16	8	5	Excellent	Excellent
	Species Richness	10	55	85	68	10	Excellent	Excellent
	Abundance of Dominant Species (%)	10	9	24	14	4	Excellent	Excellent
	Abnormal Cells (%)[a]	10	0	0.1	0.0	0.1	Good	--
B7	Shannon Diversity	10	3.18	4.48	4.02	0.40	Excellent	Excellent
	Pollution Tolerance Index	10	2.5	2.9	2.7	0.1	Excellent	Excellent
	Siltation Index (%)	10	3	45	24	13	Good	Excellent
	Disturbance Index (%)	10	0	14	6	4	Excellent	Excellent
	Species Richness	10	31	57	42	8	Excellent	Excellent
	Abundance of Dominant Species (%)	10	11	34	20	7	Excellent	Excellent
	Abnormal Cells (%)[a]	10	0	0.0	0.0	0.0	Excellent	--
B8	Shannon Diversity	10	2.75	4.67	3.83	0.53	Excellent	Excellent
	Pollution Tolerance Index	10	2.5	2.9	2.7	0.1	Excellent	Excellent
	Siltation Index (%)	10	7	34	23	10	Good	Excellent
	Disturbance Index (%)	10	0	41	21	15	Excellent	Excellent
	Species Richness	10	30	54	43	7	Excellent	Excellent
	Abundance of Dominant Species (%)	10	9	51	28	13	Good	Good
	Abnormal Cells (%)[a]	10	0	0.5	0.1	0.2	Good	--
B10	Shannon Diversity	10	4.09	5.33	4.72	0.42	Excellent	Excellent
	Pollution Tolerance Index	10	2.4	2.7	2.5	0.1	Excellent	Excellent
	Siltation Index (%)	10	30	62	45	11	Fair	Excellent
	Disturbance Index (%)	10	1	14	6	4	Excellent	Excellent
	Species Richness	10	49	88	68	14	Excellent	Excellent
	Abundance of Dominant Species (%)	10	11	29	19	7	Excellent	Excellent
	Abnormal Cells (%)[a]	10	0	0.1	0.0	0.0	Good	--

[a]Biological integrity ratings have not been established for abnormal cell (%) in plains streams.

The slightly lower ratings at Station B2 for Mountain Streams are reflected in that station's overall impairment rating of "Severe" in one and "Moderate" in three of the previous 10 years which were caused mainly by poor scores for the siltation index and abundances of dominant species (Appendix D). This station has limited habitat due to increased channel braiding and the poorer metric scores may have been the result of a side channel being included in sampling (personal communication with Andy Welch). The Mountain Streams siltation index was also an issue at Station B10 which was rated with "Moderate" impairment in five of the 10 years and "Severe" impairment in one year. Certainly, the size of the Missouri River at Station B10 (i.e., large river) and substrate characteristics are more characteristic of a Plains Stream than a Mountain Stream, so the metric rating should be considered in context. All other stations in all years were rated with a minimal number of "Moderate" impairment years and mostly "Minor" impairment or "None." These rating results are very similar to those from 2007 to 2016 (GEI 2017).

Longitudinal patterns of median diatom metric values are presented in the following box plots (center bar) and data distributions (25^{th} & 75^{th} percentiles [box], and the 10^{th} & 90^{th} percentiles [whiskers]). These figures illustrate the spatial distributions of data from Station B2 (Downstream from Hebgen Dam) to Station B10 (Downstream from Great Falls Dams) for the 2011 to 20120 period.

From 2011 to 2020, no longitudinal increasing or decreasing trends in diatom metrics were apparent Shannon diversity, pollution tolerance index, siltation index, disturbance index, species richness, or dominant species (Figure 5-61 through Figure 5-66) except for a decrease in abnormal cells (%) in a downstream direction (Table 5-12, Figure 5-67). This decrease may have been the result of increased ice and geothermal effects at the upstream stations. Shannon diversity, siltation index, and species richness generally followed a pattern of improved diatom community health from Station B2 to Station B4, a decline in health after the Three Forks confluence to stations B7 and B8 downstream of Upper Holter and Holter Reservoirs, respectively, and an improvement to Station B10, downstream from Great Falls reservoir, the city of Great Falls, and Sun and Smith Rivers. Abundance of dominant species (%) followed an opposite pattern. These similar patterns are expected as many diatom taxa are involved in multiple metrics. These patterns are very similar to those from 2007 to 2016 (GEI 2017).

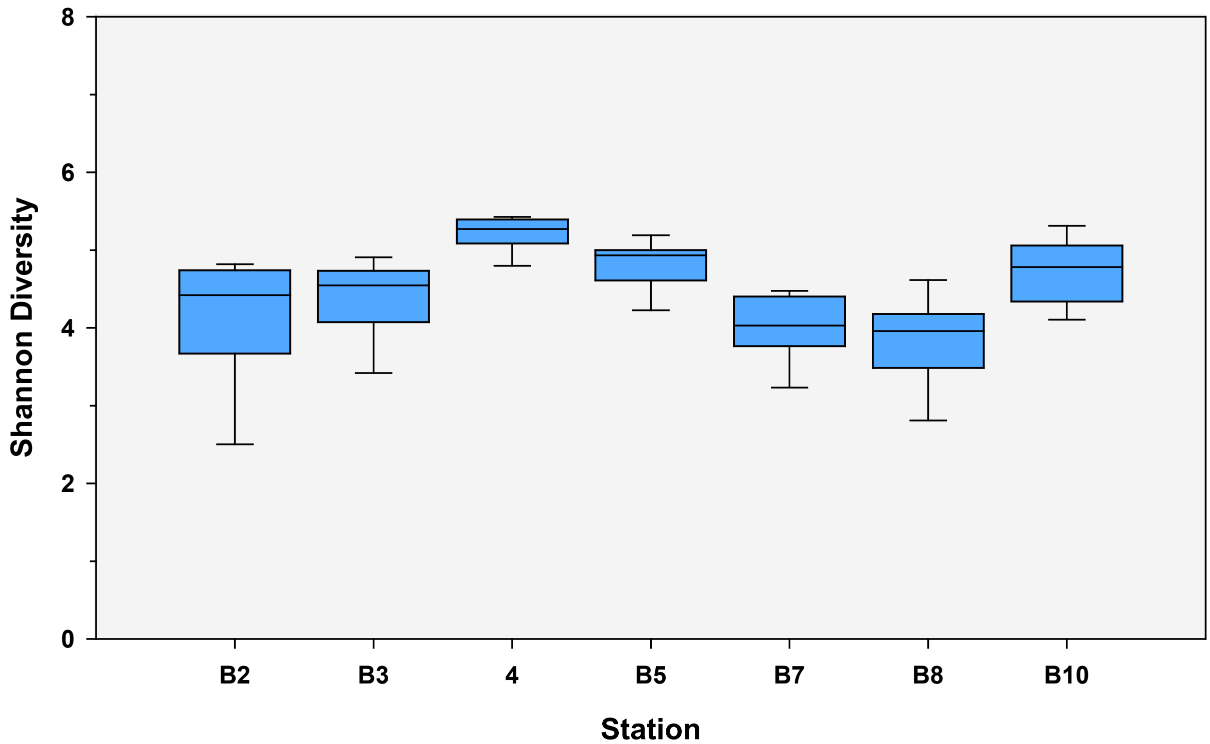


Figure 5-61: Shannon diversity for each biological monitoring station in August, 2011 to 2020.

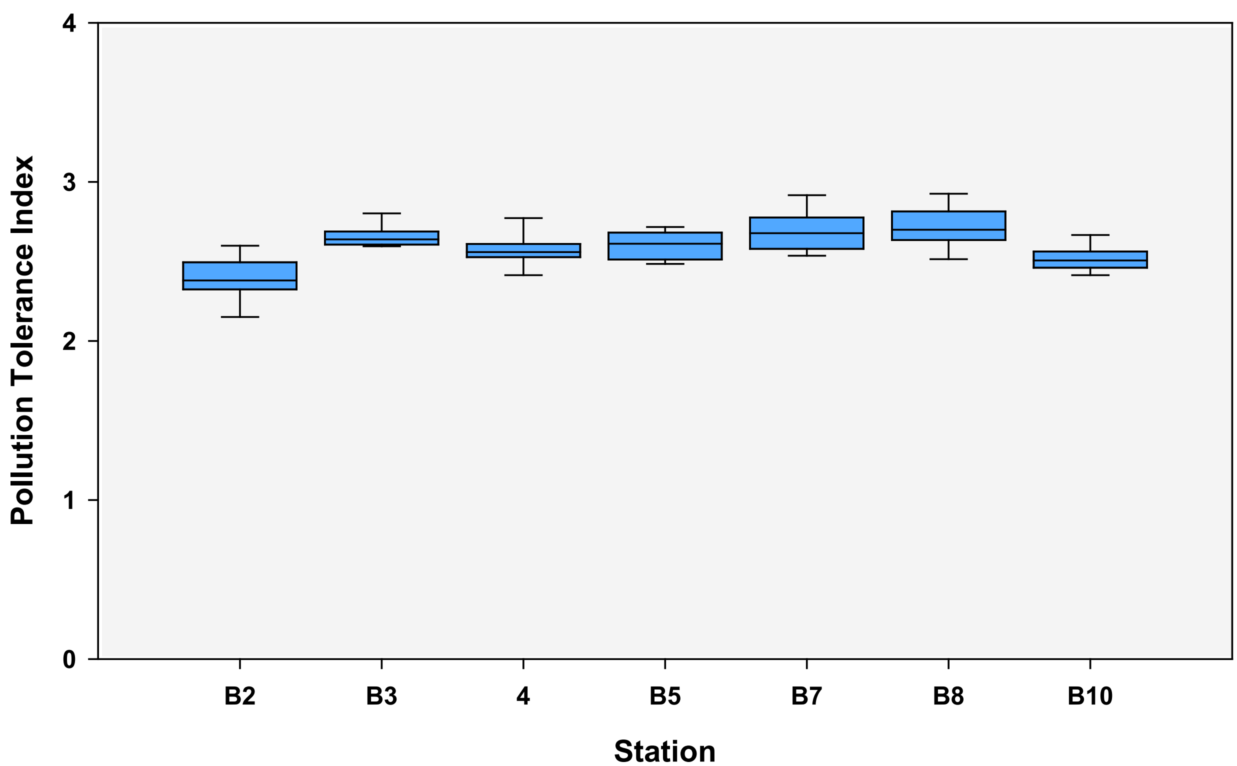


Figure 5-62: Pollution tolerance index for each biological monitoring station in August, 2011 to 2020.

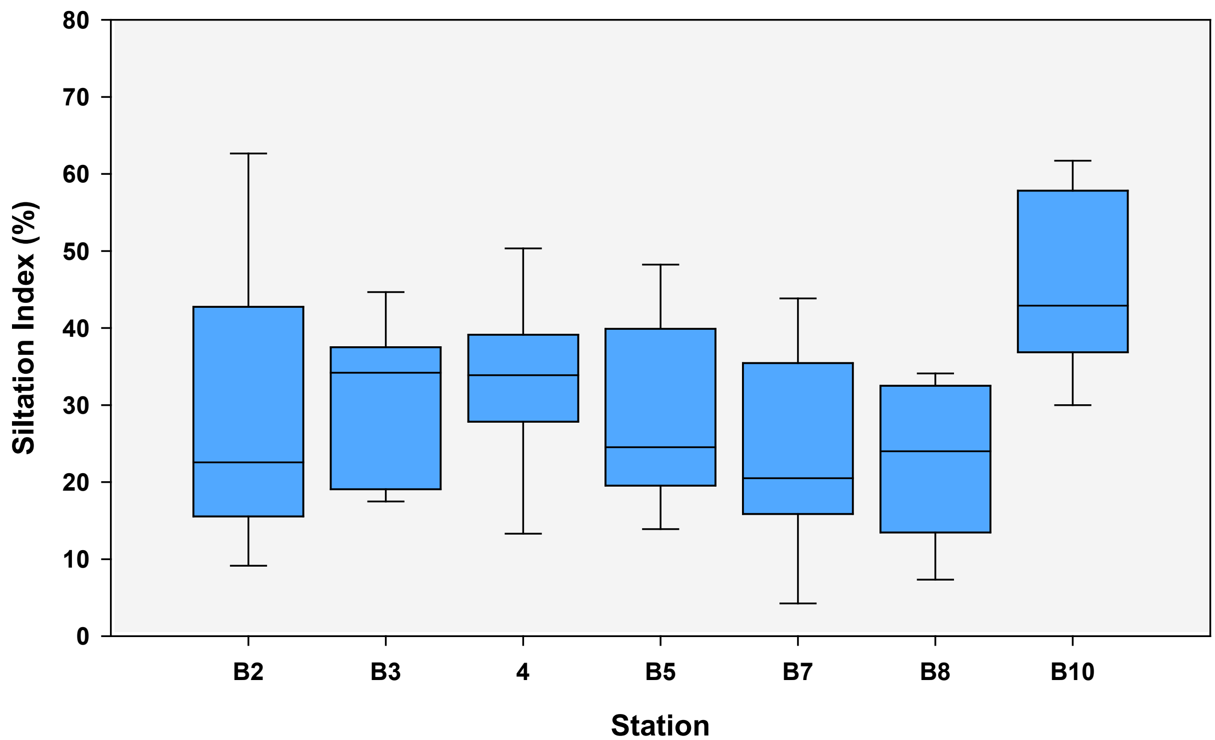


Figure 5-63: Siltation index (%) for each biological monitoring station in August, 2011 to 2020.

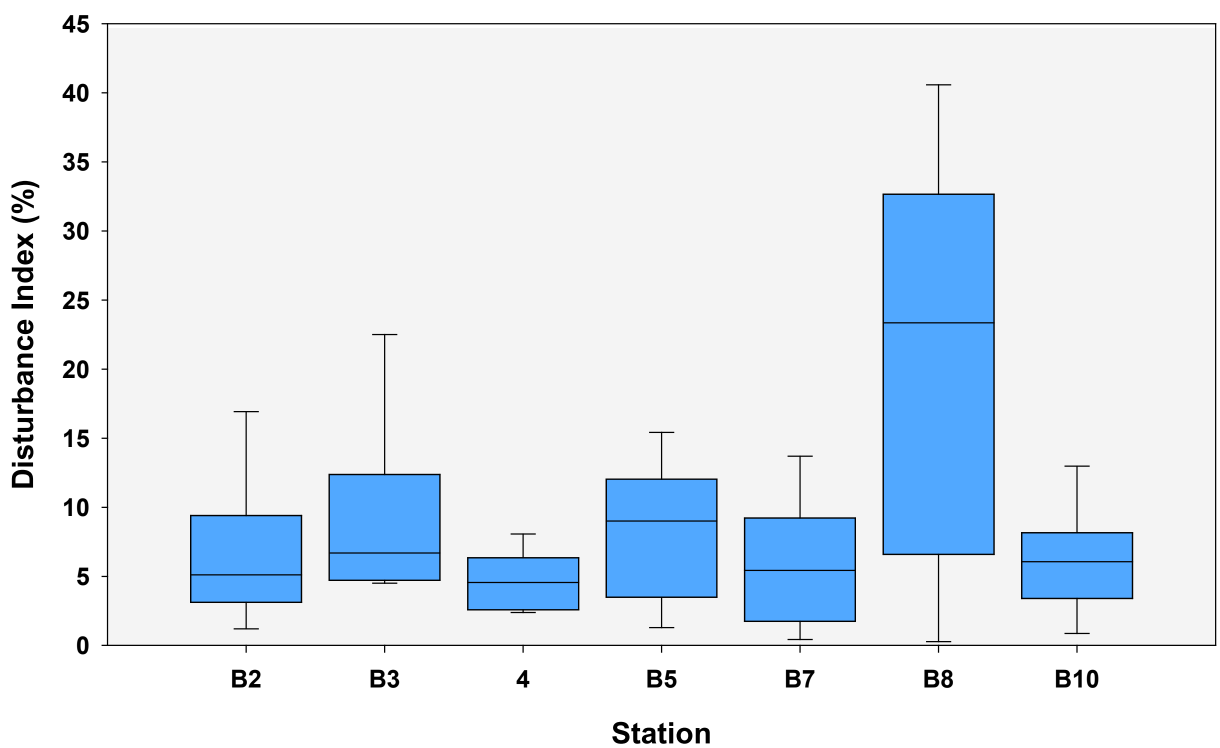


Figure 5-64: Disturbance index (%) for each biological monitoring station in August, 2011 to 2020.

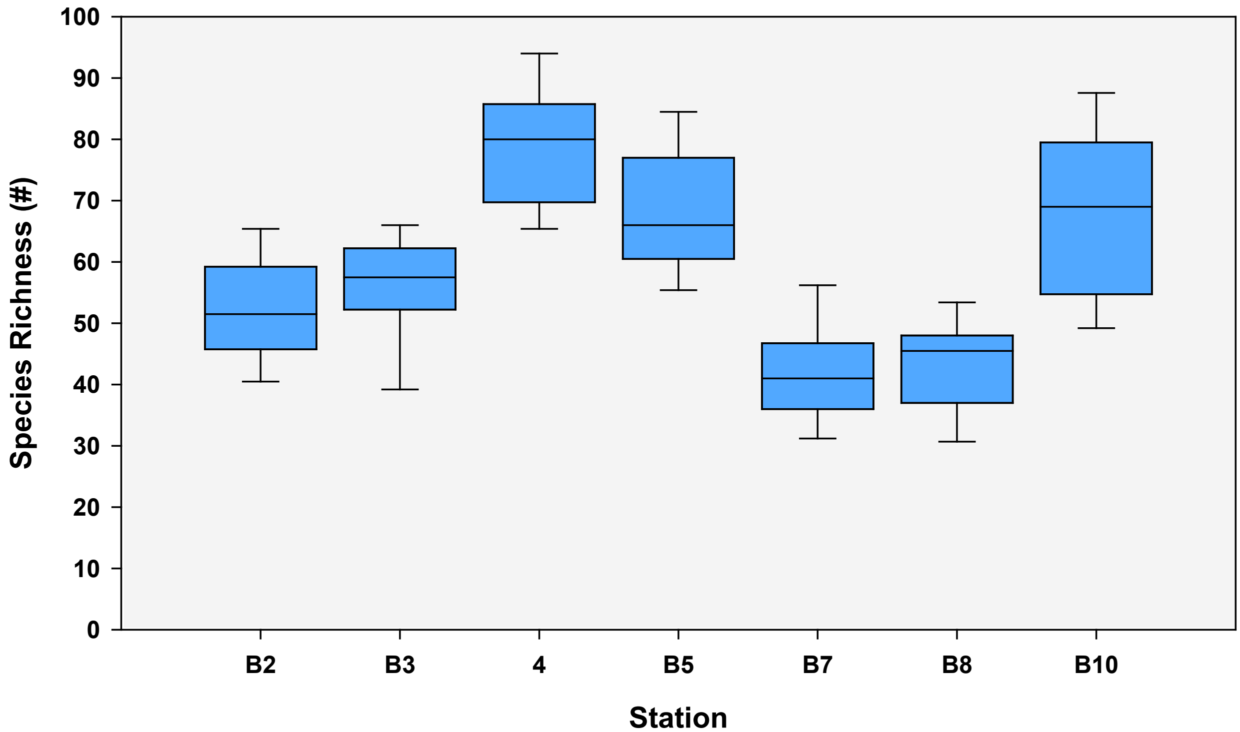


Figure 5-65: Species richness for each biological monitoring station in August, 2011 to 2020.

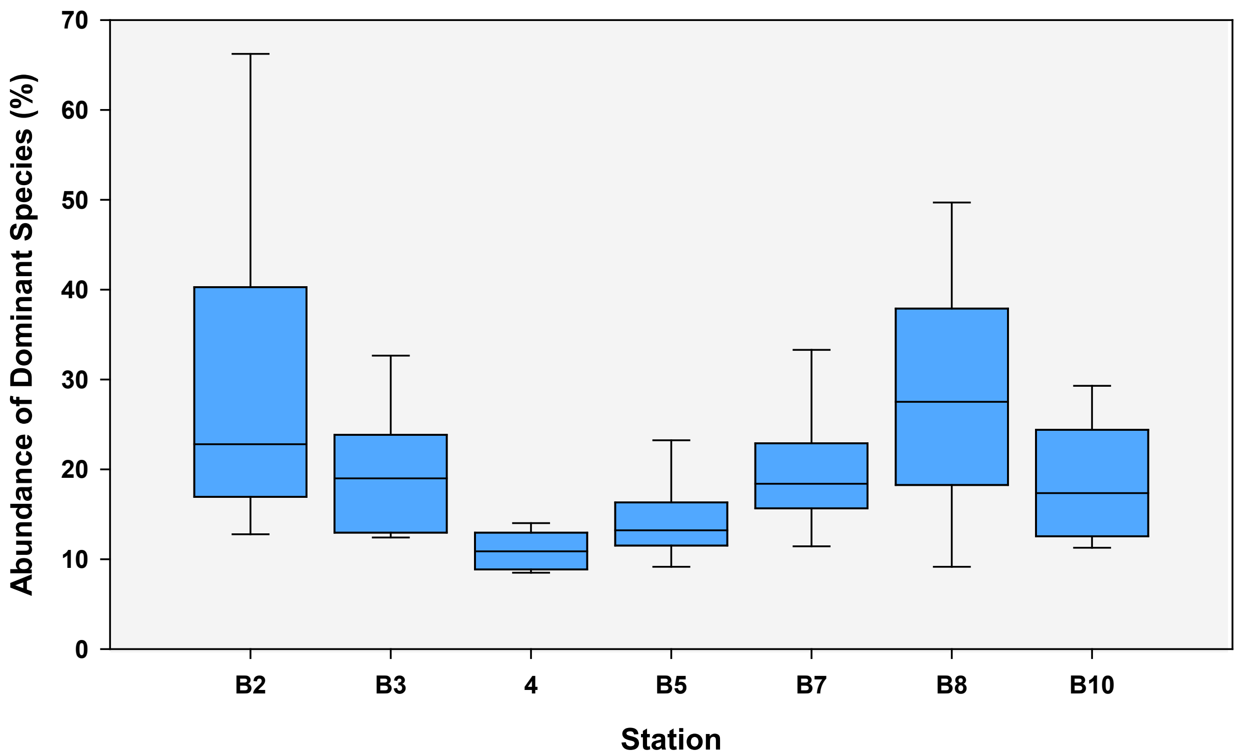


Figure 5-66: Percentage of dominant species (%) for each biological monitoring station in August, 2011 to 2020.

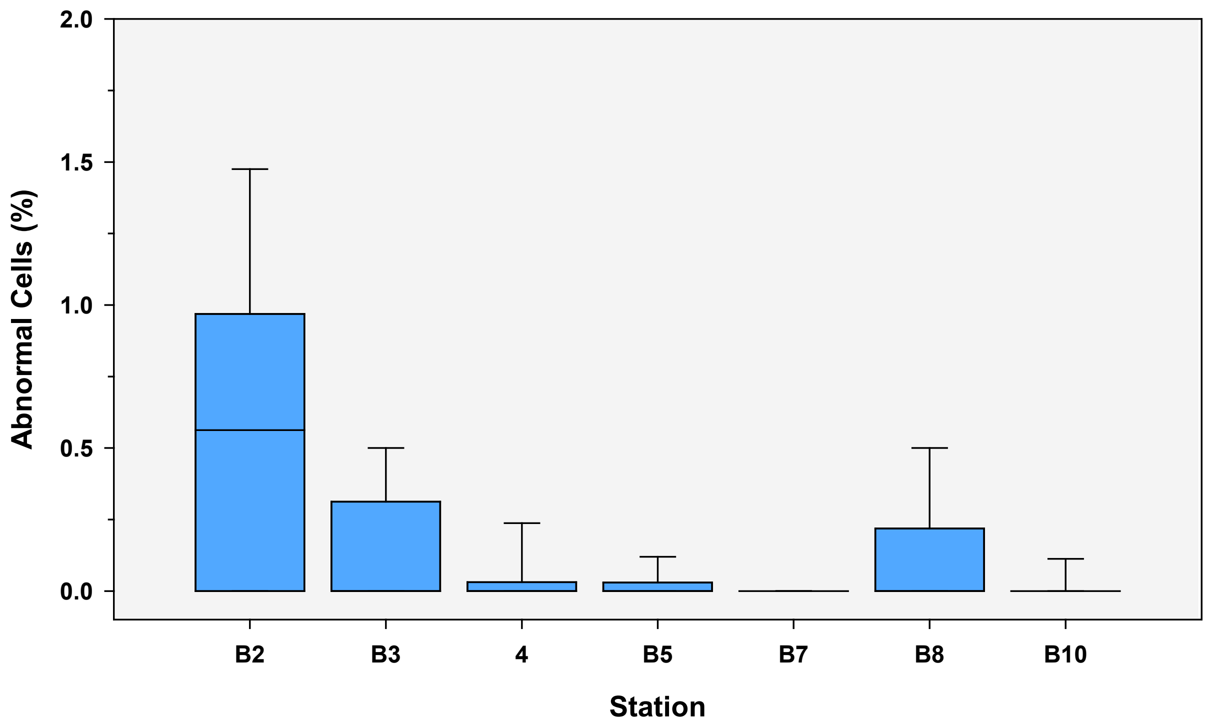


Figure 5-67: Abnormal cells (%) for each biological monitoring station in August, 2011 to 2020.

5.2.2.2.2 Upstream-Downstream Comparisons

Comparisons of median diatom metric values at paired biological monitoring stations directly upstream-downstream of the reservoirs and dams were made using the Mann-Whitney *U* non-parametric test. This analysis was performed to identify persistent statistical differences from 2011 to 2020. A summary of significance and percent change is presented in Table 5-13 and complete statistical results are provided in Appendix D.

Statistically significantly differences occurred for multiple metrics at all station pairs ($p < 0.05$; Table 5-13). However, no more than five of the seven metrics were statistically different between any of the paired stations. Shannon diversity, pollution tolerance index, species richness, and abundance of dominant species (%) were statistically different between stations B3 and 4 and indicate an improvement in diatom community biological integrity. In contrast, Shannon diversity, species richness, and abundance of dominant species as a percentage were statistically different between stations 4 and B5 and station B5 and B7 and indicate a decline in diatom community biological integrity. The significant changes between all other paired station were not consistently in the same direction and represented a mix of improving or declining conditions.

These results differ from the 2007 to 2016 assessment in which multiple metrics were significantly different between stations B2 and B3 and between stations B3 and 4 indicating improvements in diatom community biological integrity (GEI 2017).

Table 5-13: Change (%) in median diatom metric values between diatom monitoring stations upstream-downstream of reservoirs and dams from 2011 to 2020. Grey cells indicate a statistically significant ($p < 0.05$) difference in mean ranks as determined by Mann–Whitney U tests.

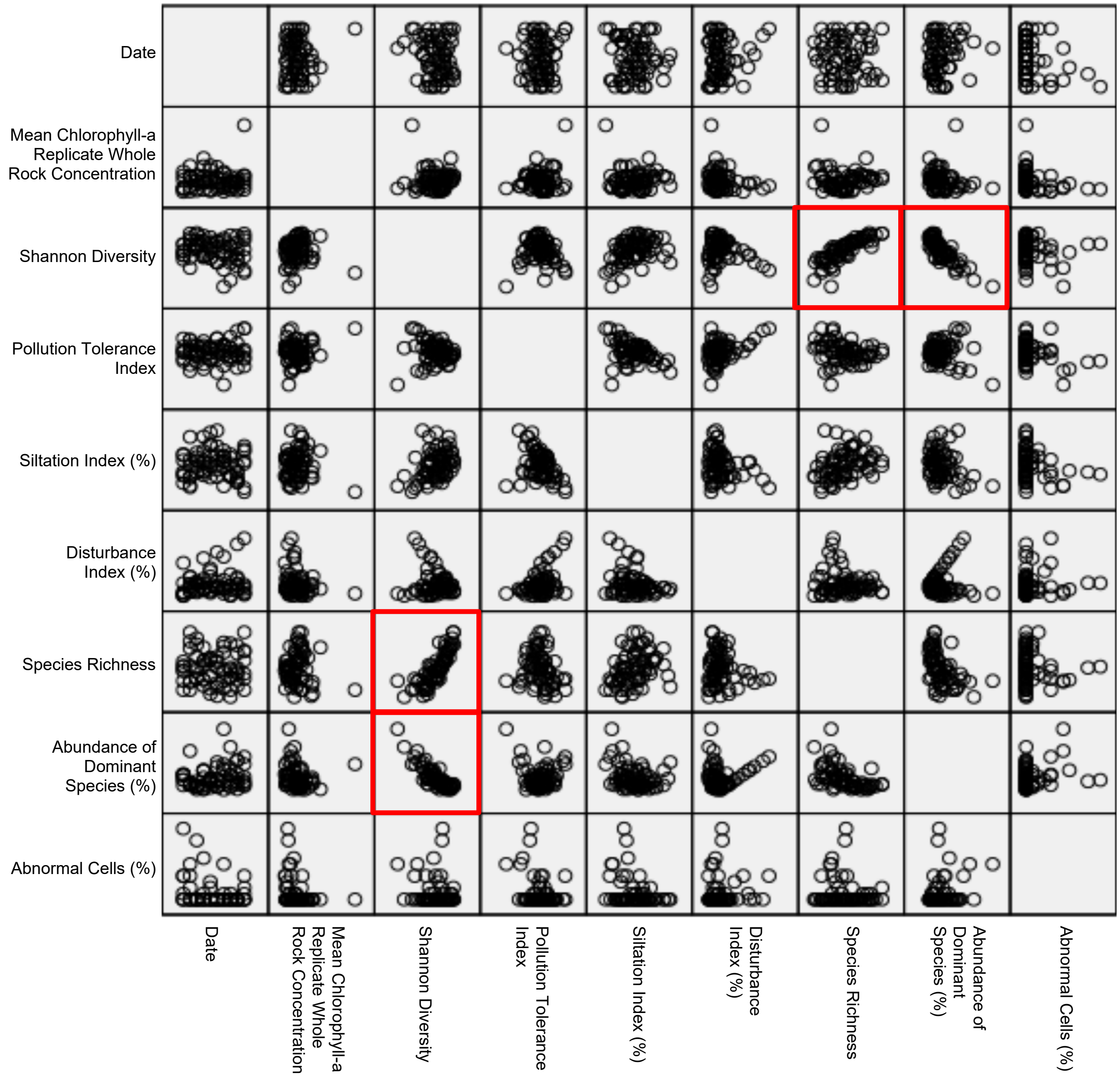
Metric	B2 and B3	B3 and 4	4 and B5	B5 and B7	B7 and B8	B8 and B10
Shannon Diversity	2.9	15.9	-6.4	-18.3	-1.7	20.8
Pollution Tolerance Index	10.9	-3.0	2.0	2.5	0.8	-7.2
Siltation Index (%)	51.6	-1.0	-27.6	-16.4	17.1	78.7
Disturbance Index (%)	30.8	-31.8	97.3	-39.7	330.0	-74.0
Species Richness	11.7	39.1	-17.5	-37.9	11.0	51.6
Dominant Species (%)	-16.7	-42.7	21.5	39.1	49.6	-36.9
Abnormal Cells (%)	-100.0	0.0	0.0	0.0	0.0	0.0

5.2.2.2.3 Metric Correlations

Correlations between diatom metrics and scrape and whole rock methods mean chlorophyll-a concentrations were evaluated using the non-parametric Kendall-tau statistic at each diatom monitoring station on data from 2011 to 2020. This analysis identified parameters that were statistically correlated, and the strength of the relationship was determined based on a correlation coefficient > 0.5 and a statistically significant relationship ($p < 0.05$). A summary of these results in the form of a scatterplot matrix is presented in Table 5-14 and the complete statistical results are presented in Appendix D. The scatter plot matrix incorporates multiple scatter plot relationships from multiple variable combinations into one table. Variables are listed along the rows and columns of the table.

The individual station diatom correlation analyses are quite extensive and are not detailed in narrative form. Suffice to say that significant correlations between metrics were expected at each station as many diatom taxa are involved in multiple metrics. Specifically, Shannon diversity, abundance of dominant species as a percentage, and mean chlorophyll-a replicate whole rock concentration were often correlated with other metrics at the same station (Appendix D). Significant relationships occurred between Shannon diversity and species richness metrics for all stations, except for Station B8. Similarly, significant relationships were observed between Shannon diversity and abundance of dominant species as a percentage for all stations, except for Station 4 (Table 5-14). The abundance of significant correlations at specific stations but scarcity of metric relationships among all stations indicates that relationships between metrics differ greatly between stations. Results are very similar to those from 2007 to 2016 (GEI 2017).

Table 5-14: Diatom metrics scatterplot matrix for all diatom monitoring stations in August, 2011-2020. Red boxes indicate a significant relationship ($p < 0.05$) between parameters with a correlation coefficient < -0.5 or > 0.5.



5.2.2.2.4 Trend Analysis

Temporal trends in diatom metric values over time for each station were evaluated using Least Squares Regression analysis on data from 2011 to 2020. This analysis provides a coefficient of determination indicating the relative degree of association between paired diatom metric and year values. Summary of diatom metric trends are presented in Table 5-15. Bar graphs of Station B2 (Downstream from Hebgen Dam) to Station B10 (Downstream from Great Falls Dams) illustrating the temporal distributions of data and overall biological integrity and impairment ratings by diatom monitoring station and year from 2011 to 2020 are also presented in Appendix D.

Significant temporal trends ($p < 0.05$) of diatom metrics occurred mostly at Station B8, downstream from Holter Dam, and at Station B7, downstream from Hauser Dam (Table 5-15). At Station B7, Shannon diversity and abundance of dominant species (%) significantly worsened over time and at Station B8, Shannon diversity, pollution tolerance index, disturbance index (%), and abundance of dominant species (%) also significantly worsened over time. In addition, abnormal cells (%) improved at Station B2. These results indicate a decline in the diatom community downstream from Hauser and Holter dams but little change elsewhere from 2011 to 2020. From 2007 to 2016, significant trends were not limited to stations B7 and B8 and four of the seven stations revealed only one significant trend (GEI 2017).

Table 5-15: Trend analyses of diatom metrics in August, 2011 to 2020 at all diatom monitoring stations. Grey cells indicate statistically significant ($p < 0.05$) trends as determined by Least Squares Regression.

Metric	Statistics	B2	B3	4	B5	B7	B8	B10
Shannon Diversity	Coefficient of determination	0.027	0.310	0.085	0.053	0.503	0.415	0.001
	Significance	0.648	0.094	0.413	0.522	0.022	0.044	0.936
	Slope	-0.042	-0.087	0.020	0.023	-0.093	-0.113	0.004
	N	10	10	10	10	10	10	10
Pollution Tolerance Index	Coefficient of determination	0.007	0.029	0.147	0.066	0.015	0.539	0.001
	Significance	0.824	0.640	0.273	0.473	0.735	0.016	0.939
	Slope	-0.004	0.004	-0.012	-0.007	0.005	0.032	-0.001
	N	10	10	10	10	10	10	10
Siltation Index (%)	Coefficient of determination	0.200	0.015	0.047	0.037	0.270	0.100	0.219
	Significance	0.195	0.735	0.546	0.594	0.123	0.374	0.173
	Slope	2.622	0.388	0.763	-0.738	-2.163	-1.070	-1.742
	N	10	10	10	10	10	10	10
Disturbance Index (%)	Coefficient of determination	0.161	0.215	0.276	0.149	0.061	0.401	0.102
	Significance	0.250	0.177	0.119	0.270	0.491	0.049	0.369
	Slope	-0.648	-0.919	0.368	0.604	-0.360	3.036	0.369
	N	10	10	10	10	10	10	10
Species Richness	Coefficient of determination	0.039	0.130	0.089	0.028	0.083	0.072	0.001
	Significance	0.586	0.305	0.402	0.644	0.419	0.452	0.938
	Slope	0.527	-0.982	0.976	-0.527	-0.745	0.642	0.127
	N	10	10	10	10	10	10	10
Abundance of Dominant Species (%)	Coefficient of determination	0.003	0.219	0.133	0.063	0.436	0.643	0.002
	Significance	0.889	0.172	0.300	0.485	0.038	0.005	0.906
	Slope	0.298	1.038	-0.236	-0.348	1.512	3.357	-0.097
	N	10	10	10	10	10	10	10
Abnormal Cells (%)	Coefficient of determination	0.713	0.273	0.060	0.273	.	0.001	0.273
	Significance	0.002	0.122	0.494	0.122	.	0.928	0.122
	Slope	-0.156	-0.036	-0.007	0.009	.	-0.002	-0.007
	N	10	10	10	10	10	10	10

- All results were zero.

5.2.3 Macroinvertebrate

The health of an aquatic ecosystem is often assessed via the macroinvertebrate community and their associated metrics. Nine macroinvertebrate samples were collected and composited in August from 2011 to 2020 at each of the 11 biological monitoring stations. Species were identified, enumerated and metrics were calculated by the taxonomist.

5.2.3.1.1 Spatial Metrics Summary

A summary of descriptive statistics by macroinvertebrate metrics is presented in Table 5-16. Longitudinal patterns of median macroinvertebrate metric values are presented in the following box plots (center bar) and data distributions (25th & 75th percentiles [box], and the 10th & 90th percentiles [whiskers]). These figures illustrate the spatial distributions of data from Station B1 (Yellowstone National Park) to Station B10 (Downstream from Great Falls Dams) including flush stations for 2011 to 2020.

From 2011 to 2020, no longitudinal increasing or decreasing trends in macroinvertebrate metrics were apparent (Table 5-16; Figure 5-68 through Figure 5-75). All metrics, including multimetric assessment (% of possible score), except for relative abundance of Chironomidae (%), followed a general pattern of a consistent or decline in macroinvertebrate community health from Station B1 to Station F1, improved community health to Station B3, decline in community health to Station 4, improved community health to Station F3, decline community health through Station B7, and improved community health through Station B10. These similar patterns among the metrics highlight the effects of Ennis Lake and Madison Dam on the macroinvertebrate community in the Madison River, and the effects of Canyon Ferry Reservoir/Dam on the community in the Missouri River. Macroinvertebrate community health was poorer for the stations downstream of Hauser and Holter dams (B7 and B8), but improved by Station B10. The standard deviation for community density (0.25 m^2) was very high at all stations indicating a large variability in the number of organisms collected per year. Metrics at the biological control Station B5 often depicted a healthier community than stations downstream of the reservoirs on the Missouri River. Overall, the metrics, including multimetric assessment (% of possible), indicated a pattern of improving and declining macroinvertebrate health throughout the stations which is largely tied to the effects of Ennis Lake/Madison Dam and Canyon Ferry, Hauser, and Holter dams. Results are very similar to those from 2007 to 2016 (GEI 2017).

Table 5-16: Macroinvertebrate metrics descriptive statistics of samples at all macroinvertebrate monitoring stations in August, 2011 to 2020.

Station	Metric	N	Min.	Max.	Mean	Stand. Dev.
B1	Taxa Richness[a]	10	23.6	38.2	30.4	4.5
	Shannon Diversity[a]	10	3.13	4.11	3.61	0.34
	Biotic Index[a]	10	4.1	5.6	4.8	0.4
	EPT Richness[a]	10	11.8	17.8	14.2	2.0
	Relative Abundance of EPT (%)[a]	10	33.0	69.0	57.7	12.1
	Relative Abundance of Chironomidae (%)[a]	10	4.0	10.0	8.2	2.1
	Community Density (0.25 m^2)[b]	10	340	859	577	168
	Multimetric Assessment (Total)[c]	10	21.0	26.0	24.3	1.9
	Multimetric Assessment (% of Possible)[c]	10	70.0	86.7	81.0	6.3
B2	Taxa Richness[a]	10	21.6	39.2	30.1	6.1
	Shannon Diversity[a]	10	2.68	4.14	3.43	0.44
	Biotic Index[a]	10	3.9	5.1	4.6	0.4
	EPT Richness[a]	10	8.0	19.0	13.7	3.6
	Relative Abundance of EPT (%)[a]	10	38.0	66.0	54.2	8.6
	Relative Abundance of Chironomidae (%)[a]	10	2.0	44.0	18.2	15.6
	Community Density (0.25 m^2)[b]	10	504	2,417	1,027	569
	Multimetric Assessment (Total)[c]	10	18.0	27.0	22.0	2.9
	Multimetric Assessment (% of Possible)[c]	10	60.0	90.0	73.3	9.8
F1	Taxa Richness[a]	10	25.8	35.4	30.8	3.2
	Shannon Diversity[a]	10	2.59	4.10	3.45	0.42
	Biotic Index[a]	10	4.2	6.2	5.2	0.6
	EPT Richness[a]	10	11.6	18.4	14.6	1.9
	Relative Abundance of EPT (%)[a]	10	19.0	56.0	33.5	12.5
	Relative Abundance of Chironomidae (%)[a]	10	6.0	32.0	14.5	7.4
	Community Density (0.25 m^2)[b]	10	880	4,153	2,154	1,098
	Multimetric Assessment (Total)[c]	10	16.0	24.0	20.6	2.8
	Multimetric Assessment (% of Possible)[c]	10	53.3	80.0	68.7	9.5
B3	Taxa Richness[a]	10	28.2	37.6	34.1	2.9
	Shannon Diversity[a]	10	3.39	4.14	3.79	0.26
	Biotic Index[a]	10	3.1	4.3	3.5	0.4
	EPT Richness[a]	10	14.6	21.2	17.6	1.9
	Relative Abundance of EPT (%)[a]	10	51.0	76.0	65.9	7.8
	Relative Abundance of Chironomidae (%)[a]	10	4.0	14.0	7.1	3.1
	Community Density (0.25 m^2)[b]	10	486	1,735	883	363
	Multimetric Assessment (Total)[c]	10	27.0	30.0	28.5	1.1
	Multimetric Assessment (% of Possible)[c]	10	90.0	100.0	95.0	3.6
4	Taxa Richness[a]	10	20.6	35.2	27.0	4.3
	Shannon Diversity[a]	10	2.62	3.72	3.05	0.31
	Biotic Index[a]	10	5.6	6.7	6.0	0.4
	EPT Richness[a]	10	5.4	13.0	8.3	2.5
	Relative Abundance of EPT (%)[a]	10	14.0	54.0	30.6	12.9
	Relative Abundance of Chironomidae (%)[a]	10	8.0	39.0	26.4	9.8
	Community Density (0.25 m^2)[b]	10	2,299	8,008	3,642	1,755
	Multimetric Assessment (Total)[c]	10	9.0	20.0	14.0	3.6
	Multimetric Assessment (% of Possible)[c]	10	30.0	66.7	46.7	11.9
F3	Taxa Richness[a]	10	29.6	42.8	36.5	3.8
	Shannon Diversity[a]	10	3.59	4.50	3.98	0.26
	Biotic Index[a]	10	3.8	5.7	4.6	0.5
	EPT Richness[a]	10	11.4	21.6	17.5	3.0
	Relative Abundance of EPT (%)[a]	10	32.0	71.0	57.9	11.5
	Relative Abundance of Chironomidae (%)[a]	10	11.0	29.0	20.4	5.7

Station	Metric	N	Min.	Max.	Mean	Stand. Dev.
	Community Density (0.25 m^2)[b]	10	495	2,515	1,233	585
	Multimetric Assessment (Total)[c]	10	18.0	30.0	25.7	3.4
	Multimetric Assessment (% of Possible)[c]	10	60.0	100.0	85.7	11.4
F4	Taxa Richness[a]	10	25.4	40.4	34.3	4.3
	Shannon Diversity[a]	10	3.50	4.39	3.92	0.30
	Biotic Index[a]	10	3.8	4.7	4.3	0.4
	EPT Richness[a]	10	11.8	19.4	17.0	2.6
	Relative Abundance of EPT (%)[a]	10	60.0	84.0	72.5	7.1
	Relative Abundance of Chironomidae (%)[a]	10	7.0	21.0	12.1	4.6
	Community Density (0.25 m^2)[b]	10	902	2,843	2,003	623
	Multimetric Assessment (Total)[c]	10	25.0	30.0	27.6	2.0
	Multimetric Assessment (% of Possible)[c]	10	83.3	100.0	92.0	6.7
B5	Taxa Richness[a]	10	28.0	37.2	32.6	3.2
	Shannon Diversity[a]	10	3.38	4.29	3.79	0.27
	Biotic Index[a]	10	4.4	5.5	4.8	0.3
	EPT Richness[a]	10	14.0	22.0	17.9	3.1
	Relative Abundance of EPT (%)[a]	10	33.0	85.0	65.0	15.8
	Relative Abundance of Chironomidae (%)[a]	10	6.0	51.0	19.3	13.9
	Community Density (0.25 m^2)[b]	10	765	3,952	1,824	956
	Multimetric Assessment (Total)[c]	10	16.0	29.0	25.1	3.9
	Multimetric Assessment (% of Possible)[c]	10	53.3	96.7	83.7	13.0
B7	Taxa Richness[a]	10	14.2	25.8	18.7	4.1
	Shannon Diversity[a]	10	2.08	3.39	2.70	0.46
	Biotic Index[a]	10	5.2	6.3	5.6	0.3
	EPT Richness[a]	10	3.6	9.6	5.7	2.3
	Relative Abundance of EPT (%)[a]	10	5.0	44.0	19.9	15.1
	Relative Abundance of Chironomidae (%)[a]	10	5.0	33.0	16.4	10.7
	Community Density (0.25 m^2)[b]	10	2,097	9,748	3,986	2,203
	Multimetric Assessment (Total)[c]	10	9.0	19.0	12.6	3.1
	Multimetric Assessment (% of Possible)[c]	10	30.0	63.3	42.0	10.3
B8	Taxa Richness[a]	10	17.8	25.0	21.0	2.5
	Shannon Diversity[a]	10	2.57	3.38	2.94	0.28
	Biotic Index[a]	10	5.4	6.2	5.7	0.2
	EPT Richness[a]	10	3.8	9.0	5.9	1.7
	Relative Abundance of EPT (%)[a]	10	7.0	65.0	30.4	17.6
	Relative Abundance of Chironomidae (%)[a]	10	6.0	47.0	14.0	12.0
	Community Density (0.25 m^2)[b]	10	3,328	6,060	4,456	972
	Multimetric Assessment (Total)[c]	10	11.0	21.0	15.0	3.8
	Multimetric Assessment (% of Possible)[c]	10	36.7	70.0	50.0	12.6
B10	Taxa Richness[a]	10	25.4	37.8	30.4	4.6
	Shannon Diversity[a]	10	3.21	4.03	3.51	0.24
	Biotic Index[a]	10	4.6	5.8	5.1	0.4
	EPT Richness[a]	10	11.0	19.4	14.7	3.0
	Relative Abundance of EPT (%)[a]	10	38.0	87.0	66.8	16.3
	Relative Abundance of Chironomidae (%)[a]	10	8.0	40.0	22.8	11.9
	Community Density (0.25 m^2)[b]	10	697	2,998	1,475	690
	Multimetric Assessment (Total)[c]	10	16.0	28.0	22.7	4.5
	Multimetric Assessment (% of Possible)[c]	10	53.3	93.3	75.7	15.1

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

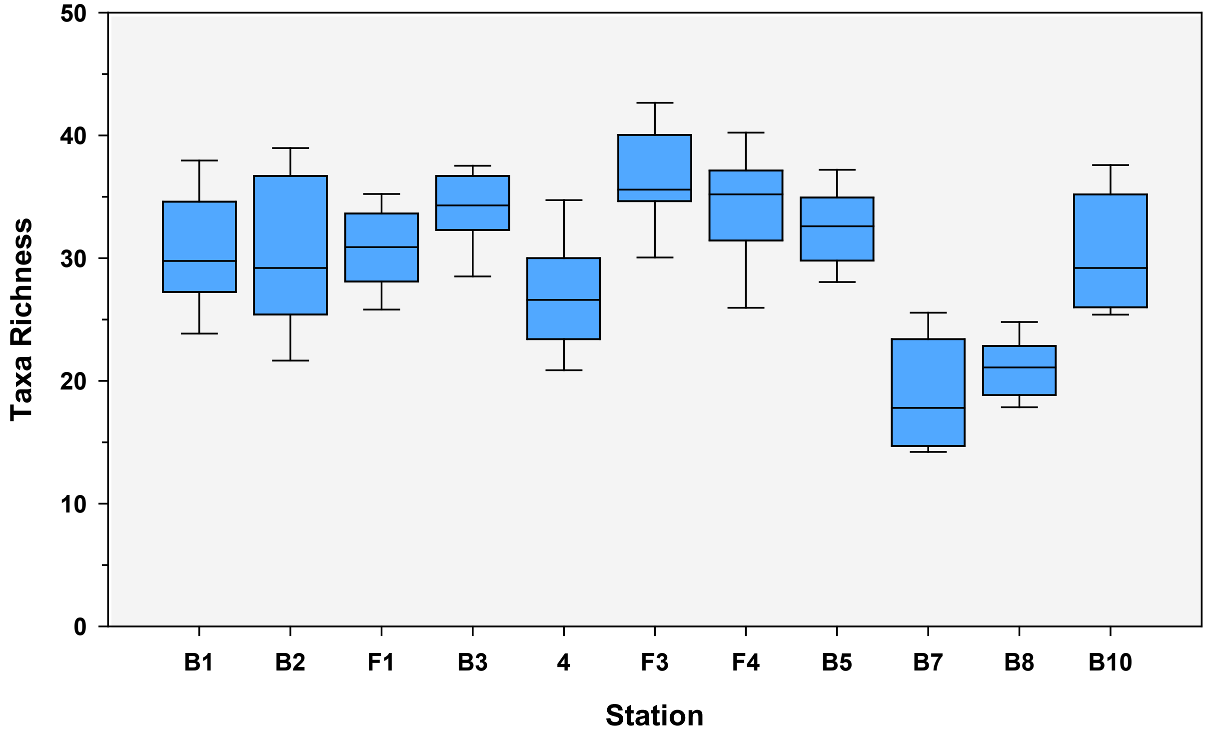


Figure 5-68: Taxa richness boxplot for each macroinvertebrate monitoring station in August, 2011 to 2020.

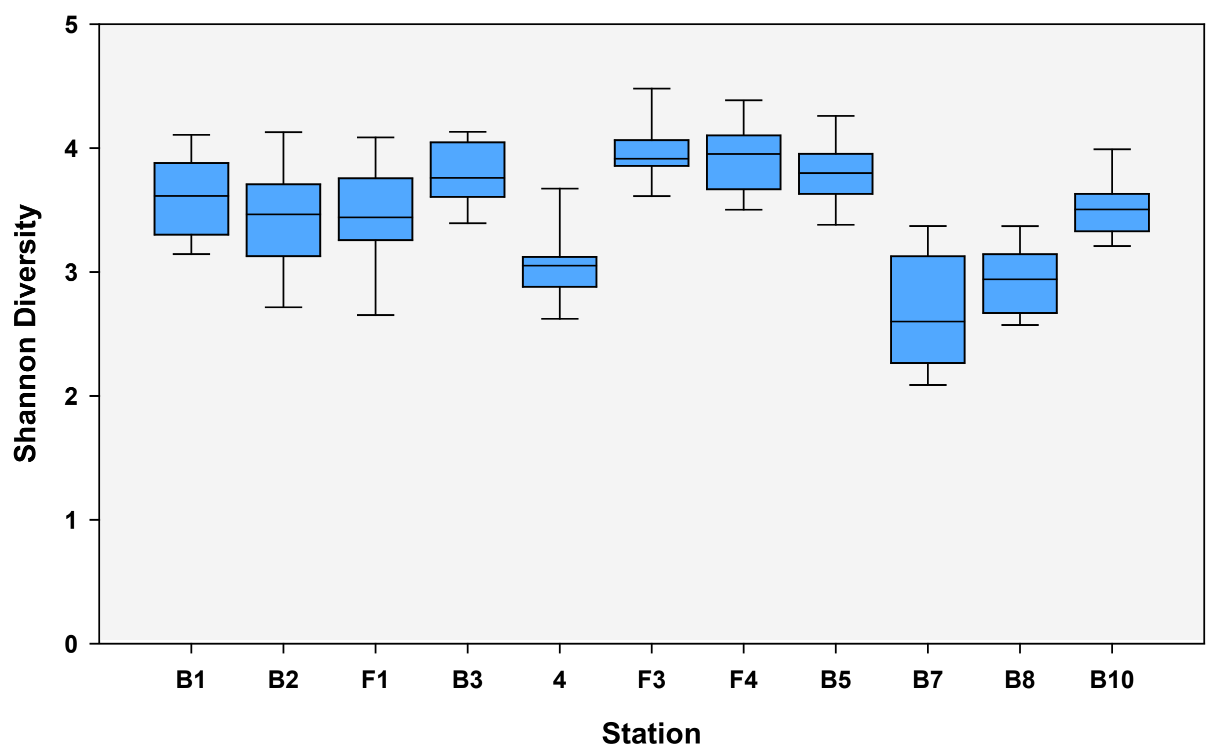


Figure 5-69: Shannon diversity boxplot for each macroinvertebrate monitoring station in August, 2011 to 2020.

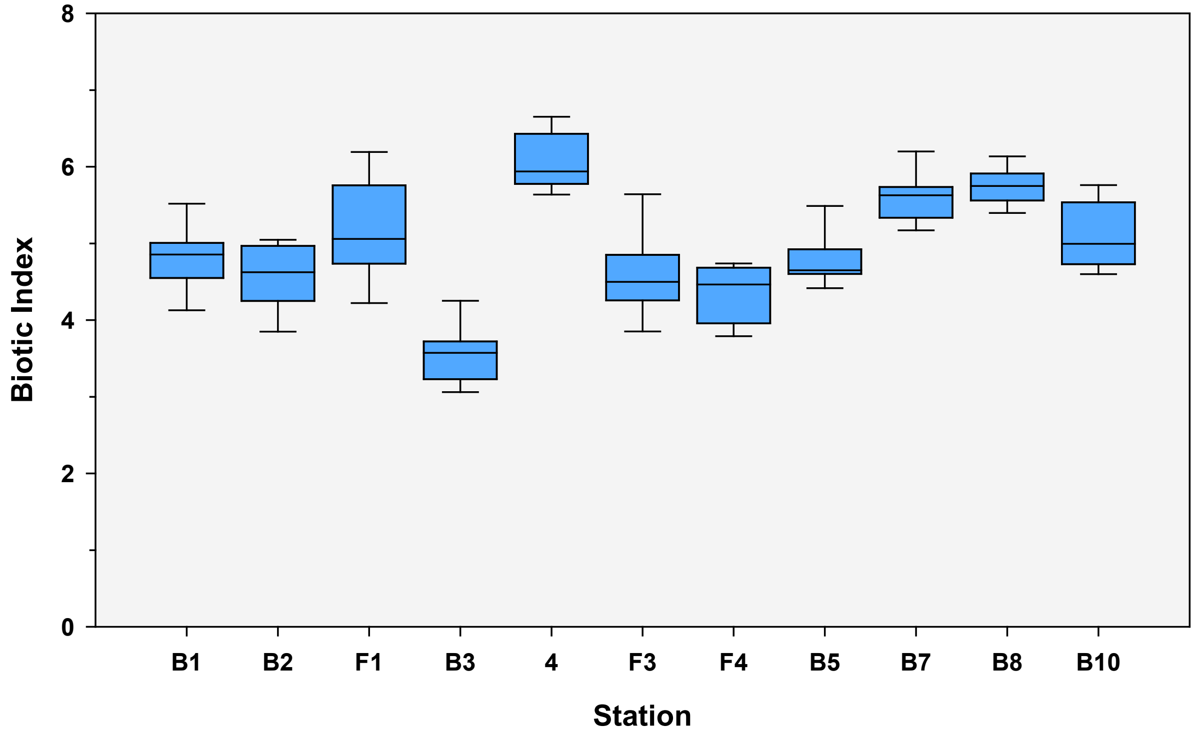


Figure 5-70: Biotic index boxplot for each macroinvertebrate monitoring station in August, 2011 to 2020.

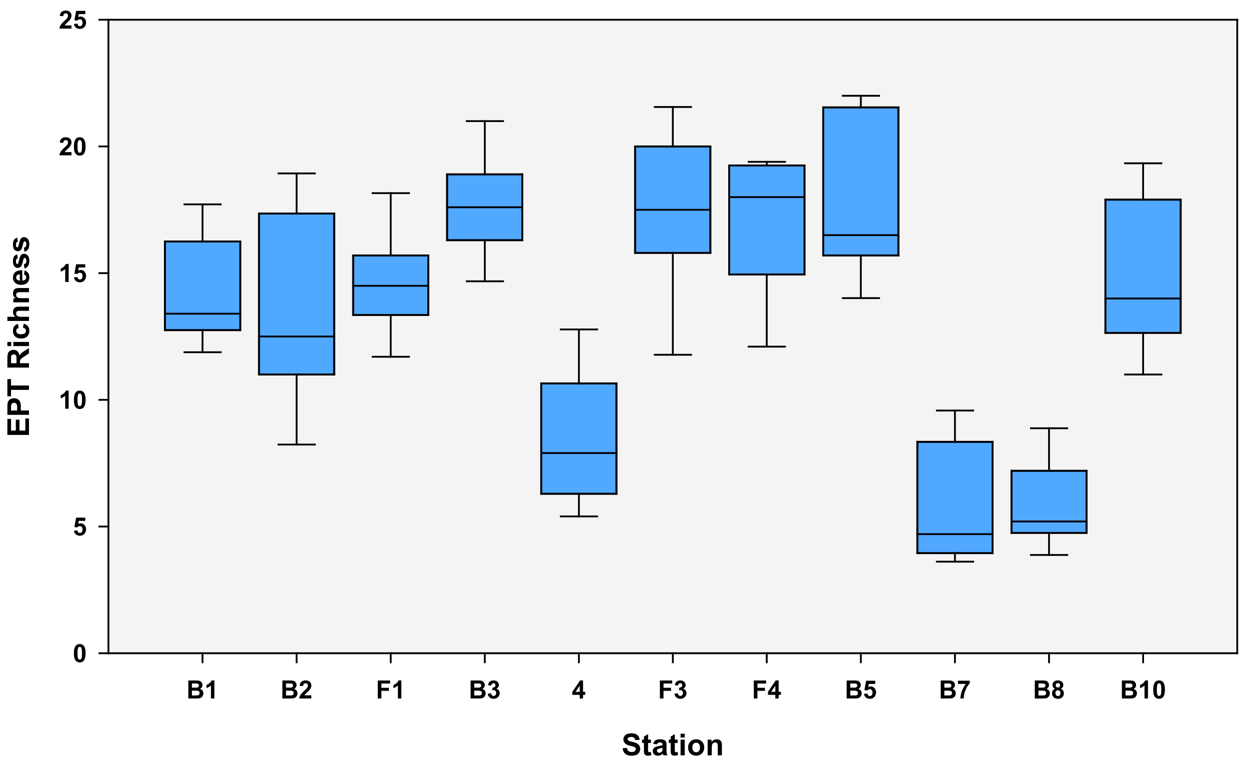


Figure 5-71: EPT richness boxplot for each macroinvertebrate monitoring station in August, 2011 to 2020.

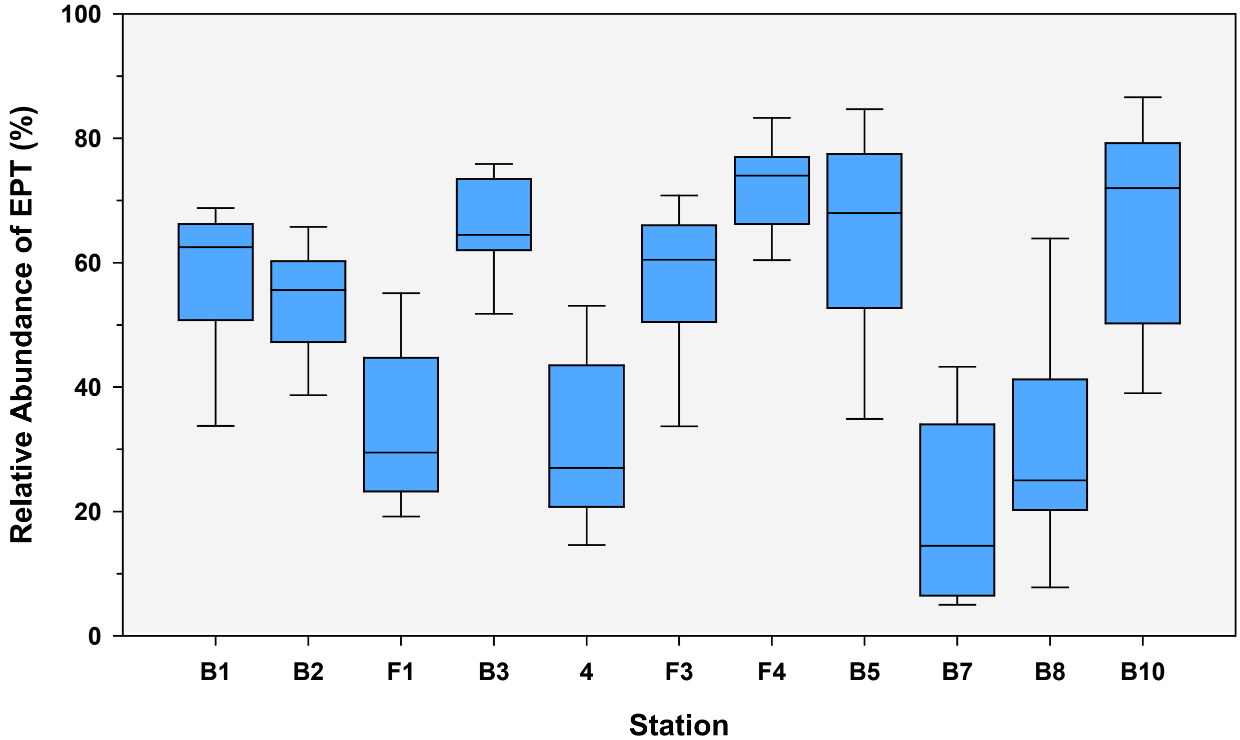


Figure 5-72: Relative abundance of EPT (%) boxplot for each macroinvertebrate monitoring station in August, 2011 to 2020.

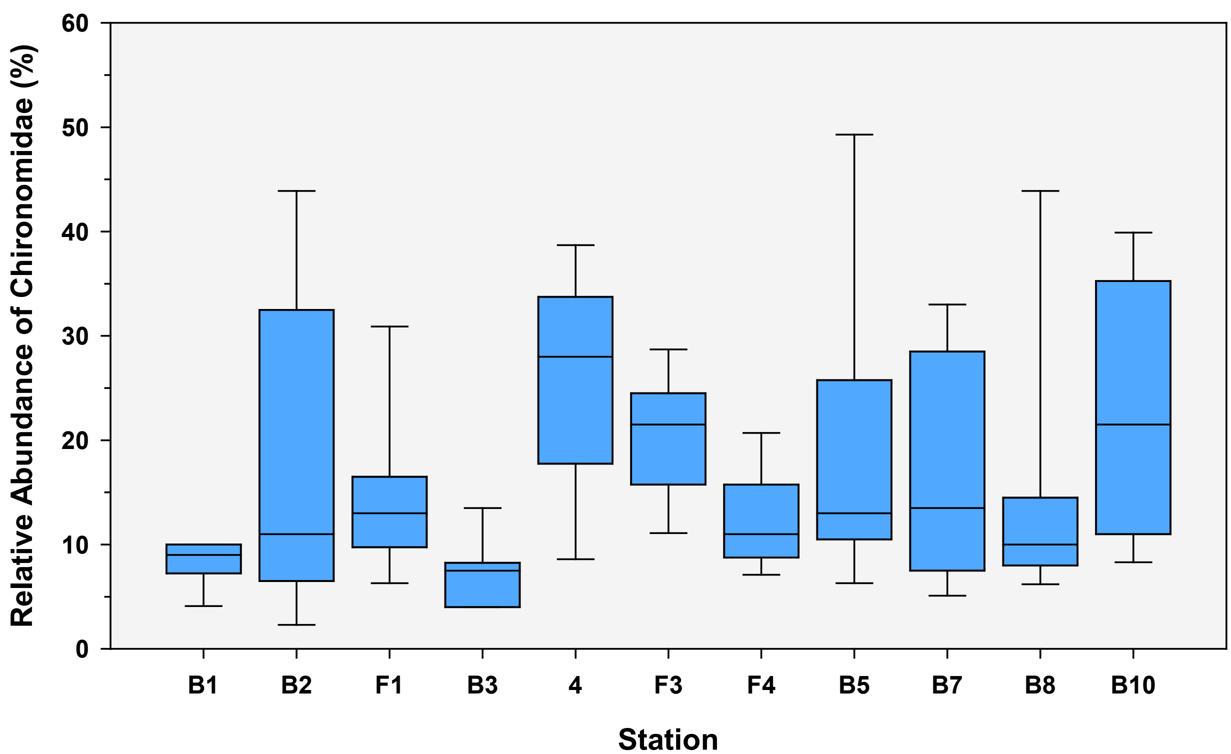


Figure 5-73: Relative abundance of Chironomidae (%) boxplot for each macroinvertebrate monitoring station in August, 2011 to 2020.

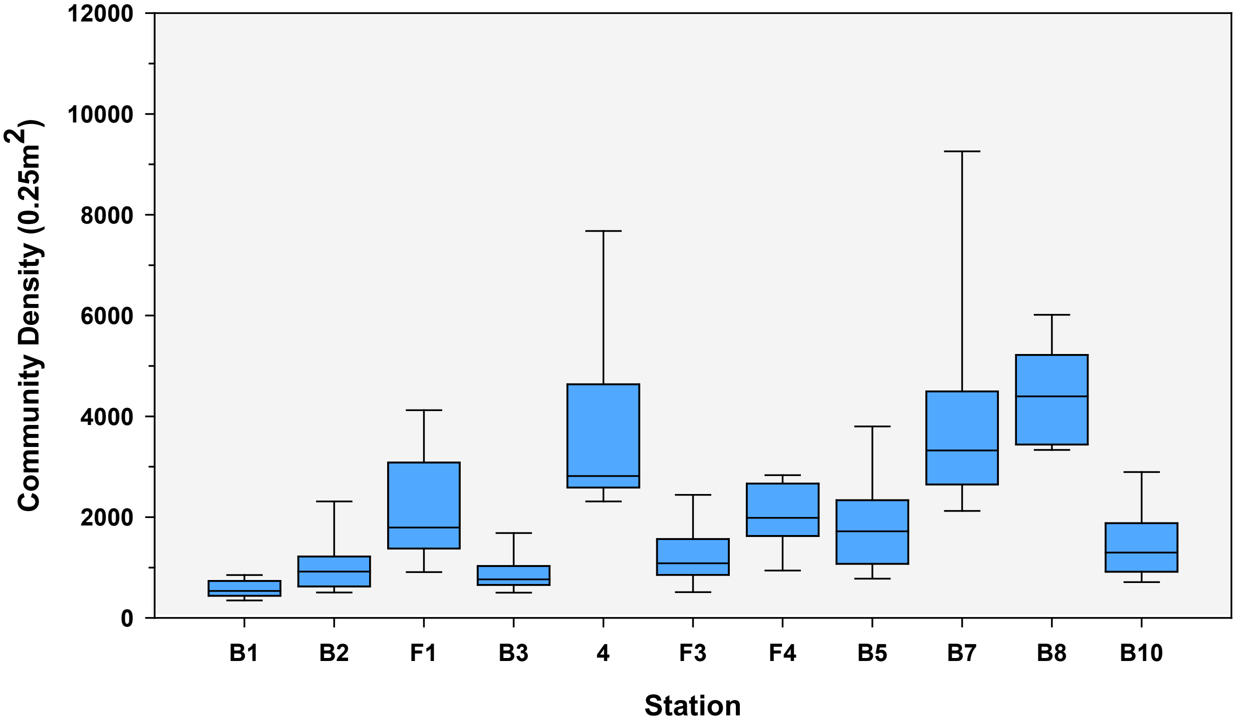


Figure 5-74: Community density (0.25 m^2) boxplot for each macroinvertebrate monitoring station in August, 2011 to 2020.

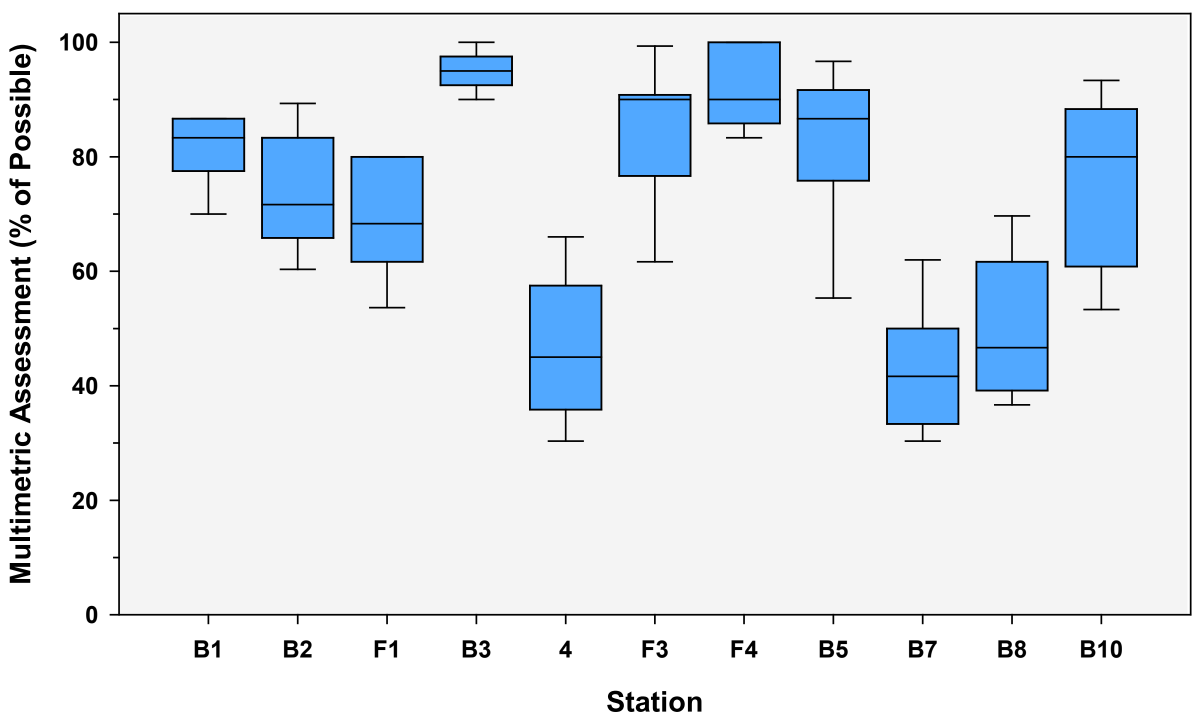


Figure 5-75: Multimetric assessment (% of possible) boxplot for each macroinvertebrate monitoring station in August, 2011 to 2020.

5.2.3.1.2 *Upstream-Downstream Comparisons*

Comparisons of median macroinvertebrate metric values at paired macroinvertebrate monitoring stations directly upstream-downstream of the reservoirs and dams were made using the Mann-Whitney *U* non-parametric test. This analysis was performed to identify persistent statistical differences from 2011 to 2020. A summary of significance and percent change is presented in Table 5-17 and complete statistical results are provided in Appendix E.

Statistically significantly differences occurred at all station pairs ($p < 0.05$; Table 5-17) except for B7 and B8. A significant increase in the macroinvertebrate community health, including multimetric assessment (total and % of possible), was observed between stations F1 and B3, a section of the Madison River between Kirby and the Ennis campground, between stations 4 and F3, a section of the Madison River downstream of the Madison Dam to downstream of the Warm Springs FA site, and between stations B-8 and B-10, a section of the Missouri River from downstream of the Holter Dam to downstream of Great Falls Dams. In addition, a conclusive decline in health, including multimetric assessment (% of possible), was observed between stations B3 and 4, upstream-downstream of Ennis Reservoir, respectively, and between stations B5 and B7, upstream-downstream of Canyon Ferry and Hauser Reservoirs, respectively. Significant differences were observed between other station pairs, but they did not display the same consistency in significant metric changes. Multimetric assessment (% of possible) did not significantly change between any other station pairs. These data indicate that sections of the river absent of direct reservoir influence maintain healthier macroinvertebrate assemblages while the larger reservoirs, Ennis, Canyon Ferry, Hauser, and Hebgen, negatively affected the macroinvertebrate assemblages.

Results are very similar to those from 2007 to 2016 (GEI 2017) except for the change between stations B7 and B8. During this time, multiple significantly improving metrics, including multimetric assessment (% of possible) were observed.

Table 5-17: Change (%) in median macroinvertebrate metric values between macroinvertebrate monitoring stations upstream-downstream of reservoirs and dams from 2011 to 2020. Grey cells indicate a statistically significant (p < 0.05) difference in mean ranks as determined by Mann–Whitney U tests.

Metric	B1 and B2	B2 and F1	F1 and B3	B3 and 4	4 and F3	F3 and F4	F4 and B5	B5 and B7	B7 and B8	B-8 and B-10
Taxa Richness[a]	-1.9	5.8	11.0	-22.4	33.8	-1.1	-7.4	-45.4	18.5	38.4
Shannon Diversity[a]	-4.1	-0.7	9.3	-18.8	28.3	1.0	-3.9	-31.6	13.1	19.2
Biotic Index[a]	-4.7	9.4	-29.4	66.2	-24.2	-0.8	4.1	21.1	2.2	-13.1
EPT Richness[a]	-6.7	16.0	21.4	-55.1	121.5	2.9	-8.3	-71.5	10.6	169.2
Relative Abundance of EPT (%)[a]	-11.0	-46.9	118.6	-58.1	124.1	22.3	-8.1	-78.7	72.4	188.0
Relative Abundance of Chironomidae (%)[a]	22.2	18.2	-42.3	273.3	-23.2	-48.8	18.2	3.8	-25.9	115.0
Community Density (0.25 m^2)[b]	72.2	94.7	-57.4	268.3	-61.5	83.2	-13.3	93.2	32.3	-70.5
Multimetric Assessment (Total)[c]	-14.0	-4.7	39.0	-52.6	100.0	0.0	-3.7	-51.9	12.0	71.4
Multimetric Assessment (% of Possible)[c]	-14.1	-5.6	58.4	-62.7	79.6	38.4	-35.6	-43.6	22.0	71.4

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score

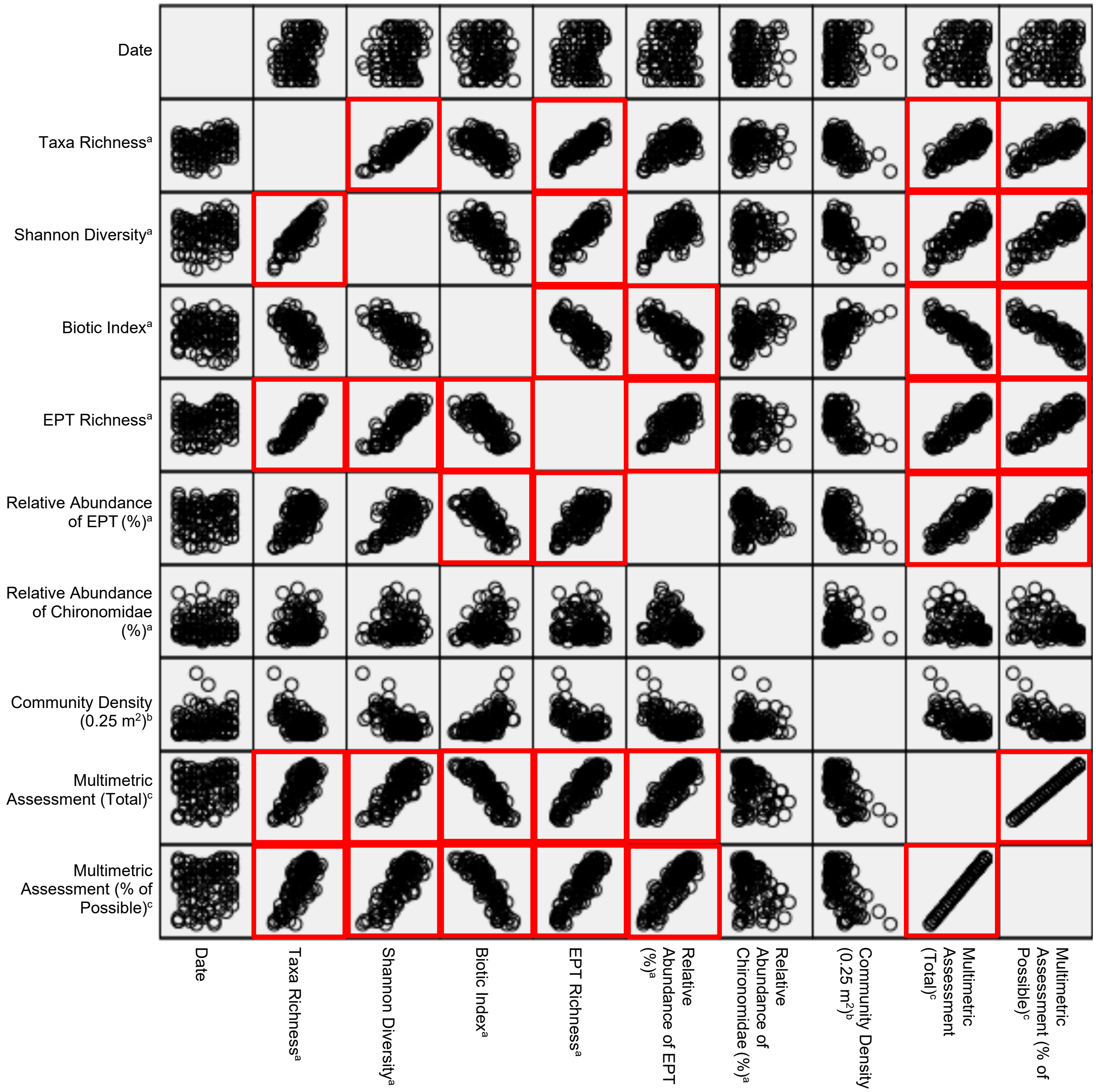
5.2.3.1.3 Metric Correlations

Correlations between macroinvertebrate metrics were evaluated using the Kendall-tau non-parametric test at each macroinvertebrate monitoring station on data from 2011 to 2020. This analysis identified parameters that were statistically correlated, and the strength of the relationship was determined based on a correlation coefficient > 0.5 and a statistically significant relationship ($p < 0.05$). A summary of these results in the form of a metric scatterplot is presented in Table 5-18 and complete statistical results are provided in Appendix E. The scatter plot matrix incorporates multiple scatter plot relationships from multiple variable combinations into one table. Variables are listed along the row and column of the table. Results from multimetric assessment (Total) are included in data tables and figures but will not be discussed as the metric is simply the score which is placed into context of the total possible score – multimetric assessment (% of possible).

The macroinvertebrate metrics matrices of cross-correlations are quite extensive and are not detailed in narrative form. Suffice to say that significant correlations between metrics and the multimetric assessment index were expected among all sites because these metrics were selected based on their descriptive ability of the macroinvertebrate assemblages. All metrics except for date and community density (0.25 m^2) were often correlated with other metrics at the same station (Appendix E). In addition, throughout all stations, metric relationships occurred between all metrics except for date, percent relative abundance of Chironomidae, and community density (0.25 m^2; Table 5-18). This abundance of correlations at specific stations among all stations indicates that relationships between metrics are somewhat similar between stations.

Results are very similar to those from 2007 to 2016 (GEI 2017) except for community density which was correlated with most other metrics during this time.

Table 5-18: Macroinvertebrate metrics scatterplot matrix for all macroinvertebrate monitoring stations in August, 2011-2021. Red boxes indicate a significant relationship ($p < 0.05$) between parameters with a correlation coefficient < -0.5 or > 0.5.



[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

5.2.3.1.4 Trend Analysis

Temporal trends in macroinvertebrate metric values over time for each station were evaluated using Least Squares Regression analysis on data from 2011 to 2020. This analysis provides a coefficient of determination indicating the relative degree of association between paired macroinvertebrate metric and year values. Summary of macroinvertebrate metric trends are presented in Table 5-19. Box plots of Station B1 (Yellowstone National Park) to Station B10 (Downstream from Great Falls Dams), including flush stations, illustrating the temporal distributions of multimetric assessment (% of possible) data for the 2011 to 2020 are found in Figure 5-76 through Figure 5-86 while box plots for all other metrics are found in Appendix E.

Significant temporal trends ($p < 0.05$) in macroinvertebrate metrics were limited in number and sporadic throughout the macroinvertebrate monitoring stations (Table 5-19). Most significant trends had a slope near zero indicating the metrics remained relatively consistent from 2011 to 2020 and did not substantially increase or decrease. The exception was community density (0.25 m^2) which significantly increased at Station F1 ($R^2 = 0.72$, $p < 0.01$, $m = 308$ individuals / 0.25 m^2/ year) and at Station B10 ($R^2 = 0.53$, $p = 0.02$, $m = 165$ individuals / 0.25 m^2/ year). No statistically significant trends occurred at Station B5 while most other stations had only one metric with a significant trend. In addition, multimetric assessment (% of possible) slightly but significantly ($R^2 = 0.77$, $p < 0.01$, $m = 1.09$) increased at Station B8 from 2011 to 2020 while no significant trends were observed at any other station (Figure 5-76 through Figure 5-86). Overall, these results indicate little change in the macroinvertebrate community health at each station from 2011 to 2020 and differed little from the 2007 to 2016 results (GEI 2017).

Table 5-19: Trend analyses of macroinvertebrate metrics in August, 2011 to 2020 at all macroinvertebrate monitoring stations. Grey cells indicate statistically significant ($p < 0.05$) trends as determined by Least Squares Regression.

Metric	Statistics	B1	B2	F1	B3	4	F3	F4	B5	B7	B8	B10
Taxa Richness[a]	Coefficient of determination	0.062	0.554	0.062	0.037	0.371	0.333	0.379	0.308	0.483	0.592	0.510
	Significance	0.490	0.014	0.487	0.593	0.062	0.080	0.058	0.096	0.026	0.009	0.020
	Slope	0.369	1.507	0.267	-0.182	0.865	0.733	0.884	0.578	0.943	0.625	1.097
	N	9	9	9	9	9	8	8	9	9	9	9
Shannon Diversity[a]	Coefficient of determination	0.063	0.228	0.061	0.157	0.355	0.467	0.134	0.064	0.240	0.139	0.281
	Significance	0.484	0.163	0.492	0.257	0.069	0.029	0.298	0.480	0.151	0.288	0.115
	Slope	0.028	0.070	-0.034	-0.034	0.061	0.058	0.036	0.022	0.074	0.034	0.042
	N	9	9	9	9	9	8	8	9	9	9	9
Biotic Index[a]	Coefficient of determination	0.218	0.128	0.049	0.415	0.098	0.001	0.212	0.103	0.256	0.325	0.035
	Significance	0.173	0.311	0.538	0.044	0.379	0.934	0.180	0.366	0.135	0.085	0.603
	Slope	0.062	-0.051	0.047	-0.079	-0.037	-0.005	-0.058	-0.035	-0.052	-0.045	-0.026
	N	9	9	9	9	9	8	8	9	9	9	9
EPT Richness[a]	Coefficient of determination	0.039	0.581	0.030	0.072	0.353	0.275	0.646	0.036	0.570	0.602	0.537
	Significance	0.586	0.010	0.633	0.453	0.070	0.119	0.005	0.602	0.012	0.008	0.016
	Slope	0.131	0.915	0.109	-0.171	0.495	0.522	0.693	0.193	0.585	0.425	0.720
	N	9	9	9	9	9	8	8	9	9	9	9
Relative Abundance of EPT (%)[a]	Coefficient of determination	0.472	0.070	0.000	0.386	0.000	0.003	0.102	0.001	0.173	0.251	0.036
	Significance	0.028	0.459	0.978	0.055	0.981	0.872	0.368	0.929	0.232	0.140	0.600
	Slope	-2.745	-0.753	-0.042	1.594	0.036	0.224	0.745	0.170	2.067	2.909	1.018
	N	9	9	9	9	9	8	8	9	9	9	9
Relative Abundance of Chironomidae (%)[a]	Coefficient of determination	0.078	0.472	0.051	0.008	0.843	0.001	0.000	0.059	0.020	0.336	0.115
	Significance	0.433	0.028	0.530	0.808	0.000	0.944	0.974	0.497	0.698	0.079	0.338
	Slope	0.194	3.539	-0.552	-0.091	2.982	-0.048	-0.018	-1.121	0.497	-2.291	-1.333
	N	9	9	9	9	9	8	8	9	9	9	9
Community Density ($0.25 m^2$)[b]	Coefficient of determination	0.018	0.329	0.722	0.006	0.084	0.232	0.230	0.250	0.016	0.055	0.525
	Significance	0.709	0.083	0.002	0.827	0.416	0.158	0.161	0.141	0.732	0.513	0.018
	Slope	7.521	107.769	308.315	9.552	168.079	93.183	98.697	157.909	-90.624	75.534	164.994
	N	9	9	9	9	9	8	8	9	9	9	9
Multimetric Assessment, Total[c]	Coefficient of determination	0.050	0.030	0.024	0.035	0.004	0.001	0.363	0.045	0.323	0.767	0.175
	Significance	0.535	0.630	0.668	0.605	0.865	0.942	0.065	0.557	0.086	0.001	0.229
	Slope	-0.139	0.170	0.145	0.067	0.073	0.030	0.400	0.273	0.582	1.091	0.624
	N	9	9	9	9	9	8	8	9	9	9	9
Multimetric Assessment, % of Possible[c]	Coefficient of determination	0.050	0.030	0.024	0.035	0.004	0.001	0.363	0.045	0.323	0.767	0.175
	Significance	0.535	0.630	0.668	0.605	0.865	0.942	0.065	0.557	0.086	0.001	0.229
	Slope	-0.465	0.566	0.485	0.222	0.242	0.101	1.333	0.909	1.939	3.636	2.081
	N	9	9	9	9	9	8	8	9	9	9	9

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

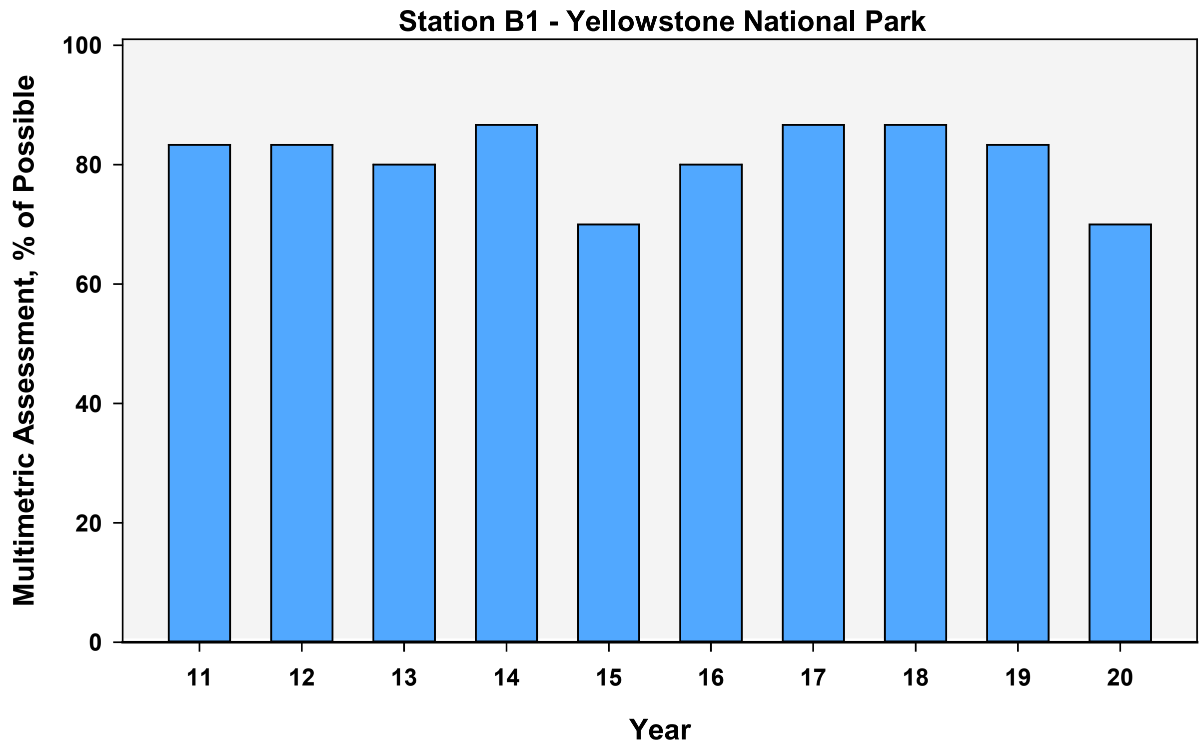


Figure 5-76: Multimetric Assessment (% of Possible) for Station B1 from August, 2011 to 2020.

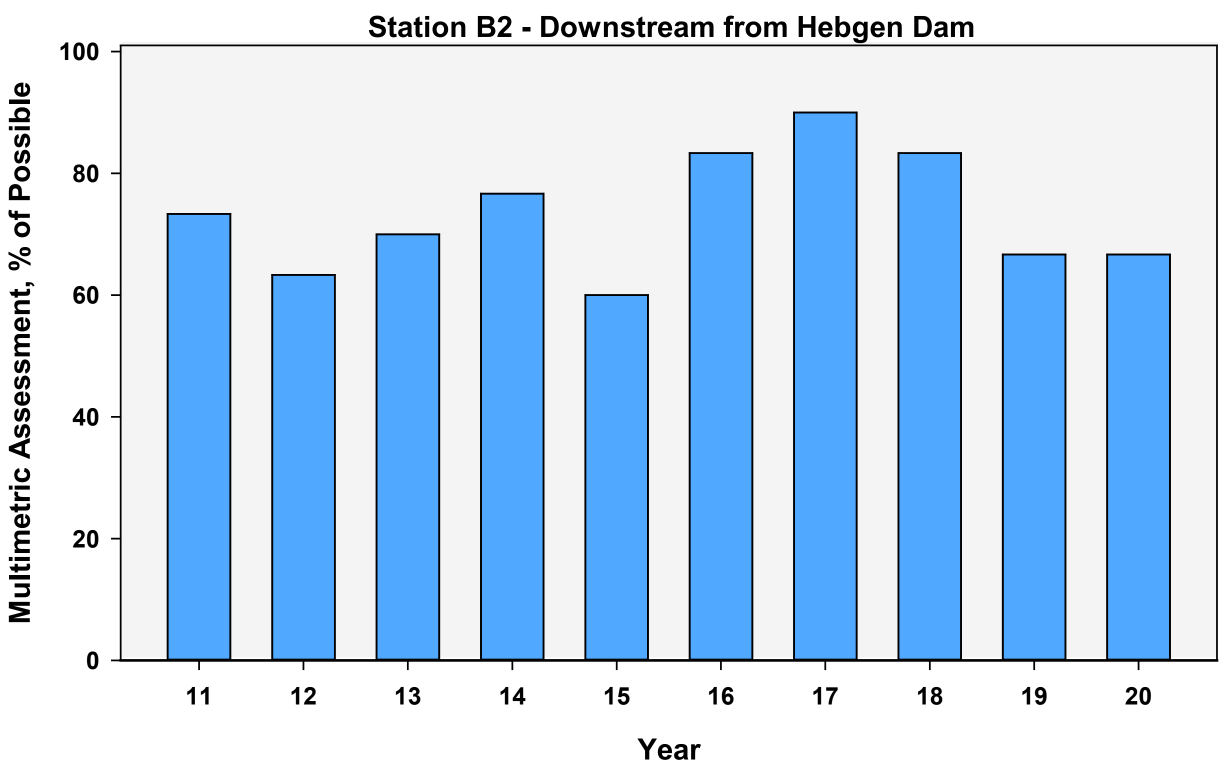


Figure 5-77: Multimetric Assessment (% of Possible) for Station B2 from August, 2011 to 2020.

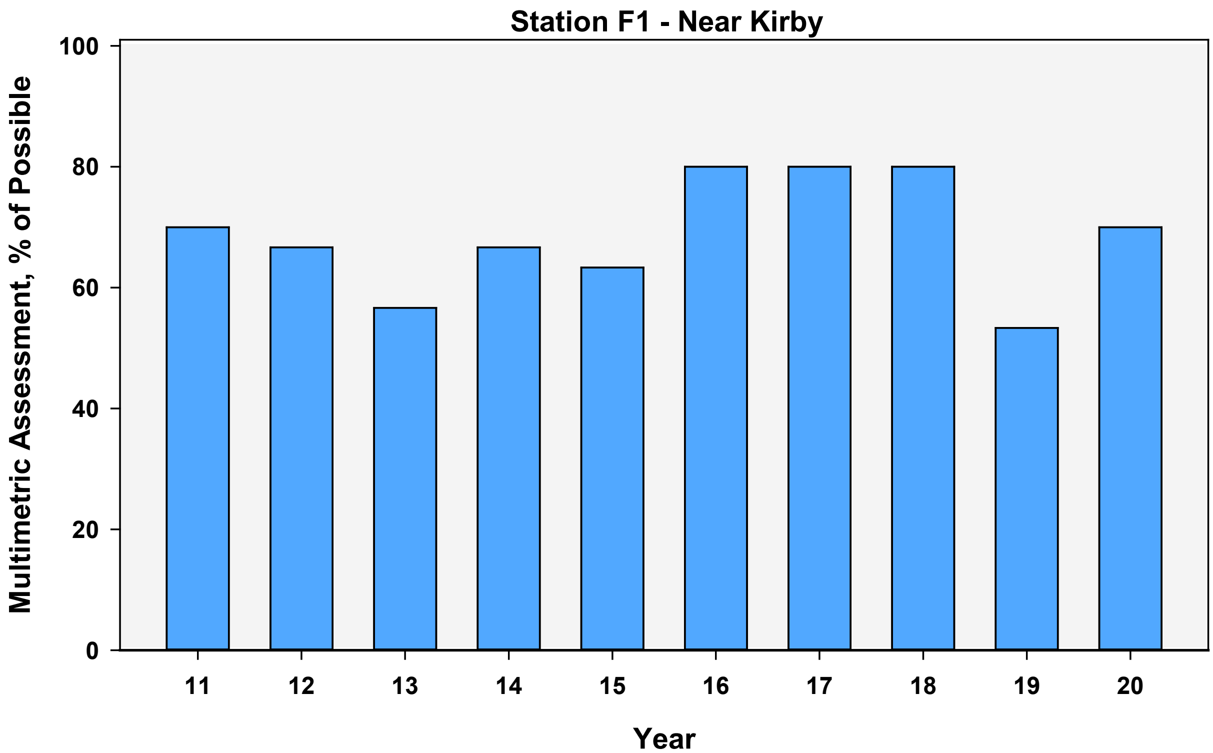


Figure 5-78: Multimetric Assessment (% of Possible) for Station F1 from August, 2011 to 2020.

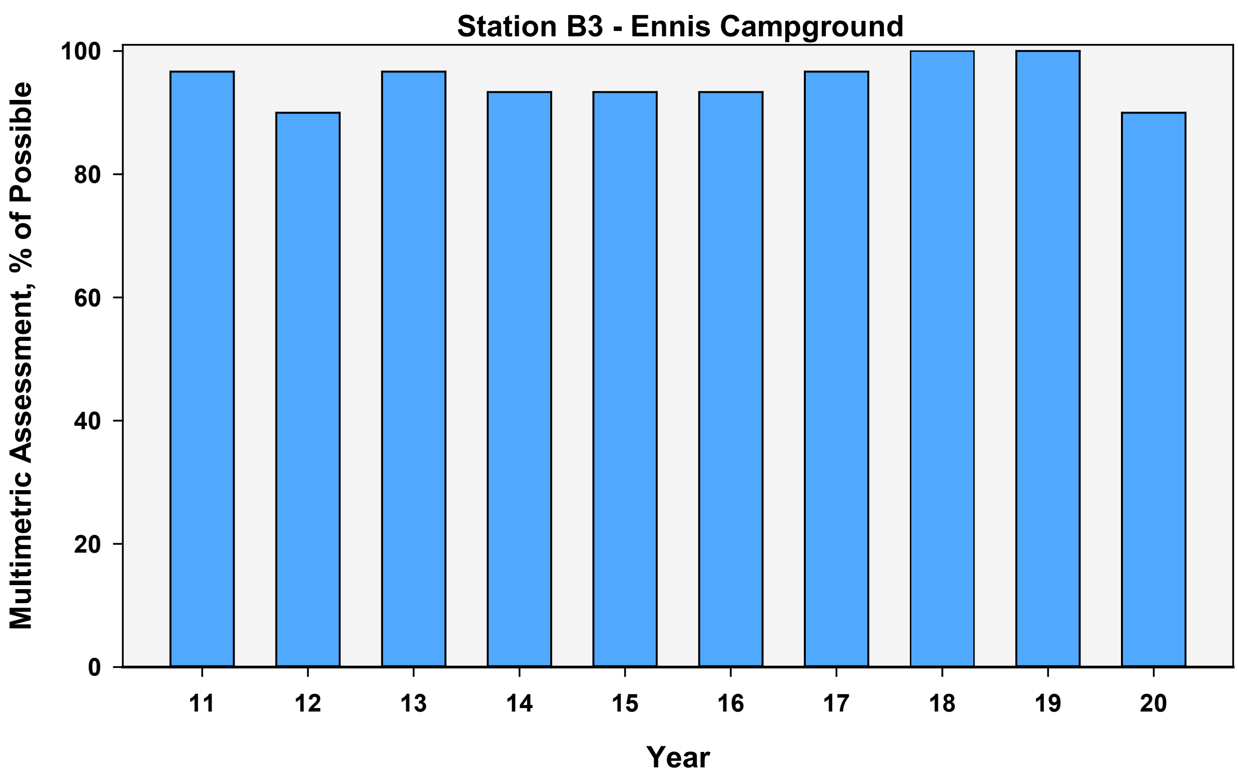


Figure 5-79: Multimetric Assessment (% of Possible) for Station B3 from August, 2011 to 2020.

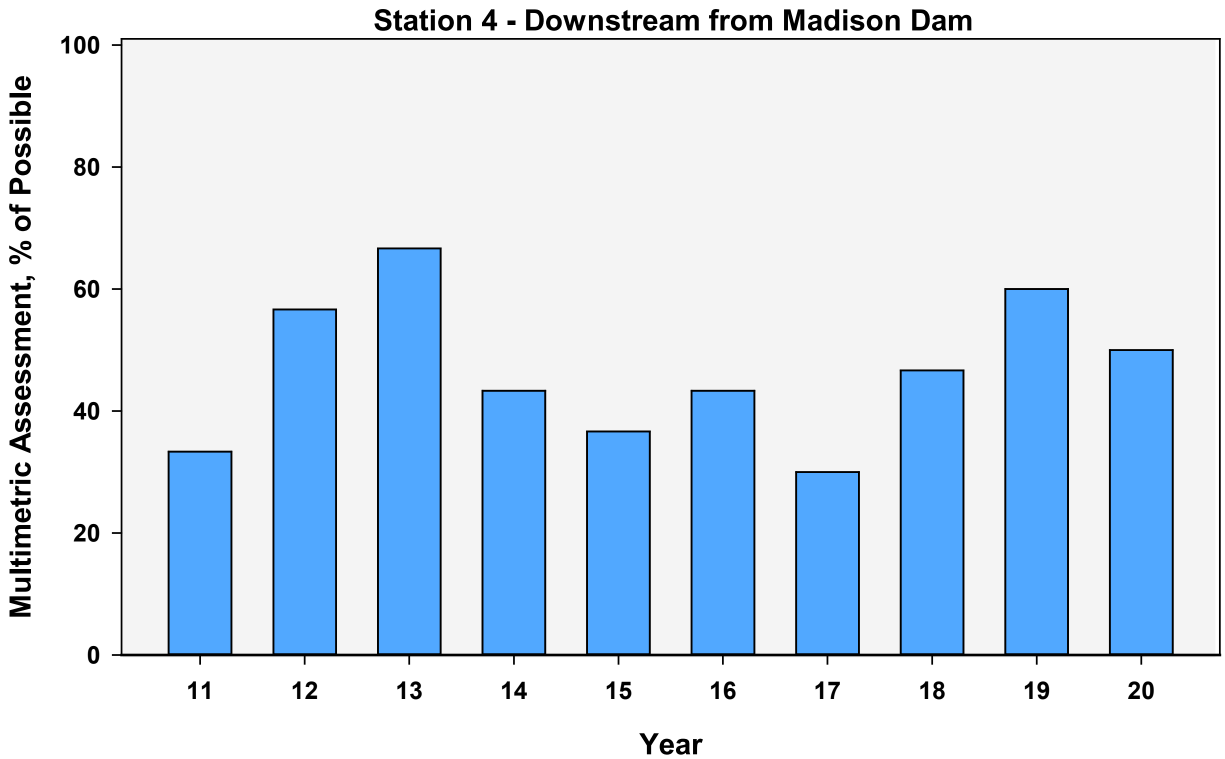


Figure 5-80: Multimetric Assessment (% of Possible) for Station 4 from August, 2011 to 2020.

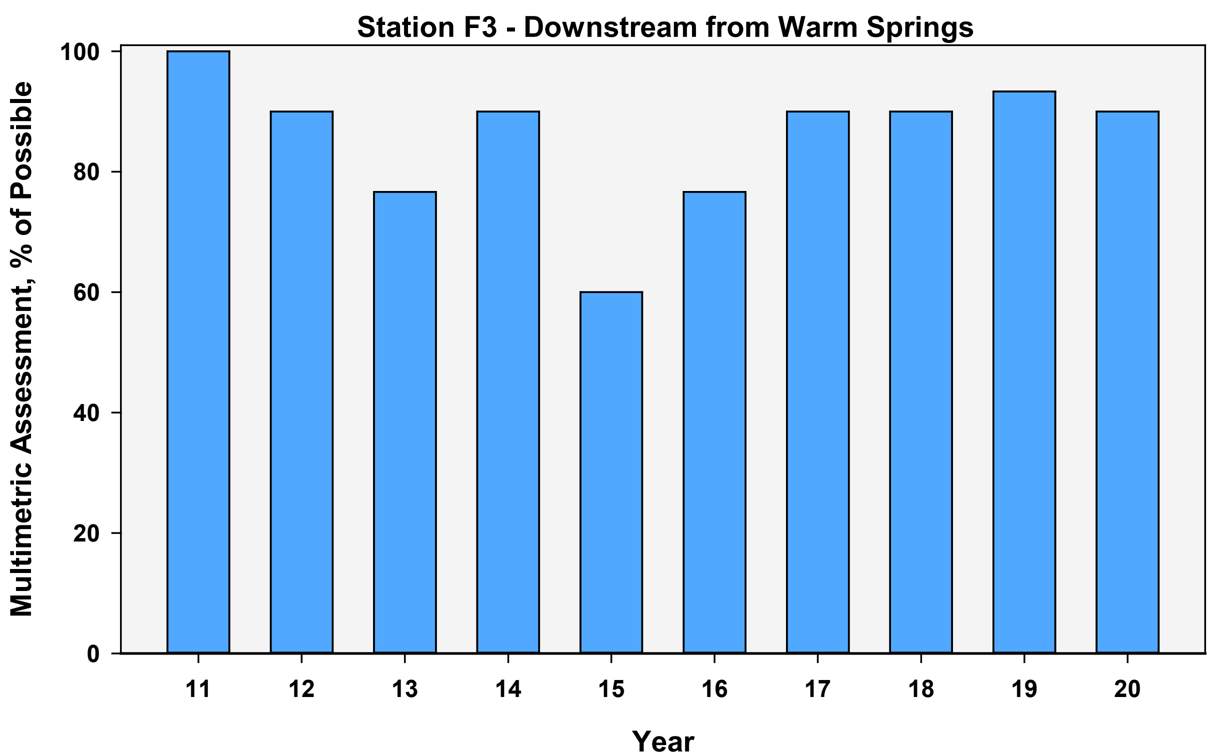


Figure 5-81: Multimetric Assessment (% of Possible) for Station F3 from August, 2011 to 2020.

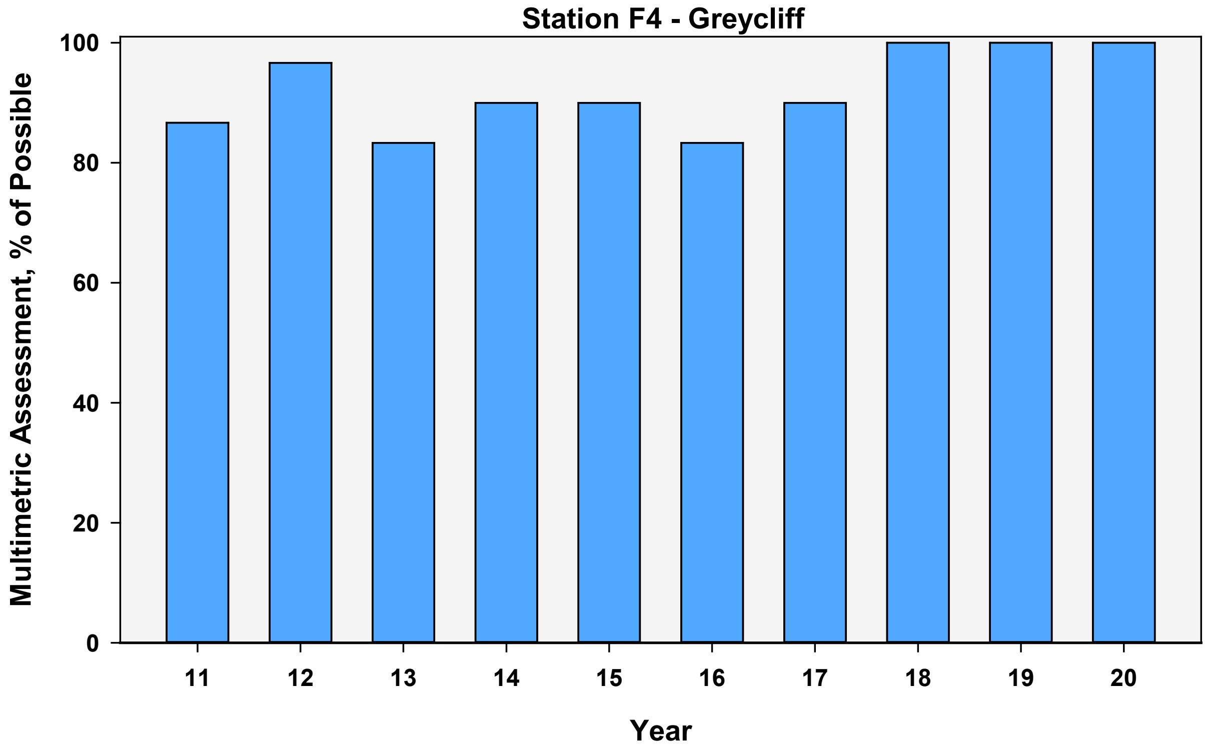


Figure 5-82: Multimetric Assessment (% of Possible) for Station F4 from August, 2011 to 2020.

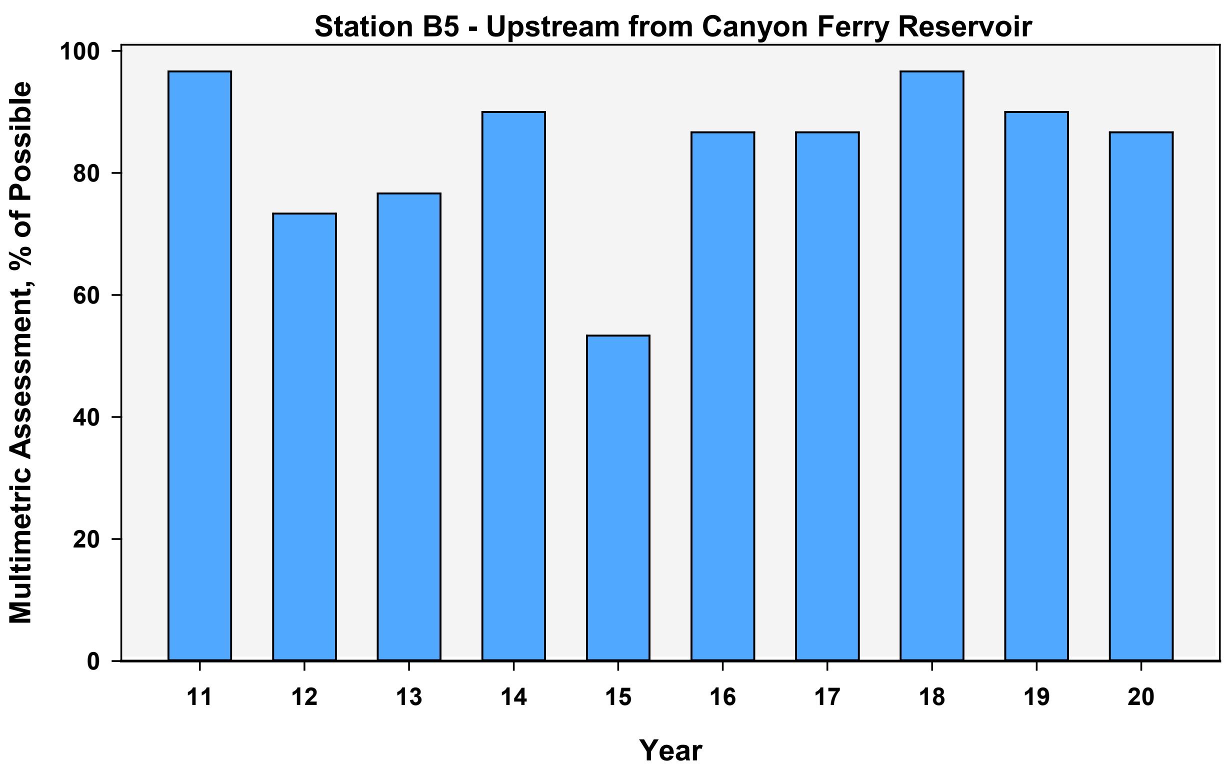


Figure 5-83: Multimetric Assessment (% of Possible) for Station B5 from August, 2011 to 2020.

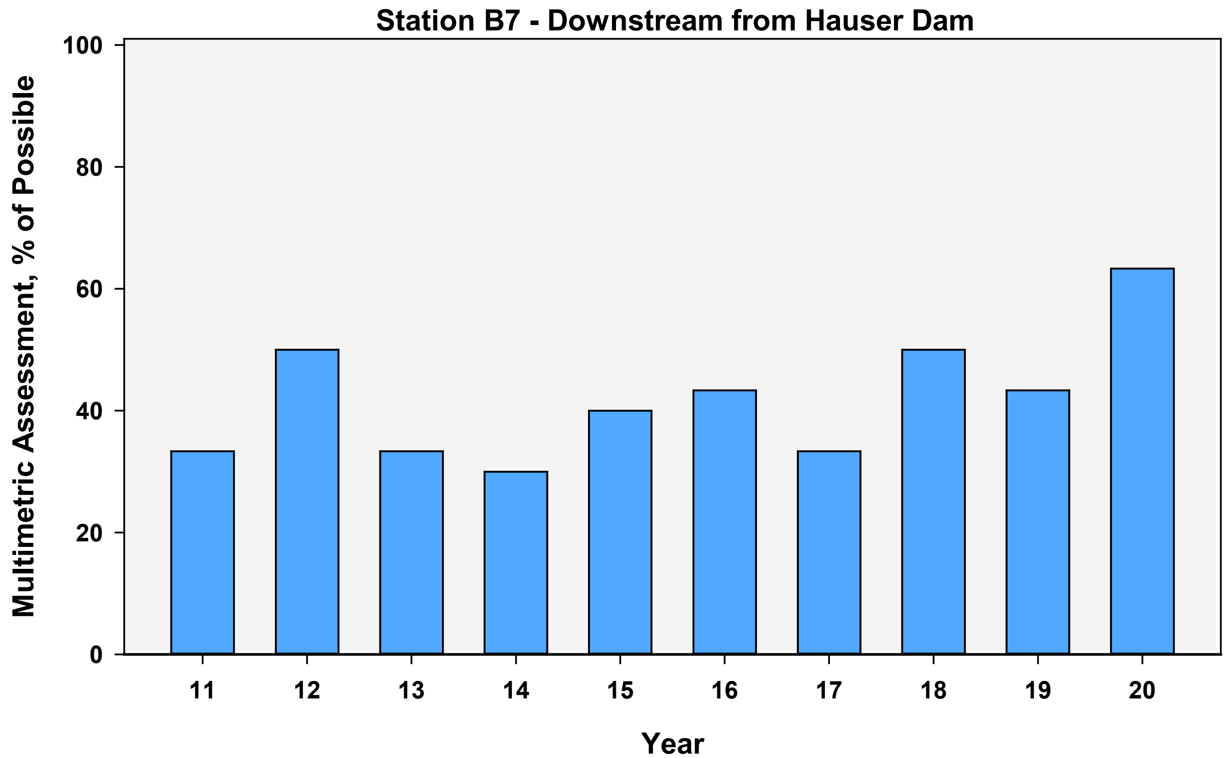


Figure 5-84: Multimetric Assessment (% of Possible) for Station B7 from August, 2011 to 2020.

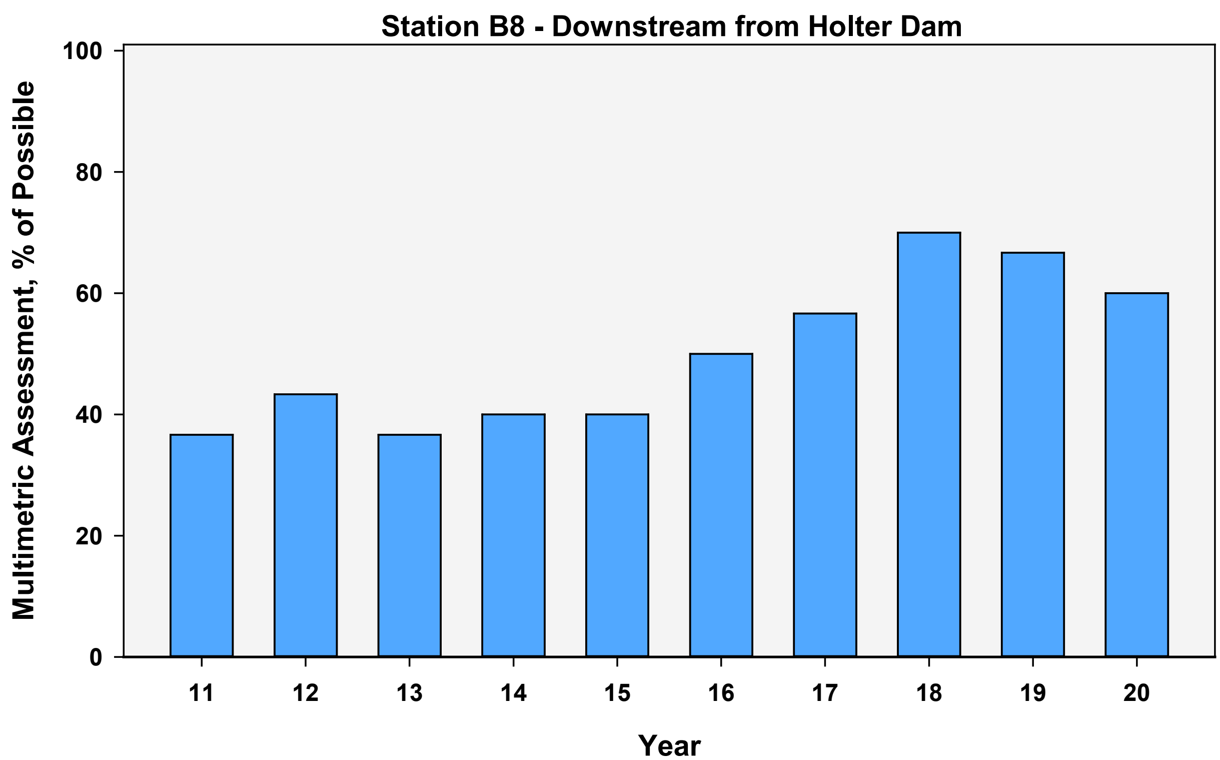


Figure 5-85: Multimetric Assessment (% of Possible) for Station B8 from August, 2011 to 2020.

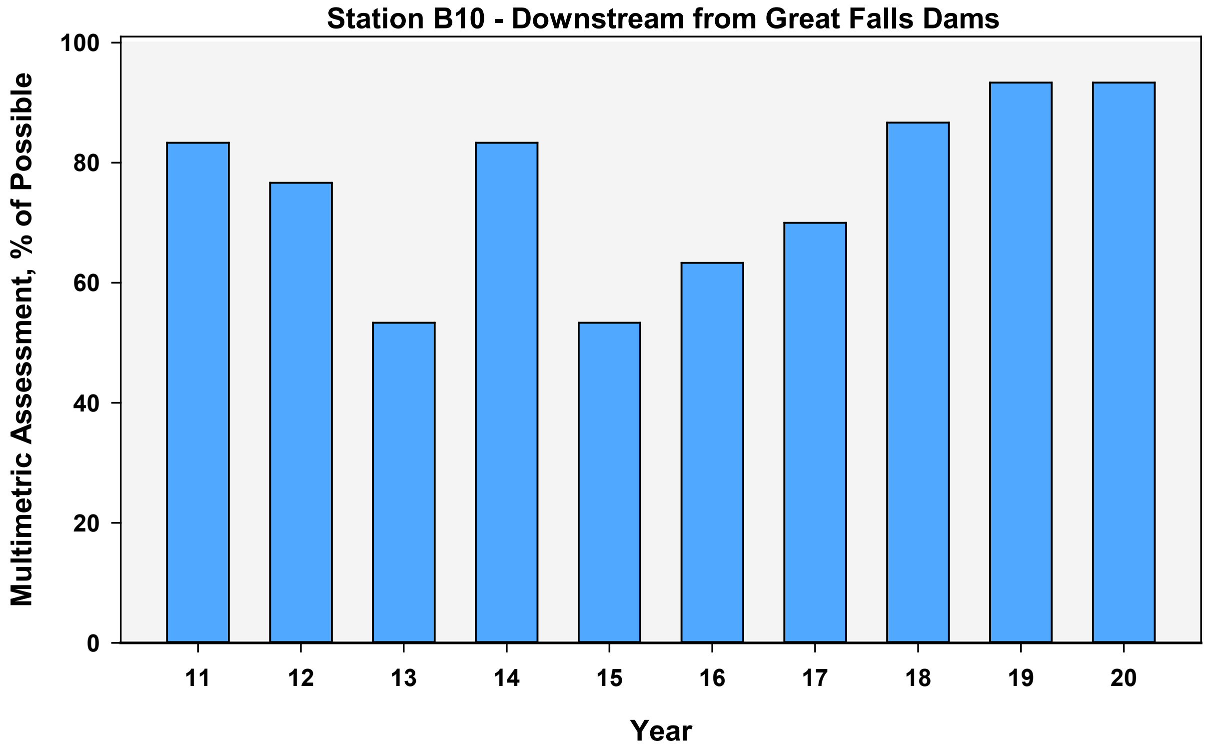


Figure 5-86: Multimetric Assessment (% of Possible) for Station B10 from August, 2011 to 2020.

5.2.4 *Fish Tissue Analysis*

Fish tissue samples were collected at Hebgen (B2), Varney (B3), Hauser (B7), Holter (B8), Central Ave. Bridge (9), and Morony (B10) monitoring stations in 2013 to 2015 and 2017 to 2019. Brown Trout (*Salmo trutta*), Rainbow Trout (*Oncorhynchus mykiss*), and Walleye (*Sander vitreus*) were categorized as "Predator" while Utah Chub (*Gila atraria*), White Sucker (*Catostomus commersonii*), and Longnose Sucker (*Catostomus catostomus*) were categorized as "Bottom Dwelling" (Bottom) according to feeding styles. Tissue samples were analyzed for a select group of organopesticides, polychlorinated biphenyls (PCBs), and metals.

5.2.4.1.1 Spatial Fish Data Summary

Individual fish length and weight measurements were only available at stations B2, B3, B7, B8, and B10 for 2017 to 2019. A summary of the size of fish collected is presented in Table 5-20. Comparative data was not available for fish collected in 2013, 2014, and 2015.

Table 5-20: Fish descriptive statistics grouped by life history traits.

Station	Year	Life History	Length				Weight			
			Min. (in.)	Max. (in.)	Mean (in.)	Stand. Dev.	Min. (lbs.)	Max. (lbs.)	Mean (lbs.)	Stand. Dev.
B2	2017	Predator	16.6	21.6	19.7	1.74	1.6	3.1	2.4	0.47
		Bottom	15.6	19.0	16.7	1.54	1.6	3.0	2.0	0.68
B3	2017	Predator	14.1	18.3	15.8	1.65	1.0	2.1	1.4	0.47
		Bottom	9.1	19.6	13.0	3.52	0.4	3.0	1.2	0.83
B7	2018	Predator	12.7	19.4	15.2	2.29	0.7	3.2	1.5	0.85
		Bottom	12.6	14.2	13.4	0.59	0.9	1.3	1.1	0.13
B8	2018	Predator	12.5	17.7	15.0	1.91	0.6	2.4	1.4	0.70
		Bottom	16.8	17.1	17.0	0.11	2.3	2.4	2.3	0.07
B10	2019	Predator	16.5	18.4	17.3	0.72	1.6	1.9	1.8	0.15
		Bottom	15.3	16.8	16.0	0.64	1.9	2.3	2.0	0.16

Note: Length and weight was not available for stations B4 or 9 in any year.

5.2.4.1.2 Spatial Biocontaminants Data Summary

Fish tissue samples, filets from Predator fish and whole-body for Bottom fish, were analyzed for a variety of biocontaminants (Table 3-2). Non-detect values were very common for the biocontaminants across all stations for both Predator and Bottom fish (Table 5-21). Detectable concentrations which included Aroclor 1254 and most metals, are summarized in Table 5-22 for both Predator and Bottom fish. Due to the small sample size, high number of non-detects, and rotational sampling schedule (i.e., different stations in different years), the upstream to downstream, correlations, and trends analyses were not performed on fish tissue data.

Most fish tissue biocontaminants were not detected in either fish type, and in fact, no organochlorine pesticides were detected in any Predator or Bottom fish collected. Aroclor (1254) was the only PCB variant measured in the fish samples but was only found in one Bottom fish. Twelve of 13 metals were detected in both fish types while four metals were detected in all Predator fish and five metals were detected in all Bottom fish.

Table 5-21: Number of fish tissue biocontaminant detections grouped by life history traits at all fish monitoring stations.

Biocontaminants	Predator			Bottom		
	Above MDL	Non-detect	Non-detect (%)	Above MDL	Non-detect	Non-detect (%)
Organochlorine Pesticides (2013-2015)						
Aldrin	0	6	100.0	0	6	100.0
alpha-BHC	0	6	100.0	0	6	100.0
beta-BHC	0	6	100.0	0	6	100.0
delta-BHC	0	6	100.0	0	6	100.0
Chlordane	0	18	100.0	0	18	100.0
DDD	0	6	100.0	0	6	100.0
DDE	0	6	100.0	0	6	100.0
DDT	0	6	100.0	0	6	100.0
Dieldrin	0	6	100.0	0	6	100.0

Biocontaminants	Predator			Bottom		
	Above MDL	Non-detect	Non-detect (%)	Above MDL	Non-detect	Non-detect (%)
Endosulfan I	0	6	100.0	0	6	100.0
Endosulfan II	0	6	100.0	0	6	100.0
Endosulfan Sulfate	0	6	100.0	0	6	100.0
Endrin	0	6	100.0	0	6	100.0
Endrin Aldehyde	0	6	100.0	0	6	100.0
Heptachlor	0	6	100.0	0	6	100.0
Heptachlor Epoxide	0	6	100.0	0	6	100.0
Isodrin	0	6	100.0	0	6	100.0
Kepone	0	6	100.0	0	6	100.0
Methoxychlor	0	6	100.0	0	6	100.0
Toxaphene	0	6	100.0	0	6	100.0
PCBs (Aroclor; 2013-2015)						
1016	0	6	100.0	0	6	100.0
1221	0	6	100.0	0	6	100.0
1232	0	6	100.0	0	6	100.0
1242	0	6	100.0	0	6	100.0
1248	0	6	100.0	0	6	100.0
1254	0	6	100.0	1	5	83.3
1260	0	6	100.0	0	6	100.0
Metals (2013-2015 and 2017-2019)						
Aluminum	15	0	0.0	12	0	0.0
Arsenic	10	5	33.3	10	2	16.7
Cadmium	0	15	100.0	0	12	100.0
Chromium	5	10	66.7	7	5	41.7
Copper	15	0	0.0	12	0	0.0
Iron	12	3	20.0	12	0	0.0
Lead	3	12	80.0	5	7	58.3
Manganese	10	5	33.3	11	1	8.3
Mercury	15	0	0.0	9	3	25.0
Nickel	1	14	93.3	4	8	66.7
Selenium	14	1	6.7	10	2	16.7
Strontium	11	4	26.7	12	0	0.0
Zinc	15	0	0.0	12	0	0.0

In general, Predator fish tissue contained less aluminum, arsenic, copper, iron, manganese, strontium, and zinc and more mercury than Bottom fish tissue at most stations in which both Predator and Bottom fish were captured (Table 5-22). Predator fish tissue at Station B8, Holter Reservoir, often contained greater concentrations of metals than at other stations. However, the fish tissue collected from other stations were not consistently higher or lower with respect to fish type.

Table 5-22: Mean fish tissue biocontaminant concentrations (mg/kg dry weight) at fish monitoring stations in 2013 to 2015 and 2017 to 2019. Only concentrations above detection limit were included. Pred. = Predator fish, Bot. = Bottom fish. NA = No predator fish collected at site.

Bio-contaminants	B2						B3						B7						B8						9						B10					
	Pred.			Bot.			Pred.			Bot.			Pred.			Bot.			Pred.			Bot.			Pred.			Bot.			Pred.			Bot.		
	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD	n	Ave.	SD
PCBs (Aroclor)																																				
1254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Metals																																				
Aluminum	4	15.8	12.5	2	67.5	85.6	3	11.7	6.4	3	76.0	62.0	3	14.0	14.7	2	69.0	58.0	3	20.0	28.6	2	64.0	32.5	1	189.0	--	2	10.0	8.5	2	208.0	171.1	4	15.8	12.5
Arsenic	4	2.1	1.8	2	2.2	2.5	3	1.0	0.5	3	0.9	0.4	1	0.4	--	1	0.7	--	1	0.3	--	1	0.5	--	1	2.0	--	1	0.5	--	2	1.8	1.8	4	2.1	1.8
Chromium	3	1.1	0.4	1	6.7	--	--	--	--	2	0.7	0.4	1	0.6	--	1	0.9	--	1	3.0	--	1	0.5	--	--	--	--	--	--	--	2	0.8	0.3	3	1.1	0.4
Copper	4	7.7	10.7	2	17.5	14.8	3	2.0	0.9	3	2.6	0.8	3	1.5	0.4	2	3.7	0.4	3	1.9	0.4	2	4.0	1.4	1	3.0	--	2	4.0	4.2	2	3.5	0.7	4	7.7	10.7
Iron	4	43.3	21.9	2	128.0	116.0	3	24.7	2.9	3	82.0	33.4	3	15.3	3.1	2	88.0	59.4	2	20.0	1.4	2	106.5	47.4	1	300.0	--	--	--	--	2	294.5	126.6	4	43.3	21.9
Lead	2	0.2	0.1	1	0.2	--	--	--	--	2	0.2	0.1	--	--	--	1	0.6	--	1	0.2	--	1	0.2	--	--	--	--	--	--	--	--	--	--	2	0.2	0.1
Manganese	2	1.5	0.7	2	11.1	10.0	3	1.6	0.4	2	10.9	6.1	3	1.0	0.6	2	14.6	19.0	2	0.9	0.2	2	15.1	18.2	1	10.0	--	--	--	--	2	14.7	8.1	2	1.5	0.7
Mercury	4	0.7	0.3	2	0.4	0.1	3	0.3	0.1	3	0.2	0.1	3	0.4	0.2	1	0.4	--	3	0.9	0.5	2	0.2	0.1	--	--	--	2	1.6	1.3	1	0.4	--	4	0.7	0.3
Nickel	--	--	--	2	1.8	1.8	--	--	--	--	--	--	1	0.5	--	1	0.8	--	--	--	--	1	0.6	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	4	0.8	0.1	2	1.0	0.1	3	1.6	0.2	3	1.7	0.8	3	1.2	0.2	2	1.1	0.0	3	1.4	0.3	2	1.4	0.2	--	--	--	1	1.6	--	1	1.3	--	4	0.8	0.1
Strontium	4	1.2	0.4	2	5.6	3.4	3	3.1	0.1	3	16.1	13.3	2	2.2	1.8	2	29.6	40.6	1	1.0	--	2	19.8	27.2	1	21.0	--	1	8.0	--	2	39.2	17.3	4	1.2	0.4
Zinc	4	25.4	5.8	2	52.3	16.5	3	26.0	1.7	3	41.8	19.9	3	17.2	5.1	2	35.2	20.1	3	18.0	5.2	2	33.5	13.4	1	34.0	--	2	19.0	5.7	2	40.5	6.4	4	25.4	5.8

Note: The organochlorine pesticides aldrin, alpha-BHC, beta-BHC, delta-BHC, chlordane, DDD, DDE, DDT, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, isodrin, kepone, methoxychlor, and toxaphene; the PCBs (aroclor) 1016, 1221, 1232, 1242, 1248, and 1260; and the metal cadmium were not detected any site in any year.

Few longitudinal trends of fish tissue biocontaminants were observed. In Predator fish tissue, arsenic, iron, and mercury concentrations decreased and selenium and strontium concentrations tended to increase in a downstream direction. Aluminum and strontium concentrations in Bottom fish tissue tended to increase in a downstream direction through all stations.

The lack of organochlorine pesticide detections at fish monitoring stations (Table 5-21) is consistent with the low level of detections in fish from 500 lakes and reservoirs sampled in the lower 48 states (Stahl et al. 2009). In this national level survey, the median DDT concentration was 0.001 mg/kg in Predator fish and 0.013 mg/kg in Bottom fish. Chlordane was detected in Predator fish but the median was below the detection limit while the concentration was 0.002 mg/kg in Bottom fish. In the Missouri and Madison rivers, both DDT and Chlordane were not detected in any fish sample.

The Aroclor 1254 (PCB) concentrations in the one Bottom fish collected was greater than the national medians of 0.002 mg/kg and 0.014 mg/kg, respectively (Stahl et al. 2009) at Station B-7 (Table 5-22). Arsenic was detected in fish tissue samples at most stations which is not consistent with infrequent detection in the national survey (Stahl et al. 2009). The mean mercury concentration at stations with detectable concentrations in Predator fish (0.153 mg/kg-wet weight, 21.6 % solids) is less than the mean of 0.352 mg/kg-wet weight for the national lakes survey (Stahl et al. 2009 Table 5-22). Mean mercury concentrations in Bottom fish (0.073 mg/kg-wet weight, 26.2 % solids) is also less than the national mean of 0.096 mg/kg-wet (Stahl et al. 2009) at all stations with detectable concentrations. Results are very similar to those from 2007 to 2016 (GEI 2017).

5.2.4.1.3 Upstream-Downstream Comparisons

Percent change in mean Predator and Bottom fish concentrations between stations upstream-downstream of reservoirs and dams are presented in Table 5-23. Means were compared as opposed to medians due to the small sample size and low number of values above detection limits. Statistical comparisons between the stations were not practicable due to the small number of detectable results, including Stations B7 and B8 which were sampled in 2014 and 2018. A summary of the percent change is presented in Table 5-23.

Percent change in mean Predator and Bottom fish selenium concentrations increased between all compared stations. However, the results should be cautiously interpreted because samples sizes are small for each station. Few other patterns were observed in the percent changes between mean fish tissue biocontaminant concentrations (Table 5-23). This indicates a large variability in the data between years and between feeding style of the Predator and Bottom fish. Large percent increases in chromium were observed in Predator fish between stations B7 and B8 in 2014 (+400.0 %) and for strontium in Bottom fish between stations B2 and B3 in 2017 (609 %); although the magnitude in change is relatively small (e.g., chromium for B7 and B8, 0.6 mg/kg and 3.0 mg/kg, respectively).

Table 5-23: Change (%) in mean fish tissue biocontaminant concentrations between fish monitoring stations upstream-downstream of reservoirs and dams in 2013 to 2015, 2017 and 2018. Only concentrations above detection limit were included. -- = one or both stations in a pair were not sampled or no biocontaminant was detected. Pred. = Predator fish, Bot. = Bottom fish.

	B2 and B3 (2013)		B7 and B8 (2014)		9 and B10 (2015)	B2 and B3 (2017)		B7 and B8 (2018)	
Biocontaminant	**Pred.**	**Bot.**	**Pred.**	**Bot.**	**Bot.**	**Pred.**	**Bot.**	**Pred.**	**Bot.**
PCBs (Aroclor)									
1254	--	--	--	--	--	--	--	--	--
Metals									
Aluminum	0.0	85.7	71.0	46.4	-54.0	-42.6	-16.0	-36.4	-20.9
Arsenic	-16.7	25.0	--	--	50.0	-67.1	-72.5	-25.0	-28.6
Chromium	--	--	400.0	-44.4	--	--	-94.0	--	--
Copper	50.0	-57.1	0.0	-25.0	0.0	-88.3	-91.3	46.2	47.1
Iron	0.0	-2.2	31.3	58.7	-31.7	-60.7	-52.1	26.7	7.7
Lead	--	--	--	--	--	--	-25.0	--	-66.7
Manganese	--	--	-41.2	83.3	-10.0	-10.0	-39.8	0.0	0.0
Mercury	-50.0	-40.0	116.7	-25.0	--	-68.2	-53.8	141.5	--
Nickel	--	--	--	-25.0	--	--	--	--	--
Selenium	114.3	18.2	30.8	36.4	--	112.5	105.6	4.2	9.1
Strontium	160.9	-62.5	-70.6	-33.3	28.6	173.9	609.4	--	-33.1
Zinc	5.2	-70.1	4.3	14.3	5.9	-3.6	31.0	4.5	-13.2

6. Summary

6.1 Water Quality

Concentrations of numerous constituents tended to either increase or decrease in the downstream direction throughout the monitoring period. These observations in spatial trends were consistent with previous studies (Land & Water 1999; PBS&J 2011; GEI 2017). The change in water quality conditions in the downstream direction are largely attributed to geologic factors in the headwaters of the Madison River, or source water inputs from the Jefferson, Gallatin, and Sun rivers. For example, elevated concentrations of total arsenic, total sodium, and total chloride observed at Station 1 at the upstream end of the study area are due to the geothermal activity in Yellowstone National Park whereas the increase in total suspended solids downstream at Station 9 is due to watershed/agricultural practices in the Sun River. The longitudinal increase in total calcium, total sulfates, and nutrients are due to shifts in the geological conditions of the various watersheds, anthropogenic influences of treated wastewater, and irrigation return flows, with the largest influence on water quality observed downstream of the Three Forks confluence. The observed differences in concentrations between the two 10-year monitoring periods is largely due to the different hydrological regimes.

Statistically significant changes in concentrations of constituents between monitoring stations was common between upstream stations 1 through 5. These shifts were largely a function of the corresponding dilution of constituents from hydrological gains, losses due to reservoir sinks, and gains due to changing geological sources. Stations lower in the watershed, especially those from immediately downstream of Canyon Ferry Dam and Holter Dam tended to show consistent patterns and stability in water quality concentrations with few significant differences between stations. Few changes in water quality appeared to be directly related to hydroelectric operations, except for total suspended solids/turbidity and dissolved oxygen content. Both Station 4 and Station 6 downstream of reservoirs revealed lower dissolved oxygen content relative to their respective upstream station.

Concentrations of many constituents were strongly correlated with one another. These correlations included geology-related factors (e.g. a strong association of sodium, chloride, and arsenic) and ionic chemistry, specific conductance, and total dissolved solids. Other erosion based watershed parameters such as total suspended solids and metals (e.g. iron) were strongly correlated. Furthermore, many parameter concentrations were strongly correlated to flow via dilution or watershed inputs. These parameters included total alkalinity, total bicarbonate, total calcium, total chloride, dissolved potassium (Madison River only), dissolved sodium, total suspended solids, turbidity, total arsenic, total iron, and specific conductance.

Temporal trends in both field and analytical parameters were analyzed for non-flow adjusted and flow-adjusted data from 2011 to 2020. Statistically significant increasing trends in non-flow adjusted concentrations were observed for multiple parameters. Total sulfate concentrations significantly increased in the Madison River at Station 1 (Hwy 297) and Station 3 (Varney), and total dissolved solids significantly increased over time at Station 1 (Hwy 287) and Station 7 (Hauser) in the Missouri River. Dissolved oxygen data, mg/L and % saturation, increased over time at most stations but was only significant at Station 3 (Varney) and Station 5 (Toston) which represents background conditions for the Missouri River stations. Decreasing trends also existed in the Madison and Missouri Rivers. Total alkalinity exhibited a statistically significant decreasing trend over time at Station 6 (Canyon Ferry). Nitrogen (total nitrate-nitrite and total nitrogen) concentrations did not trend except for a significant decrease in total nitrite-nitrate at Station 3 (Varney). Total phosphorus concentrations decreased at all sites and exhibited significant trends over time at multiple stations in both the Madison and Missouri rivers. Water temperature decreased at most sites and significantly decreased over time at Station 7 (Hauser). Total and dissolved, calcium and potassium exhibited statistically significant trends over time for almost all stations. However, these parameters were collected only either the first or second half of the 10-year period and results should be cautiously interpreted. No significant temporal trends were observed in flow, and in fact, hydrological conditions represented more typical flow conditions from 2011-2020, whereas the flow conditions from 2001-2020 represented extreme dry and wet year type flow conditions.

Of the eleven parameters that showed a strong relationship with flow, only a few exhibited significant trends over time (2011-2020) once the effects of flow were removed. Specific conductance significantly decreased over time at five of the ten monitoring stations, with most of decreasing trends occurring in the Missouri River. Similarly, alkalinity revealed significant decreasing trends over time at many of the Missouri River stations. Of the ten monitoring stations evaluated, Station 4 (Madison) revealed the most significant trends for water quality, with five of the eleven parameters significantly decreasing over time. Most of the trends at Station 4 were related to the ionic condition of the water, although total arsenic significantly decreased over time as well. Overall, the effects of watershed influence or hydroelectric dams had little to no effect on water quality conditions outside of the effects of flow from 2011 to 2020. For the stations that exhibited significant trends over time for alkalinity and conductivity, there was a downstream carry-over effect observed at successive downstream stations.

6.2 Periphyton

From 2011 to 2020, the mean whole-rock chlorophyll-a concentrations were less than 100 mg/m^2 at all stations except for at Station 4 (Madison) and Station B7 (Hauser) where the mean concentrations were higher (126 and 184 mg/m^2, respectively). Wadeable streams with chlorophyll-a concentrations greater than 120 mg/m^2 are often considered nutrient impaired by the State of Montana.

No longitudinal trend (i.e., over river miles) in chlorophyll-a concentrations was apparent among stations. Each station exhibited a high degree of intra/inter annual variability, except for Station B2 (Hebgen). The direction of change (e.g. decrease or increase) in median chlorophyll-a concentrations between paired stations alternated longitudinally between stations. The median concentration was the lowest at Station B2 (Hebgen) and the greatest at Station B7 (Hauser) which experienced nuisance bloom conditions in August 2020. Stations downstream of Holter and Great Falls dams exhibited algal biomass conditions similar to stations in the Madison River, between the Madison Dam and Canyon Ferry Reservoir.

The diatom assemblages typically revealed “Excellent” or “Good” ratings for the Mountain MTM biological index at all stations, except for one “Fair” rating at Station B10 (Morony), which is downstream of Great Falls Reservoir, the city of Great Falls, and Sun and Smith Rivers. Station B2 (Hebgen), exhibited more “Good” ratings for the diatom assemblage than any other station which is reflected in its overall impairment rating of “Severe” in one and “Moderate” in three of the previous ten years of data. The cause of these low ratings were mainly high results for siltation index and abundances of dominant species. The mountain streams siltation index also scored poorly at Station B10 which was rated as “Moderate” impairment in five of the last ten years along with one “Severe” impairment rating. All other stations in all years were rated with a minimal number of “Moderate” impairment and with mostly “Minor” impairment or “None.”

From 2011 to 2020, no longitudinal increasing or decreasing trends in diatom metrics were apparent among the stations except for a decrease in Abnormal Cells (%) in a downstream direction. Many diatom metrics followed similar patterns between stations indicating improving or declining community health from one station to the next. Multiple metrics statistically improved between stations B3 (Varney) and 4 (Madison), and B8 (Holter) and B10 (Morony), indicating an improvement in biological integrity for the diatom communities, while multiple metrics statistically worsened between stations 4 and B5 (Toston) and station B5 and B7 (Hauser), indicating a decline in community health.

Many correlations between metrics at individual stations were observed but few relationships among metrics at all stations occurred indicating that the periphyton communities differ greatly between stations. There were few significant temporal trends in diatom metrics and most represented very minor changes over time. Multiple metrics declined downstream from Hauser and Holter dams which characterize the poorer assemblages in these downstream reaches of the Missouri River; however, little change occurred elsewhere from 2011 to 2020. Overall, the results indicate little change in the diatom community at each station from 2011 to 2020 and little to no direct influence from the hydroelectric facilities.

6.3 Macroinvertebrates

From 2011 to 2020, no longitudinal increasing or decreasing trends in macroinvertebrate metrics were apparent. Most metrics, including the multimetric index, followed a similar pattern of improving or declining macroinvertebrate health from one station to the next station. The biological monitoring stations upstream of Ennis Lake and Canyon Ferry Reservoir revealed the most robust macroinvertebrate assemblages based on the multimetric index. The similar decreasing patterns among the metrics downstream of these locations highlight the negative effects of Ennis Lake and Madison Dam on the community in the Madison River, and the negative effects of Canyon Ferry Reservoir/Dam on community in the Missouri River. Macroinvertebrate community health was poorer for the stations downstream of Hauser and Holter dams, but improved by the last station downstream of Morony Dam.

The abundance of significant correlations within and among stations highlights the descriptive ability of the metrics, especially in the context of the multimetric index. The macroinvertebrate metrics are good descriptors of the biological integrity at each station and reveal consistent improving or declining conditions at successive stations.

Significant temporal trends of macroinvertebrate metrics were limited, and all had relatively shallow slopes. These results indicate little change in the macroinvertebrate community over time at each station from 2011 to 2020.

6.4 Fish Tissue

From 2011 to 2020, fish tissues were collected from seven biological monitoring stations ranging from Hebgen Reservoir to the Great Falls Reservoirs. However, fish tissue sampling did not occur at all stations within the same year, and instead occurred on a rotational basis targeting the upstream-downstream stations in different years. Most fish tissue biocontaminants were not detected in any predator or bottom dwelling fish. No organochlorine pesticides were detected and only one PCB congener was detected in predator and bottom dwelling fish at relatively low levels. Twelve of 13 metals were detected in both fish types while no metal was detected in all samples.

The lack of detectable organochlorine pesticide concentrations in fish tissue samples is consistent with the relatively low number of detectable concentrations in a national fish survey of over 500 lakes and reservoirs sampled in the lower 48 states. Aroclor 1254 (PCB congener) concentrations in both predators and bottom dwelling fish were often greater than the concentrations found in respective fish types for the national survey, while detectable mercury concentrations in both predator and bottom dwelling fish were less than their respective fish tissue concentrations sampled during the national lake survey.

Few patterns were observed in the percent changes between mean fish tissue biocontaminant concentrations and indicates a large variability in the data between years and between feeding styles. Statistical comparisons of fish tissue data between stations were not practicable due to the small number of detectable results, and alternating sampling frequency between stations which limited the number of results for a given station.

7. References

Bahls, L. L. 1993. Periphyton Bioassessment Methods for Montana Streams. Water Quality Bureau, Dept. of Health and Environmental Sciences. Helena, Montana.

Bahls, L. 1999. Periphyton of the Madison and Missouri Rivers: Summary of Baseline Data and Evaluation of the Monitoring Program. Pilot Phase, Missouri-Madison Water Quality Monitoring Program, FERC Project No. 2188. Prepared by Loren Bahls, Ph.D., Helena, MT, for the Montana Power Company. June 1999.

Barbour, M.T., Gerritsen, J., Snyder, B.D., and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. US EPA Office of Water.

Bukantis. 1996. Rapid Bioassessment Macroinvertebrate Protocols: sample and analysis SOP's. Draft. Montana Dept. of Environ. Quality.

GEI Consultants Inc. (GEI). 2017. Water Quality and Biological Monitoring Trend Analysis, Madison-Missouri Water Quality Monitoring Program. Submitted to NorthWestern Energy, Helena, MT, June 2017

GEI Consultants Inc. (GEI). 2021. Root Cause Analysis for 2188 Missouri-Madison Chlorophyll Data, Submitted to NorthWestern Energy, Helena, MT, Memorandum dated December 13, 2021.

Helsel, D.R., D.K. Mueller, and J.R. Slack. 2005. Computer Program for the Kendall Family of Trend Tests. U.S. Geological Survey Scientific Investigations Report 2005-5275.

Helsel, D.R. and R.M. Hirsch. 2002. Statistical Methods in Water Resources, *In* Hydrological Analysis and Interpretation. U.S. Geological Survey. http://water.usgs.gov/pubs/twri/twri4a3/.

Hilsenhoff, W.L. 1988. Rapid Field Assessment of Organic Pollution with a Family Level Biotic Index. J. N. Am. Benthol. Soc. 7(1):65-68.

Land & Water. 1999. Water Quality Statistical Analysis, Missouri-Madison Basin. Prepared by Land & Water Consulting, Inc. for the Montana Power Company. January 2000.

McBride, G.B. 2005. Using Statistical Methods for Water Quality Management: Issues, Problems and Solutions. John Wiley & Sons, Inc. Hoboken, New Jersey.

McGuire. 1997. Aquatic Macroinvertebrate Biomonitoring: Madison and Missouri Rivers, Montana. Prepared by McGuire Consulting, Espanola, New Mexico, for the Montana Power Company.

McGuire. 1999. Aquatic Macroinvertebrate Biomonitoring: Madison and Missouri Rivers, Montana, Summary Report: 1995-1998.

Montana Department of Health and Environmental Sciences (MDHES) 1993. Biological Monitoring Component, Long-Term Water Quality Monitoring Program, MPC Missouri/Madison Hydroelectric Project, FERC License No. 2188. Montana Department of Health and Environmental Sciences, Water Quality Division, Helena.

Montana Department of Environmental Quality (MTDEQ). 2011. Water Quality Assessment Method. Helena, MT: Water Quality Planning Bureau, Montana Department of Environmental Quality. Report No. WQPBWQM-001.

Montana Department of Environmental Quality (MTDEQ). 2012b. Sample Collection, Sorting, Taxonomic Identification, and Analysis of Benthic Macroinvertebrate Communities Standard Operating Procedure Version 3.0. Helena, MT: Montana Dept. of Environmental Quality.

Montana Department of Environmental Quality (MTDEQ). 2015. Water Quality Planning Bureau. Montana EQuIS Water Quality Exchange Guidance Manual, Version 3.0. Helena, MT: Montana Dept. of Environmental Quality.

Montana Department of Environmental Quality (MTDEQ). 2019. Sample Collection for Chemistry Analysis: Water Sediment, and Biological Tissue, WQDWQPBFM-02, Version 1.0. Helena, MT: Montana Department of Environmental Quality, Water Quality Planning Bureau.

Montana Department of Public Health and Human Services (MDHHS). 2014. Montana Sport Fish Consumption Guidelines. Communicable Disease Control and Prevention Bureau, Food and Consumer Safety Section.

PBS&J. 2011. Water Quality and Biological Monitoring Trend Analysis, Missouri-Madison Water Monitoring Program. Prepared by PBS&J Atkins for PPL Montana. July 2011.

Phillips, G. and L. Bahls. 1994. Lake Water Quality assessment and Contaminant Monitoring of Fishes and Sediments from Montana Waters. Final Report to the U.S. Environmental Protection Agency. 21 pp.

PPL Montana (PPLMT). 2011. Water Quality and Biological Monitoring Plan for The Years 2012 – 2021, Missouri-Madison Water Monitoring Program. Project No: 100011042.

Plafkin, J.L., Barbour, M.T., Porter, K.D., Gross, S.K., and R.M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Reservoirs, Benthic Macroinvertebrates and Fish. USEPA Office of Water. EPA/440/4-89/001. May 1989.

Prepared by McGuire Consulting, Espanola, New Mexico, for the Montana Power Company. August, 1999.

Stahl, L. L., Snyder, B. D., Olsen, A. R., and Pitt, J. L. 2009. Contaminants in fish tissue from US lakes and reservoirs: a national probabilistic study. Environ. Monit. Assess. 150:3–19

Suplee, M.W., and R. Sada de Suplee. 2011 Assessment Methodology for Determining Wadeable Stream Impairment Due to Excess Nitrogen and Phosphorus Levels. Helena, MT: Water Quality Planning Bureau, Water Quality Standards Section, Montana Department of Environmental Quality. Report No. WQPBMASTR-01.

Teply, M. and L. Bahls. 2006. Interpretation of Periphyton Samples for Montana Streams – Middle Rockies Ecoregion 2006. Prepared for the Montana Department of Environmental Quality by Larix Systems, Inc. of Helena, Montana. October 2006.

U. S. Environmental Protection Agency (EPA) 1998. Lake and Reservoir Bioassessment and Biocriteria, Technical Guidance Document. U.S. EPA Office of Water. EPA 841-B-98-007. August 1998.

U. S. Environmental Protection Agency (EPA). 2000. Guidance for assessing chemical contaminant data for use in fish advisories, volume 2: Risk assessment and fish consumption limits, 3rd ed. US EPA, Office of Water, Office of Science and Technology, Washington, DC. EPA 823-B-00-008

Weber, C.I., ed. 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents. EPA 670/4-73-001. US Environmental Protection Agency, Cincinnati, Ohio.

Appendix A Monitoring Objectives

Table A-1: Summary of monitoring objectives and methodology for 2011 to 2020.

Objective	Description	Sub-Objectives	Sampling	Methodology
Water quality				
Long-Term Trend Identification	Change in parameters at monitoring locations over time.	■ Identification of a trend. ■ Determine if trend is positive or negative. ■ Estimate trend magnitude. ■ Evaluate trend relationship to dam operation.	Quarterly	■ Statistical trend analysis of parameter data over time. Analyzed for each parameter at each location.
Parameter Correlation	Relationship between parameters.	■ Determine if relationship exists between parameters.	Quarterly	■ Correlation analysis between parameters/metrics. Analyzed for each parameter/metric at each location.
Dam Effect Evaluation	Difference in parameters between paired (upstream-downstream of a dam) monitoring locations.	■ Quantify differences. ■ Determine if differences are a function of time (season or year). ■ Determine if differences vary spatially.	Quarterly	■ Statistical comparison of parameter data between upstream-downstream locations. Analyzed for each parameter at each paired location for each time (quarter or annual); ■ Statistical comparison of computed parameter differences at each location for different times. ■ Analyzed for seasonal (water quality only) and annual variations for each parameter; ■ Statistical comparison of computed parameter differences between paired locations.
Site Specific Special Studies	Dissolved oxygen downstream of Canyon Ferry and Madison dams.	■ Evaluate spatial and seasonal related dissolved oxygen characteristics below dams.	Quarterly	■ Up/downstream spatial comparison; ■ Statistical analysis of dissolved oxygen data daily, seasonally, and min/max variations.
Biological				
Periphyton Long-Term Trend Identification	Change in metrics at monitoring locations over time.	■ Identification of a trend. ■ Determine if trend is positive or negative. ■ Estimate trend magnitude.	Annual	■ Statistical trend analysis of metrics data over time. Analyzed for each metrics at each location.
Periphyton Targets	Comparison of median values with target limits.	■ Identification of values exceeding targets.	Annual	■ Comparison of median values with target limits. Analyzed for each parameter at each location.
Macroinvertebrate Long-Term Trend Identification	Change in multimetric assessment over time.	■ Identification of a trend. ■ Determine if trend is positive or negative. ■ Estimate trend magnitude.	Annual	■ Statistical trend analysis of composite (multimetric) measures of macroinvertebrate data over time. Analyzed for multimetric set at each location.
Macroinvertebrate Targets	Comparison of median values with target limits.	■ Identification of values exceeding targets.	Annual	■ Comparison of median values with target limits. Analyzed for each metric at each location.
Fish Tissue Biocontaminants	Detect differences in means/medians between years.	■ Compare differences between stations. ■ Compare to targets. ■ Compare to Human Health Standards.	Once every 3 to 9 years	■ Parametric or non-parametric comparison of means/medians between sample events. ■ Comparison to reference values.

Table A-2: Summary of water quality data statistical analysis methodology for 2011 to 2020.

Objective	Description	Statistics and Data Evaluations
Summary Data	Summarize spatially collected data, background control stations, and longitudinal patterns	■ Minimum, maximum, and mean values; standard deviations; and percentages of non-detect data for each station and year ■ Graphical presentation and observations of longitudinal patterns in the data
Parameter Correlation	Evaluation of correlation between parameters	■ Kendall-tau correlation analysis between non-adjusted parameters and flow. ■ A combination of a strong relationship (i.e., correlation coefficient > 0.5) and a statistically significant p-value (i.e., <0.1) between concentration and flow or flow percentile provided the rationale for "flow adjustment" of parameters.
Long-Term Trend Identification	Raw Data Identification of trend, summary of positive and negative trends for non-flow adjusted and flow-adjusted parameters	■ Graphical presentation and evaluation of temporal patterns in the data ■ Non-detect values were substituted with one-half of method detection limit. ■ Seasonal Kendall non-parametric test of trend using non-flow-adjusted data over time. The seasonal covariate was based on month. ■ Seasonal Kendall test for trend (0.05 significance level) ■ Sen slope estimate of trend magnitude ■ Percent change between 2011-2013 mean water quality concentration and 2018-2020 mean water quality concentration at each station
	Flow-Adjusted Data Identification of trend, summary of positive and negative trends	■ Graphical presentation and evaluation of temporal patterns in the data ■ Non-detect values were substituted with one-half of method detection limit ■ Natural logarithm transformation of chemistry results paired with probability of flow for respective sample date ■ Least Squares Regression analysis and calculation of residuals (flow-adjusted values) ■ Pearson correlation analysis of flow-adjusted values with decimal year (0.10 significance level) ■ Locally weighted scatterplot smoothing (LOESS) regression was performed on flow-adjusted parameters of interest to evaluate non-monotonic relationships ■ Percent change between 2011-2013 mean flow-adjusted concentration and 2018-2020 mean flow-adjusted concentration at each station
Dam effect evaluation	Compared data between paired stations upstream-downstream of reservoirs and dams	■ Graphical presentation and evaluation of data patterns ■ Non-detect values were substituted with one-half of method detection limit ■ Mann-Whitney U non-parametric test between stations (0.05 significance level) ■ Mean Rank differences and evaluation of 10-year medians to confirm significant differences ■ Percent change of 10-year median between stations
Special Studies Dissolved Oxygen	Evaluation of spatial and seasonal dissolve oxygen characteristics downstream of Madison Dam and Canyon Ferry Dam	■ Graphical presentation and evaluation of data patterns ■ Mann-Whitney U non-parametric test between stations (0.05 significance level) ■ Kruskal-Wallis H non-parametric test of seasonal effects within a station (0.05 significance level)

Table A-3: Summary of biological data statistical analysis methodology for 2011 to 2020.

Objective	Description	Data	Statistics and Data Evaluations
Summary data	Summarization of collected data, guidelines, control stations, and longitudinal patterns	Chlorophyll-a	■ Minimum, maximum, and mean values; standard deviations; and percentages of non-detect data for each station and year ■ Compared to guidelines established by Montana Department of Water quality ■ Potentially impacted stations compared to background control stations (B1 and B5) ■ Observations of longitudinal patterns
		Diatoms	■ Minimum, maximum, and mean values and standard deviations by metric for each station and year ■ Biological integrity ratings for each metric and impairment ratings for each station and year ■ Potentially impacted stations compared to control stations (B1 and B5) ■ Observations of longitudinal patterns
		Macroinvertebrates	■ Minimum, maximum, and mean values and standard deviations by metric for each station and year ■ Potentially impacted stations compared to control stations (B1 and B5) ■ Observations of longitudinal patterns
		Fish tissue	■ Minimum, maximum, and mean values and standard deviations for fish length and weight for Predator and Bottom fish for each station and year ■ Number of fish tissue biocontaminant concentration detections above the detection limit, number or non-detects, and percentage of non-detects and mean biocontaminant concentrations for Predator and Bottom fish for each station ■ Compared to national median concentrations and Montana and EPA fish consumption guidelines ■ Observations of differences between Predator and Bottom fish concentrations and longitudinal patterns by metric
Dam effect evaluation	Compared data between paired stations upstream-downstream of reservoirs and dams	Chlorophyll-a	■ Non-parametric Mann-Whitney U test between stations ■ Percent change of median between stations
		Diatoms and macroinvertebrates	■ Mann-Whitney U Non-parametric test between stations for each metric ■ Percent change of median between stations for each metric
		Fish tissue	■ Percent change in means for Predator and Bottom fish between stations for biocontaminants detected above detection limit ■ Mann-Whitney U Non-parametric test between stations for each biocontaminant
Metric relationships	Determined relationships between metrics and slope	Diatoms and macroinvertebrates	■ Scatter plot matrix of metrics of all data ■ Correlation analysis between metrics each station using the non-parametric Kendall-tau statistic
Long-term trend identification	Determined long-term trends in data	Chlorophyll-a	■ Mann-Kendall trends analysis at each station
		Diatoms	■ Least Squares Regression analysis for trends in each metric at each station
		Macroinvertebrates	■ Least Squares Regression analysis for trends in each metric at each station

Appendix B Water Quality

Appendix B.1 Descriptive Statistics

Table B-1: Water quality analyte descriptive statistics at Station 1 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	12	57.0	114.0	95.6	18.4
Bicarbonate as HCO_3, Total (mg/L)	12	70.0	139.0	115.4	21.8
Calcium, Total (mg/L)	12	4.0	9.0	5.9	1.2
Chloride, Total (mg/L)	12	25.0	70.0	50.3	14.8
Magnesium, Dissolved (mg/L)	12	0.5	0.5	0.5	0.0
Potassium, Total (mg/L)	12	5.0	9.0	7.6	1.4
Sodium, Dissolved (mg/L)	12	39.0	97.0	74.4	18.6
Sulfate, Total (mg/L)	12	7.0	16.0	11.8	3.0
Dissolved Solids, Total (mg/L)	12	165.0	368.0	285.5	63.5
Suspended Solids, Total (mg/L)	12	5.0	21.0	8.3	5.4
Turbidity (NTU)	12	1.1	11.9	3.4	2.9
Arsenic, Total (mg/L)	12	0.127	0.328	0.231	0.062
Cadmium, Total (mg/L)	12	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	12	0.001	0.002	0.001	0.001
Iron, Total (mg/L)	12	0.070	0.710	0.222	0.179
Lead, Total (mg/L)	12	0.001	0.004	0.001	0.001
Manganese, Total (mg/L)	12	0.010	0.090	0.034	0.024
Zinc, Total (mg/L)	12	0.005	0.005	0.005	0.000
Nitrate Nitrite, Dissolved (mg/L)	12	0.020	0.060	0.040	0.016
Nitrogen, Total (mg/L)	12	0.050	0.300	0.150	0.077
Phosphorus, Total (mg/L)	12	0.017	0.038	0.025	0.007
Dissolved Oxygen (mg/L)	6	6.4	9.0	7.6	1.1
Dissolved Oxygen (% Sat)	6	81.0	86.2	83.4	1.9
pH (s.u.)	12	7.47	7.98	7.83	0.18
Specific Conductance (µS/cm)	12	214	504	379	92
Temperature, Water (°C)	12	1.4	18.2	8.6	5.2

Table B-2: Water quality analyte descriptive statistics at Station 1 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	61.0	114.0	98.3	25.0
Bicarbonate as HCO_3, Total (mg/L)	4	74.0	139.0	119.8	30.7
Calcium, Total (mg/L)	4	5.0	7.0	6.0	0.8
Chloride, Total (mg/L)	4	29.0	58.0	47.3	12.7
Magnesium, Dissolved (mg/L)	4	0.5	0.5	0.5	0.0
Potassium, Total (mg/L)	4	5.0	8.0	7.3	1.5
Sodium, Dissolved (mg/L)	4	43.0	86.0	70.3	18.8
Sulfate, Total (mg/L)	4	8.0	14.0	11.5	2.5
Dissolved Solids, Total (mg/L)	4	187.0	299.0	256.8	49.2
Suspended Solids, Total (mg/L)	4	5.0	21.0	9.0	8.0
Turbidity (NTU)	4	1.2	7.1	3.0	2.8
Arsenic, Total (mg/L)	4	0.142	0.260	0.211	0.050
Nitrite Nitrate, Total (mg/L)	4	0.030	0.040	0.035	0.004
Nitrogen, Total (mg/L)	4	0.010	0.040	0.025	0.013
Phosphorus, Total (mg/L)	4	0.060	0.140	0.088	0.036
Dissolved Oxygen (mg/L)	4	6.5	9.8	7.7	1.5
Dissolved Oxygen (% Sat)	4	80.8	96.4	85.2	7.5
pH (s.u.)	4	7.48	7.82	7.73	0.16
Specific Conductance (µS/cm)	4	242	411	358	78
Temperature, Water (°C)	4	4.8	15.0	9.8	5.0

Table B-3: Water quality analyte descriptive statistics at Station 1 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	53.0	115.0	97.0	29.5
Bicarbonate as HCO_3, Total (mg/L)	4	65.0	140.0	118.5	35.9
Calcium, Total (mg/L)	4	4.0	7.0	5.8	1.3
Chloride, Total (mg/L)	4	28.0	60.0	50.8	15.3
Magnesium, Dissolved (mg/L)	4	0.5	0.5	0.5	0.0
Potassium, Total (mg/L)	4	5.0	9.0	7.5	1.7
Sodium, Dissolved (mg/L)	4	41.0	92.0	75.0	23.1
Sulfate, Total (mg/L)	4	7.0	15.0	11.5	3.3
Dissolved Solids, Total (mg/L)	4	169.0	327.0	277.8	73.5
Suspended Solids, Total (mg/L)	4	5.0	80.0	23.8	37.5
Turbidity (NTU)	4	1.1	23.0	7.0	10.7
Arsenic, Total (mg/L)	4	0.155	0.271	0.239	0.056
Nitrite Nitrate, Total (mg/L)	4	0.020	0.050	0.033	0.013
Nitrogen, Total (mg/L)	4	0.005	0.220	0.111	0.088
Phosphorus, Total (mg/L)	4	0.029	0.082	0.049	0.023
Dissolved Oxygen (mg/L)	4	6.3	8.5	7.3	1.0
Dissolved Oxygen (% Sat)	4	78.3	79.8	79.1	0.7
pH (s.u.)	4	7.48	8.18	7.78	0.30
Specific Conductance (µS/cm)	4	218	456	387	113
Temperature, Water (°C)	4	2.5	14.0	9.1	5.5

Table B-4: Water quality analyte descriptive statistics at Station 1 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	58.0	118.0	97.8	27.0
Bicarbonate as HCO_3, Total (mg/L)	4	70.0	143.0	118.8	33.0
Calcium, Total (mg/L)	4	4.0	7.0	6.0	1.4
Chloride, Total (mg/L)	4	28.0	62.0	49.5	14.8
Magnesium, Dissolved (mg/L)	4	0.5	0.5	0.5	0.0
Potassium, Total (mg/L)	4	5.0	9.0	7.5	1.7
Sodium, Dissolved (mg/L)	4	45.0	93.0	76.8	21.6
Sulfate, Total (mg/L)	4	10.0	15.0	11.3	2.5
Dissolved Solids, Total (mg/L)	4	170.0	327.0	277.5	72.9
Suspended Solids, Total (mg/L)	4	5.0	32.0	11.8	13.5
Turbidity (NTU)	4	1.2	11.9	4.6	4.9
Arsenic, Total (mg/L)	4	0.163	0.281	0.230	0.050
Nitrite Nitrate, Total (mg/L)	4	0.010	0.080	0.038	0.031
Nitrogen, Total (mg/L)	4	0.100	0.600	0.250	0.238
Phosphorus, Total (mg/L)	4	0.017	0.055	0.033	0.017
Dissolved Oxygen (mg/L)	4	6.4	9.1	7.7	1.3
Dissolved Oxygen (% Sat)	4	77.7	79.9	78.8	0.9
pH (s.u.)	4	6.84	7.95	7.38	0.46
Specific Conductance (µS/cm)	4	231	469	386	106
Temperature, Water (°C)	4	0.3	14.4	6.9	6.7

Table B-5: Water quality analyte descriptive statistics at Station 1 in 2015.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	85.0	120.0	107.5	15.8
Bicarbonate as HCO_3, Total (mg/L)	4	104.0	147.0	131.3	19.2
Calcium, Dissolved (mg/L)	4	6.0	7.0	6.5	0.6
Chloride, Total (mg/L)	4	42.0	66.0	56.5	10.2
Magnesium, Dissolved (mg/L)	4	0.5	0.5	0.5	0.0
Potassium, Dissolved (mg/L)	4	7.0	9.0	8.3	1.0
Sodium, Dissolved (mg/L)	4	66.0	98.0	86.3	14.1
Sulfate, Total (mg/L)	4	11.0	14.0	12.8	1.5
Dissolved Solids, Total (mg/L)	4	250.0	348.0	315.0	45.0
Suspended Solids, Total (mg/L)	4	5.0	10.0	6.3	2.5
Turbidity (NTU)	4	0.9	4.4	2.3	1.5
Arsenic, Total (mg/L)	4	0.214	0.289	0.264	0.034
Nitrite Nitrate, Total (mg/L)	4	0.010	0.050	0.030	0.018
Nitrogen, Total (mg/L)	4	0.060	0.250	0.128	0.084
Phosphorus, Total (mg/L)	4	0.008	0.019	0.016	0.005
Dissolved Oxygen (mg/L)	4	6.7	8.4	7.5	0.9
Dissolved Oxygen (% Sat)	4	77.6	80.0	78.9	1.1
pH (s.u.)	4	7.18	8.07	7.71	0.43
Specific Conductance (µS/cm)	4	338	474	432	64
Temperature, Water (°C)	4	2.9	12.7	7.8	5.6

Table B-6: Water quality analyte descriptive statistics at Station 1 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	91.0	127.0	114.8	16.2
Bicarbonate as HCO_3, Total (mg/L)	4	110.0	154.0	139.5	20.0
Calcium, Dissolved l (mg/L)	4	6.0	7.0	6.8	0.5
Chloride, Total (mg/L)	4	45.0	68.0	60.5	10.5
Magnesium, Dissolved (mg/L)	4	0.5	0.5	0.5	0.0
Potassium, Dissolved (mg/L)	4	7.0	9.0	8.5	1.0
Sodium, Dissolved (mg/L)	4	70.0	96.0	87.3	11.8
Sulfate, Total (mg/L)	4	10.0	15.0	12.5	2.4
Dissolved Solids, Total (mg/L)	4	266.0	360.0	333.0	45.0
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.9	3.0	2.0	1.1
Arsenic, Total (mg/L)	4	0.223	0.321	0.280	0.041
Nitrite Nitrate, Total (mg/L)	4	0.010	0.050	0.025	0.017
Nitrogen, Total (mg/L)	4	0.015	0.190	0.106	0.087
Phosphorus, Total (mg/L)	4	0.010	0.015	0.013	0.002
Dissolved Oxygen (mg/L)	4	6.3	7.7	7.1	0.6
Dissolved Oxygen (% Sat)	4	78.3	80.2	79.1	0.8
pH (s.u.)	4	7.66	7.92	7.81	0.11
Specific Conductance (µS/cm)	4	351	491	449	66
Temperature, Water (°C)	4	5.6	14.9	10.1	4.0

Table B-7: Water quality analyte descriptive statistics at Station 1 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	59.0	120.0	94.5	25.6
Bicarbonate as HCO_3, Total (mg/L)	4	72.0	140.0	115.5	30.1
Calcium, Dissolved (mg/L)	4	4.0	7.0	5.8	1.3
Chloride, Total (mg/L)	4	27.0	62.0	47.3	14.8
Magnesium, Dissolved (mg/L)	4	0.5	0.5	0.5	0.0
Potassium, Dissolved (mg/L)	4	5.0	9.0	7.5	1.7
Sodium, Dissolved (mg/L)	4	43.0	96.0	74.0	22.3
Sulfate, Total (mg/L)	4	8.3	15.0	11.8	3.2
Dissolved Solids, Total (mg/L)	4	185.0	351.0	288.3	72.8
Suspended Solids, Total (mg/L)	4	5.0	17.0	8.0	6.0
Turbidity (NTU)	4	1.0	7.1	3.6	2.7
Arsenic, Total (mg/L)	4	0.146	0.313	0.232	0.069
Nitrite Nitrate, Total (mg/L)	4	0.010	0.050	0.028	0.017
Nitrogen, Total (mg/L)	4	0.050	0.190	0.130	0.063
Phosphorus, Total (mg/L)	4	0.011	0.025	0.019	0.006
Dissolved Oxygen (mg/L)	4	6.4	7.9	7.1	0.7
Dissolved Oxygen (% Sat)	4	76.0	79.1	77.5	1.5
pH (s.u.)	4	7.16	7.88	7.61	0.31
Specific Conductance (µS/cm)	4	231	472	377	104
Temperature, Water (°C)	4	4.7	14.4	9.1	4.4

Table B-8: Water quality analyte descriptive statistics at Station 1 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	49.0	110.0	88.8	27.1
Bicarbonate as HCO_3, Total (mg/L)	4	59.0	130.0	107.3	32.5
Calcium, Dissolved (mg/L)	4	4.0	7.0	5.8	1.3
Chloride, Total (mg/L)	4	20.0	61.0	43.3	17.1
Magnesium, Dissolved (mg/L)	4	0.5	0.5	0.5	0.0
Potassium, Dissolved (mg/L)	4	5.0	9.0	7.0	1.6
Sodium, Dissolved (mg/L)	4	37.0	93.0	70.0	23.6
Sulfate, Total (mg/L)	4	6.0	15.0	11.0	3.9
Dissolved Solids, Total (mg/L)	4	160.0	352.0	270.3	80.1
Suspended Solids, Total (mg/L)	4	5.0	14.0	7.3	4.5
Turbidity (NTU)	4	1.2	6.4	3.2	2.2
Arsenic, Total (mg/L)	4	0.116	0.296	0.210	0.074
Nitrite Nitrate, Total (mg/L)	4	0.020	0.040	0.030	0.012
Nitrogen, Total (mg/L)	4	0.100	0.240	0.155	0.068
Phosphorus, Total (mg/L)	4	0.012	0.020	0.016	0.003
Dissolved Oxygen (mg/L)	4	6.3	9.6	8.0	1.6
Dissolved Oxygen (% Sat)	4	75.5	85.8	81.6	4.9
pH (s.u.)	4	7.10	7.69	7.30	0.27
Specific Conductance (µS/cm)	4	194	472	357	118
Temperature, Water (°C)	4	0.0	13.3	6.9	7.2

Table B-9: Water quality analyte descriptive statistics at Station 1 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	63.0	110.0	95.8	22.3
Bicarbonate as HCO_3, Total (mg/L)	4	76.0	140.0	119.0	29.1
Calcium, Dissolved (mg/L)	4	4.0	7.0	6.0	1.4
Chloride, Total (mg/L)	4	27.0	58.0	47.5	14.2
Magnesium, Dissolved (mg/L)	4	0.5	0.5	0.5	0.0
Potassium, Dissolved (mg/L)	4	5.0	8.0	7.3	1.5
Sodium, Dissolved (mg/L)	4	46.0	86.0	73.5	18.6
Sulfate, Total (mg/L)	4	9.0	15.0	12.8	2.9
Dissolved Solids, Total (mg/L)	4	211.0	325.0	290.3	53.4
Suspended Solids, Total (mg/L)	4	5.0	26.0	11.8	9.9
Turbidity (NTU)	4	1.2	5.8	3.1	2.0
Arsenic, Total (mg/L)	4	0.142	0.265	0.221	0.057
Nitrite Nitrate, Total (mg/L)	4	0.020	0.040	0.028	0.010
Nitrogen, Total (mg/L)	4	0.080	0.280	0.168	0.098
Phosphorus, Total (mg/L)	4	0.017	0.025	0.022	0.004
Dissolved Oxygen (mg/L)	4	7.6	10.4	8.8	1.1
Dissolved Oxygen (% Sat)	4	92.6	97.7	95.0	2.6
pH (s.u.)	4	7.81	8.13	7.97	0.18
Specific Conductance (µS/cm)	4	234	446	379	98
Temperature, Water (°C)	4	0.9	16.1	8.7	6.3

Table B-10: Water quality analyte descriptive statistics at Station 1 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	68.0	110.0	99.5	21.0
Bicarbonate as HCO_3, Total (mg/L)	4	82.0	140.0	123.0	27.7
Calcium, Dissolved (mg/L)	4	4.0	7.0	5.8	1.3
Chloride, Total (mg/L)	4	32.0	59.0	49.5	12.5
Magnesium, Dissolved (mg/L)	4	0.5	0.5	0.5	0.0
Potassium, Dissolved (mg/L)	4	5.0	8.0	7.3	1.5
Sodium, Dissolved (mg/L)	4	49.0	90.0	75.3	18.2
Sulfate, Total (mg/L)	4	10.0	16.0	13.5	3.0
Dissolved Solids, Total (mg/L)	4	230.0	343.0	305.0	51.3
Suspended Solids, Total (mg/L)	4	5.0	15.0	7.5	5.0
Turbidity (NTU)	4	1.3	7.2	3.6	2.5
Arsenic, Total (mg/L)	4	0.151	0.280	0.230	0.055
Nitrite Nitrate, Total (mg/L)	4	0.005	0.070	0.034	0.028
Nitrogen, Total (mg/L)	4	0.110	0.230	0.180	0.060
Phosphorus, Total (mg/L)	4	0.009	0.014	0.012	0.003
Dissolved Oxygen (mg/L)	4	7.5	10.5	8.7	1.4
Dissolved Oxygen (% Sat)	4	93.4	96.0	94.6	1.3
pH (s.u.)	4	7.61	8.12	7.79	0.23
Specific Conductance (µS/cm)	4	244	434	381	91
Temperature, Water (°C)	4	1.1	16.5	9.3	7.1

Table B-11: Water quality analyte descriptive statistics at Station 2 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	12	62.0	105.0	82.2	13.8
Bicarbonate as HCO_3, Total (mg/L)	12	76.0	128.0	99.9	16.7
Calcium, Total (mg/L)	12	9.0	14.0	10.1	1.4
Chloride, Total (mg/L)	12	16.0	43.0	26.7	10.1
Magnesium, Dissolved (mg/L)	12	2.0	3.0	2.1	0.3
Potassium, Total (mg/L)	12	4.0	7.0	4.9	1.1
Sodium, Dissolved (mg/L)	12	29.0	65.0	42.4	13.2
Sulfate, Total (mg/L)	12	6.0	11.0	8.3	1.8
Dissolved Solids, Total (mg/L)	12	142.0	271.0	191.8	51.6
Suspended Solids, Total (mg/L)	12	5.0	5.0	5.0	0.0
Turbidity (NTU)	12	0.4	1.9	1.0	0.5
Arsenic, Total (mg/L)	12	0.077	0.186	0.123	0.040
Cadmium, Total (mg/L)	12	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	12	0.001	0.001	0.001	0.000
Iron, Total (mg/L)	12	0.040	0.160	0.081	0.036
Lead, Total (mg/L)	12	0.001	0.001	0.001	0.000
Manganese, Total (mg/L)	12	0.010	0.070	0.027	0.019
Zinc, Total (mg/L)	12	0.005	0.005	0.005	0.000
Nitrite Nitrate, Dissolved (mg/L)	12	0.005	0.110	0.032	0.035
Nitrogen, Total (mg/L)	12	0.050	0.200	0.179	0.050
Phosphorus, Total (mg/L)	12	0.016	0.031	0.024	0.005
Dissolved Oxygen (mg/L)	6	6.7	9.9	7.9	1.3
Dissolved Oxygen (% Sat)	6	91.0	92.2	91.6	0.5
pH (s.u.)	12	7.74	8.30	8.06	0.19
Specific Conductance (µS/cm)	12	126	343	242	67
Temperature, Water (°C)	12	1.9	19.4	7.9	6.8

Table B-12: Water quality analyte descriptive statistics at Station 2 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	68.0	86.0	78.3	8.3
Bicarbonate as HCO_3, Total (mg/L)	4	83.0	105.0	95.8	10.2
Calcium, Total (mg/L)	4	10.0	10.0	10.0	0.0
Chloride, Total (mg/L)	4	20.0	31.0	25.0	4.5
Magnesium, Dissolved (mg/L)	4	2.0	2.0	2.0	0.0
Potassium, Total (mg/L)	4	4.0	6.0	5.0	0.8
Sodium, Dissolved (mg/L)	4	33.0	51.0	40.8	7.5
Sulfate, Total (mg/L)	4	8.0	10.0	9.0	0.8
Dissolved Solids, Total (mg/L)	4	146.0	203.0	180.5	27.4
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.7	1.7	1.2	0.4
Arsenic, Total (mg/L)	4	0.097	0.151	0.118	0.023
Nitrite Nitrate, Total (mg/L)	4	0.005	0.040	0.014	0.018
Nitrogen, Total (mg/L)	4	0.100	0.210	0.165	0.051
Phosphorus, Total (mg/L)	4	0.019	0.043	0.030	0.010
Dissolved Oxygen (mg/L)	4	6.7	10.5	8.8	1.7
Dissolved Oxygen (% Sat)	4	90.0	103.9	94.0	6.6
pH (s.u.)	4	7.75	8.46	8.13	0.34
Specific Conductance (µS/cm)	4	228	278	253	20
Temperature, Water (°C)	4	2.6	18.6	9.0	7.0

Table B-13: Water quality analyte descriptive statistics at Station 2 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	76.0	87.0	81.8	5.1
Bicarbonate as HCO_3, Total (mg/L)	4	91.0	107.0	99.5	7.3
Calcium, Total (mg/L)	4	10.0	12.0	10.8	1.0
Chloride, Total (mg/L)	4	25.0	35.0	29.0	4.5
Magnesium, Dissolved (mg/L)	4	2.0	3.0	2.5	0.6
Potassium, Total (mg/L)	4	4.0	6.0	5.0	0.8
Sodium, Dissolved (mg/L)	4	40.0	52.0	45.5	6.4
Sulfate, Total (mg/L)	4	9.0	11.0	9.5	1.0
Dissolved Solids, Total (mg/L)	4	164.0	213.0	189.3	20.8
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.8	1.2	1.0	0.2
Arsenic, Total (mg/L)	4	0.110	0.151	0.126	0.019
Nitrite Nitrate, Total (mg/L)	4	0.005	0.040	0.020	0.018
Nitrogen, Total (mg/L)	4	0.080	0.250	0.153	0.073
Phosphorus, Total (mg/L)	4	0.028	0.056	0.040	0.012
Dissolved Oxygen (mg/L)	4	6.4	9.4	8.2	1.3
Dissolved Oxygen (% Sat)	4	86.2	88.0	86.9	0.8
pH (s.u.)	4	7.76	8.67	8.21	0.43
Specific Conductance (µS/cm)	4	262	303	279	20
Temperature, Water (°C)	4	2.1	18.7	8.2	7.3

Table B-14: Water quality analyte descriptive statistics at Station 2 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	72.0	96.0	84.8	11.2
Bicarbonate as HCO_3, Total (mg/L)	4	81.0	117.0	101.8	16.2
Calcium, Total (mg/L)	4	10.0	11.0	10.3	0.5
Chloride, Total (mg/L)	4	23.0	36.0	29.8	6.7
Magnesium, Dissolved (mg/L)	4	2.0	2.0	2.0	0.0
Potassium, Total (mg/L)	4	4.0	6.0	5.3	1.0
Sodium, Dissolved (mg/L)	4	39.0	58.0	49.8	9.7
Sulfate, Total (mg/L)	4	7.0	12.0	9.3	2.6
Dissolved Solids, Total (mg/L)	4	159.0	222.0	193.5	27.3
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.5	1.4	1.0	0.4
Arsenic, Total (mg/L)	4	0.110	0.156	0.133	0.021
Nitrite Nitrate, Total (mg/L)	4	0.005	0.030	0.016	0.011
Nitrogen, Total (mg/L)	4	0.050	0.600	0.238	0.250
Phosphorus, Total (mg/L)	4	0.020	0.059	0.036	0.018
Dissolved Oxygen (mg/L)	4	6.4	9.1	8.4	1.3
Dissolved Oxygen (% Sat)	4	84.8	87.3	86.2	1.1
pH (s.u.)	4	6.62	8.41	7.71	0.77
Specific Conductance (µS/cm)	4	247	332	291	41
Temperature, Water (°C)	4	2.8	19.0	7.5	7.7

Table B-15: Water quality analyte descriptive statistics at Station 2 in 2015.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	80.0	94.0	88.0	6.1
Bicarbonate as HCO_3, Total (mg/L)	4	98.0	115.0	107.8	7.5
Calcium, Dissolved (mg/L)	4	10.0	10.0	10.0	0.0
Chloride, Total (mg/L)	4	28.0	36.0	33.0	3.6
Magnesium, Dissolved (mg/L)	4	2.0	2.0	2.0	0.0
Potassium, Dissolved (mg/L)	4	5.0	6.0	5.5	0.6
Sodium, Dissolved (mg/L)	4	45.0	58.0	52.5	5.8
Sulfate, Total (mg/L)	4	8.0	11.0	9.8	1.5
Dissolved Solids, Total (mg/L)	4	186.0	238.0	207.5	21.9
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.7	1.2	0.9	0.2
Arsenic, Total (mg/L)	4	0.131	0.157	0.148	0.012
Nitrite Nitrate, Total (mg/L)	4	0.005	0.060	0.029	0.026
Nitrogen, Total (mg/L)	4	0.150	0.230	0.183	0.036
Phosphorus, Total (mg/L)	4	0.012	0.027	0.021	0.006
Dissolved Oxygen (mg/L)	4	6.6	9.2	8.1	1.1
Dissolved Oxygen (% Sat)	4	84.1	85.8	85.1	0.7
pH (s.u.)	4	7.41	8.58	8.03	0.48
Specific Conductance (µS/cm)	4	285	323	307	17
Temperature, Water (°C)	4	2.8	16.9	8.1	6.1

Table B-16: Water quality analyte descriptive statistics at Station 2 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	86.0	104.0	95.0	8.0
Bicarbonate as HCO3, Total	4	105.0	126.0	115.5	9.3
Calcium, Dissolved	4	10.0	12.0	11.3	0.96
Chloride, Total	4	28.0	42.0	35.3	6.1
Magnesium, Dissolved	4	2.0	3.0	2.8	0.5
Potassium, Dissolved	4	5.0	6.0	5.5	0.6
Sodium, Dissolved	4	43.0	63.0	53.8	8.69
Sulfate, Total	4	8.0	11.0	9.8	1.26
Dissolved Solids, Total	4	181.0	239.0	214.0	29.1
Suspended Solids Total	4	5.0	5.0	5.0	0.0
Turbidity	4	0.64	1.93	1.23	0.53
Arsenic, Total	4	0.126	0.188	0.156	0.028
Nitrate Nitrite, Total	4	0.005	0.030	0.021	0.011
Nitrogen, Total	4	0.140	0.200	0.170	0.029
Phosphorus, Total	4	0.019	0.037	0.028	0.008
Dissolved Oxygen (DO)	4	6.6	9.2	8.1	1.1
Dissolved Oxygen Saturation	4	85.1	86.3	85.6	0.5
pH, field	4	7.68	8.06	7.87	0.17
Specific conductance	4	283	358	319	33
Temperature, water	4	2.6	16.9	8.3	6.1

Table B-17: Water quality analyte descriptive statistics at Station 2 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	72.0	100	83	12.4
Bicarbonate as HCO3, Total	4	87.0	120	99.75	14
Calcium, Dissolved	4	10	12	11	0.816
Chloride, Total	4	21.0	41	29	8.6
Magnesium, Dissolved	4	2.0	3	2.75	0.5
Potassium, Dissolved	4	4.0	7	5.25	1.3
Sodium, Dissolved	4	37.0	64	47.25	12.09
Sulfate, Total	4	8.0	12	9.675	1.70
Dissolved Solids, Total	4	168.0	247	203.25	33.12
Suspended Solids Total	4	5.0	5	5	0.0
Turbidity	4	0.640	1.930	1.2325	0.534
Arsenic, Total	4	0.099	0.178	0.13125	0.034
Nitrate Nitrite, Total	4	0.005	0.03	0.01125	0.013
Nitrogen, Total	4	0.12	0.19	0.145	0.031
Phosphorus, Total	4	0.01	0.027	0.02025	0.008
Dissolved Oxygen (DO)	4	6.59	9.168	8.0745	1.080
Dissolved Oxygen Saturation	4	85.1	86.28	85.585	0.532
pH, field	4	7.68	8.06	7.87	0.170
Specific conductance	4	283	358	319	33.7
Temperature, water	4	2.6	16.9	8.3	6.1

Table B-18: Water quality analyte descriptive statistics at Station 2 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	65	87	75.3	9.0
Bicarbonate as HCO3, Total	4	79	110	92.5	12.9
Calcium, Dissolved	4	10	11.0	10.3	0.50
Chloride, Total	4	17	34.0	24.8	6.99
Magnesium, Dissolved	4	2	2.0	2.0	0.0
Potassium, Dissolved	4	4	6.0	4.80	0.96
Sodium, Dissolved	4	31.0	57.0	41.5	11.27
Sulfate, Total	4	7.0	10.0	8.5	1.29
Dissolved Solids, Total	4	153	238	188.5	36.15
Suspended Solids Total	4	5.0	5.0	5.0	0.0
Turbidity	4	0.66	1.68	1.14	0.470
Arsenic, Total	4	0.088	0.166	0.119	0.03
Nitrate Nitrite, Total	4	0.01	0.05	0.028	0.02
Nitrogen, Total	4	0.15	0.19	0.163	0.02
Phosphorus, Total	4	0.013	0.021	0.016	0.004
Dissolved Oxygen (DO)	4	7.348	9.40	8.444	1.02
Dissolved Oxygen Saturation	4	84.8	94.2	89.201	4.69
pH, field	4	7.27	8.05	7.54	0.344
Specific conductance	4	211	323	259	47.20
Temperature, water	4	2.3	16.2	8.1	5.95

Table B-19: Water quality analyte descriptive statistics at Station 2 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	69.0	87.0	78.3	7.46
Bicarbonate as HCO3, Total	4	83.0	110.0	96.3	11.15
Calcium, Dissolved	4	10.0	10.0	10.0	0.00
Chloride, Total	4	20.0	34.0	26.5	5.80
Magnesium, Dissolved	4	2.0	2.0	2.0	0.00
Potassium, Dissolved	4	4.0	6.0	4.8	0.96
Sodium, Dissolved	4	33.0	51.0	41.8	7.46
Sulfate, Total	4	8.0	11.0	9.5	1.29
Dissolved Solids, Total	4	164.0	210.0	190.3	21.70
Suspended Solids Total	4	5.0	5.0	5.0	0.00
Turbidity	4	0.7	1.6	1.0	0.41
Arsenic, Total	4	0.090	0.147	0.122	0.0236
Nitrate Nitrite, Total	4	0.005	0.030	0.019	0.0103
Nitrogen, Total	4	0.120	0.170	0.148	0.0222
Phosphorus, Total	4	0.019	0.026	0.023	0.0032
Dissolved Oxygen (DO)	4	8.3	10.8	10.1	1.17
Dissolved Oxygen Saturation	4	101	108	104	3.05
pH, field	4	7.6	8.2	7.8	0.31
Specific conductance	4	212	301	250	37.39
Temperature, water	4	2.6	16.4	6.9	6.51

Table B-20: Water quality analyte descriptive statistics at Station 2 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	74.0	91.0	80.3	8.10
Bicarbonate as HCO3, Total	4	90.0	110.0	97.3	9.50
Calcium, Dissolved	4	10.0	11.0	10.5	0.58
Chloride, Total	4	21.0	34.0	26.5	5.57
Magnesium, Dissolved	4	2.0	3.0	2.3	0.50
Potassium, Dissolved	4	4.0	6.0	4.8	0.96
Sodium, Dissolved	4	35.0	56.0	42.3	9.50
Sulfate, Total	4	8.0	11.0	9.8	1.26
Dissolved Solids, Total	4	170.0	237.0	193.5	29.69
Suspended Solids Total	4	5.0	5.0	5.0	0.00
Turbidity	4	0.6	2.0	1.5	0.61
Arsenic, Total	4	0.102	0.164	0.124	0.028
Nitrate Nitrite, Total	4	0.005	0.040	0.014	0.018
Nitrogen, Total	4	0.110	0.170	0.145	0.025
Phosphorus, Total	4	0.012	0.018	0.015	0.003
Dissolved Oxygen (DO)	4	7.9	11.1	9.8	1.5
Dissolved Oxygen Saturation	4	102	107	104	2.20
pH, field	4	6.8	8.5	7.9	0.77
Specific conductance	4	211	315	253	44.27
Temperature, water	4	2.6	19.2	8.6	7.57

Table B-21: Water quality analyte descriptive statistics at Station 3 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	12	64.0	108.0	86.8	13.08
Bicarbonate as HCO3, Total	12	78.0	132.0	105.8	16.04
Calcium, Total	12	14.0	16.0	15.2	0.72
Chloride, Total	12	8.0	34.0	20.3	8.98
Magnesium, Dissolved	12	3.0	4.0	3.9	0.29
Potassium, Total	12	2.0	6.0	4.0	1.21
Sodium, Dissolved	12	15.0	52.0	33.1	12.16
Sulfate, Total	12	8.0	12.0	9.7	1.37
Dissolved Solids, Total	12	135.0	237.0	179.4	41.99
Suspended Solids Total	12	5.0	39.0	8.9	10.18
Turbidity	12	1.1	24.3	4.9	7.55
Arsenic, Total	12	0.0	0.1	0.1	0.04
Cadmium, Total	12	0.000	0.000	0.000	0.000
Copper, Total	12	0.001	0.005	0.002	0.001
Iron, Total	12	0.050	1.240	0.240	0.372
Lead, Total	12	0.001	0.003	0.001	0.001
Manganese, Total	12	0.010	0.090	0.022	0.028
Zinc, Total	12	0.005	0.005	0.005	0.000
Nitrate Nitrite, Dissolved	12	0.020	0.130	0.068	0.042
Nitrogen, Total	12	0.050	0.600	0.238	0.182
Phosphorus, Total	12	0.015	0.065	0.028	0.018
Dissolved Oxygen (DO)	6	7.5	10.5	8.9	1.22
Dissolved Oxygen Saturation	6	87	93	90	2.25
pH, field	12	7.6	8.4	8.2	0.25
Specific conductance	12	170	328	252	56.27
Temperature, water	12	0.0	16.8	6.2	5.46

Table B-22: Water quality analyte descriptive statistics at Station 3 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	78.0	93.0	85.0	7.62
Bicarbonate as HCO3, Total	4	95.0	113.0	103.5	9.33
Calcium, Total	4	15.0	17.0	15.5	1.00
Chloride, Total	4	13.0	25.0	18.3	5.38
Magnesium, Dissolved	4	4.0	4.0	4.0	0.00
Potassium, Total	4	3.0	4.0	3.8	0.50
Sodium, Dissolved	4	21.0	40.0	30.3	8.42
Sulfate, Total	4	9.0	11.0	10.3	0.96
Dissolved Solids, Total	4	144.0	184.0	159.5	17.62
Suspended Solids Total	4	5.0	47.0	15.5	21.00
Turbidity	4	1.0	23.4	7.0	10.97
Arsenic, Total	4	0.055	0.106	0.081	0.023
Nitrate Nitrite, Total	4	0.010	0.060	0.028	0.024
Nitrogen, Total	4	0.110	0.150	0.128	0.017
Phosphorus, Total	4	0.018	0.080	0.035	0.030
Dissolved Oxygen (DO)	4	7.6	11.7	9.5	1.76
Dissolved Oxygen Saturation	4	89	103	93	6.43
pH, field	4	7.9	8.3	8.1	0.15
Specific conductance	4	211	264	237	23.12
Temperature, water	4	2.5	15.3	7.3	6.06

Table B-23: Water quality analyte descriptive statistics at Station 3 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	86.0	93.0	90.0	3.16
Bicarbonate as HCO3, Total	4	105.0	113.0	109.8	3.95
Calcium, Total	4	15.0	17.0	16.0	0.82
Chloride, Total	4	19.0	28.0	23.5	3.70
Magnesium, Dissolved	4	4.0	5.0	4.3	0.50
Potassium, Total	4	4.0	5.0	4.3	0.50
Sodium, Dissolved	4	31.0	40.0	36.0	3.74
Sulfate, Total	4	10.0	11.0	10.3	0.50
Dissolved Solids, Total	4	161.0	193.0	179.5	15.26
Suspended Solids Total	4	5.0	29.0	11.0	12.00
Turbidity	4	1.3	19.4	6.2	8.83
Arsenic, Total	4	0.080	0.118	0.099	0.016
Nitrate Nitrite, Total	4	0.005	0.080	0.046	0.039
Nitrogen, Total	4	0.050	0.210	0.133	0.071
Phosphorus, Total	4	0.025	0.087	0.042	0.030
Dissolved Oxygen (DO)	4	7.6	10.2	9.0	1.15
Dissolved Oxygen Saturation	4	85	90	88	2.28
pH, field	4	7.6	8.5	8.1	0.40
Specific conductance	4	252	286	271	14.05
Temperature, water	4	0.1	15.2	6.8	6.63

Table B-24: Water quality analyte descriptive statistics at Station 3 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	82.0	99.0	90.5	7.047
Bicarbonate as HCO3, Total	4	99.0	121.0	110.3	9.069
Calcium, Total	4	15.0	16.0	15.3	0.500
Chloride, Total	4	17.0	28.0	21.8	4.856
Magnesium, Dissolved	4	4.0	4.0	4.0	0.000
Potassium, Total	4	4.0	5.0	4.5	0.577
Sodium, Dissolved	4	30.0	46.0	37.8	7.136
Sulfate, Total	4	8.0	11.0	9.5	1.732
Dissolved Solids, Total	4	149.0	182.0	165.5	14.480
Suspended Solids Total	4	5.0	17.0	8.0	6.000
Arsenic, Total	4	0.080	0.116	0.097	0.015
Nitrate Nitrite, Total	4	0.005	0.100	0.044	0.042
Nitrogen, Total	4	0.050	0.700	0.263	0.298
Phosphorus, Total	4	0.023	0.065	0.037	0.019
Dissolved Oxygen (DO)	4	7.0	10.5	9.1	1.56
Dissolved Oxygen Saturation	4	85	89	87	1.50
pH, field	4	7.7	8.3	8.1	0.26
Specific conductance	4	238	307	272	28.75
Temperature, water	4	0.0	16.0	6.0	7.34

Table B-25: Water quality analyte descriptive statistics at Station 3 in 2015.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	83.0	99.0	92.3	6.70
Bicarbonate as HCO3, Total	4	101.0	120.0	112.5	8.10
Calcium, Dissolved	4	15.0	20.0	16.5	2.38
Chloride, Total	4	16.0	24.0	21.0	3.83
Magnesium, Dissolved	4	4.0	5.0	4.3	0.50
Potassium, Dissolved	4	3.0	5.0	4.0	0.82
Sodium, Dissolved	4	26.0	45.0	36.0	8.04
Sulfate, Total	4	9.0	12.0	10.5	1.29
Dissolved Solids, Total	4	146.0	214.0	178.8	28.65
Suspended Solids Total	4	5.0	5.0	5.0	0.00
Turbidity	4	1.4	9.1	3.8	3.56
Arsenic, Total	4	0.063	0.118	0.094	0.024
Nitrate Nitrite, Total	4	0.005	0.090	0.039	0.037
Nitrogen, Total	4	0.130	0.220	0.178	0.038
Phosphorus, Total	4	0.012	0.029	0.022	0.007
Dissolved Oxygen (DO)	4	7.7	10.9	9.5	1.46
Dissolved Oxygen Saturation	4	88	90	89	1.19
pH, field	4	7.8	8.5	8.1	0.31
Specific conductance	4	246	299	272	22.49
Temperature, water	4	0.2	13.9	5.4	6.45

Table B-26: Water quality analyte descriptive statistics at Station 3 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	95.0	105.0	98.3	4.57
Bicarbonate as HCO3, Total	4	115.0	125.0	118.8	4.35
Calcium, Dissolved	4	16.0	20.0	18.0	1.83
Chloride, Total	4	17.0	32.0	23.0	6.38
Magnesium, Dissolved	4	4.0	5.0	4.5	0.58
Potassium, Dissolved	4	3.0	5.0	4.0	0.82
Sodium, Dissolved	4	27.0	47.0	35.8	8.30
Sulfate, Total	4	9.0	12.0	10.3	1.50
Dissolved Solids, Total	4	170.0	212.0	184.5	18.79
Suspended Solids Total	4	5.0	12.0	6.8	3.50
Turbidity	4	1.7	12.8	4.9	5.31
Arsenic, Total	4	0.075	0.133	0.097	0.025
Nitrate Nitrite, Total	4	0.005	0.060	0.020	0.027
Nitrogen, Total	4	0.080	0.250	0.145	0.073
Phosphorus, Total	4	0.015	0.044	0.023	0.014
Dissolved Oxygen (DO)	4	7.5	10.4	9.0	1.18
Dissolved Oxygen Saturation	4	89	94	92	2.06
pH, field	4	8.0	8.4	8.2	0.18
Specific conductance	4	246	323	278	31.99
Temperature, water	4	3.2	16.1	8.5	5.49

Table B-27: Water quality analyte descriptive statistics at Station 3 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	81.0	110.0	90.5	13.33
Bicarbonate as HCO3, Total	4	98.0	130.0	109.5	14.64
Calcium, Dissolved	4	15.0	18.0	16.8	1.50
Chloride, Total	4	16.0	29.0	20.0	6.16
Magnesium, Dissolved	4	4.0	5.0	4.8	0.50
Potassium, Dissolved	4	3.0	5.0	4.0	0.82
Sodium, Dissolved	4	28.0	46.0	33.8	8.26
Sulfate, Total	4	9.0	12.0	10.0	1.41
Dissolved Solids, Total	4	162.0	216.0	182.3	23.67
Suspended Solids Total	4	5.0	22.0	9.3	8.50
Turbidity	4	1.2	21.8	6.7	10.11
Arsenic, Total	4	0.070	0.120	0.087	0.023
Nitrate Nitrite, Total	4	0.005	0.060	0.030	0.029
Nitrogen, Total	4	0.100	0.170	0.138	0.033
Phosphorus, Total	4	0.010	0.046	0.022	0.017
Dissolved Oxygen (DO)	4	7.4	9.7	8.7	1.07
Dissolved Oxygen Saturation	4	87	89	88	1.33
pH, field	4	7.4	8.2	7.9	0.37
Specific conductance	4	234	317	260	38.72
Temperature, water	4	3.2	15.0	7.6	5.28

Table B-28: Water quality analyte descriptive statistics at Station 3 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	76.0	97.0	84.5	9.33
Bicarbonate as HCO3, Total	4	92.0	120.0	102.0	12.44
Calcium, Dissolved	4	15.0	17.0	15.5	1.00
Chloride, Total	4	12.0	30.0	18.3	8.26
Magnesium, Dissolved	4	4.0	4.0	4.0	0.00
Potassium, Dissolved	4	3.0	6.0	4.0	1.41
Sodium, Dissolved	4	23.0	51.0	32.0	13.04
Sulfate, Total	4	8.0	12.0	9.8	1.71
Dissolved Solids, Total	4	152.0	235.0	176.3	39.72
Suspended Solids Total	4	5.0	29.0	11.0	12.00
Turbidity	4	1.8	20.3	6.5	9.21
Arsenic, Total	4	0.056	0.141	0.086	0.039
Nitrate Nitrite, Total	4	0.020	0.050	0.030	0.014
Nitrogen, Total	4	0.140	0.220	0.175	0.033
Phosphorus, Total	4	0.015	0.053	0.026	0.018
Dissolved Oxygen (DO)	4	8.4	11.5	9.7	1.53
Dissolved Oxygen Saturation	4	87	94	90	4.06
pH, field	4	7.6	8.0	7.8	0.21
Specific conductance	4	211	335	251	57.32
Temperature, water	4	0.0	12.0	5.2	6.04

Table B-29: Water quality analyte descriptive statistics at Station 3 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	78.0	99.0	86.8	9.14
Bicarbonate as HCO3, Total	4	95.0	120.0	106.3	11.09
Calcium, Dissolved	4	14.0	18.0	16.0	1.63
Chloride, Total	4	12.0	28.0	18.8	6.80
Magnesium, Dissolved	4	4.0	4.0	4.0	0.00
Potassium, Dissolved	4	3.0	5.0	4.0	0.82
Sodium, Dissolved	4	23.0	43.0	31.3	8.50
Sulfate, Total	4	9.0	12.0	10.8	1.50
Dissolved Solids, Total	4	156.0	199.0	169.5	20.34
Suspended Solids Total	4	5.0	5.0	5.0	0.00
Turbidity	4	1.3	8.7	3.9	3.35
Arsenic, Total	4	0.058	0.120	0.083	0.027
Nitrate Nitrite, Total	4	0.010	0.040	0.020	0.014
Nitrogen, Total	4	0.110	0.230	0.160	0.053
Phosphorus, Total	4	0.017	0.029	0.022	0.005
Dissolved Oxygen (DO)	4	8.8	12.6	10.9	1.55
Dissolved Oxygen Saturation	4	103	108	105	2.30
pH, field	4	7.9	8.7	8.2	0.34
Specific conductance	4	195	290	236	39.96
Temperature, water	4	-0.1	15.7	6.4	6.72

Table B-30: Water quality analyte descriptive statistics at Station 3 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	83.0	99.0	91.3	6.55
Bicarbonate as HCO3, Total	4	96.0	120.0	109.0	9.87
Calcium, Dissolved	4	15.0	17.0	16.3	0.96
Chloride, Total	4	16.0	26.0	20.3	4.19
Magnesium, Dissolved	4	4.0	4.0	4.0	0.00
Potassium, Dissolved	4	4.0	5.0	4.3	0.50
Sodium, Dissolved	4	28.0	43.0	33.3	6.70
Sulfate, Total	4	10.0	14.0	11.8	1.71
Dissolved Solids, Total	4	163.0	216.0	183.8	25.36
Suspended Solids Total	4	5.0	78.0	23.3	36.50
Turbidity	4	1.5	62.8	17.2	30.39
Arsenic, Total	4	0.076	0.122	0.093	0.020
Nitrate Nitrite, Total	4	0.005	0.050	0.025	0.023
Nitrogen, Total	4	0.130	0.370	0.203	0.112
Phosphorus, Total	4	0.010	0.120	0.038	0.055
Dissolved Oxygen (DO)	4	9.2	12.3	10.8	1.48
Dissolved Oxygen Saturation	4	101	112	106	4.89
pH, field	4	5.4	8.5	7.6	1.48
Specific conductance	4	234	279	249	21.06
Temperature, water	4	0.0	16.4	7.2	7.11

Table B-31: Water quality analyte descriptive statistics at Station 4 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	12	73.0	122.0	100.9	13.61
Bicarbonate as HCO3, Total	12	89.0	147.0	122.8	16.37
Calcium, Total	12	18.0	23.0	20.3	1.48
Chloride, Total	12	7.0	28.0	18.2	7.78
Magnesium, Dissolved	12	4.0	6.0	5.3	0.78
Potassium, Total	12	2.0	5.0	3.8	1.03
Sodium, Dissolved	12	14.0	44.0	30.1	10.26
Sulfate, Total	12	9.0	15.0	12.9	2.19
Dissolved Solids, Total	12	123.0	238.0	184.5	38.94
Suspended Solids Total	12	5.0	22.0	6.9	5.05
Turbidity	12	2.2	14.2	6.5	4.19
Arsenic, Total	12	0.035	0.119	0.075	0.030
Cadmium, Total	12	0.000	0.000	0.000	0.000
Copper, Total	12	0.001	0.002	0.001	0.001
Iron, Total	12	0.120	0.490	0.249	0.134
Lead, Total	12	0.001	0.001	0.001	0.000
Manganese, Total	12	0.010	0.060	0.036	0.012
Zinc, Total	12	0.005	0.005	0.005	0.000
Nitrate Nitrite, Dissolved	12	0.005	0.130	0.050	0.046
Nitrogen, Total	12	0.100	0.500	0.250	0.109
Phosphorus, Total	12	0.021	0.048	0.028	0.007
Dissolved Oxygen (DO)	6	6.8	10.9	8.6	1.84
Dissolved Oxygen Saturation	6	84	97	89	5.08
pH, field	12	7.8	8.7	8.3	0.31
Specific conductance	12	185	353	275	53.23
Temperature, water	12	0.5	20.5	8.5	7.35

Table B-32: Water quality analyte descriptive statistics at Station 4 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	95.0	110.0	101.5	6.24
Bicarbonate as HCO3, Total	4	113.0	134.0	121.3	9.29
Calcium, Total	4	19.0	22.0	20.0	1.41
Chloride, Total	4	14.0	21.0	16.5	3.11
Magnesium, Dissolved	4	5.0	6.0	5.5	0.58
Potassium, Total	4	3.0	4.0	3.5	0.58
Sodium, Dissolved	4	25.0	36.0	29.0	4.97
Sulfate, Total	4	12.0	14.0	13.0	1.15
Dissolved Solids, Total	4	162.0	191.0	172.3	13.72
Suspended Solids Total	4	5.0	5.0	5.0	0.00
Turbidity	4	1.5	5.3	3.0	1.71
Arsenic, Total	4	0.061	0.087	0.071	0.011
Nitrate Nitrite, Total	4	0.005	0.060	0.023	0.026
Nitrogen, Total	4	0.090	0.190	0.148	0.042
Phosphorus, Total	4	0.019	0.030	0.026	0.005
Dissolved Oxygen (DO)	4	6.7	11.7	9.4	2.34
Dissolved Oxygen Saturation	4	90	99	95	4.34
pH, field	4	7.6	8.4	8.1	0.36
Specific conductance	4	254	273	265	8.52
Temperature, water	4	1.0	21.2	9.7	10.11

Table B-33: Water quality analyte descriptive statistics at Station 4 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	92.0	108.0	102.0	6.98
Bicarbonate as HCO3, Total	4	103.0	131.0	120.3	12.04
Calcium, Total	4	17.0	23.0	20.5	2.52
Chloride, Total	4	17.0	24.0	20.5	3.11
Magnesium, Dissolved	4	5.0	7.0	6.0	0.82
Potassium, Total	4	4.0	4.0	4.0	0.00
Sodium, Dissolved	4	30.0	35.0	32.8	2.06
Sulfate, Total	4	12.0	16.0	13.8	1.71
Dissolved Solids, Total	4	155.0	197.0	182.5	18.79
Suspended Solids Total	4	5.0	20.0	8.8	7.50
Arsenic, Total	4	0.073	0.094	0.088	0.010
Turbidity	4	1.8	14.1	6.1	5.5
Nitrate Nitrite, Total	4	0.005	0.080	0.034	0.033
Nitrogen, Total	4	0.150	0.300	0.200	0.068
Phosphorus, Total	4	0.020	0.044	0.036	0.011
Dissolved Oxygen (DO)	4	6.0	10.9	8.3	2.28
Dissolved Oxygen Saturation	4	77	92	84	6.22
pH, field	4	7.5	8.9	8.1	0.66
Specific conductance	4	267	310	292	17.70
Temperature, water	4	1.2	19.7	9.9	9.68

Table B-34: Water quality analyte descriptive statistics at Station 4 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	90.0	115.0	104.0	10.74
Bicarbonate as HCO3, Total	4	92.0	140.0	122.5	21.24
Calcium, Total	4	18.0	22.0	20.3	2.06
Chloride, Total	4	15.0	25.0	20.0	5.23
Magnesium, Dissolved	4	5.0	6.0	5.5	0.58
Potassium, Total	4	4.0	5.0	4.5	0.58
Sodium, Dissolved	4	27.0	42.0	34.8	7.37
Sulfate, Total	4	10.0	16.0	12.8	2.75
Dissolved Solids, Total	4	145.0	211.0	188.8	30.66
Suspended Solids Total	4	5.0	12.0	8.3	3.77
Turbidity	4	2.1	13.1	6.4	4.94
Arsenic, Total	4	0.068	0.108	0.087	0.018
Nitrate Nitrite, Total	4	0.005	0.080	0.034	0.034
Nitrogen, Total	4	0.050	0.700	0.313	0.278
Phosphorus, Total	4	0.031	0.049	0.037	0.008
Dissolved Oxygen (DO)	4	7.0	9.7	8.3	1.32
Dissolved Oxygen Saturation	4	77	95	84	7.97
pH, field	4	6.8	8.7	7.8	0.96
Specific conductance	4	254	328	295	31.45
Temperature, water	4	0.5	21.8	9.3	10.21

Table B-35: Water quality analyte descriptive statistics at Station 4 in 2015.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	92.0	107.0	101.3	6.65
Bicarbonate as HCO3, Total	4	113.0	130.0	123.8	7.59
Calcium, Dissolved	4	20.0	23.0	21.8	1.26
Chloride, Total	4	12.0	20.0	16.8	3.40
Magnesium, Dissolved	4	6.0	6.0	6.0	0.00
Potassium, Dissolved	4	3.0	4.0	3.8	0.50
Sodium, Dissolved	4	22.0	36.0	30.8	6.40
Sulfate, Total	4	11.0	15.0	13.5	1.91
Dissolved Solids, Total	4	160.0	191.0	179.0	14.02
Suspended Solids Total	4	5.0	20.0	8.8	7.50
Turbidity	4	3.1	14.1	8.0	4.68
Arsenic, Total	4	0.054	0.082	0.073	0.013
Nitrate Nitrite, Total	4	0.005	0.040	0.019	0.015
Nitrogen, Total	4	0.120	0.250	0.198	0.055
Phosphorus, Total	4	0.021	0.033	0.028	0.005
Dissolved Oxygen (DO)	4	5.91	9.86	8.14	1.85
Dissolved Oxygen Saturation	4	75	83	79	3.39
pH, field	4	8.0	8.6	8.3	0.26
Specific conductance	4	256	296	282	17.90
Temperature, water	4	1.0	19.1	8.0	8.57

Table B-36: Water quality analyte descriptive statistics at Station 4 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	102.0	114.0	107.3	5.737
Bicarbonate as HCO3, Total	4	125.0	139.0	131.0	6.683
Calcium, Dissolved	4	20.0	25.0	22.5	2.380
Chloride, Total	4	15.0	25.0	19.0	4.320
Magnesium, Dissolved	4	5.0	7.0	6.0	0.816
Potassium, Dissolved	4	3.0	4.0	3.8	0.500
Sodium, Dissolved	4	27.0	38.0	30.8	5.188
Sulfate, Total	4	11.0	15.0	12.8	2.062
Dissolved Solids, Total	4	172.0	202.0	183.3	13.048
Suspended Solids Total	4	5.0	5.0	5.0	0.000
Turbidity	4	2.7	9.7	5.7	2.93
Arsenic, Total	4	0.054	0.094	0.076	0.019
Nitrate Nitrite, Total	4	0.005	0.040	0.014	0.018
Nitrogen, Total	4	0.140	0.290	0.205	0.066
Phosphorus, Total	4	0.011	0.041	0.025	0.013
Dissolved Oxygen (DO)	4	5.9	10.0	8.1	1.68
Dissolved Oxygen Saturation	4	77	87	82	4.10
pH, field	4	7.9	8.3	8.1	0.14
Specific conductance	4	265	315	289	20.41
Temperature, water	4	2.1	19.2	9.5	7.21

Table B-37: Water quality analyte descriptive statistics at Station 4 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	93.0	110.0	98.5	7.77
Bicarbonate as HCO3, Total	4	110.0	130.0	117.5	9.57
Calcium, Dissolved	4	20.0	23.0	20.8	1.50
Chloride, Total	4	14.0	23.0	17.8	3.77
Magnesium, Dissolved	4	5.0	6.0	5.5	0.58
Potassium, Dissolved	4	4.0	4.0	4.0	0.00
Sodium, Dissolved	4	27.0	36.0	30.3	3.95
Sulfate, Total	4	10.0	14.0	12.3	1.71
Dissolved Solids, Total	4	174.0	201.0	186.3	12.15
Suspended Solids Total	4	5.0	13.0	7.0	4.00
Turbidity	4	2.9	16.2	7.4	5.96
Arsenic, Total	4	0.070	0.088	0.075	0.009
Nitrate Nitrite, Total	4	0.005	0.090	0.036	0.037
Nitrogen, Total	4	0.130	0.220	0.185	0.040
Phosphorus, Total	4	0.014	0.035	0.022	0.009
Dissolved Oxygen (DO)	4	6.6	9.7	8.3	1.46
Dissolved Oxygen Saturation	4	81	86	83	2.48
pH, field	4	7.6	8.5	8.1	0.40
Specific conductance	4	257	307	273	23.04
Temperature, water	4	2.5	20.1	9.1	8.12

Table B-38: Water quality analyte descriptive statistics at Station 4 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	90.0	100.0	96.0	4.90
Bicarbonate as HCO3, Total	4	110.0	130.0	117.5	9.57
Calcium, Dissolved	4	20.0	21.0	20.8	0.50
Chloride, Total	4	12.0	24.0	16.3	5.32
Magnesium, Dissolved	4	5.0	6.0	5.5	0.58
Potassium, Dissolved	4	3.0	5.0	3.8	0.96
Sodium, Dissolved	4	24.0	41.0	29.3	7.93
Sulfate, Total	4	10.0	15.0	13.0	2.45
Dissolved Solids, Total	4	170.0	222.0	184.5	25.16
Suspended Solids Total	4	5.0	11.0	6.5	3.00
Turbidity	4	2.0	8.0	5.2	3.01
Arsenic, Total	4	0.060	0.105	0.072	0.022
Nitrate Nitrite, Total	4	0.005	0.040	0.019	0.015
Nitrogen, Total	4	0.160	0.350	0.213	0.092
Phosphorus, Total	4	0.010	0.032	0.019	0.009
Dissolved Oxygen (DO)	4	7.2	10.9	8.8	1.92
Dissolved Oxygen Saturation	4	84	89	86	2.67
pH, field	4	7.8	8.2	8.0	0.18
Specific conductance	4	252	316	271	30.82
Temperature, water	4	0.6	17.3	8.3	8.59

Table B-39: Water quality analyte descriptive statistics at Station 4 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	90.0	110.0	97.0	9.45
Bicarbonate as HCO3, Total	4	110.0	140.0	120.0	14.14
Calcium, Dissolved	4	18.0	23.0	20.5	2.08
Chloride, Total	4	13.0	22.0	16.3	4.03
Magnesium, Dissolved	4	5.0	6.0	5.5	0.58
Potassium, Dissolved	4	3.0	4.0	3.3	0.50
Sodium, Dissolved	4	23.0	35.0	27.3	5.32
Sulfate, Total	4	11.0	17.0	13.8	2.75
Dissolved Solids, Total	4	168.0	200.0	177.5	15.26
Suspended Solids Total	4	5.0	5.0	5.0	0.00
Turbidity	4	1.9	10.4	4.6	3.89
Arsenic, Total	4	0.058	0.085	0.070	0.011
Nitrate Nitrite, Total	4	0.005	0.070	0.025	0.031
Nitrogen, Total	4	0.130	0.220	0.178	0.038
Phosphorus, Total	4	0.019	0.032	0.025	0.006
Dissolved Oxygen (DO)	4	8.2	11.5	10.2	1.43
Dissolved Oxygen Saturation	4	89	107	100	7.79
pH, field	4	7.7	8.4	8.2	0.31
Specific conductance	4	224	306	257	35.27
Temperature, water	4	0.1	20.1	7.7	8.90

Table B-40: Water quality analyte descriptive statistics at Station 4 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as CaCO3, Total	4	92.0	110.0	103.0	8.72
Bicarbonate as HCO3, Total	4	110.0	130.0	122.5	9.57
Calcium, Dissolved	4	18.0	23.0	20.8	2.06
Chloride, Total	4	14.0	21.0	18.3	3.10
Magnesium, Dissolved	4	5.0	7.0	5.8	0.96
Potassium, Dissolved	4	3.0	4.0	3.8	0.50
Sodium, Dissolved	4	26.0	36.0	30.8	4.27
Sulfate, Total	4	13.0	17.0	15.0	1.83
Dissolved Solids, Total	4	171.0	213.0	194.0	17.61
Suspended Solids Total	4	5.0	5.0	5.0	0.00
Turbidity	4	1.8	6.1	3.7	1.97
Arsenic, Total	4	0.065	0.093	0.078	0.012
Nitrate Nitrite, Total	4	0.005	0.050	0.023	0.022
Nitrogen, Total	4	0.140	0.210	0.175	0.031
Phosphorus, Total	4	0.008	0.018	0.014	0.004
Dissolved Oxygen (DO)	4	8.2	12.3	10.3	1.94
Dissolved Oxygen Saturation	4	100	107	103	3.19
pH, field	4	7.6	8.6	8.2	0.45
Specific conductance	4	256	293	274	15.94
Temperature, water	4	0.8	20.4	9.0	9.26

Table B-41: Water quality analyte descriptive statistics at Station 5 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	12	91.0	146	128	21.6
Bicarbonate as HCO_3, Total (mg/L)	12	111	177	154	25.3
Calcium, Total (mg/L)	12	25.0	41.0	35.1	6.3
Chloride, Total (mg/L)	12	5.0	14.0	10.0	3.1
Magnesium, Dissolved (mg/L)	12	6.0	13.0	10.5	2.4
Potassium, Total (mg/L)	12	2.0	4.0	3.7	0.7
Sodium, Dissolved (mg/L)	12	9.0	24.0	17.8	5.0
Sulfate, Total (mg/L)	12	17.0	39.0	31.4	8.4
Dissolved Solids, Total (mg/L)	12	134	274	211	40.9
Suspended Solids, Total (mg/L)	12	5.0	215.0	41.7	59.1
Turbidity (NTU)	12	4.3	105.7	20.7	28.5
Arsenic, Total (mg/L)	12	0.013	0.038	0.026	0.008
Cadmium, Total (mg/L)	12	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	12	0.002	0.012	0.004	0.003
Iron, Total (mg/L)	12	0.190	5.020	0.948	1.392
Lead, Total (mg/L)	12	0.001	0.016	0.003	0.004
Manganese, Total (mg/L)	12	0.030	0.210	0.057	0.052
Zinc, Total (mg/L)	12	0.005	0.040	0.008	0.010
Nitrate Nitrite, Dissolved (mg/L)	12	0.020	0.330	0.138	0.104
Nitrogen, Total (mg/L)	12	0.200	0.600	0.408	0.124
Phosphorus, Total (mg/L)	12	0.014	0.273	0.065	0.073
Dissolved Oxygen (mg/L)	6	7.1	11.1	8.9	1.7
Dissolved Oxygen (% Sat)	6	83.8	91.6	88.1	2.8
pH (s.u.)	12	7.81	8.68	8.22	0.31
Specific Conductance (µS/cm)	12	220	381	324	61.5
Temperature, Water (°C)	12	-0.1	19.8	8.1	7.6

Table B-42: Water quality analyte descriptive statistics at Station 5 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	93.0	147	127	23.8
Bicarbonate as HCO_3, Total (mg/L)	4	114	174	151	27.6
Calcium, Total (mg/L)	4	25.0	41.0	34.0	7.8
Chloride, Total (mg/L)	4	7.0	13.0	11.0	2.7
Magnesium, Dissolved (mg/L)	4	8.0	12.0	10.5	1.9
Potassium, Total (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	14.0	24.0	20.3	4.3
Sulfate, Total (mg/L)	4	19.0	37.0	29.3	9.2
Dissolved Solids, Total (mg/L)	4	151	242	199	39.9
Suspended Solids, Total (mg/L)	4	5.0	37.0	14.8	15.2
Turbidity (NTU)	4	6.2	21.4	10.7	7.2
Arsenic, Total (mg/L)	4	0.021	0.047	0.035	0.011
Nitrate Nitrite, Total (mg/L)	4	0.010	0.220	0.110	0.106
Nitrogen, Total (mg/L)	4	0.210	0.430	0.333	0.098
Phosphorus, Total (mg/L)	4	0.023	0.170	0.061	0.073
Dissolved Oxygen (mg/L)	4	6.0	12.0	8.8	2.8
Dissolved Oxygen (% Sat)	4	76.5	95.5	83.6	8.2
pH (s.u.)	4	7.40	8.54	8.06	0.49
Specific Conductance (µS/cm)	4	242	348	310	47.9
Temperature, Water (°C)	4	0.1	20.3	9.5	10.8

Table B-43: Water quality analyte descriptive statistics at Station 5 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	95.0	140	122	19.6
Bicarbonate as HCO_3, Total (mg/L)	4	116	170	146	22.7
Calcium, Total (mg/L)	4	27.0	43.0	34.3	7.5
Chloride, Total (mg/L)	4	8.0	15.0	12.8	3.3
Magnesium, Dissolved (mg/L)	4	7.0	13.0	10.3	2.8
Potassium, Total (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	15.0	24.0	21.3	4.3
Sulfate, Total (mg/L)	4	17.0	39.0	28.5	9.9
Dissolved Solids, Total (mg/L)	4	158	234	202	32.3
Suspended Solids, Total (mg/L)	4	5.0	44.0	16.3	18.7
Turbidity (NTU)	4	5.2	26.9	11.0	10.6
Arsenic, Total (mg/L)	4	0.027	0.058	0.039	0.014
Nitrate Nitrite, Total (mg/L)	4	0.020	0.170	0.108	0.071
Nitrogen, Total (mg/L)	4	0.230	0.400	0.285	0.080
Phosphorus, Total (mg/L)	4	0.019	0.085	0.041	0.030
Dissolved Oxygen (mg/L)	4	6.1	10.3	8.0	2.1
Dissolved Oxygen (% Sat)	4	72.0	82.7	78.8	4.8
pH (s.u.)	4	8.30	8.98	8.59	0.29
Specific Conductance (µS/cm)	4	254	365	323	49.1
Temperature, Water (°C)	4	0.3	19.2	9.9	9.3

Table B-44: Water quality analyte descriptive statistics at Station 5 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	84.0	152	126	29.5
Bicarbonate as HCO_3, Total (mg/L)	4	103	186	149	36.4
Calcium, Total (mg/L)	4	23.0	42.0	34.8	8.5
Chloride, Total (mg/L)	4	8.0	15.0	12.0	3.2
Magnesium, Dissolved (mg/L)	4	6.0	12.0	10.3	2.9
Potassium, Total (mg/L)	4	3.0	5.0	4.0	0.8
Sodium, Dissolved (mg/L)	4	14.0	26.0	21.0	5.1
Sulfate, Total (mg/L)	4	17.0	39.0	29.3	10.1
Dissolved Solids, Total (mg/L)	4	143	259	198	47.8
Suspended Solids, Total (mg/L)	4	5.0	137.0	39.5	65.1
Turbidity (NTU)	4	3.9	69.8	20.9	32.6
Arsenic, Total (mg/L)	4	0.031	0.037	0.034	0.003
Nitrate Nitrite, Total (mg/L)	4	0.010	0.280	0.145	0.145
Nitrogen, Total (mg/L)	4	0.300	1.100	0.575	0.359
Phosphorus, Total (mg/L)	4	0.019	0.209	0.072	0.092
Dissolved Oxygen (mg/L)	4	6.8	10.1	8.6	1.5
Dissolved Oxygen (% Sat)	4	76.8	89.4	83.4	6.2
pH (s.u.)	4	217	388	325	76.2
Specific Conductance (µS/cm)	4	0.1	20.7	8.7	10.2
Temperature, Water (°C)	4	6.8	10.1	8.6	1.5

Table B-45: Water quality analyte descriptive statistics at Station 5 in 2015.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	93.0	139	122	21.9
Bicarbonate as HCO_3, Total (mg/L)	4	114	170	148	27.0
Calcium, Dissolved (mg/L)	4	28.0	43.0	35.3	6.9
Chloride, Total (mg/L)	4	6.0	13.0	10.8	3.2
Magnesium, Dissolved (mg/L)	4	8.0	13.0	11.0	2.2
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	12.0	23.0	20.0	5.4
Sulfate, Total (mg/L)	4	21.0	37.0	29.5	8.7
Dissolved Solids, Total (mg/L)	4	165	236	212	33.0
Suspended Solids, Total (mg/L)	4	5.0	67.0	23.5	29.1
Turbidity (NTU)	4	5.3	33.5	13.2	13.6
Arsenic, Total (mg/L)	4	0.016	0.049	0.031	0.014
Nitrate Nitrite, Total (mg/L)	4	0.020	0.220	0.115	0.088
Nitrogen, Total (mg/L)	4	0.220	0.460	0.345	0.106
Phosphorus, Total (mg/L)	4	0.018	0.087	0.038	0.033
Dissolved Oxygen (mg/L)	4	6.7	10.1	8.5	1.6
Dissolved Oxygen (% Sat)	4	78.5	80.7	79.4	1.0
pH (s.u.)	4	7.91	8.65	8.27	0.31
Specific Conductance (µS/cm)	4	232	367	322	61.4
Temperature, Water (°C)	4	6.7	10.1	8.5	1.6

Table B-46: Water quality analyte descriptive statistics at Station 5 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	97.0	138	124	19.1
Bicarbonate as HCO_3, Total (mg/L)	4	118	168	151	23.6
Calcium, Dissolved l (mg/L)	4	26.0	39.0	33.0	6.1
Chloride, Total (mg/L)	4	6.0	15.0	11.3	4.1
Magnesium, Dissolved (mg/L)	4	7.0	12.0	10.0	2.2
Potassium, Dissolved (mg/L)	4	2.0	4.0	3.3	1.0
Sodium, Dissolved (mg/L)	4	12.0	26.0	20.0	6.1
Sulfate, Total (mg/L)	4	19.0	37.0	28.0	8.8
Dissolved Solids, Total (mg/L)	4	157	220	196	27.2
Suspended Solids, Total (mg/L)	4	10.0	60.0	26.3	22.9
Turbidity (NTU)	4	6.0	30.3	14.5	10.9
Arsenic, Total (mg/L)	4	0.019	0.057	0.034	0.017
Nitrate Nitrite, Total (mg/L)	4	0.005	0.240	0.099	0.102
Nitrogen, Total (mg/L)	4	0.180	0.520	0.340	0.166
Phosphorus, Total (mg/L)	4	0.022	0.087	0.045	0.030
Dissolved Oxygen (mg/L)	4	6.2	9.1	7.6	1.2
Dissolved Oxygen (% Sat)	4	78.0	79.7	78.7	0.7
pH (s.u.)	4	7.86	8.44	8.17	0.24
Specific Conductance (µS/cm)	4	233	360	318	57.8
Temperature, Water (°C)	4	3.0	20.6	11.3	7.8

Table B-47: Water quality analyte descriptive statistics at Station 5 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	88.0	140	120	22.5
Bicarbonate as HCO_3, Total (mg/L)	4	110	170	145	26.5
Calcium, Dissolved (mg/L)	4	25.0	40.0	34.0	6.7
Chloride, Total (mg/L)	4	7.3	12.0	10.3	2.1
Magnesium, Dissolved (mg/L)	4	7.0	12.0	10.3	2.4
Potassium, Dissolved (mg/L)	4	2.0	4.0	3.0	0.8
Sodium, Dissolved (mg/L)	4	12.0	21.0	18.5	4.4
Sulfate, Total (mg/L)	4	19.0	35.0	27.3	7.9
Dissolved Solids, Total (mg/L)	4	143	222	197	36.7
Suspended Solids, Total (mg/L)	4	5.0	87.0	39.5	41.2
Turbidity (NTU)	4	4.5	41.4	22.1	19.4
Arsenic, Total (mg/L)	4	0.022	0.045	0.031	0.010
Nitrate Nitrite, Total (mg/L)	4	0.030	0.240	0.115	0.093
Nitrogen, Total (mg/L)	4	0.280	0.670	0.420	0.173
Phosphorus, Total (mg/L)	4	0.011	0.091	0.046	0.039
Dissolved Oxygen (mg/L)	4	6.6	9.5	8.3	1.2
Dissolved Oxygen (% Sat)	4	70.9	86.4	80.2	6.6
pH (s.u.)	4	6.86	8.56	7.63	0.79
Specific Conductance (µS/cm)	4	226	357	309	57.1
Temperature, Water (°C)	4	0.3	18.9	8.2	8.3

Table B-48: Water quality analyte descriptive statistics at Station 5 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	85.0	140	124	26.3
Bicarbonate as HCO_3, Total (mg/L)	4	100	170	150	33.7
Calcium, Dissolved (mg/L)	4	24.0	40.0	35.0	7.6
Chloride, Total (mg/L)	4	4.0	15.0	10.3	4.6
Magnesium, Dissolved (mg/L)	4	6.0	12.0	10.0	2.7
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	11.0	27.0	18.8	6.6
Sulfate, Total (mg/L)	4	14.0	39.0	29.3	11.2
Dissolved Solids, Total (mg/L)	4	159	263	217	43.2
Suspended Solids, Total (mg/L)	4	5.0	139.0	38.5	67.0
Turbidity (NTU)	4	1.5	71.8	21.1	33.8
Arsenic, Total (mg/L)	4	0.017	0.046	0.031	0.013
Nitrate Nitrite, Total (mg/L)	4	0.060	0.270	0.155	0.097
Nitrogen, Total (mg/L)	4	0.330	0.550	0.415	0.096
Phosphorus, Total (mg/L)	4	0.011	0.224	0.067	0.105
Dissolved Oxygen (mg/L)	4	8.1	11.3	9.3	1.5
Dissolved Oxygen (% Sat)	4	75.8	94.9	87.8	8.3
pH (s.u.)	4	7.48	8.34	7.73	0.41
Specific Conductance (µS/cm)	4	213	395	327	79.1
Temperature, Water (°C)	4	0.0	15.5	7.5	8.3

Table B-49: Water quality analyte descriptive statistics at Station 5 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	87.0	150	127	27.7
Bicarbonate as HCO_3, Total (mg/L)	4	110	180	153	31.0
Calcium, Dissolved (mg/L)	4	26.0	44.0	35.3	8.6
Chloride, Total (mg/L)	4	5.0	15.0	10.8	4.2
Magnesium, Dissolved (mg/L)	4	7.0	13.0	10.5	2.6
Potassium, Dissolved (mg/L)	4	2.0	4.0	3.3	1.0
Sodium, Dissolved (mg/L)	4	10.0	24.0	18.5	6.2
Sulfate, Total (mg/L)	4	19.0	45.0	33.5	11.5
Dissolved Solids, Total (mg/L)	4	158	279	219	50.1
Suspended Solids, Total (mg/L)	4	5.0	50.0	17.5	21.8
Turbidity (NTU)	4	2.0	23.8	9.0	10.0
Arsenic, Total (mg/L)	4	0.016	0.042	0.030	0.012
Nitrate Nitrite, Total (mg/L)	4	0.030	0.290	0.145	0.115
Nitrogen, Total (mg/L)	4	0.230	0.470	0.350	0.099
Phosphorus, Total (mg/L)	4	0.018	0.075	0.033	0.028
Dissolved Oxygen (mg/L)	4	8.9	11.0	10.4	1.0
Dissolved Oxygen (% Sat)	4	88.4	115.2	101.3	11.7
pH (s.u.)	4	8.07	8.53	8.33	0.19
Specific Conductance (µS/cm)	4	209	405	327	84.6
Temperature, Water (°C)	4	0.1	21.0	8.3	9.1

Table B-50: Water quality analyte descriptive statistics at Station 5 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	96.0	140	124	20.9
Bicarbonate as HCO_3, Total (mg/L)	4	120	170	150	24.5
Calcium, Dissolved (mg/L)	4	25.0	40.0	33.8	6.8
Chloride, Total (mg/L)	4	7.0	14.0	11.3	3.0
Magnesium, Dissolved (mg/L)	4	7.0	12.0	9.8	2.2
Potassium, Dissolved (mg/L)	4	2.0	4.0	3.3	1.0
Sodium, Dissolved (mg/L)	4	15.0	24.0	20.5	4.0
Sulfate, Total (mg/L)	4	19.0	41.0	30.8	10.9
Dissolved Solids, Total (mg/L)	4	164	244	210	39.0
Suspended Solids, Total (mg/L)	4	5.0	129.0	36.0	62.0
Turbidity (NTU)	4	4.8	68.5	21.0	31.6
Arsenic, Total (mg/L)	4	0.025	0.051	0.036	0.013
Nitrate Nitrite, Total (mg/L)	4	0.050	0.220	0.125	0.083
Nitrogen, Total (mg/L)	4	0.280	0.490	0.375	0.087
Phosphorus, Total (mg/L)	4	0.012	0.149	0.047	0.068
Dissolved Oxygen (mg/L)	3	8.2	12.3	10.5	2.1
Dissolved Oxygen (% Sat)	3	93.3	97.6	95.6	2.1
pH (s.u.)	4	7.73	8.56	8.29	0.38
Specific Conductance (µS/cm)	4	220	364	313	65.0
Temperature, Water (°C)	4	0.4	21.3	10.1	9.7

Table B-51: Water quality analyte descriptive statistics at Station 6 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	12	98.0	144	124	14.8
Bicarbonate as HCO_3, Total (mg/L)	12	120	176	150	17.5
Calcium, Total (mg/L)	12	28.0	41.0	34.3	4.1
Chloride, Total (mg/L)	12	5.0	12.0	8.3	2.5
Magnesium, Dissolved (mg/L)	12	8.0	13.0	10.1	1.6
Potassium, Total (mg/L)	12	3.0	4.0	3.4	0.5
Sodium, Dissolved (mg/L)	12	11.0	21.0	15.9	3.3
Sulfate, Total (mg/L)	12	20.0	38.0	28.8	6.2
Dissolved Solids, Total (mg/L)	12	156	241	203	30.3
Suspended Solids Total (mg/L)	12	5.0	5.0	5.0	0.0
Turbidity (NTU)	12	0.9	9.5	3.5	2.8
Arsenic, Total (mg/L)	12	0.017	0.025	0.021	0.002
Cadmium, Total (mg/L)	12	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	12	0.001	0.005	0.003	0.001
Iron, Total (mg/L)	12	0.015	0.400	0.137	0.132
Lead, Total (mg/L)	12	0.001	0.007	0.002	0.002
Manganese, Total (mg/L)	12	0.010	0.070	0.033	0.018
Zinc, Total (mg/L)	12	0.005	0.005	0.005	0.000
Nitrate Nitrite, Dissolved (mg/L)	12	0.120	0.280	0.205	0.046
Nitrogen, Total (mg/L)	12	0.400	0.700	0.467	0.089
Phosphorus, Total (mg/L)	12	0.023	0.055	0.040	0.011
Dissolved Oxygen (mg/L)	6	3.5	9.6	6.0	2.4
Dissolved Oxygen (% Sat)	6	40.9	84.5	61.7	17.3
pH (s.u.)	12	7.48	8.21	7.91	0.25
Specific Conductance (µS/cm)	12	245	363	310	44.2
Temperature, Water (°C)	12	2.6	17.6	8.6	5.5

Table B-52: Water quality analyte descriptive statistics at Station 6 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	123	142	133	7.8
Bicarbonate as HCO_3, Total (mg/L)	4	150	173	161	9.4
Calcium, Total (mg/L)	4	33.0	39.0	36.0	2.6
Chloride, Total (mg/L)	4	8.0	10.0	9.0	0.8
Magnesium, Dissolved (mg/L)	4	10.0	12.0	10.8	1.0
Potassium, Total (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	16.0	19.0	17.5	1.3
Sulfate, Total (mg/L)	4	27.0	34.0	30.5	3.1
Dissolved Solids, Total (mg/L)	4	174	216	193	19.3
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.9	3.0	1.9	1.1
Arsenic, Total (mg/L)	4	0.021	0.026	0.024	0.002
Nitrate Nitrite, Total (mg/L)	4	0.160	0.260	0.210	0.042
Nitrogen, Total (mg/L)	4	0.390	0.580	0.460	0.083
Phosphorus, Total (mg/L)	4	0.020	0.044	0.032	0.012
Dissolved Oxygen (mg/L)	4	3.9	10.4	7.9	2.8
Dissolved Oxygen (% Sat)	4	43.1	85.9	73.4	20.3
pH (s.u.)	4	7.31	8.26	7.91	0.42
Specific Conductance (µS/cm)	4	306	346	319	19.0
Temperature, Water (°C)	4	1.6	14.3	8.0	5.2

Table B-53: Water quality analyte descriptive statistics at Station 6 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	128	133	131	2.2
Bicarbonate as HCO_3, Total (mg/L)	4	151	162	157	5.4
Calcium, Total (mg/L)	4	36.0	40.0	38.0	1.8
Chloride, Total (mg/L)	4	10.0	12.0	11.0	0.8
Magnesium, Dissolved (mg/L)	4	11.0	12.0	11.5	0.6
Potassium, Total (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	19.0	21.0	19.8	1.0
Sulfate, Total (mg/L)	4	28.0	33.0	30.8	2.2
Dissolved Solids, Total (mg/L)	4	179	211	200	14.9
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.3	4.8	2.7	1.7
Arsenic, Total (mg/L)	4	0.023	0.030	0.027	0.003
Nitrate Nitrite, Total (mg/L)	4	0.070	0.230	0.145	0.073
Nitrogen, Total (mg/L)	4	0.210	0.400	0.338	0.088
Phosphorus, Total (mg/L)	4	0.031	0.065	0.046	0.015
Dissolved Oxygen (mg/L)	4	4.1	9.5	7.4	2.4
Dissolved Oxygen (% Sat)	4	44.3	83.3	68.9	17.7
pH (s.u.)	4	7.82	8.36	8.14	0.24
Specific Conductance (µS/cm)	4	322	349	339	12.6
Temperature, Water (°C)	4	2.8	13.1	7.5	4.3

Table B-54: Water quality analyte descriptive statistics at Station 6 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	105	140	123	16.5
Bicarbonate as HCO_3, Total (mg/L)	4	128	171	150	20.1
Calcium, Total (mg/L)	4	30.0	40.0	35.3	4.6
Chloride, Total (mg/L)	4	8.0	12.0	9.8	2.1
Magnesium, Dissolved (mg/L)	4	8.0	12.0	10.3	2.1
Potassium, Total (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	15.0	21.0	18.3	3.2
Sulfate, Total (mg/L)	4	20.0	36.0	28.5	7.7
Dissolved Solids, Total (mg/L)	4	165	214	189	21.0
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.0	7.0	3.1	2.7
Arsenic, Total (mg/L)	4	0.026	0.028	0.027	0.001
Nitrate Nitrite, Total (mg/L)	4	0.060	0.210	0.158	0.068
Nitrogen, Total (mg/L)	4	0.300	0.900	0.475	0.287
Phosphorus, Total (mg/L)	4	0.030	0.050	0.040	0.011
Dissolved Oxygen (mg/L)	4	3.6	8.6	6.9	2.4
Dissolved Oxygen (% Sat)	4	41.4	83.8	65.5	17.8
pH (s.u.)	4	7.50	8.31	7.91	0.35
Specific Conductance (µS/cm)	4	272	355	315	43.0
Temperature, Water (°C)	4	2.3	15.8	8.7	5.5

Table B-55: **Water quality analyte descriptive statistics at Station 6 in 2015.**

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	113	153	132	18.1
Bicarbonate as HCO_3, Total (mg/L)	4	137	187	161	22.1
Calcium, Dissolved (mg/L)	4	33.0	39.0	35.8	3.2
Chloride, Total (mg/L)	4	9.0	11.0	9.8	1.0
Magnesium, Dissolved (mg/L)	4	10.0	12.0	10.8	1.0
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	17.0	21.0	18.8	1.7
Sulfate, Total (mg/L)	4	25.0	34.0	29.0	3.9
Dissolved Solids, Total (mg/L)	4	197	222	205	11.6
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.0	5.8	2.8	2.3
Arsenic, Total (mg/L)	4	0.024	0.027	0.026	0.001
Nitrate Nitrite, Total (mg/L)	4	0.140	0.230	0.198	0.040
Nitrogen, Total (mg/L)	4	0.330	0.400	0.378	0.032
Phosphorus, Total (mg/L)	4	0.019	0.058	0.038	0.016
Dissolved Oxygen (mg/L)	4	3.3	9.2	6.9	2.7
Dissolved Oxygen (% Sat)	4	35.9	82.8	65.1	20.6
pH (s.u.)	4	7.78	8.39	8.00	0.29
Specific Conductance (µS/cm)	4	316	329	320	6.2
Temperature, Water (°C)	4	2.4	13.8	8.6	4.7

Table B-56: Water quality analyte descriptive statistics at Station 6 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	125	142	134	7.9
Bicarbonate as HCO_3, Total (mg/L)	4	153	169	162	8.0
Calcium, Dissolved (mg/L)	4	36.0	39.0	37.0	1.4
Chloride, Total (mg/L)	4	10.0	12.0	10.8	1.0
Magnesium, Dissolved (mg/L)	4	10.0	11.0	10.8	0.5
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	19.0	21.0	19.5	1.0
Sulfate, Total (mg/L)	4	27.0	32.0	29.8	2.6
Dissolved Solids, Total (mg/L)	4	190	239	213	21.4
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.0	6.4	3.0	2.5
Arsenic, Total (mg/L)	4	0.024	0.029	0.026	0.002
Nitrate Nitrite, Total (mg/L)	4	0.040	0.260	0.148	0.090
Nitrogen, Total (mg/L)	4	0.260	0.420	0.318	0.076
Phosphorus, Total (mg/L)	4	0.018	0.041	0.031	0.011
Dissolved Oxygen (mg/L)	4	3.4	8.3	6.5	2.3
Dissolved Oxygen (% Sat)	4	38.5	78.4	62.5	17.2
pH (s.u.)	4	7.49	8.02	7.74	0.22
Specific Conductance (µS/cm)	4	320	355	335	15.4
Temperature, Water (°C)	4	2.5	14.4	8.7	4.9

Table B-57: Water quality analyte descriptive statistics at Station 6 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	110	140	125	12.9
Bicarbonate as HCO_3, Total (mg/L)	4	130	170	153	17.1
Calcium, Dissolved (mg/L)	4	32.0	42.0	36.0	4.5
Chloride, Total (mg/L)	4	8.0	12.0	10.0	1.8
Magnesium, Dissolved (mg/L)	4	8.0	13.0	10.5	2.1
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	15.0	22.0	18.3	3.3
Sulfate, Total (mg/L)	4	21.0	34.0	28.5	6.6
Dissolved Solids, Total (mg/L)	4	183	228	203	18.9
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.1	2.8	2.2	0.7
Arsenic, Total (mg/L)	4	0.025	0.028	0.027	0.001
Nitrate Nitrite, Total (mg/L)	4	0.040	0.270	0.173	0.096
Nitrogen, Total (mg/L)	4	0.220	0.450	0.348	0.096
Phosphorus, Total (mg/L)	4	0.017	0.045	0.034	0.013
Dissolved Oxygen (mg/L)	4	2.9	9.3	7.1	2.9
Dissolved Oxygen (% Sat)	4	33.0	90.3	66.1	24.0
pH (s.u.)	4	7.04	8.41	7.58	0.58
Specific Conductance (µS/cm)	4	281	360	323	37.5
Temperature, Water (°C)	4	2.0	15.6	8.0	5.6

Table B-58: Water quality analyte descriptive statistics at Station 6 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	98.0	130	120	15.1
Bicarbonate as HCO_3, Total (mg/L)	4	120	150	140	14.1
Calcium, Dissolved (mg/L)	4	30.0	39.0	34.0	4.2
Chloride, Total (mg/L)	4	6.0	11.0	8.8	2.2
Magnesium, Dissolved (mg/L)	4	8.0	11.0	9.5	1.3
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	12.0	23.0	17.0	5.0
Sulfate, Total (mg/L)	4	20.0	31.0	27.0	4.8
Dissolved Solids, Total (mg/L)	4	171	226	202	25.5
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.7	3.2	2.0	1.1
Arsenic, Total (mg/L)	4	0.018	0.027	0.024	0.004
Nitrate Nitrite, Total (mg/L)	4	0.160	0.230	0.205	0.031
Nitrogen, Total (mg/L)	4	0.380	0.480	0.425	0.044
Phosphorus, Total (mg/L)	4	0.024	0.045	0.034	0.011
Dissolved Oxygen (mg/L)	4	4.0	9.6	7.2	2.4
Dissolved Oxygen (% Sat)	4	46.2	80.0	68.2	15.1
pH (s.u.)	4	7.32	7.64	7.47	0.17
Specific Conductance (µS/cm)	4	252	346	306	42.3
Temperature, Water (°C)	4	2.5	16.3	8.6	5.7

Table B-59: Water quality analyte descriptive statistics at Station 6 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	110	130	123	9.6
Bicarbonate as HCO_3, Total (mg/L)	4	140	160	150	8.2
Calcium, Dissolved l (mg/L)	4	29.0	39.0	35.0	4.2
Chloride, Total (mg/L)	4	8.0	10.0	9.0	0.8
Magnesium, Dissolved (mg/L)	4	8.0	11.0	10.0	1.4
Potassium, Dissolved (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	16.0	17.0	16.3	0.5
Sulfate, Total (mg/L)	4	28.0	33.0	31.0	2.2
Dissolved Solids, Total (mg/L)	4	187	223	208	17.4
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.9	2.8	1.9	0.8
Arsenic, Total (mg/L)	4	0.020	0.026	0.023	0.002
Nitrate Nitrite, Total (mg/L)	4	0.110	0.250	0.198	0.061
Nitrogen, Total (mg/L)	4	0.300	0.450	0.400	0.069
Phosphorus, Total (mg/L)	4	0.028	0.041	0.033	0.006
Dissolved Oxygen (mg/L)	4	4.4	10.7	8.8	2.9
Dissolved Oxygen (% Sat)	4	49.5	97.7	81.0	21.5
pH (s.u.)	4	7.38	8.27	8.00	0.42
Specific Conductance (µS/cm)	4	286	326	306	16.3
Temperature, Water (°C)	4	2.0	14.5	7.4	5.2

Table B-60: Water quality analyte descriptive statistics at Station 6 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	110	140	125	12.9
Bicarbonate as HCO_3, Total (mg/L)	4	130	160	148	15.0
Calcium, Dissolved l (mg/L)	4	32.0	39.0	35.0	3.6
Chloride, Total (mg/L)	4	7.0	11.0	9.3	1.7
Magnesium, Dissolved (mg/L)	4	9.0	12.0	10.3	1.5
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	16.0	21.0	17.8	2.4
Sulfate, Total (mg/L)	4	23.0	37.0	30.8	6.1
Dissolved Solids, Total (mg/L)	4	182	223	206	18.7
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.0	2.6	1.6	0.7
Arsenic, Total (mg/L)	4	0.024	0.026	0.025	0.001
Nitrate Nitrite, Total (mg/L)	4	0.050	0.220	0.153	0.073
Nitrogen, Total (mg/L)	4	0.240	0.410	0.345	0.079
Phosphorus, Total (mg/L)	4	0.013	0.037	0.026	0.013
Dissolved Oxygen (mg/L)	3	9.6	11.5	10.6	0.9
Dissolved Oxygen (% Sat)	3	90.4	101.3	94.5	5.9
pH (s.u.)	4	7.32	8.40	7.98	0.51
Specific Conductance (µS/cm)	4	275	327	302	23.3
Temperature, Water (°C)	4	1.4	14.8	7.5	5.5

Table B-61: Water quality analyte descriptive statistics at Station 7 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	12	104	147	124	15.0
Bicarbonate as HCO_3, Total (mg/L)	12	127	179	150	16.9
Calcium, Total (mg/L)	12	29.0	41.0	34.6	4.0
Chloride, Total (mg/L)	12	5.0	12.0	8.3	2.5
Magnesium, Dissolved (mg/L)	12	8.0	13.0	10.0	1.6
Potassium, Total (mg/L)	12	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	12	12.0	21.0	15.6	3.2
Sulfate, Total (mg/L)	12	22.0	39.0	29.1	6.3
Dissolved Solids, Total (mg/L)	12	165	230	193	25.6
Suspended Solids, Total (mg/L)	12	5.0	5.0	5.0	0.0
Turbidity (NTU)	12	1.3	8.1	3.7	2.2
Arsenic, Total (mg/L)	12	0.016	0.025	0.021	0.003
Cadmium, Total (mg/L)	12	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	12	0.001	0.003	0.002	0.001
Iron, Total (mg/L)	12	0.030	0.290	0.133	0.095
Lead, Total (mg/L)	12	0.001	0.001	0.001	0.000
Manganese, Total (mg/L)	12	0.010	0.070	0.032	0.019
Zinc, Total (mg/L)	12	0.005	0.005	0.005	0.000
Nitrate Nitrite, Dissolved (mg/L)	12	0.090	0.250	0.187	0.062
Nitrogen, Total (mg/L)	12	0.400	0.700	0.500	0.128
Phosphorus, Total (mg/L)	12	0.022	0.078	0.043	0.015
Dissolved Oxygen (mg/L)	6	7.2	10.4	8.3	1.2
Dissolved Oxygen (% Sat)	6	82.1	94.6	87.2	5.6
pH (s.u.)	12	8.00	8.49	8.18	0.16
Specific Conductance (µS/cm)	12	261	363	309	41.9
Temperature, Water (°C)	12	2.2	18.4	9.3	6.1

Table B-62: Water quality analyte descriptive statistics at Station 7 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	119	135	130	7.4
Bicarbonate as HCO_3, Total (mg/L)	4	145	162	158	8.3
Calcium, Total (mg/L)	4	35.0	40.0	37.0	2.2
Chloride, Total (mg/L)	4	9.0	10.0	9.3	0.5
Magnesium, Dissolved (mg/L)	4	10.0	12.0	11.0	0.8
Potassium, Total (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	16.0	19.0	17.5	1.3
Sulfate, Total (mg/L)	4	28.0	35.0	31.3	3.3
Dissolved Solids, Total (mg/L)	4	188	220	206	15.0
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.3	4.2	2.8	1.4
Arsenic, Total (mg/L)	4	0.020	0.025	0.023	0.002
Nitrate Nitrite, Total (mg/L)	4	0.110	0.260	0.190	0.063
Nitrogen, Total (mg/L)	4	0.410	0.450	0.428	0.017
Phosphorus, Total (mg/L)	4	0.020	0.054	0.037	0.018
Dissolved Oxygen (mg/L)	4	5.1	11.0	8.8	2.6
Dissolved Oxygen (% Sat)	4	57.4	102.5	83.3	18.9
pH (s.u.)	4	7.79	8.35	8.11	0.25
Specific Conductance (µS/cm)	4	310	348	322	17.1
Temperature, Water (°C)	4	1.5	14.9	8.3	5.7

Table B-63: Water quality analyte descriptive statistics at Station 7 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	130	140	134	4.3
Bicarbonate as HCO_3, Total (mg/L)	4	152	169	160	8.3
Calcium, Total (mg/L)	4	36.0	41.0	38.5	2.1
Chloride, Total (mg/L)	4	10.0	12.0	11.3	1.0
Magnesium, Dissolved (mg/L)	4	10.0	12.0	11.3	1.0
Potassium, Total (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	19.0	21.0	20.3	1.0
Sulfate, Total (mg/L)	4	29.0	35.0	32.5	3.0
Dissolved Solids, Total (mg/L)	4	205	222	214	7.7
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.5	8.5	3.5	3.4
Arsenic, Total (mg/L)	4	0.022	0.029	0.026	0.003
Nitrate Nitrite, Total (mg/L)	4	0.050	0.220	0.120	0.072
Nitrogen, Total (mg/L)	4	0.260	0.370	0.325	0.054
Phosphorus, Total (mg/L)	4	0.024	0.053	0.038	0.012
Dissolved Oxygen (mg/L)	4	5.1	10.2	8.3	2.3
Dissolved Oxygen (% Sat)	4	59.4	97.1	78.9	16.2
pH (s.u.)	4	7.56	8.58	8.17	0.44
Specific Conductance (µS/cm)	4	323	366	347	17.8
Temperature, Water (°C)	4	2.4	16.2	8.6	5.9

Table B-64: Water quality analyte descriptive statistics at Station 7 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	113	143	127	14.5
Bicarbonate as HCO_3, Total (mg/L)	4	138	174	155	17.5
Calcium, Total (mg/L)	4	31.0	41.0	36.8	4.3
Chloride, Total (mg/L)	4	8.0	12.0	10.0	2.3
Magnesium, Dissolved (mg/L)	4	9.0	13.0	11.0	1.8
Potassium, Total (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	16.0	22.0	19.0	2.9
Sulfate, Total (mg/L)	4	21.0	37.0	29.8	8.0
Dissolved Solids, Total (mg/L)	4	181	212	197	15.5
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.3	6.4	3.5	2.1
Arsenic, Total (mg/L)	4	0.025	0.028	0.026	0.001
Nitrate Nitrite, Total (mg/L)	4	0.030	0.190	0.128	0.069
Nitrogen, Total (mg/L)	4	0.300	1.000	0.500	0.337
Phosphorus, Total (mg/L)	4	0.031	0.059	0.044	0.014
Dissolved Oxygen (mg/L)	4	4.6	9.6	7.8	2.2
Dissolved Oxygen (% Sat)	4	54.7	95.9	74.0	17.0
pH (s.u.)	4	7.63	8.44	7.98	0.34
Specific Conductance (µS/cm)	4	289	362	323	40.1
Temperature, Water (°C)	4	4.6	9.6	7.8	2.2

Table B-65: Water quality analyte descriptive statistics at Station 7 in 2015.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	116	140	127	10.0
Bicarbonate as HCO_3, Total (mg/L)	4	142	165	154	9.7
Calcium, Dissolved (mg/L)	4	34.0	42.0	37.8	3.9
Chloride, Total (mg/L)	4	9.0	11.0	9.8	1.0
Magnesium, Dissolved (mg/L)	4	10.0	12.0	11.0	0.8
Potassium, Dissolved (mg/L)	1	3.0	3.0	3.0	--
Potassium, Dissolved (mg/L)	3	3.0	4.0	3.3	0.6
Sodium, Dissolved (mg/L)	4	17.0	21.0	18.8	1.7
Sulfate, Total (mg/L)	4	27.0	35.0	30.3	3.4
Dissolved Solids, Total (mg/L)	4	197	221	208	10.8
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.5	3.1	2.1	0.7
Arsenic, Total (mg/L)	4	0.024	0.027	0.025	0.001
Nitrate Nitrite, Total (mg/L)	4	0.070	0.210	0.158	0.064
Nitrogen, Total (mg/L)	4	0.280	0.400	0.368	0.059
Phosphorus, Total (mg/L)	4	0.015	0.052	0.032	0.015
Dissolved Oxygen (mg/L)	4	6.1	10.4	8.3	1.8
Dissolved Oxygen (% Sat)	4	69.9	90.3	79.3	9.7
pH (s.u.)	4	7.64	8.70	8.16	0.43
Specific Conductance (µS/cm)	4	320	331	326	4.5
Temperature, Water (°C)	4	6.1	10.4	8.3	1.8

Table B-66: Water quality analyte descriptive statistics at Station 7 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	130	144	136	6.7
Bicarbonate as HCO_3, Total (mg/L)	4	158	170	164	5.7
Calcium, Dissolved (mg/L)	4	36.0	39.0	37.0	1.4
Chloride, Total (mg/L)	4	10.0	12.0	10.8	1.0
Magnesium, Dissolved (mg/L)	4	10.0	11.0	10.8	0.5
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	19.0	21.0	20.0	0.8
Sulfate, Total (mg/L)	4	29.0	33.0	30.8	2.1
Dissolved Solids, Total (mg/L)	4	194	244	218	20.5
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.4	3.9	2.5	1.1
Arsenic, Total (mg/L)	4	0.025	0.026	0.026	0.001
Nitrate Nitrite, Total (mg/L)	4	0.030	0.260	0.133	0.100
Nitrogen, Total (mg/L)	4	0.250	0.420	0.323	0.075
Phosphorus, Total (mg/L)	4	0.020	0.045	0.033	0.011
Dissolved Oxygen (mg/L)	4	6.7	9.3	8.0	1.5
Dissolved Oxygen (% Sat)	4	66.6	92.4	79.2	10.5
pH (s.u.)	4	7.95	8.33	8.08	0.17
Specific Conductance (µS/cm)	4	329	356	340	11.7
Temperature, Water (°C)	4	2.8	16.7	9.4	5.7

Table B-67: Water quality analyte descriptive statistics at Station 7 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	110	140	128	15.0
Bicarbonate as HCO_3, Total (mg/L)	4	140	180	155	19.1
Calcium, Dissolved (mg/L)	4	33.0	44.0	37.3	5.0
Chloride, Total (mg/L)	4	9.0	12.0	10.3	1.5
Magnesium, Dissolved (mg/L)	4	9.0	13.0	10.8	1.7
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	16.0	22.0	19.0	2.9
Sulfate, Total (mg/L)	4	25.0	34.0	29.5	5.2
Dissolved Solids, Total (mg/L)	4	190	227	207	16.9
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.4	3.7	2.6	1.1
Arsenic, Total (mg/L)	4	0.025	0.028	0.026	0.001
Nitrate Nitrite, Total (mg/L)	4	0.005	0.270	0.156	0.111
Nitrogen, Total (mg/L)	4	0.380	0.480	0.433	0.050
Phosphorus, Total (mg/L)	4	0.019	0.050	0.037	0.014
Dissolved Oxygen (mg/L)	4	4.7	9.6	8.1	2.3
Dissolved Oxygen (% Sat)	4	55.1	95.6	76.9	17.2
pH (s.u.)	4	7.60	8.74	8.04	0.50
Specific Conductance (µS/cm)	4	296	362	328	32.8
Temperature, Water (°C)	4	2.3	17.0	8.5	6.3

Table B-68: Water quality analyte descriptive statistics at Station 7 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	100	130	118	12.6
Bicarbonate as HCO_3, Total (mg/L)	4	130	160	145	12.9
Calcium, Dissolved (mg/L)	4	31.0	37.0	34.3	2.5
Chloride, Total (mg/L)	4	6.0	10.0	8.5	1.9
Magnesium, Dissolved (mg/L)	4	8.0	11.0	9.5	1.3
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	13.0	20.0	16.5	3.5
Sulfate, Total (mg/L)	4	23.0	30.0	27.8	3.2
Dissolved Solids, Total (mg/L)	4	173	222	204	23.5
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.1	5.9	3.4	2.0
Arsenic, Total (mg/L)	4	0.018	0.026	0.023	0.003
Nitrate Nitrite, Total (mg/L)	4	0.070	0.240	0.148	0.070
Nitrogen, Total (mg/L)	4	0.400	0.740	0.515	0.153
Phosphorus, Total (mg/L)	4	0.023	0.054	0.038	0.014
Dissolved Oxygen (mg/L)	4	7.2	10.7	9.0	1.5
Dissolved Oxygen (% Sat)	4	84.3	89.4	87.3	2.2
pH (s.u.)	4	7.56	7.95	7.77	0.16
Specific Conductance (µS/cm)	4	271	342	311	31.3
Temperature, Water (°C)	4	1.7	16.7	9.0	6.5

Table B-69: Water quality analyte descriptive statistics at Station 7 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	120	130	125	5.8
Bicarbonate as HCO_3, Total (mg/L)	4	140	160	153	9.6
Calcium, Dissolved (mg/L)	4	29.0	38.0	35.3	4.2
Chloride, Total (mg/L)	4	8.0	10.0	9.3	1.0
Magnesium, Dissolved (mg/L)	4	8.0	11.0	10.0	1.4
Potassium, Dissolved (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	17.0	17.0	17.0	0.0
Sulfate, Total (mg/L)	4	27.0	34.0	32.3	3.5
Dissolved Solids, Total (mg/L)	4	193	227	211	14.1
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.1	2.9	2.1	0.7
Arsenic, Total (mg/L)	4	0.020	0.024	0.022	0.002
Nitrate Nitrite, Total (mg/L)	4	0.120	0.260	0.188	0.061
Nitrogen, Total (mg/L)	4	0.330	0.450	0.398	0.050
Phosphorus, Total (mg/L)	4	0.028	0.039	0.033	0.005
Dissolved Oxygen (mg/L)	4	7.6	12.3	10.8	2.2
Dissolved Oxygen (% Sat)	4	86.7	115.3	100.6	11.7
pH (s.u.)	4	7.68	8.22	7.92	0.27
Specific Conductance (µS/cm)	4	291	330	316	18.1
Temperature, Water (°C)	4	7.6	12.3	10.8	2.2

Table B-70: Water quality analyte descriptive statistics at Station 7 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	110	130	125	10.0
Bicarbonate as HCO_3, Total (mg/L)	4	140	160	153	9.6
Calcium, Dissolved (mg/L)	4	33.0	39.0	35.8	2.8
Chloride, Total (mg/L)	4	8.0	11.0	9.5	1.3
Magnesium, Dissolved (mg/L)	4	9.0	12.0	10.8	1.5
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	16.0	20.0	17.8	1.7
Sulfate, Total (mg/L)	4	25.0	37.0	31.8	5.4
Dissolved Solids, Total (mg/L)	4	189	224	210	15.0
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.2	3.0	2.2	0.7
Arsenic, Total (mg/L)	4	0.023	0.025	0.024	0.001
Nitrate Nitrite, Total (mg/L)	4	0.050	0.170	0.123	0.053
Nitrogen, Total (mg/L)	4	0.250	0.420	0.345	0.079
Phosphorus, Total (mg/L)	4	0.007	0.039	0.024	0.014
Dissolved Oxygen (mg/L)	3	10.2	13.1	11.6	1.5
Dissolved Oxygen (% Sat)	3	91.1	112.5	102.7	10.8
pH (s.u.)	4	7.98	8.60	8.25	0.29
Specific Conductance (µS/cm)	4	284	324	304	20.8
Temperature, Water (°C)	4	1.3	16.7	7.9	6.7

Table B-71: Water quality analyte descriptive statistics at Station 8 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	12	105	160	128	17.0
Bicarbonate as HCO_3, Total (mg/L)	12	128	187	156	19.4
Calcium, Total (mg/L)	12	30.0	41.0	35.0	3.5
Chloride, Total (mg/L)	12	6.0	12.0	8.1	2.2
Magnesium, Dissolved (mg/L)	12	8.0	13.0	10.3	1.4
Potassium, Total (mg/L)	12	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	12	13.0	20.0	15.5	2.5
Sulfate, Total (mg/L)	12	23.0	40.0	30.2	5.5
Dissolved Solids, Total (mg/L)	12	169	245	204	25.0
Suspended Solids, Total (mg/L)	12	5.0	5.0	5.0	0.0
Turbidity (NTU)	12	1.2	5.7	2.8	1.4
Arsenic, Total (mg/L)	12	0.016	0.024	0.020	0.002
Cadmium, Total (mg/L)	12	0.000	0.001	0.000	0.000
Copper, Total (mg/L)	12	0.001	0.005	0.002	0.001
Iron, Total (mg/L)	12	0.030	0.200	0.076	0.051
Lead, Total (mg/L)	12	0.001	0.001	0.001	0.000
Manganese, Total (mg/L)	12	0.010	0.050	0.021	0.015
Zinc, Total (mg/L)	12	0.005	0.005	0.005	0.000
Nitrate Nitrite, Dissolved (mg/L)	12	0.080	0.250	0.166	0.067
Nitrogen, Total (mg/L)	12	0.400	1.600	0.525	0.341
Phosphorus, Total (mg/L)	12	0.021	0.072	0.042	0.016
Dissolved Oxygen (mg/L)	6	6.3	10.3	7.9	1.4
Dissolved Oxygen (% Sat)	6	73.6	96.4	82.9	8.5
pH (s.u.)	12	8.01	8.52	8.23	0.16
Specific Conductance (µS/cm)	12	266	366	313	37.1
Temperature, Water (°C)	12	1.0	19.4	9.2	6.8

Table B-72: Water quality analyte descriptive statistics at Station 8 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	125	153	139	11.4
Bicarbonate as HCO_3, Total (mg/L)	4	153	186	167	13.9
Calcium, Total (mg/L)	4	36.0	38.0	37.3	1.0
Chloride, Total (mg/L)	4	7.0	10.0	8.8	1.3
Magnesium, Dissolved (mg/L)	4	10.0	13.0	11.5	1.3
Potassium, Total (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	15.0	19.0	17.3	1.7
Sulfate, Total (mg/L)	4	30.0	36.0	32.0	2.8
Dissolved Solids, Total (mg/L)	4	180	226	202	18.9
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.1	2.0	1.4	0.4
Arsenic, Total (mg/L)	4	0.020	0.027	0.023	0.003
Nitrate Nitrite, Total (mg/L)	4	0.050	0.260	0.140	0.090
Nitrogen, Total (mg/L)	4	0.310	0.520	0.400	0.088
Phosphorus, Total (mg/L)	4	0.027	0.100	0.059	0.036
Dissolved Oxygen (mg/L)	4	6.9	10.9	9.3	1.7
Dissolved Oxygen (% Sat)	4	81.6	98.6	89.7	7.2
pH (s.u.)	4	8.06	8.42	8.25	0.15
Specific Conductance (µS/cm)	4	293	352	324	25.3
Temperature, Water (°C)	4	1.3	17.6	9.3	6.8

Table B-73: Water quality analyte descriptive statistics at Station 8 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	128	139	135	4.7
Bicarbonate as HCO_3, Total (mg/L)	4	152	165	158	5.4
Calcium, Total (mg/L)	4	37.0	41.0	38.5	1.7
Chloride, Total (mg/L)	4	10.0	13.0	11.5	1.3
Magnesium, Dissolved (mg/L)	4	11.0	12.0	11.5	0.6
Potassium, Total (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	18.0	22.0	20.3	1.7
Sulfate, Total (mg/L)	4	29.0	37.0	33.0	3.7
Dissolved Solids, Total (mg/L)	4	176	222	201	19.2
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.8	1.9	1.5	0.5
Arsenic, Total (mg/L)	4	0.021	0.028	0.026	0.003
Nitrate Nitrite, Total (mg/L)	4	0.005	0.240	0.091	0.110
Nitrogen, Total (mg/L)	4	0.210	0.400	0.308	0.096
Phosphorus, Total (mg/L)	4	0.017	0.071	0.037	0.024
Dissolved Oxygen (mg/L)	4	7.2	9.8	8.7	1.1
Dissolved Oxygen (% Sat)	4	76.9	94.9	85.8	8.2
pH (s.u.)	4	7.71	8.62	8.31	0.42
Specific Conductance (µS/cm)	4	318	369	348	21.6
Temperature, Water (°C)	4	2.1	19.9	9.9	7.7

Table B-74: Water quality analyte descriptive statistics at Station 8 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	117	141	129	13.0
Bicarbonate as HCO_3, Total (mg/L)	4	142	172	156	14.8
Calcium, Total (mg/L)	4	34.0	40.0	37.3	3.2
Chloride, Total (mg/L)	4	8.0	12.0	10.3	2.1
Magnesium, Dissolved (mg/L)	4	10.0	12.0	11.0	1.2
Potassium, Total (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	16.0	22.0	19.3	2.8
Sulfate, Total (mg/L)	4	25.0	39.0	31.3	6.8
Dissolved Solids, Total (mg/L)	4	190	220	204	13.0
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.3	3.8	2.3	1.2
Arsenic, Total (mg/L)	4	0.022	0.028	0.026	0.003
Nitrate Nitrite, Total (mg/L)	4	0.005	0.210	0.101	0.085
Nitrogen, Total (mg/L)	4	0.200	1.000	0.425	0.386
Phosphorus, Total (mg/L)	4	0.028	0.060	0.039	0.014
Dissolved Oxygen (mg/L)	4	6.1	9.9	8.5	1.8
Dissolved Oxygen (% Sat)	4	74.8	100.0	82.9	11.6
pH (s.u.)	4	7.38	8.55	8.08	0.50
Specific Conductance (µS/cm)	4	291	362	331	33.6
Temperature, Water (°C)	4	1.4	19.4	9.3	7.6

Table B-75: Water quality analyte descriptive statistics at Station 8 in 2015.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	120	131	126	4.5
Bicarbonate as HCO_3, Total (mg/L)	4	136	154	149	8.7
Calcium, Dissolved (mg/L)	4	35.0	41.0	38.0	2.6
Chloride, Total (mg/L)	4	9.0	10.0	9.5	0.6
Magnesium, Dissolved (mg/L)	4	11.0	12.0	11.3	0.5
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.5	0.6
Sodium, Dissolved (mg/L)	4	18.0	21.0	18.8	1.5
Sulfate, Total (mg/L)	4	29.0	36.0	31.3	3.2
Dissolved Solids, Total (mg/L)	4	206	223	214	7.7
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.8	3.9	2.4	1.1
Arsenic, Total (mg/L)	4	0.022	0.028	0.024	0.003
Nitrate Nitrite, Total (mg/L)	4	0.020	0.170	0.098	0.078
Nitrogen, Total (mg/L)	4	0.210	0.400	0.313	0.085
Phosphorus, Total (mg/L)	4	0.013	0.070	0.034	0.027
Dissolved Oxygen (mg/L)	4	7.8	10.3	8.6	1.2
Dissolved Oxygen (% Sat)	4	74.9	95.7	84.3	8.6
pH (s.u.)	4	8.03	8.64	8.32	0.30
Specific Conductance (µS/cm)	4	313	338	328	11.4
Temperature, Water (°C)	4	7.8	10.3	8.6	1.2

Table B-76: Water quality analyte descriptive statistics at Station 8 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	130	146	136	6.9
Bicarbonate as HCO_3, Total (mg/L)	4	159	168	163	3.7
Calcium, Dissolved (mg/L)	4	36.0	39.0	37.5	1.3
Chloride, Total (mg/L)	4	10.0	11.0	10.5	0.6
Magnesium, Dissolved (mg/L)	4	10.0	11.0	10.8	0.5
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	19.0	20.0	19.5	0.6
Sulfate, Total (mg/L)	4	28.0	34.0	31.3	2.5
Dissolved Solids, Total (mg/L)	4	189	238	214	20.7
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	0.8	1.7	1.3	0.4
Arsenic, Total (mg/L)	4	0.025	0.028	0.026	0.001
Nitrate Nitrite, Total (mg/L)	4	0.005	0.230	0.099	0.100
Nitrogen, Total (mg/L)	4	0.190	0.410	0.283	0.099
Phosphorus, Total (mg/L)	4	0.020	0.051	0.035	0.013
Dissolved Oxygen (mg/L)	4	6.3	9.8	8.1	1.4
Dissolved Oxygen (% Sat)	4	75.9	89.0	81.0	5.8
pH (s.u.)	4	7.99	8.44	8.17	0.20
Specific Conductance (µS/cm)	4	326	359	340	15.3
Temperature, Water (°C)	4	2.1	17.9	10.2	6.5

Table B-77: Water quality analyte descriptive statistics at Station 8 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	120	140	130	11.5
Bicarbonate as HCO_3, Total (mg/L)	4	140	170	155	17.3
Calcium, Dissolved (mg/L)	4	34.0	40.0	37.0	2.9
Chloride, Total (mg/L)	4	9.0	12.0	10.3	1.3
Magnesium, Dissolved (mg/L)	4	10.0	12.0	11.0	1.2
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	17.0	21.0	18.8	2.1
Sulfate, Total (mg/L)	4	27.0	36.0	31.0	3.9
Dissolved Solids, Total (mg/L)	4	193	221	207	12.1
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.2	3.4	1.9	1.0
Arsenic, Total (mg/L)	4	0.025	0.027	0.026	0.001
Nitrate Nitrite, Total (mg/L)	4	0.005	0.220	0.121	0.097
Nitrogen, Total (mg/L)	4	0.120	0.490	0.325	0.154
Phosphorus, Total (mg/L)	4	0.019	0.065	0.037	0.020
Dissolved Oxygen (mg/L)	4	7.4	9.4	8.7	1.0
Dissolved Oxygen (% Sat)	4	76.3	93.1	85.1	8.2
pH (s.u.)	4	7.74	8.63	8.18	0.45
Specific Conductance (µS/cm)	4	303	360	330	25.6
Temperature, Water (°C)	4	1.7	19.3	9.0	7.5

Table B-78: Water quality analyte descriptive statistics at Station 8 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	110	130	123	9.6
Bicarbonate as HCO_3, Total (mg/L)	4	130	150	145	10.0
Calcium, Dissolved (mg/L)	4	32.0	37.0	34.3	2.6
Chloride, Total (mg/L)	4	7.0	11.0	8.8	2.1
Magnesium, Dissolved (mg/L)	4	9.0	11.0	9.8	1.0
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	13.0	20.0	16.5	3.5
Sulfate, Total (mg/L)	4	24.0	31.0	28.5	3.1
Dissolved Solids, Total (mg/L)	4	174	221	201	21.9
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.2	2.4	2.1	0.6
Arsenic, Total (mg/L)	4	0.018	0.026	0.023	0.004
Nitrate Nitrite, Total (mg/L)	4	0.060	0.220	0.160	0.073
Nitrogen, Total (mg/L)	4	0.380	0.460	0.415	0.033
Phosphorus, Total (mg/L)	4	0.025	0.057	0.035	0.015
Dissolved Oxygen (mg/L)	4	7.7	10.1	8.9	1.0
Dissolved Oxygen (% Sat)	4	80.8	93.4	86.9	5.7
pH (s.u.)	4	7.78	8.14	7.92	0.16
Specific Conductance (µS/cm)	4	280	344	313	31.4
Temperature, Water (°C)	4	1.1	18.6	9.4	7.3

Table B-79: Water quality analyte descriptive statistics at Station 8 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	120	140	128	9.6
Bicarbonate as HCO_3, Total (mg/L)	4	150	170	158	9.6
Calcium, Dissolved (mg/L)	4	32.0	39.0	36.5	3.1
Chloride, Total (mg/L)	4	9.0	10.0	9.5	0.6
Magnesium, Dissolved (mg/L)	4	9.0	12.0	10.8	1.3
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	16.0	18.0	17.0	0.8
Sulfate, Total (mg/L)	4	32.0	35.0	33.3	1.3
Dissolved Solids, Total (mg/L)	4	205	232	214	12.5
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.0	2.2	1.6	0.5
Arsenic, Total (mg/L)	4	0.020	0.024	0.022	0.002
Nitrate Nitrite, Total (mg/L)	4	0.110	0.250	0.160	0.062
Nitrogen, Total (mg/L)	4	0.340	0.440	0.385	0.041
Phosphorus, Total (mg/L)	4	0.018	0.052	0.031	0.016
Dissolved Oxygen (mg/L)	4	8.9	12.1	11.0	1.5
Dissolved Oxygen (% Sat)	4	96.3	116.2	103.7	9.2
pH (s.u.)	4	8.13	8.57	8.42	0.20
Specific Conductance (µS/cm)	4	300	329	317	12.1
Temperature, Water (°C)	4	0.5	17.2	7.6	7.1

Table B-80: Water quality analyte descriptive statistics at Station 8 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	120	140	128	9.6
Bicarbonate as HCO_3, Total (mg/L)	4	150	160	155	5.8
Calcium, Dissolved (mg/L)	4	34.0	38.0	36.0	1.8
Chloride, Total (mg/L)	4	9.0	11.0	9.5	1.0
Magnesium, Dissolved (mg/L)	4	10.0	12.0	10.8	1.0
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	16.0	21.0	18.5	2.1
Sulfate, Total (mg/L)	4	29.0	38.0	32.8	4.1
Dissolved Solids, Total (mg/L)	4	199	225	210	10.8
Suspended Solids, Total (mg/L)	4	5.0	5.0	5.0	0.0
Turbidity (NTU)	4	1.2	2.1	1.6	0.4
Arsenic, Total (mg/L)	4	0.023	0.025	0.024	0.001
Nitrate Nitrite, Total (mg/L)	4	0.005	0.170	0.096	0.071
Nitrogen, Total (mg/L)	4	0.190	0.440	0.313	0.103
Phosphorus, Total (mg/L)	4	0.010	0.076	0.033	0.029
Dissolved Oxygen (mg/L)	3	10.3	12.8	11.1	1.4
Dissolved Oxygen (% Sat)	3	94.0	102.8	99.5	4.8
pH (s.u.)	4	8.31	8.65	8.50	0.15
Specific Conductance (µS/cm)	4	286	316	303	12.9
Temperature, Water (°C)	4	1.3	18.4	8.8	7.2

Table B-81: Water quality analyte descriptive statistics at Station 9 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	12	118	153	134	10.8
Bicarbonate as HCO_3, Total (mg/L)	12	144	186	163	13.1
Calcium, Total (mg/L)	12	33.0	43.0	37.7	2.6
Chloride, Total (mg/L)	12	6.0	9.0	7.2	1.2
Magnesium, Dissolved (mg/L)	12	10.0	14.0	12.3	1.4
Potassium, Total (mg/L)	12	3.0	4.0	3.2	0.4
Sodium, Dissolved (mg/L)	12	14.0	22.0	16.3	2.7
Sulfate, Total (mg/L)	12	32.0	57.0	39.5	8.5
Dissolved Solids, Total (mg/L)	12	180	262	213	22.7
Suspended Solids, Total (mg/L)	12	5.0	73.0	22.4	20.9
Turbidity (NTU)	12	4.3	39.3	13.3	11.1
Arsenic, Total (mg/L)	12	0.013	0.019	0.017	0.002
Cadmium, Total (mg/L)	12	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	12	0.002	0.010	0.004	0.003
Iron, Total (mg/L)	12	0.120	1.500	0.488	0.434
Lead, Total (mg/L)	12	0.001	0.026	0.005	0.007
Manganese, Total (mg/L)	12	0.010	0.060	0.029	0.017
Zinc, Total (mg/L)	12	0.005	0.005	0.005	0.000
Nitrate Nitrite, Dissolved (mg/L)	12	0.060	0.320	0.185	0.094
Nitrogen, Total (mg/L)	12	0.300	0.600	0.467	0.089
Phosphorus, Total (mg/L)	12	0.030	0.087	0.056	0.019
Dissolved Oxygen (mg/L)	6	6.8	10.8	8.5	1.6
Dissolved Oxygen (% Sat)	6	83.3	86.0	84.8	1.0
pH (s.u.)	12	7.55	8.40	8.14	0.24
Specific Conductance (µS/cm)	12	297	396	339	33.8
Temperature, Water (°C)	12	-0.2	20.1	8.3	7.3

Table B-82: Water quality analyte descriptive statistics at Station 9 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	144	156	151	5.1
Bicarbonate as HCO_3, Total (mg/L)	4	169	187	179	8.7
Calcium, Total (mg/L)	4	37.0	43.0	40.0	2.4
Chloride, Total (mg/L)	4	7.0	8.0	7.8	0.5
Magnesium, Dissolved (mg/L)	4	13.0	15.0	13.8	1.0
Potassium, Total (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	16.0	20.0	17.8	2.1
Sulfate, Total (mg/L)	4	38.0	41.0	39.8	1.5
Dissolved Solids, Total (mg/L)	4	193	222	210	12.1
Suspended Solids, Total (mg/L)	4	5.0	20.0	10.5	7.1
Turbidity (NTU)	4	3.4	13.0	8.4	5.2
Arsenic, Total (mg/L)	4	0.017	0.022	0.019	0.002
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.003	0.002	0.001
Iron, Total (mg/L)	4	0.080	0.460	0.270	0.179
Lead, Total (mg/L)	4	0.001	0.008	0.002	0.004
Manganese, Total (mg/L)	4	0.015	0.026	0.021	0.005
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.060	0.290	0.158	0.116
Nitrogen, Total (mg/L)	4	0.300	0.430	0.383	0.057
Phosphorus, Total (mg/L)	4	0.023	0.056	0.035	0.014
Dissolved Oxygen (mg/L)	4	7.6	11.9	9.6	2.1
Dissolved Oxygen (% Sat)	4	83.9	98.6	91.1	6.9
pH (s.u.)	4	7.42	8.67	8.15	0.52
Specific Conductance (µS/cm)	4	315	369	348	22.9
Temperature, Water (°C)	4	0.5	18.1	9.3	8.9

Table B-83: Water quality analyte descriptive statistics at Station 9 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	130	154	142	11.8
Bicarbonate as HCO_3, Total (mg/L)	4	152	181	168	12.7
Calcium, Total (mg/L)	4	36.0	44.0	39.3	3.4
Chloride, Total (mg/L)	4	7.0	11.0	9.3	1.7
Magnesium, Dissolved (mg/L)	4	12.0	15.0	13.3	1.5
Potassium, Total (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	15.0	21.0	18.3	2.8
Sulfate, Total (mg/L)	4	31.0	49.0	38.8	7.6
Dissolved Solids, Total (mg/L)	4	191	242	219	21.1
Suspended Solids, Total (mg/L)	4	5.0	30.0	14.5	12.0
Turbidity (NTU)	4	3.1	22.2	10.6	8.8
Arsenic, Total (mg/L)	4	0.013	0.023	0.019	0.004
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.003	0.002	0.001
Iron, Total (mg/L)	4	0.070	0.680	0.318	0.279
Lead, Total (mg/L)	4	0.001	0.005	0.002	0.002
Manganese, Total (mg/L)	4	0.016	0.040	0.024	0.011
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.050	0.240	0.110	0.090
Nitrogen, Total (mg/L)	4	0.100	0.400	0.250	0.129
Phosphorus, Total (mg/L)	4	0.037	0.054	0.046	0.008
Dissolved Oxygen (mg/L)	4	6.5	10.3	8.6	1.9
Dissolved Oxygen (% Sat)	4	79.3	84.3	81.3	2.1
pH (s.u.)	4	7.60	8.78	8.37	0.53
Specific Conductance (µS/cm)	4	333	408	361	35.2
Temperature, Water (°C)	4	0.6	21.8	9.4	10.4

Table B-84: Water quality analyte descriptive statistics at Station 9 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	132	146	136	6.7
Bicarbonate as HCO_3, Total (mg/L)	4	146	178	162	13.1
Calcium, Total (mg/L)	4	37.0	39.0	38.0	0.8
Chloride, Total (mg/L)	4	7.0	10.0	8.8	1.3
Magnesium, Dissolved (mg/L)	4	12.0	14.0	12.8	1.0
Potassium, Total (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	16.0	21.0	17.8	2.4
Sulfate, Total (mg/L)	4	30.0	52.0	39.0	9.3
Dissolved Solids, Total (mg/L)	4	214	261	229	21.6
Suspended Solids, Total (mg/L)	4	5.0	58.0	21.0	25.2
Turbidity (NTU)	4	3.9	27.3	11.7	11.0
Arsenic, Total (mg/L)	4	0.019	0.022	0.021	0.002
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.002	0.003	0.003	0.001
Iron, Total (mg/L)	4	0.100	1.100	0.520	0.498
Lead, Total (mg/L)	4	0.001	0.009	0.005	0.004
Manganese, Total (mg/L)	4	0.016	0.055	0.031	0.018
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.010	0.230	0.103	0.102
Nitrogen, Total (mg/L)	4	0.200	0.800	0.425	0.263
Phosphorus, Total (mg/L)	4	0.040	0.064	0.050	0.010
Dissolved Oxygen (mg/L)	4	6.3	10.3	8.5	1.8
Dissolved Oxygen (% Sat)	4	78.3	85.0	80.5	3.0
pH (s.u.)	4	6.76	8.67	7.95	0.83
Specific Conductance (µS/cm)	4	319	386	343	30.3
Temperature, Water (°C)	4	0.1	20.3	8.9	9.6

Table B-85: Water quality analyte descriptive statistics at Station 9 in 2015.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	135	147	140	5.5
Bicarbonate as HCO_3, Total (mg/L)	4	160	172	167	5.9
Calcium, Dissolved (mg/L)	4	39.0	40.0	39.8	0.5
Chloride, Total (mg/L)	4	7.0	9.0	7.8	1.0
Magnesium, Dissolved (mg/L)	4	12.0	14.0	13.3	1.0
Potassium, Dissolved (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	18.0	21.0	19.0	1.4
Sulfate, Total (mg/L)	4	33.0	45.0	39.3	4.9
Dissolved Solids, Total (mg/L)	4	207	235	222	12.2
Suspended Solids, Total (mg/L)	4	5.0	31.0	16.3	11.0
Turbidity (NTU)	4	4.4	20.6	10.4	7.1
Arsenic, Total (mg/L)	4	0.014	0.023	0.020	0.004
Cadmium, Total (mg/L)	2	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	2	0.001	0.002	0.001	0.001
Iron, Total (mg/L)	2	0.100	0.240	0.170	0.099
Lead, Total (mg/L)	2	0.001	0.001	0.001	0.000
Manganese, Total (mg/L)	2	0.016	0.019	0.018	0.002
Zinc, Total (mg/L)	2	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.005	0.160	0.104	0.074
Nitrogen, Total (mg/L)	4	0.160	0.400	0.298	0.101
Phosphorus, Total (mg/L)	4	0.025	0.056	0.042	0.013
Dissolved Oxygen (mg/L)	4	6.8	10.4	8.6	1.6
Dissolved Oxygen (% Sat)	4	79.0	81.9	80.3	1.4
pH (s.u.)	4	8.05	8.43	8.31	0.18
Specific Conductance (µS/cm)	4	330	370	350	18.1
Temperature, Water (°C)	4	0.1	17.7	8.1	8.0

Table B-86: Water quality analyte descriptive statistics at Station 9 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	142	143	143	0.6
Bicarbonate as HCO_3, Total (mg/L)	4	165	175	170	5.0
Calcium, Dissolved (mg/L)	4	39.0	41.0	40.0	0.8
Chloride, Total (mg/L)	4	8.0	10.0	9.0	0.8
Magnesium, Dissolved (mg/L)	4	13.0	14.0	13.3	0.5
Potassium, Dissolved (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	18.0	22.0	20.0	1.8
Sulfate, Total (mg/L)	4	34.0	41.0	37.3	3.0
Dissolved Solids, Total (mg/L)	4	206	222	216	7.1
Suspended Solids, Total (mg/L)	4	5.0	28.0	13.3	10.9
Turbidity (NTU)	4	4.0	14.9	8.2	5.1
Arsenic, Total (mg/L)	4	0.018	0.023	0.021	0.002
Cadmium, Total (mg/L)	3	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	3	0.001	0.002	0.001	0.001
Iron, Total (mg/L)	3	0.090	0.480	0.237	0.212
Lead, Total (mg/L)	3	0.002	0.005	0.003	0.002
Manganese, Total (mg/L)	3	0.018	0.034	0.024	0.009
Zinc, Total (mg/L)	3	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.010	0.180	0.075	0.079
Nitrogen, Total (mg/L)	4	0.190	0.300	0.248	0.061
Phosphorus, Total (mg/L)	4	0.027	0.038	0.034	0.005
Dissolved Oxygen (mg/L)	4	6.1	9.3	7.8	1.3
Dissolved Oxygen (% Sat)	4	76.4	84.1	79.7	3.7
pH (s.u.)	4	8.25	8.38	8.31	0.06
Specific Conductance (µS/cm)	4	341	373	358	13.7
Temperature, Water (°C)	4	3.7	21.2	11.5	7.8

Table B-87: Water quality analyte descriptive statistics at Station 9 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	130	150	138	9.6
Bicarbonate as HCO_3, Total (mg/L)	4	150	180	165	12.9
Calcium, Dissolved (mg/L)	4	37.0	43.0	39.0	2.7
Chloride, Total (mg/L)	4	8.4	9.1	8.9	0.3
Magnesium, Dissolved (mg/L)	4	11.0	15.0	12.8	1.7
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	16.0	22.0	18.5	2.5
Sulfate, Total (mg/L)	4	31.0	47.0	38.3	6.7
Dissolved Solids, Total (mg/L)	4	189	240	216	20.9
Suspended Solids, Total (mg/L)	4	5.0	103.0	33.3	46.7
Turbidity (NTU)	4	3.5	47.3	16.7	20.5
Arsenic, Total (mg/L)	4	0.019	0.024	0.021	0.002
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.004	0.002	0.001
Iron, Total (mg/L)	4	0.070	1.900	0.598	0.871
Lead, Total (mg/L)	4	0.001	0.010	0.005	0.004
Manganese, Total (mg/L)	4	0.017	0.077	0.034	0.029
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.005	0.230	0.103	0.115
Nitrogen, Total (mg/L)	4	0.140	0.450	0.310	0.159
Phosphorus, Total (mg/L)	4	0.025	0.077	0.048	0.022
Dissolved Oxygen (mg/L)	4	6.4	9.7	8.4	1.5
Dissolved Oxygen (% Sat)	4	78.6	82.4	80.0	1.7
pH (s.u.)	4	7.80	8.67	8.22	0.47
Specific Conductance (µS/cm)	4	326	378	347	21.9
Temperature, Water (°C)	4	2.1	20.0	8.9	8.1

Table B-88: Water quality analyte descriptive statistics at Station 9 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	130	140	135	5.8
Bicarbonate as HCO_3, Total (mg/L)	4	150	170	163	9.6
Calcium, Dissolved (mg/L)	4	35.0	42.0	37.5	3.1
Chloride, Total (mg/L)	4	6.0	8.0	7.0	0.8
Magnesium, Dissolved (mg/L)	4	11.0	14.0	12.3	1.3
Potassium, Dissolved (mg/L)	4	2.0	3.0	2.8	0.5
Sodium, Dissolved (mg/L)	4	14.0	20.0	15.8	2.9
Sulfate, Total (mg/L)	4	28.0	43.0	35.5	6.5
Dissolved Solids, Total (mg/L)	4	205	249	221	19.4
Suspended Solids, Total (mg/L)	4	5.0	85.0	29.3	37.4
Turbidity (NTU)	4	3.2	47.3	17.1	20.4
Arsenic, Total (mg/L)	4	0.015	0.020	0.018	0.002
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.002	0.004	0.003	0.001
Iron, Total (mg/L)	4	0.100	1.550	0.553	0.671
Lead, Total (mg/L)	4	0.001	0.002	0.001	0.001
Manganese, Total (mg/L)	4	0.014	0.063	0.030	0.022
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.140	0.270	0.213	0.063
Nitrogen, Total (mg/L)	4	0.430	0.500	0.468	0.030
Phosphorus, Total (mg/L)	4	0.022	0.127	0.062	0.045
Dissolved Oxygen (mg/L)	4	7.3	10.2	8.7	1.6
Dissolved Oxygen (% Sat)	4	76.9	86.7	81.8	5.4
pH (s.u.)	4	6.84	8.22	7.74	0.62
Specific Conductance (µS/cm)	4	298	330	319	14.4
Temperature, Water (°C)	4	0.0	17.2	8.3	7.8

Table B-89: Water quality analyte descriptive statistics at Station 9 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	3	140	140	140	0.0
Bicarbonate as HCO_3, Total (mg/L)	3	160	170	167	5.8
Calcium, Dissolved (mg/L)	3	35.0	41.0	38.3	3.1
Chloride, Total (mg/L)	3	7.0	8.0	7.7	0.6
Magnesium, Dissolved (mg/L)	3	12.0	13.0	12.7	0.6
Potassium, Dissolved (mg/L)	3	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	3	17.0	19.0	18.0	1.0
Sulfate, Total (mg/L)	3	38.0	44.0	41.7	3.2
Dissolved Solids, Total (mg/L)	3	229	231	230	1.0
Suspended Solids, Total (mg/L)	3	5.0	38.0	21.0	16.5
Turbidity (NTU)	3	4.0	23.5	13.4	9.8
Arsenic, Total (mg/L)	3	0.014	0.019	0.017	0.003
Cadmium, Total (mg/L)	3	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	3	0.001	0.002	0.002	0.001
Iron, Total (mg/L)	3	0.090	0.610	0.310	0.269
Lead, Total (mg/L)	3	0.001	0.002	0.001	0.001
Manganese, Total (mg/L)	3	0.016	0.040	0.025	0.013
Zinc, Total (mg/L)	3	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	3	0.050	0.160	0.117	0.059
Nitrogen, Total (mg/L)	3	0.320	0.480	0.397	0.080
Phosphorus, Total (mg/L)	3	0.025	0.051	0.039	0.013
Dissolved Oxygen (mg/L)	3	8.6	11.7	10.3	1.6
Dissolved Oxygen (% Sat)	3	98.4	109.0	103.3	5.4
pH (s.u.)	3	8.20	8.61	8.42	0.21
Specific Conductance (µS/cm)	3	339	355	348	7.7
Temperature, Water (°C)	3	3.0	20.4	10.9	8.8

Table B-90: Water quality analyte descriptive statistics at Station 9 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	140	140	140	0.0
Bicarbonate as HCO_3, Total (mg/L)	4	160	170	168	5.0
Calcium, Dissolved (mg/L)	4	40.0	40.0	40.0	0.0
Chloride, Total (mg/L)	4	7.0	9.0	8.3	1.0
Magnesium, Dissolved (mg/L)	4	12.0	17.0	14.0	2.2
Potassium, Dissolved (mg/L)	4	2.0	3.0	2.8	0.5
Sodium, Dissolved (mg/L)	4	18.0	26.0	20.5	3.7
Sulfate, Total (mg/L)	4	40.0	81.0	54.3	18.7
Dissolved Solids, Total (mg/L)	4	219	278	242	27.8
Suspended Solids, Total (mg/L)	4	5.0	184.0	51.8	88.2
Turbidity (NTU)	4	4.1	133.0	38.1	63.3
Arsenic, Total (mg/L)	4	0.012	0.021	0.018	0.004
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.004	0.002	0.001
Iron, Total (mg/L)	4	0.070	1.590	0.510	0.725
Lead, Total (mg/L)	4	0.001	0.006	0.003	0.002
Manganese, Total (mg/L)	4	0.015	0.087	0.034	0.036
Zinc, Total (mg/L)	4	0.005	0.010	0.006	0.003
Nitrate Nitrite, Total (mg/L)	4	0.060	0.250	0.150	0.078
Nitrogen, Total (mg/L)	4	0.310	0.540	0.418	0.125
Phosphorus, Total (mg/L)	4	0.025	0.166	0.065	0.068
Dissolved Oxygen (mg/L)	3	8.7	12.7	10.8	2.0
Dissolved Oxygen (% Sat)	3	92.4	97.2	95.3	2.5
pH (s.u.)	4	5.88	8.36	7.60	1.17
Specific Conductance (µS/cm)	4	334	367	355	15.4
Temperature, Water (°C)	4	0.0	20.5	9.3	9.0

Table B-91: Water quality analyte descriptive statistics at Station 10 in 2011.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	12	106	155	134	12.2
Bicarbonate as HCO_3, Total (mg/L)	12	110	187	161	19.4
Calcium, Total (mg/L)	12	34.0	45.0	39.3	2.7
Chloride, Total (mg/L)	12	6.0	9.0	7.2	1.2
Magnesium, Dissolved (mg/L)	12	10.0	15.0	13.2	1.5
Potassium, Total (mg/L)	12	3.0	4.0	3.2	0.4
Sodium, Dissolved (mg/L)	12	13.0	21.0	15.6	2.5
Sulfate, Total (mg/L)	12	36.0	67.0	47.0	9.7
Dissolved Solids, Total (mg/L)	12	188	267	222	21.5
Suspended Solids, Total (mg/L)	12	5.0	74.0	20.6	24.2
Turbidity (NTU)	12	3.7	44.6	14.9	13.9
Arsenic, Total (mg/L)	12	0.013	0.018	0.016	0.002
Cadmium, Total (mg/L)	12	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	12	0.002	0.005	0.003	0.001
Iron, Total (mg/L)	12	0.110	1.580	0.512	0.526
Lead, Total (mg/L)	12	0.001	0.007	0.002	0.002
Manganese, Total (mg/L)	12	0.010	0.060	0.028	0.019
Zinc, Total (mg/L)	12	0.005	0.005	0.005	0.000
Nitrate Nitrite, Dissolved (mg/L)	12	0.005	0.330	0.191	0.110
Nitrogen, Total (mg/L)	12	0.300	0.800	0.525	0.160
Phosphorus, Total (mg/L)	12	0.023	0.090	0.055	0.021
Dissolved Oxygen (mg/L)	6	7.2	10.8	8.9	1.4
Dissolved Oxygen (% Sat)	6	84.1	97.2	88.6	4.5
pH (s.u.)	12	7.94	8.58	8.33	0.19
Specific Conductance (µS/cm)	12	307	412	355	31.9
Temperature, Water (°C)	12	0.2	20.1	8.7	7.2

Table B-92: Water quality analyte descriptive statistics at Station 10 in 2012.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	135	159	145	10.4
Bicarbonate as HCO_3, Total (mg/L)	4	165	189	173	11.4
Calcium, Total (mg/L)	4	39.0	47.0	43.5	3.4
Chloride, Total (mg/L)	4	7.0	9.0	8.0	0.8
Magnesium, Dissolved (mg/L)	4	13.0	17.0	15.0	1.8
Potassium, Total (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	15.0	19.0	17.3	2.1
Sulfate, Total (mg/L)	4	47.0	56.0	51.0	4.2
Dissolved Solids, Total (mg/L)	4	214	263	232	21.4
Suspended Solids, Total (mg/L)	4	5.0	15.0	8.8	4.8
Turbidity (NTU)	4	3.9	12.8	7.6	4.2
Arsenic, Total (mg/L)	4	0.016	0.020	0.018	0.002
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.004	0.002	0.001
Iron, Total (mg/L)	4	0.080	0.360	0.205	0.133
Lead, Total (mg/L)	4	0.001	0.004	0.001	0.002
Manganese, Total (mg/L)	4	0.012	0.029	0.021	0.007
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.060	0.300	0.173	0.120
Nitrogen, Total (mg/L)	4	0.300	0.530	0.408	0.125
Phosphorus, Total (mg/L)	4	0.024	0.058	0.035	0.015
Dissolved Oxygen (mg/L)	4	7.6	11.6	9.5	2.1
Dissolved Oxygen (% Sat)	4	85.5	95.5	90.3	4.7
pH (s.u.)	4	7.84	8.57	8.32	0.34
Specific Conductance (µS/cm)	4	337	401	377	29.4
Temperature, Water (°C)	4	1.2	19.1	10.1	9.2

Table B-93: Water quality analyte descriptive statistics at Station 10 in 2013.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	133	155	145	11.7
Bicarbonate as HCO_3, Total (mg/L)	4	155	189	173	14.9
Calcium, Total (mg/L)	4	40.0	50.0	43.5	4.5
Chloride, Total (mg/L)	4	7.0	10.0	9.0	1.4
Magnesium, Dissolved (mg/L)	4	13.0	17.0	14.8	2.1
Potassium, Total (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	14.0	21.0	17.8	3.0
Sulfate, Total (mg/L)	4	37.0	62.0	51.0	11.3
Dissolved Solids, Total (mg/L)	4	215	255	239	16.9
Suspended Solids, Total (mg/L)	4	5.0	16.0	9.0	5.2
Turbidity (NTU)	4	3.6	15.2	8.3	5.6
Arsenic, Total (mg/L)	4	0.016	0.019	0.018	0.001
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.002	0.002	0.001
Iron, Total (mg/L)	4	0.090	0.390	0.218	0.147
Lead, Total (mg/L)	4	0.001	0.007	0.004	0.003
Manganese, Total (mg/L)	4	0.014	0.031	0.022	0.009
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.050	0.260	0.150	0.093
Nitrogen, Total (mg/L)	4	0.200	0.500	0.350	0.129
Phosphorus, Total (mg/L)	4	0.038	0.044	0.041	0.003
Dissolved Oxygen (mg/L)	4	5.8	10.1	8.2	1.9
Dissolved Oxygen (% Sat)	4	72.5	83.6	77.9	5.1
pH (s.u.)	4	7.90	8.45	8.29	0.27
Specific Conductance (µS/cm)	4	353	435	391	39.3
Temperature, Water (°C)	4	1.9	21.0	10.1	9.5

Table B-94: Water quality analyte descriptive statistics at Station 10 in 2014.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	133	146	139	5.9
Bicarbonate as HCO_3, Total (mg/L)	4	162	178	168	6.9
Calcium, Total (mg/L)	3	40.0	42.0	40.7	1.2
Calcium, Dissolved (mg/L)	1	43.0	43.0	43.0	--
Chloride, Total (mg/L)	4	8.0	10.0	9.0	0.8
Magnesium, Dissolved (mg/L)	4	12.0	16.0	14.0	1.6
Potassium, Total (mg/L)	3	3.0	3.0	3.0	0.0
Potassium, Dissolved (mg/L)	1	3.0	3.0	3.0	--
Sodium, Dissolved (mg/L)	4	16.0	20.0	17.5	1.9
Sulfate, Total (mg/L)	4	35.0	64.0	48.5	11.9
Dissolved Solids, Total (mg/L)	4	209	232	224	10.4
Suspended Solids, Total (mg/L)	4	5.0	41.0	16.8	17.0
Turbidity (NTU)	4	4.0	27.0	12.0	10.8
Arsenic, Total (mg/L)	4	0.018	0.021	0.020	0.001
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.002	0.002	0.001
Iron, Total (mg/L)	4	0.080	0.730	0.320	0.301
Lead, Total (mg/L)	4	0.001	0.005	0.002	0.002
Manganese, Total (mg/L)	4	0.014	0.052	0.027	0.018
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.030	0.250	0.133	0.105
Nitrogen, Total (mg/L)	4	0.200	0.900	0.450	0.311
Phosphorus, Total (mg/L)	4	0.036	0.051	0.043	0.007
Dissolved Oxygen (mg/L)	4	6.0	9.9	8.4	1.8
Dissolved Oxygen (% Sat)	4	73.6	87.1	79.3	5.7
pH (s.u.)	4	8.03	8.43	8.23	0.21
Specific Conductance (µS/cm)	4	337	407	368	31.5
Temperature, Water (°C)	4	1.1	20.5	9.5	9.3

Table B-95: Water quality analyte descriptive statistics at Station 10 in 2015.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	131	151	141	8.2
Bicarbonate as HCO_3, Total (mg/L)	4	155	178	169	9.8
Calcium, Dissolved (mg/L)	4	42.0	44.0	43.0	0.8
Chloride, Total (mg/L)	4	7.0	9.0	7.8	1.0
Magnesium, Dissolved (mg/L)	4	14.0	16.0	14.8	1.0
Potassium, Dissolved (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	17.0	19.0	18.5	1.0
Sulfate, Total (mg/L)	4	45.0	58.0	51.3	5.4
Dissolved Solids, Total (mg/L)	4	233	254	241	9.5
Suspended Solids, Total (mg/L)	4	5.0	20.0	12.3	6.3
Turbidity (NTU)	4	5.8	17.4	10.1	5.2
Arsenic, Total (mg/L)	4	0.013	0.022	0.018	0.004
Cadmium, Total (mg/L)	2	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	2	0.001	0.006	0.003	0.004
Iron, Total (mg/L)	2	0.140	0.170	0.155	0.021
Lead, Total (mg/L)	2	0.001	0.004	0.002	0.002
Manganese, Total (mg/L)	2	0.015	0.019	0.017	0.003
Zinc, Total (mg/L)	2	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.070	0.210	0.153	0.059
Nitrogen, Total (mg/L)	4	0.250	0.400	0.338	0.075
Phosphorus, Total (mg/L)	4	0.026	0.047	0.037	0.010
Dissolved Oxygen (mg/L)	4	6.5	10.2	8.4	1.5
Dissolved Oxygen (% Sat)	4	75.6	82.3	78.3	3.1
pH (s.u.)	4	8.05	8.52	8.36	0.21
Specific Conductance (µS/cm)	4	362	402	380	18.4
Temperature, Water (°C)	4	1.2	17.6	8.8	7.2

Table B-96: Water quality analyte descriptive statistics at Station 10 in 2016.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	146	148	147	1.0
Bicarbonate as HCO_3, Total (mg/L)	4	169	179	176	4.6
Calcium, Dissolved (mg/L)	4	43.0	45.0	43.8	1.0
Chloride, Total (mg/L)	4	8.0	9.0	8.8	0.5
Magnesium, Dissolved (mg/L)	4	14.0	16.0	14.8	1.0
Potassium, Dissolved (mg/L)	4	3.0	4.0	3.3	0.5
Sodium, Dissolved (mg/L)	4	18.0	22.0	19.8	1.7
Sulfate, Total (mg/L)	4	43.0	52.0	48.8	4.3
Dissolved Solids, Total (mg/L)	4	228	246	237	9.3
Suspended Solids, Total (mg/L)	4	5.0	19.0	11.8	7.8
Turbidity (NTU)	4	4.5	16.6	10.0	5.9
Arsenic, Total (mg/L)	4	0.017	0.020	0.019	0.001
Cadmium, Total (mg/L)	3	0.000	0.001	0.000	0.000
Copper, Total (mg/L)	3	0.001	0.002	0.001	0.001
Iron, Total (mg/L)	3	0.100	0.370	0.203	0.146
Lead, Total (mg/L)	3	0.001	0.010	0.004	0.005
Manganese, Total (mg/L)	3	0.017	0.031	0.023	0.007
Zinc, Total (mg/L)	3	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.060	0.210	0.118	0.064
Nitrogen, Total (mg/L)	4	0.200	0.400	0.290	0.084
Phosphorus, Total (mg/L)	4	0.030	0.040	0.035	0.004
Dissolved Oxygen (mg/L)	4	5.9	9.0	7.6	1.3
Dissolved Oxygen (% Sat)	4	73.9	84.0	77.7	4.9
pH (s.u.)	4	8.20	8.25	8.22	0.02
Specific Conductance (µS/cm)	4	363	406	385	17.9
Temperature, Water (°C)	4	4.7	21.6	12.3	7.5

Table B-97: Water quality analyte descriptive statistics at Station 10 in 2017.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	140	150	143	5.0
Bicarbonate as HCO_3, Total (mg/L)	4	160	180	170	8.2
Calcium, Dissolved (mg/L)	4	38.0	43.0	40.3	2.6
Chloride, Total (mg/L)	4	8.0	9.0	8.6	0.4
Magnesium, Dissolved (mg/L)	4	12.0	15.0	13.5	1.3
Potassium, Dissolved (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	15.0	20.0	17.3	2.1
Sulfate, Total (mg/L)	4	35.0	59.0	47.0	9.8
Dissolved Solids, Total (mg/L)	4	191	257	229	27.7
Suspended Solids, Total (mg/L)	4	5.0	70.0	22.8	31.6
Turbidity (NTU)	4	4.3	43.6	16.0	18.5
Arsenic, Total (mg/L)	4	0.017	0.021	0.019	0.002
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.003	0.002	0.001
Iron, Total (mg/L)	4	0.080	1.360	0.458	0.604
Lead, Total (mg/L)	4	0.002	0.005	0.004	0.001
Manganese, Total (mg/L)	4	0.017	0.065	0.031	0.023
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.040	0.300	0.148	0.121
Nitrogen, Total (mg/L)	4	0.160	0.520	0.363	0.186
Phosphorus, Total (mg/L)	4	0.029	0.056	0.044	0.012
Dissolved Oxygen (mg/L)	4	6.3	9.2	8.4	1.4
Dissolved Oxygen (% Sat)	4	76.6	89.4	80.5	6.0
pH (s.u.)	4	7.67	8.55	8.26	0.40
Specific Conductance (µS/cm)	4	336	404	371	28.2
Temperature, Water (°C)	4	3.5	19.5	9.4	7.3

Table B-98: Water quality analyte descriptive statistics at Station 10 in 2018.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	130	140	135	5.8
Bicarbonate as HCO_3, Total (mg/L)	4	160	170	165	5.8
Calcium, Dissolved (mg/L)	4	37.0	42.0	39.5	2.1
Chloride, Total (mg/L)	4	6.0	9.0	7.3	1.3
Magnesium, Dissolved (mg/L)	4	11.0	13.0	12.3	1.0
Potassium, Dissolved (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	14.0	18.0	15.3	1.9
Sulfate, Total (mg/L)	4	30.0	48.0	40.8	7.6
Dissolved Solids, Total (mg/L)	4	215	247	228	14.7
Suspended Solids, Total (mg/L)	4	5.0	120.0	35.8	56.3
Turbidity (NTU)	4	2.2	55.5	18.0	25.2
Arsenic, Total (mg/L)	4	0.015	0.021	0.018	0.002
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.002	0.005	0.003	0.002
Iron, Total (mg/L)	4	0.060	1.950	0.598	0.906
Lead, Total (mg/L)	4	0.001	0.005	0.002	0.002
Manganese, Total (mg/L)	4	0.013	0.071	0.030	0.027
Zinc, Total (mg/L)	4	0.005	0.010	0.006	0.003
Nitrate Nitrite, Total (mg/L)	4	0.140	0.290	0.205	0.072
Nitrogen, Total (mg/L)	4	0.410	0.510	0.455	0.044
Phosphorus, Total (mg/L)	4	0.023	0.145	0.062	0.056
Dissolved Oxygen (mg/L)	4	7.6	10.4	9.3	1.3
Dissolved Oxygen (% Sat)	4	73.0	88.5	81.5	7.5
pH (s.u.)	4	8.00	8.30	8.11	0.13
Specific Conductance (µS/cm)	4	329	373	353	18.3
Temperature, Water (°C)	4	73.0	88.5	81.5	7.5

Table B-99: Water quality analyte descriptive statistics at Station 10 in 2019.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	140	140	140	0.0
Bicarbonate as HCO_3, Total (mg/L)	4	160	170	168	5.0
Calcium, Dissolved (mg/L)	4	38.0	43.0	41.0	2.2
Chloride, Total (mg/L)	4	7.0	9.0	8.0	0.8
Magnesium, Dissolved (mg/L)	4	13.0	15.0	13.5	1.0
Potassium, Dissolved (mg/L)	4	3.0	3.0	3.0	0.0
Sodium, Dissolved (mg/L)	4	16.0	19.0	17.3	1.5
Sulfate, Total (mg/L)	4	41.0	54.0	48.5	5.6
Dissolved Solids, Total (mg/L)	4	238	250	243	5.6
Suspended Solids, Total (mg/L)	4	5.0	33.0	13.8	13.3
Turbidity (NTU)	4	2.3	24.0	9.9	9.7
Arsenic, Total (mg/L)	4	0.014	0.018	0.016	0.002
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.002	0.001	0.001
Iron, Total (mg/L)	4	0.050	0.540	0.203	0.227
Lead, Total (mg/L)	4	0.001	0.003	0.001	0.001
Manganese, Total (mg/L)	4	0.008	0.040	0.021	0.014
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.060	0.280	0.173	0.090
Nitrogen, Total (mg/L)	4	0.370	0.480	0.403	0.053
Phosphorus, Total (mg/L)	4	0.028	0.053	0.038	0.011
Dissolved Oxygen (mg/L)	4	9.0	11.8	10.9	1.2
Dissolved Oxygen (% Sat)	4	89.3	111.4	101.7	10.5
pH (s.u.)	4	7.73	8.48	8.22	0.34
Specific Conductance (µS/cm)	4	351	391	369	16.8
Temperature, Water (°C)	4	0.4	20.4	8.7	8.6

Table B-100: Water quality analyte descriptive statistics at Station 10 in 2020.

Analyte	N	Minimum	Maximum	Mean	Standard Deviation
Alkalinity as $CaCO_3$, Total (mg/L)	4	140	140	140	0.0
Bicarbonate as HCO_3, Total (mg/L)	4	160	180	170	8.2
Calcium, Dissolved (mg/L)	4	39.0	44.0	42.5	2.4
Chloride, Total (mg/L)	4	6.0	9.0	8.0	1.4
Magnesium, Dissolved (mg/L)	4	13.0	15.0	14.3	1.0
Potassium, Dissolved (mg/L)	4	2.0	3.0	2.8	0.5
Sodium, Dissolved (mg/L)	4	17.0	18.0	17.5	0.6
Sulfate, Total (mg/L)	4	48.0	57.0	51.5	4.0
Dissolved Solids, Total (mg/L)	4	229	259	240	13.3
Suspended Solids, Total (mg/L)	4	5.0	74.0	24.0	33.5
Turbidity (NTU)	4	3.7	58.9	19.3	26.5
Arsenic, Total (mg/L)	4	0.012	0.019	0.017	0.003
Cadmium, Total (mg/L)	4	0.000	0.000	0.000	0.000
Copper, Total (mg/L)	4	0.001	0.002	0.002	0.001
Iron, Total (mg/L)	4	0.070	0.910	0.313	0.402
Lead, Total (mg/L)	4	0.001	0.002	0.001	0.001
Manganese, Total (mg/L)	4	0.014	0.049	0.025	0.017
Zinc, Total (mg/L)	4	0.005	0.005	0.005	0.000
Nitrate Nitrite, Total (mg/L)	4	0.080	0.220	0.138	0.066
Nitrogen, Total (mg/L)	4	0.320	0.490	0.388	0.079
Phosphorus, Total (mg/L)	4	0.022	0.063	0.039	0.018
Dissolved Oxygen (mg/L)	3	9.3	12.9	11.1	1.8
Dissolved Oxygen (% Sat)	3	95.8	100.5	98.5	2.5
pH (s.u.)	4	5.73	9.50	7.89	1.58
Specific Conductance (µS/cm)	4	324	381	351	24.6
Temperature, Water (°C)	4	0.8	20.5	9.9	8.8

Appendix B.2 Correlation Matrices

Table B-101: Kendall's tau correlation matrix of water quality parameters collected at Station 1 from 2011 to 2020.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.955*	0.116	0.026	0.028	0.185	0.000	-0.052	.	-0.074	0.014	-0.091	-0.096	-0.011	-0.329*	-0.297*
	Sig. (2-tailed)	.	0.000	0.276	0.806	0.799	0.270	1.000	0.630	.	0.653	0.936	0.398	0.390	0.921	0.007	0.005
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Group by Quarter	Correlation Coefficient	0.955*	1.000	0.109	0.038	0.029	0.220	0.000	-0.049	.	-0.080	0.014	-0.070	-0.100	-0.023	-0.338*	-0.324*
	Sig. (2-tailed)	0.000	.	0.320	0.733	0.796	0.214	1.000	0.658	.	0.646	0.936	0.531	0.383	0.832	0.007	0.003
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Julian Date	Correlation Coefficient	0.116	0.109	1.000	0.048	0.093	0.141	-0.197	-0.022	.	-0.067	-0.255	0.032	0.074	0.092	-0.062	-0.025
	Sig. (2-tailed)	0.276	0.320	.	0.637	0.359	0.382	0.234	0.831	.	0.676	0.112	0.749	0.478	0.360	0.584	0.803
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.026	0.038	0.048	1.000	0.885*	0.609*	0.735*	0.751*	.	0.779*	0.858*	0.746*	0.585*	0.720*	-0.383*	-0.263*
	Sig. (2-tailed)	0.806	0.733	0.637	.	0.000	0.000	0.000	0.000	.	0.000	0.000	0.000	0.000	0.000	0.001	0.009
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.028	0.029	0.093	0.885*	1.000	0.637*	0.660*	0.700*	.	0.720*	0.824*	0.715*	0.561*	0.691*	-0.360*	-0.284*
	Sig. (2-tailed)	0.799	0.796	0.359	0.000	.	0.000	0.000	0.000	.	0.000	0.000	0.000	0.000	0.000	0.002	0.005
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	0.185	0.220	0.141	0.609*	0.637*	1.000	.	0.499*	.	0.656*	.	0.552*	0.411*	0.540*	-0.404*	-0.483*
	Sig. (2-tailed)	0.270	0.214	0.382	0.000	0.000	.	.	0.002	.	0.000	.	0.001	0.014	0.001	0.027	0.003
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.000	0.000	-0.197	0.735*	0.660*	.	1.000	0.721*	.	.	0.756*	0.688*	0.614*	0.697*	-0.477*	-0.305*
	Sig. (2-tailed)	1.000	1.000	0.234	0.000	0.000	.	.	0.000	.	.	0.000	0.000	0.000	0.000	0.011	0.066
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	-0.052	-0.049	-0.022	0.751*	0.700*	0.499*	0.721*	1.000	.	0.834*	0.867*	0.881*	0.660*	0.811*	-0.289*	-0.144
	Sig. (2-tailed)	0.630	0.658	0.831	0.000	0.000	0.002	0.000	.	.	0.000	0.000	0.000	0.000	0.000	0.012	0.154
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	-0.074	-0.080	-0.067	0.779*	0.720*	0.656*	.	0.834*	.	1.000	.	0.868*	0.769*	0.771*	-0.200	-0.197
	Sig. (2-tailed)	0.653	0.646	0.676	0.000	0.000	0.000	.	0.000	.	.	.	0.000	0.000	0.000	0.267	0.219
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.014	0.014	-0.255	0.858*	0.824*	.	0.756*	0.867*	.	.	1.000	0.870*	0.546*	0.859*	-0.564*	-0.364*
	Sig. (2-tailed)	0.936	0.936	0.112	0.000	0.000	.	0.000	0.000	.	.	.	0.000	0.001	0.000	0.002	0.023
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.091	-0.070	0.032	0.746*	0.715*	0.552*	0.688*	0.881*	.	0.868*	0.870*	1.000	0.647*	0.793*	-0.314*	-0.173*
	Sig. (2-tailed)	0.398	0.531	0.749	0.000	0.000	0.001	0.000	0.000	.	0.000	0.000	.	0.000	0.000	0.006	0.086
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	-0.096	-0.100	0.074	0.585*	0.561*	0.411*	0.614*	0.660*	.	0.769*	0.546*	0.647*	1.000	0.639*	-0.157	0.010
	Sig. (2-tailed)	0.390	0.383	0.478	0.000	0.000	0.014	0.000	0.000	.	0.000	0.001	0.000	.	0.000	0.186	0.921
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	-0.011	-0.023	0.092	0.720*	0.691*	0.540*	0.697*	0.811*	.	0.771*	0.859*	0.793*	0.639*	1.000	-0.333*	-0.134
	Sig. (2-tailed)	0.921	0.832	0.360	0.000	0.000	0.001	0.000	0.000	.	0.000	0.000	0.000	0.000	.	0.003	0.179
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.329*	-0.338*	-0.062	-0.383*	-0.360*	-0.404*	-0.477*	-0.289*	.	-0.200	-0.564*	-0.314*	-0.157	-0.333*	1.000	0.598*
	Sig. (2-tailed)	0.007	0.007	0.584	0.001	0.002	0.027	0.011	0.012	.	0.267	0.002	0.006	0.186	0.003	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	-0.297*	-0.324*	-0.025	-0.263*	-0.284*	-0.483*	-0.305*	-0.144	.	-0.197	-0.364*	-0.173*	0.010	-0.134	0.598*	1.000
	Sig. (2-tailed)	0.005	0.003	0.803	0.009	0.005	0.003	0.066	0.154	.	0.219	0.023	0.086	0.921	0.179	0.000	.
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	-0.115	-0.113	-0.008	0.710*	0.670*	0.482*	0.690*	0.865*	.	0.824*	0.829*	0.839*	0.656*	0.788*	-0.263*	-0.124
	Sig. (2-tailed)	0.280	0.307	0.936	0.000	0.000	0.003	0.000	0.000	.	0.000	0.000	0.000	0.000	0.000	0.021	0.217
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	-0.305	-0.377	-0.305	-0.055	-0.072	-0.048	.	0.054	.	0.020	.	0.000	0.091	0.126	0.047	0.326
	Sig. (2-tailed)	0.210	0.148	0.210	0.824	0.767	0.860	.	0.825	.	0.939	.	1.000	0.711	0.605	0.860	0.183
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	-0.400*	-0.442*	-0.400*	-0.063	-0.047	-0.267	.	0.000	.	-0.067	.	-0.140	0.156	-0.031	0.527*	0.977*
	Sig. (2-tailed)	0.073	0.064	0.073	0.782	0.836	0.281	.	1.000	.	0.775	.	0.534	0.489	0.890	0.032	0.000
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	0.037	0.123	0.037	-0.264	-0.262	-0.397	.	-0.260	.	-0.325	.	-0.262	-0.339	-0.260	-0.196	0.112
	Sig. (2-tailed)	0.885	0.655	0.885	0.309	0.310	0.167	.	0.311	.	0.233	.	0.310	0.191	0.311	0.491	0.663
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	-0.485*	-0.572*	-0.485*	-0.098	-0.081	-0.237	.	0.000	.	0.018	.	-0.081	0.181	0.032	0.554*	0.896*
	Sig. (2-tailed)	0.035	0.020	0.035	0.673	0.725	0.354	.	1.000	.	0.942	.	0.725	0.438	0.888	0.029	0.000
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.116	-0.116	-0.012	0.344*	0.348*	0.150	0.384*	0.423*	.	0.328	0.442*	0.447*	0.480*	0.415*	-0.300*	0.149
	Sig. (2-tailed)	0.400	0.400	0.922	0.007	0.006	0.550	0.031	0.001	.	0.202	0.010	0.000	0.000	0.001	0.035	0.234
	N	36	36	36	36	36	12	24	36	36	12	24	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	-0.342	-0.397	-0.342	0.579*	0.526*	0.240	.	0.440*	.	0.411*	.	0.444*	0.613*	0.408*	0.387	0.214
	Sig. (2-tailed)	0.140	0.110	0.140	0.013	0.024	0.353	.	0.058	.	0.095	.	0.057	0.009	0.079	0.130	0.360
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.215*	-0.220*	0.059	-0.268*	-0.243*	-0.223	-0.401*	-0.200*	.	-0.224	-0.404*	-0.186*	-0.040	-0.136	0.452*	0.614*
	Sig. (2-tailed)	0.049	0.051	0.561	0.010	0.019	0.190	0.017	0.053	.	0.181	0.013	0.072	0.711	0.186	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.199*	-0.204*	-0.369*	-0.093	-0.151	-0.221	-0.110	-0.114	.	-0.073	-0.324*	-0.143	-0.056	-0.250*	0.332*	0.235*
	Sig. (2-tailed)	0.065	0.067	0.000	0.363	0.141	0.179	0.515	0.265	.	0.655	0.047	0.162	0.596	0.013	0.004	0.020
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.055	0.025	0.179*	0.270*	0.273*	0.210	0.206	0.301*	.	0.343*	0.155	0.304*	0.495*	0.321*	-0.166	0.144
	Sig. (2-tailed)	0.632	0.831	0.095	0.013	0.012	0.272	0.213	0.006	.	0.071	0.335	0.005	0.000	0.003	0.177	0.179
	N	42	42	42	42	42	18	24	42	42	18	24	42	42	42	42	42
Dissolved Oxygen (% Sat.)	Correlation Coefficient	0.106	0.114	0.041	-0.113	-0.097	0.000	-0.081	-0.163	.	-0.151	-0.222	-0.183*	0.026	-0.106	-0.082	-0.094
	Sig. (2-tailed)	0.362	0.333	0.704	0.297	0.373	1.000	0.626	0.134	.	0.425	0.167	0.092	0.818	0.324	0.505	0.380
	N	42	42	42	42	42	18	24	42	42	18	24	42	42	42	42	42
pH, Taken in field	Correlation Coefficient	0.118	0.130	-0.105	0.172*	0.138	0.257	0.368*	0.196*	.	0.360*	0.096	0.165	0.168	0.133	-0.087	-0.290*
	Sig. (2-tailed)	0.269	0.239	0.294	0.089	0.173	0.113	0.027	0.052	.	0.024	0.549	0.101	0.108	0.185	0.445	0.004
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	-0.060	-0.051	0.053	0.772*	0.725*	0.556*	0.727*	0.882*	.	0.843*	0.858*	0.897*	0.643*	0.801*	-0.297*	-0.188*
	Sig. (2-tailed)	0.574	0.645	0.594	0.000	0.000	0.001	0.000	0.000	.	0.000	0.000	0.000	0.000	0.000	0.009	0.060
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	0.143	0.164	0.011	-0.278*	-0.267*	-0.212	-0.278*	-0.347*	.	-0.367*	-0.264	-0.361*	-0.424*	-0.335*	0.093	-0.101
	Sig. (2-tailed)	0.180	0.136	0.915	0.006	0.008	0.190	0.094	0.001	.	0.021	0.101	0.000	0.000	0.001	0.412	0.311
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.022	-0.033	-0.009	-0.700*	-0.696*	-0.477*	-0.553*	-0.695*	.	-0.743*	-0.687*	-0.700*	-0.451*	-0.613*	0.401*	0.391*
	Sig. (2-tailed)	0.835	0.761	0.929	0.000	0.000	0.003	0.001	0.000	.	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesium, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-102: Kendall's tau correlation matrix of water quality parameters collected at Station 1 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	-0.115	.	-0.305	-0.400*	0.037	-0.485*	.	-0.116	-0.342	-0.215*	-0.199*	0.055	0.106	0.118	-0.060	0.143	-0.022
	Sig. (2-tailed)	0.280	.	0.210	0.073	0.885	0.035	.	0.400	0.140	0.049	0.065	0.632	0.362	0.269	0.574	0.180	0.835
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Group by Quarter	Correlation Coefficient	-0.113	.	-0.377	-0.442*	0.123	-0.572*	.	-0.116	-0.397	-0.220*	-0.204*	0.025	0.114	0.130	-0.051	0.164	-0.033
	Sig. (2-tailed)	0.307	.	0.148	0.064	0.655	0.020	.	0.400	0.110	0.051	0.067	0.831	0.333	0.239	0.645	0.136	0.761
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Julian Date	Correlation Coefficient	-0.008	.	-0.305	-0.400*	0.037	-0.485*	.	-0.012	-0.342	0.059	-0.369*	0.179*	0.041	-0.105	0.053	0.011	-0.009
	Sig. (2-tailed)	0.936	.	0.210	0.073	0.885	0.035	.	0.922	0.140	0.561	0.000	0.095	0.704	0.294	0.594	0.915	0.929
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.710*	.	-0.055	-0.063	-0.264	-0.098	.	0.344*	0.579*	-0.268*	-0.093	0.270*	-0.113	0.172*	0.772*	-0.278*	-0.700*
	Sig. (2-tailed)	0.000	.	0.824	0.782	0.309	0.673	.	0.007	0.013	0.010	0.363	0.013	0.297	0.089	0.000	0.006	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.670*	.	-0.072	-0.047	-0.262	-0.081	.	0.348*	0.526*	-0.243*	-0.151	0.273*	-0.097	0.138	0.725*	-0.267*	-0.696*
	Sig. (2-tailed)	0.000	.	0.767	0.836	0.310	0.725	.	0.006	0.024	0.019	0.141	0.012	0.373	0.173	0.000	0.008	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	0.482*	.	-0.048	-0.267	-0.397	-0.237	.	0.150	0.240	-0.223	-0.221	0.210	0.000	0.257	0.556*	-0.212	-0.477*
	Sig. (2-tailed)	0.003	.	0.860	0.281	0.167	0.354	.	0.550	0.353	0.190	0.179	0.272	1.000	0.113	0.001	0.190	0.003
	N	24	12	12	12	12	12	12	12	12	24	24	18	18	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.690*	.	.	.	.	.	.	0.384*	.	-0.401*	-0.110	0.206	-0.081	0.368*	0.727*	-0.278*	-0.553*
	Sig. (2-tailed)	0.000	.	.	.	.	.	.	0.031	.	0.017	0.515	0.213	0.626	0.027	0.000	0.094	0.001
	N	24	0	0	0	0	0	0	24	0	24	24	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	0.865*	.	0.054	0.000	-0.260	0.000	.	0.423*	0.440*	-0.200*	-0.114	0.301*	-0.163	0.196*	0.882*	-0.347*	-0.695*
	Sig. (2-tailed)	0.000	.	0.825	1.000	0.311	1.000	.	0.001	0.058	0.053	0.265	0.006	0.134	0.052	0.000	0.001	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	0.824*	.	0.020	-0.067	-0.325	0.018	.	0.328	0.411*	-0.224	-0.073	0.343*	-0.151	0.360*	0.843*	-0.367*	-0.743*
	Sig. (2-tailed)	0.000	.	0.939	0.775	0.233	0.942	.	0.202	0.095	0.181	0.655	0.071	0.425	0.024	0.000	0.021	0.000
	N	24	12	12	12	12	12	12	12	12	24	24	18	18	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.829*	.	.	.	.	.	.	0.442*	.	-0.404*	-0.324*	0.155	-0.222	0.096	0.858*	-0.264	-0.687*
	Sig. (2-tailed)	0.000	.	.	.	.	.	.	0.010	.	0.013	0.047	0.335	0.167	0.549	0.000	0.101	0.000
	N	24	0	0	0	0	0	0	24	0	24	24	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.839*	.	0.000	-0.140	-0.262	-0.081	.	0.447*	0.444*	-0.186*	-0.143	0.304*	-0.183*	0.165	0.897*	-0.361*	-0.700*
	Sig. (2-tailed)	0.000	.	1.000	0.534	0.310	0.725	.	0.000	0.057	0.072	0.162	0.005	0.092	0.101	0.000	0.000	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.656*	.	0.091	0.156	-0.339	0.181	.	0.480*	0.613*	-0.040	-0.056	0.495*	0.026	0.168	0.643*	-0.424*	-0.451*
	Sig. (2-tailed)	0.000	.	0.711	0.489	0.191	0.438	.	0.000	0.009	0.711	0.596	0.000	0.818	0.108	0.000	0.000	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.788*	.	0.126	-0.031	-0.260	0.032	.	0.415*	0.408*	-0.136	-0.250*	0.321*	-0.106	0.133	0.801*	-0.335*	-0.613*
	Sig. (2-tailed)	0.000	.	0.605	0.890	0.311	0.888	.	0.001	0.079	0.186	0.013	0.003	0.324	0.185	0.000	0.001	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.263*	.	0.047	0.527*	-0.196	0.554*	.	-0.300*	0.387	0.452*	0.332*	-0.166	-0.082	-0.087	-0.297*	0.093	0.401*
	Sig. (2-tailed)	0.021	.	0.860	0.032	0.491	0.029	.	0.035	0.130	0.000	0.004	0.177	0.505	0.445	0.009	0.412	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	-0.124	.	0.326	0.977*	0.112	0.896*	.	0.149	0.214	0.614*	0.235*	0.144	-0.094	-0.290*	-0.188*	-0.101	0.391*
	Sig. (2-tailed)	0.217	.	0.183	0.000	0.663	0.000	.	0.234	0.360	0.000	0.020	0.179	0.380	0.004	0.060	0.311	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	.	0.018	0.000	-0.334	0.032	.	0.369*	0.440*	-0.187*	-0.110	0.224*	-0.200*	0.177*	0.840*	-0.309*	-0.628*
	Sig. (2-tailed)	.	.	0.941	1.000	0.192	0.888	.	0.003	0.058	0.068	0.277	0.037	0.064	0.077	0.000	0.002	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	0.018	.	1.000	0.328	-0.044	0.364	.	.	0.135	0.146	0.261	-0.078	0.545	-0.164	0.054	-0.090	-0.054
	Sig. (2-tailed)	0.941	.	.	0.182	0.877	0.153	.	.	0.598	0.583	0.296	0.837	0.150	0.505	0.825	0.712	0.825
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	0.000	.	0.328	1.000	0.113	0.886*	.	.	0.215	0.536*	0.736*	-0.215	0.501	-0.188	0.000	0.185	0.092
	Sig. (2-tailed)	1.000	.	0.182	.	0.663	0.000	.	.	0.359	0.027	0.001	0.559	0.173	0.406	1.000	0.408	0.679
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	-0.334	.	-0.044	0.113	1.000	0.000	.	.	-0.359	-0.172	-0.039	-0.577	0.577	-0.113	-0.260	0.408	0.260
	Sig. (2-tailed)	0.192	.	0.877	0.663	.	1.000	.	.	0.184	0.539	0.884	0.143	0.143	0.663	0.311	0.111	0.311
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	0.032	.	0.364	0.886*	0.000	1.000	.	.	0.226	0.469*	0.824*	-0.389	0.389	-0.131	0.000	0.129	0.032
	Sig. (2-tailed)	0.888	.	0.153	0.000	1.000	.	.	.	0.351	0.062	0.001	0.304	0.304	0.573	1.000	0.575	0.888
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	0.369*	.	.	.	.	.	.	1.000	.	0.160	-0.050	0.552*	-0.030	-0.142	0.366*	-0.650*	-0.188
	Sig. (2-tailed)	0.003	.	.	.	.	.	.	.	.	0.206	0.694	0.000	0.812	0.256	0.003	0.000	0.134
	N	36	0	0	0	0	0	0	36	0	36	36	36	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.440*	.	0.135	0.215	-0.359	0.226	.	.	1.000	0.454*	0.407*	0.745*	-0.149	-0.050	0.440*	-0.636*	-0.571*
	Sig. (2-tailed)	0.058	.	0.598	0.359	0.184	0.351	.	.	.	0.072	0.088	0.044	0.687	0.832	0.058	0.006	0.014
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.187*	.	0.146	0.536*	-0.172	0.469*	.	0.160	0.454*	1.000	0.062	0.198*	-0.004	-0.307*	-0.206*	-0.204*	0.339*
	Sig. (2-tailed)	0.068	.	0.583	0.027	0.539	0.062	.	0.206	0.072	.	0.549	0.071	0.974	0.003	0.044	0.046	0.001
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.110	.	0.261	0.736*	-0.039	0.824*	.	-0.050	0.407*	0.062	1.000	-0.097	-0.055	-0.012	-0.132	0.003	0.134
	Sig. (2-tailed)	0.277	.	0.296	0.001	0.884	0.001	.	0.694	0.088	0.549	.	0.373	0.610	0.908	0.191	0.979	0.185
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.224*	.	-0.078	-0.215	-0.577	-0.389	.	0.552*	0.745*	0.198*	-0.097	1.000	0.270*	-0.107	0.270*	-0.658*	-0.158
	Sig. (2-tailed)	0.037	.	0.837	0.559	0.143	0.304	.	0.000	0.044	0.071	0.373	.	0.012	0.319	0.012	0.000	0.140
	N	42	6	6	6	6	6	6	36	6	42	42	42	42	42	42	42	42
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.200*	.	0.545	0.501	0.577	0.389	.	-0.030	-0.149	-0.004	-0.055	0.270*	1.000	0.273*	-0.159	0.069	0.050
	Sig. (2-tailed)	0.064	.	0.150	0.173	0.143	0.304	.	0.812	0.687	0.974	0.610	0.012	.	0.011	0.138	0.523	0.641
	N	42	6	6	6	6	6	6	36	6	42	42	42	42	42	42	42	42
pH, Taken in field	Correlation Coefficient	0.177*	.	-0.164	-0.188	-0.113	-0.131	.	-0.142	-0.050	-0.307*	-0.012	-0.107	0.273*	1.000	0.197*	0.169*	-0.245*
	Sig. (2-tailed)	0.077	.	0.505	0.406	0.663	0.573	.	0.256	0.832	0.003	0.908	0.319	0.011	.	0.048	0.091	0.014
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	0.840*	.	0.054	0.000	-0.260	0.000	.	0.366*	0.440*	-0.206*	-0.132	0.270*	-0.159	0.197*	1.000	-0.298*	-0.713*
	Sig. (2-tailed)	0.000	.	0.825	1.000	0.311	1.000	.	0.003	0.058	0.044	0.191	0.012	0.138	0.048	.	0.003	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	-0.309*	.	-0.090	0.185	0.408	0.129	.	-0.650*	-0.636*	-0.204*	0.003	-0.658*	0.069	0.169*	-0.298*	1.000	0.170*
	Sig. (2-tailed)	0.002	.	0.712	0.408	0.111	0.575	.	0.000	0.006	0.046	0.979	0.000	0.523	0.091	0.003	.	0.088
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.628*	.	-0.054	0.092	0.260	0.032	.	-0.188	-0.571*	0.339*	0.134	-0.158	0.050	-0.245*	-0.713*	0.170*	1.000
	Sig. (2-tailed)	0.000	.	0.825	0.679	0.311	0.888	.	0.134	0.014	0.001	0.185	0.140	0.641	0.014	0.000	0.088	.
	N	48	12	12	12	12	12	12	36	12	48	48	42	42	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-103: Kendall's tau correlation matrix of water quality parameters collected at Station 2 from 2011 to 2020.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.955*	0.116	-0.413*	-0.403*	-0.168	0.215	-0.435*	0.120	-0.461*	-0.590*	-0.413*	-0.463*	-0.495*	.	0.310*
	Sig. (2-tailed)	.	0.000	0.276	0.000	0.000	0.323	0.242	0.000	0.352	0.006	0.001	0.000	0.000	0.000	.	0.004
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Group by Quarter	Correlation Coefficient	0.955*	1.000	0.109	-0.412*	-0.404*	-0.219	0.215	-0.444*	0.126	-0.484*	-0.590*	-0.427*	-0.487*	-0.518*	.	0.334*
	Sig. (2-tailed)	0.000	.	0.320	0.000	0.000	0.222	0.242	0.000	0.345	0.007	0.001	0.000	0.000	0.000	.	0.003
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Julian Date	Correlation Coefficient	0.116	0.109	1.000	-0.082	-0.075	0.180	-0.044	0.007	0.128	-0.043	-0.385*	0.020	0.112	0.037	.	0.197*
	Sig. (2-tailed)	0.276	0.320	.	0.418	0.455	0.274	0.794	0.943	0.286	0.792	0.018	0.845	0.294	0.709	.	0.052
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	-0.413*	-0.412*	-0.082	1.000	0.960*	0.319*	0.173	0.809*	0.186	0.710*	0.784*	0.783*	0.622*	0.663*	.	-0.237*
	Sig. (2-tailed)	0.000	0.000	0.418	.	0.000	0.053	0.308	0.000	0.127	0.000	0.000	0.000	0.000	0.000	.	0.021
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	-0.403*	-0.404*	-0.075	0.960*	1.000	0.304*	0.168	0.789*	0.172	0.696*	0.786*	0.760*	0.626*	0.663*	.	-0.230*
	Sig. (2-tailed)	0.000	0.000	0.455	0.000	.	0.065	0.322	0.000	0.155	0.000	0.000	0.000	0.000	0.000	.	0.024
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Calcium, Total (mg/L)	Correlation Coefficient	-0.168	-0.219	0.180	0.319*	0.304*	1.000	.	0.366*	0.604*	0.318*	.	0.354*	0.463*	0.416*	.	-0.159
	Sig. (2-tailed)	0.323	0.222	0.274	0.053	0.065	.	.	0.028	0.002	0.083	.	0.033	0.008	0.011	.	0.347
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	23
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.215	0.215	-0.044	0.173	0.168	.	1.000	0.114	0.823*	.	0.040	0.064	0.112	0.044	.	0.244
	Sig. (2-tailed)	0.242	0.242	0.794	0.308	0.322	.	.	0.503	0.000	.	0.830	0.705	0.533	0.793	.	0.146
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	-0.435*	-0.444*	0.007	0.809*	0.789*	0.366*	0.114	1.000	0.142	0.802*	0.834*	0.922*	0.705*	0.787*	.	-0.306*
	Sig. (2-tailed)	0.000	0.000	0.943	0.000	0.000	0.028	0.503	.	0.247	0.000	0.000	0.000	0.000	0.000	.	0.003
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.120	0.126	0.128	0.186	0.172	0.604*	0.823*	0.142	1.000	-0.116	0.215	0.115	0.172	0.118	.	0.227*
	Sig. (2-tailed)	0.352	0.345	0.286	0.127	0.155	0.002	0.000	0.247	.	0.550	0.269	0.347	0.180	0.328	.	0.063
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Potassium, Total (mg/L)	Correlation Coefficient	-0.461*	-0.484*	-0.043	0.710*	0.696*	0.318*	.	0.802*	-0.116	1.000	.	0.802*	0.700*	0.744*	.	-0.477*
	Sig. (2-tailed)	0.006	0.007	0.792	0.000	0.000	0.083	.	0.000	0.550	.	.	0.000	0.000	0.000	.	0.004
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	23
Potassium, Dissolved (mg/L)	Correlation Coefficient	-0.590*	-0.590*	-0.385*	0.784*	0.786*	.	0.040	0.834*	0.215	.	1.000	0.847*	0.703*	0.816*	.	-0.356*
	Sig. (2-tailed)	0.001	0.001	0.018	0.000	0.000	.	0.830	0.000	0.269	.	.	0.000	0.000	0.000	.	0.029
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.413*	-0.427*	0.020	0.783*	0.760*	0.354*	0.064	0.922*	0.115	0.802*	0.847*	1.000	0.668*	0.785*	.	-0.306*
	Sig. (2-tailed)	0.000	0.000	0.845	0.000	0.000	0.033	0.705	0.000	0.347	0.000	0.000	.	0.000	0.000	.	0.003
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Sulfate, Total (mg/L)	Correlation Coefficient	-0.463*	-0.487*	0.112	0.622*	0.626*	0.463*	0.112	0.705*	0.172	0.700*	0.703*	0.668*	1.000	0.686*	.	-0.204*
	Sig. (2-tailed)	0.000	0.000	0.294	0.000	0.000	0.008	0.533	0.000	0.180	0.000	0.000	0.000	.	0.000	.	0.059
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Dissolved Solids, Total (mg/L)	Correlation Coefficient	-0.495*	-0.518*	0.037	0.663*	0.663*	0.416*	0.044	0.787*	0.118	0.744*	0.816*	0.785*	0.686*	1.000	.	-0.298*
	Sig. (2-tailed)	0.000	0.000	0.709	0.000	0.000	0.011	0.793	0.000	0.328	0.000	0.000	0.000	0.000	.	.	0.003
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Suspended Solids, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Turbidity (NTU)	Correlation Coefficient	0.310*	0.334*	0.197*	-0.237*	-0.230*	-0.159	0.244	-0.306*	0.227*	-0.477*	-0.356*	-0.306*	-0.204*	-0.298*	.	1.000
	Sig. (2-tailed)	0.004	0.003	0.052	0.021	0.024	0.347	0.146	0.003	0.063	0.004	0.029	0.003	0.059	0.003	.	.
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	-0.358*	-0.366*	0.032	0.731*	0.716*	0.281*	0.059	0.879*	0.091	0.758*	0.776*	0.872*	0.614*	0.727*	.	-0.323*
	Sig. (2-tailed)	0.001	0.001	0.749	0.000	0.000	0.089	0.727	0.000	0.454	0.000	0.000	0.000	0.000	0.000	.	0.001
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Cadmium, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Copper, Total (mg/L)	Correlation Coefficient	-0.037	-0.123	-0.037	-0.037	-0.075	-0.360	.	0.000	-0.091	-0.264	.	-0.111	0.000	-0.111	.	0.430
	Sig. (2-tailed)	0.885	0.655	0.885	0.885	0.771	0.207	.	1.000	0.763	0.349	.	0.664	1.000	0.664	.	0.113
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Iron, Total (mg/L)	Correlation Coefficient	-0.331	-0.401*	-0.331	0.349	0.400*	-0.057	.	0.208	0.193	0.224	.	0.142	0.317	0.142	.	-0.212
	Sig. (2-tailed)	0.144	0.098	0.144	0.125	0.081	0.819	.	0.364	0.464	0.365	.	0.532	0.179	0.532	.	0.382
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Lead, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Manganese, Total (mg/L)	Correlation Coefficient	-0.152	-0.150	-0.152	0.273	0.240	0.553*	.	0.275	0.373	0.281	.	0.321	0.250	0.423*	.	-0.100
	Sig. (2-tailed)	0.516	0.551	0.516	0.248	0.311	0.033	.	0.247	0.173	0.274	.	0.171	0.305	0.071	.	0.685
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.484*	-0.484*	-0.034	0.331*	0.329*	0.133	-0.212	0.355*	-0.143	0.458*	0.439*	0.353*	0.206	0.355*	.	-0.330*
	Sig. (2-tailed)	0.001	0.001	0.786	0.010	0.010	0.624	0.241	0.006	0.350	0.081	0.012	0.006	0.130	0.005	.	0.009
	N	36	36	36	36	36	12	24	36	36	12	24	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	-0.428*	-0.436*	-0.428*	0.597*	0.551*	0.618*	.	0.601*	0.201	0.702*	.	0.658*	0.592*	0.658*	.	-0.491*
	Sig. (2-tailed)	0.066	0.079	0.066	0.011	0.019	0.016	.	0.010	0.457	0.006	.	0.005	0.014	0.005	.	0.045
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.063	-0.030	-0.240*	0.152	0.140	-0.137	-0.046	0.094	-0.142	0.198	0.289*	0.117	-0.054	0.106	.	-0.171
	Sig. (2-tailed)	0.569	0.794	0.021	0.149	0.182	0.440	0.791	0.376	0.258	0.259	0.088	0.267	0.627	0.313	.	0.104
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.197*	-0.180	-0.302*	0.342*	0.324*	0.371*	0.306*	0.295*	0.163	0.383*	0.278*	0.262*	0.223*	0.228*	.	-0.047
	Sig. (2-tailed)	0.068	0.107	0.003	0.001	0.001	0.026	0.071	0.004	0.182	0.020	0.092	0.011	0.039	0.025	.	0.646
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.109	-0.138	0.185*	0.282*	0.291*	0.021	-0.034	0.251*	-0.054	0.442*	0.197	0.237*	0.333*	0.289*	.	-0.097
	Sig. (2-tailed)	0.355	0.249	0.088	0.010	0.008	0.918	0.839	0.023	0.682	0.027	0.226	0.031	0.004	0.008	.	0.375
	N	41	41	41	41	41	17	24	41	41	17	24	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	0.206*	0.207*	0.050	-0.380*	-0.364*	-0.501*	-0.151	-0.418*	-0.247*	-0.302	-0.496*	-0.450*	-0.217*	-0.359*	.	0.122
	Sig. (2-tailed)	0.081	0.085	0.645	0.001	0.001	0.013	0.368	0.000	0.059	0.131	0.002	0.000	0.061	0.001	.	0.261
	N	41	41	41	41	41	17	24	41	41	17	24	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	0.395*	0.415*	-0.107	-0.329*	-0.334*	-0.170	0.073	-0.339*	0.013	-0.561*	-0.376*	-0.346*	-0.367*	-0.420*	.	0.210*
	Sig. (2-tailed)	0.000	0.000	0.292	0.001	0.001	0.315	0.663	0.001	0.917	0.001	0.021	0.001	0.001	0.000	.	0.038
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47
Specific Conductance (µS/cm)	Correlation Coefficient	-0.390*	-0.410*	0.023	0.730*	0.706*	0.412*	0.092	0.786*	0.187	0.581*	0.830*	0.800*	0.544*	0.675*	.	-0.239*
	Sig. (2-tailed)	0.000	0.000	0.819	0.000	0.000	0.014	0.581	0.000	0.125	0.000	0.000	0.000	0.000	0.000	.	0.018
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47
Water Temperature (°C)	Correlation Coefficient	0.341*	0.364*	0.108	-0.490*	-0.497*	-0.200	0.024	-0.509*	0.009	-0.655*	-0.539*	-0.500*	-0.447*	-0.536*	.	0.394*
	Sig. (2-tailed)	0.002	0.001	0.283	0.000	0.000	0.234	0.885	0.000	0.938	0.000	0.001	0.000	0.000	0.000	.	0.000
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47
Flow (CFS)	Correlation Coefficient	-0.025	-0.031	-0.088	-0.241*	-0.226*	-0.361*	-0.238	-0.331*	-0.248*	-0.129	-0.359*	-0.307*	-0.270*	-0.202*	.	0.165
	Sig. (2-tailed)	0.814	0.775	0.379	0.017	0.024	0.028	0.155	0.001	0.040	0.430	0.027	0.002	0.011	0.044	.	0.104
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47

*Correlation is significant at the 0.10 level (2-tailed).
Magnesium, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-104: Kendall's tau correlation matrix of water quality parameters collected at Station 2 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	-0.358*	.	-0.037	-0.331	.	-0.152	.	-0.484*	-0.428*	-0.063	-0.197*	-0.109	0.206*	0.395*	-0.390*	0.341*	-0.025
	Sig. (2-tailed)	0.001	.	0.885	0.144	.	0.516	.	0.001	0.066	0.569	0.068	0.355	0.081	0.000	0.000	0.002	0.814
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Group by Quarter	Correlation Coefficient	-0.366*	.	-0.123	-0.401*	.	-0.150	.	-0.484*	-0.436*	-0.030	-0.180	-0.138	0.207*	0.415*	-0.410*	0.364*	-0.031
	Sig. (2-tailed)	0.001	.	0.655	0.098	.	0.551	.	0.001	0.079	0.794	0.107	0.249	0.085	0.000	0.000	0.001	0.775
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Julian Date	Correlation Coefficient	0.032	.	-0.037	-0.331	.	-0.152	.	-0.034	-0.428*	-0.240*	-0.302*	0.185*	0.050	-0.107	0.023	0.108	-0.088
	Sig. (2-tailed)	0.749	.	0.885	0.144	.	0.516	.	0.786	0.066	0.021	0.003	0.088	0.645	0.292	0.819	0.283	0.379
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.731*	.	-0.037	0.349	.	0.273	.	0.331*	0.597*	0.152	0.342*	0.282*	-0.380*	-0.329*	0.730*	-0.490*	-0.241*
	Sig. (2-tailed)	0.000	.	0.885	0.125	.	0.248	.	0.010	0.011	0.149	0.001	0.010	0.001	0.001	0.000	0.000	0.017
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.716*	.	-0.075	0.400*	.	0.240	.	0.329*	0.551*	0.140	0.324*	0.291*	-0.364*	-0.334*	0.706*	-0.497*	-0.226*
	Sig. (2-tailed)	0.000	.	0.771	0.081	.	0.311	.	0.010	0.019	0.182	0.001	0.008	0.001	0.001	0.000	0.000	0.024
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Calcium, Total (mg/L)	Correlation Coefficient	0.281*	.	-0.360	-0.057	.	0.553*	.	0.133	0.618*	-0.137	0.371*	0.021	-0.501*	-0.170	0.412*	-0.200	-0.361*
	Sig. (2-tailed)	0.089	.	0.207	0.819	.	0.033	.	0.624	0.016	0.440	0.026	0.918	0.013	0.315	0.014	0.234	0.028
	N	24	12	12	12	12	12	12	12	12	24	24	17	17	23	23	23	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.059	.	.	.	.	.	.	-0.212	.	-0.046	0.306*	-0.034	-0.151	0.073	0.092	0.024	-0.238
	Sig. (2-tailed)	0.727	.	.	.	.	.	.	0.241	.	0.791	0.071	0.839	0.368	0.663	0.581	0.885	0.155
	N	24	0	0	0	0	0	0	24	0	24	24	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	0.879*	.	0.000	0.208	.	0.275	.	0.355*	0.601*	0.094	0.295*	0.251*	-0.418*	-0.339*	0.786*	-0.509*	-0.331*
	Sig. (2-tailed)	0.000	.	1.000	0.364	.	0.247	.	0.006	0.010	0.376	0.004	0.023	0.000	0.001	0.000	0.000	0.001
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.091	.	-0.091	0.193	.	0.373	.	-0.143	0.201	-0.142	0.163	-0.054	-0.247*	0.013	0.187	0.009	-0.248*
	Sig. (2-tailed)	0.454	.	0.763	0.464	.	0.173	.	0.350	0.457	0.258	0.182	0.682	0.059	0.917	0.125	0.938	0.040
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Potassium, Total (mg/L)	Correlation Coefficient	0.758*	.	-0.264	0.224	.	0.281	.	0.458*	0.702*	0.198	0.383*	0.442*	-0.302	-0.561*	0.581*	-0.655*	-0.129
	Sig. (2-tailed)	0.000	.	0.349	0.365	.	0.274	.	0.081	0.006	0.259	0.020	0.027	0.131	0.001	0.000	0.000	0.430
	N	24	12	12	12	12	12	12	12	12	24	24	17	17	23	23	23	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.776*	.	.	.	.	.	.	0.439*	.	0.289*	0.278*	0.197	-0.496*	-0.376*	0.830*	-0.539*	-0.359*
	Sig. (2-tailed)	0.000	.	.	.	.	.	.	0.012	.	0.088	0.092	0.226	0.002	0.021	0.000	0.001	0.027
	N	24	0	0	0	0	0	0	24	0	24	24	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.872*	.	-0.111	0.142	.	0.321	.	0.353*	0.658*	0.117	0.262*	0.237*	-0.450*	-0.346*	0.800*	-0.500*	-0.307*
	Sig. (2-tailed)	0.000	.	0.664	0.532	.	0.171	.	0.006	0.005	0.267	0.011	0.031	0.000	0.001	0.000	0.000	0.002
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.614*	.	0.000	0.317	.	0.250	.	0.206	0.592*	-0.054	0.223*	0.333*	-0.217*	-0.367*	0.544*	-0.447*	-0.270*
	Sig. (2-tailed)	0.000	.	1.000	0.179	.	0.305	.	0.130	0.014	0.627	0.039	0.004	0.061	0.001	0.000	0.000	0.011
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.727*	.	-0.111	0.142	.	0.423*	.	0.355*	0.658*	0.106	0.228*	0.289*	-0.359*	-0.420*	0.675*	-0.536*	-0.202*
	Sig. (2-tailed)	0.000	.	0.664	0.532	.	0.071	.	0.005	0.005	0.313	0.025	0.008	0.001	0.000	0.000	0.000	0.044
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Turbidity (NTU)	Correlation Coefficient	-0.323*	.	0.430	-0.212	.	-0.100	.	-0.330*	-0.491*	-0.171	-0.047	-0.097	0.122	0.210*	-0.239*	0.394*	0.165
	Sig. (2-tailed)	0.001	.	0.113	0.382	.	0.685	.	0.009	0.045	0.104	0.646	0.375	0.261	0.038	0.018	0.000	0.104
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	47

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	.	-0.150	0.064	.	0.375	.	0.351*	0.646*	0.157	0.239*	0.303*	-0.365*	-0.308*	0.726*	-0.540*	-0.313*
	Sig. (2-tailed)	.	.	0.562	0.781	.	0.112	.	0.006	0.006	0.132	0.019	0.006	0.001	0.002	0.000	0.000	0.002
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Cadmium, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Copper, Total (mg/L)	Correlation Coefficient	-0.150	.	1.000	0.425	.	-0.290	.	.	-0.322	-0.592*	-0.114	.	.	-0.174	0.000	0.256	0.411
	Sig. (2-tailed)	0.562	.	.	0.107	.	0.289	.	.	0.234	0.045	0.662	.	.	0.525	1.000	0.343	0.110
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Iron, Total (mg/L)	Correlation Coefficient	0.064	.	0.425	1.000	.	-0.088	.	.	0.103	-0.084	0.339	-0.359	0.756*	-0.389	0.114	-0.114	0.175
	Sig. (2-tailed)	0.781	.	0.107	.	.	0.715	.	.	0.667	0.746	0.142	0.405	0.087	0.111	0.635	0.635	0.444
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Lead, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Manganese, Total (mg/L)	Correlation Coefficient	0.375	.	-0.290	-0.088	.	1.000	.	.	0.569*	0.420	0.381	0.120	-0.252	-0.324	0.199	-0.199	-0.051
	Sig. (2-tailed)	0.112	.	0.289	0.715	.	.	.	.	0.021	0.118	0.110	0.782	0.568	0.193	0.418	0.418	0.828
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	0.351*	.	.	.	.	.	.	1.000	.	0.248*	0.097	0.255*	-0.139	-0.456*	0.327*	-0.396*	-0.053
	Sig. (2-tailed)	0.006	.	.	.	.	.	.	.	.	0.058	0.449	0.044	0.272	0.000	0.010	0.002	0.679
	N	36	0	0	0	0	0	0	36	0	36	36	36	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.646*	.	-0.322	0.103	.	0.569*	.	.	1.000	0.262	0.455*	0.000	-0.354	-0.397	0.272	-0.467*	-0.282
	Sig. (2-tailed)	0.006	.	0.234	0.667	.	0.021	.	.	.	0.323	0.054	1.000	0.420	0.108	0.263	0.055	0.228
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Nitrogen, Total (mg/L)	Correlation Coefficient	0.157	.	-0.592*	-0.084	.	0.420	.	0.248*	0.262	1.000	0.094	0.141	-0.047	-0.036	0.073	-0.280*	0.008
	Sig. (2-tailed)	0.132	.	0.045	0.746	.	0.118	.	0.058	0.323	.	0.372	0.209	0.675	0.731	0.486	0.008	0.935
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Phosphorus, Total (mg/L)	Correlation Coefficient	0.239*	.	-0.114	0.339	.	0.381	.	0.097	0.455*	0.094	1.000	0.069	-0.181	-0.159	0.286*	-0.202*	-0.138
	Sig. (2-tailed)	0.019	.	0.662	0.142	.	0.110	.	0.449	0.054	0.372	.	0.529	0.100	0.120	0.005	0.048	0.173
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.303*	.	.	-0.359	.	0.120	.	0.255*	0.000	0.141	0.069	1.000	0.236*	-0.226*	0.161	-0.666*	0.072
	Sig. (2-tailed)	0.006	.	.	0.405	.	0.782	.	0.044	1.000	0.209	0.529	.	0.030	0.038	0.138	0.000	0.507
	N	41	5	5	5	5	5	5	36	5	41	41	41	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.365*	.	.	0.756*	.	-0.252	.	-0.139	-0.354	-0.047	-0.181	0.236*	1.000	0.193*	-0.497*	0.079	0.326*
	Sig. (2-tailed)	0.001	.	.	0.087	.	0.568	.	0.272	0.420	0.675	0.100	0.030	.	0.076	0.000	0.465	0.003
	N	41	5	5	5	5	5	5	36	5	41	41	41	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	-0.308*	.	-0.174	-0.389	.	-0.324	.	-0.456*	-0.397	-0.036	-0.159	-0.226*	0.193*	1.000	-0.268*	0.314*	-0.050
	Sig. (2-tailed)	0.002	.	0.525	0.111	.	0.193	.	0.000	0.108	0.731	0.120	0.038	0.076	.	0.008	0.002	0.620
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	47
Specific Conductance (µS/cm)	Correlation Coefficient	0.726*	.	0.000	0.114	.	0.199	.	0.327*	0.272	0.073	0.286*	0.161	-0.497*	-0.268*	1.000	-0.406*	-0.332*
	Sig. (2-tailed)	0.000	.	1.000	0.635	.	0.418	.	0.010	0.263	0.486	0.005	0.138	0.000	0.008	.	0.000	0.001
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	47
Water Temperature (°C)	Correlation Coefficient	-0.540*	.	0.256	-0.114	.	-0.199	.	-0.396*	-0.467*	-0.280*	-0.202*	-0.666*	0.079	0.314*	-0.406*	1.000	0.035
	Sig. (2-tailed)	0.000	.	0.343	0.635	.	0.418	.	0.002	0.055	0.008	0.048	0.000	0.465	0.002	0.000	.	0.727
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	47
Flow (CFS)	Correlation Coefficient	-0.313*	.	0.411	0.175	.	-0.051	.	-0.053	-0.282	0.008	-0.138	0.072	0.326*	-0.050	-0.332*	0.035	1.000
	Sig. (2-tailed)	0.002	.	0.110	0.444	.	0.828	.	0.679	0.228	0.935	0.173	0.507	0.003	0.620	0.001	0.727	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-105: Kendall's tau correlation matrix of water quality parameters collected at Station 3 from 2011 to 2020.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.955*	0.116	-0.350*	-0.344*	0.095	-0.108	-0.316*	0.065	-0.410*	-0.240	-0.283*	-0.317*	-0.373*	-0.154	-0.024
	Sig. (2-tailed)	.	0.000	0.276	0.001	0.001	0.577	0.527	0.004	0.613	0.014	0.180	0.009	0.006	0.000	0.214	0.822
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Group by Quarter	Correlation Coefficient	0.955*	1.000	0.109	-0.360*	-0.360*	0.087	-0.108	-0.335*	0.047	-0.414*	-0.240	-0.291*	-0.344*	-0.387*	-0.187	-0.046
	Sig. (2-tailed)	0.000	.	0.320	0.001	0.001	0.628	0.527	0.003	0.722	0.019	0.180	0.009	0.004	0.000	0.144	0.683
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Julian Date	Correlation Coefficient	0.116	0.109	1.000	0.041	0.021	0.159	-0.143	-0.056	0.176	0.017	0.022	-0.041	0.149	0.038	-0.018	0.165
	Sig. (2-tailed)	0.276	0.320	.	0.689	0.838	0.334	0.359	0.580	0.140	0.916	0.892	0.682	0.167	0.702	0.875	0.103
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	-0.350*	-0.360*	0.041	1.000	0.958*	-0.083	0.226	0.741*	0.233*	0.823*	0.507*	0.716*	0.564*	0.658*	-0.071	-0.095
	Sig. (2-tailed)	0.001	0.001	0.689	.	0.000	0.618	0.152	0.000	0.055	0.000	0.002	0.000	0.000	0.000	0.546	0.353
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	-0.344*	-0.360*	0.021	0.958*	1.000	-0.079	0.262	0.745*	0.248*	0.811*	0.498*	0.720*	0.547*	0.651*	-0.080	-0.095
	Sig. (2-tailed)	0.001	0.001	0.838	0.000	.	0.638	0.101	0.000	0.041	0.000	0.003	0.000	0.000	0.000	0.495	0.353
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Calcium, Total (mg/L)	Correlation Coefficient	0.095	0.087	0.159	-0.083	-0.079	1.000	.	-0.157	0.485*	-0.134	.	-0.170	-0.056	-0.096	0.450*	0.389*
	Sig. (2-tailed)	0.577	0.628	0.334	0.618	0.638	.	.	0.346	0.013	0.465	.	0.306	0.753	0.562	0.017	0.023
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	23
Calcium, Dissolved (mg/L)	Correlation Coefficient	-0.108	-0.108	-0.143	0.226	0.262	.	1.000	-0.045	0.577*	.	-0.339*	-0.142	-0.071	-0.040	0.341*	0.302*
	Sig. (2-tailed)	0.527	0.527	0.359	0.152	0.101	.	.	0.778	0.002	.	0.052	0.371	0.673	0.799	0.058	0.053
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	-0.316*	-0.335*	-0.056	0.741*	0.745*	-0.157	-0.045	1.000	0.067	0.822*	0.775*	0.914*	0.562*	0.741*	-0.152	-0.188*
	Sig. (2-tailed)	0.004	0.003	0.580	0.000	0.000	0.346	0.778	.	0.580	0.000	0.000	0.000	0.000	0.000	0.198	0.068
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.065	0.047	0.176	0.233*	0.248*	0.485*	0.577*	0.067	1.000	0.211	-0.262	0.038	0.140	0.081	0.084	0.093
	Sig. (2-tailed)	0.613	0.722	0.140	0.055	0.041	0.013	0.002	0.580	.	0.270	0.181	0.751	0.277	0.499	0.543	0.446
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Potassium, Total (mg/L)	Correlation Coefficient	-0.410*	-0.414*	0.017	0.823*	0.811*	-0.134	.	0.822*	0.211	1.000	.	0.836*	0.614*	0.672*	-0.097	-0.147
	Sig. (2-tailed)	0.014	0.019	0.916	0.000	0.000	0.465	.	0.000	0.270	.	.	0.000	0.000	0.000	0.602	0.380
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	23
Potassium, Dissolved (mg/L)	Correlation Coefficient	-0.240	-0.240	0.022	0.507*	0.498*	.	-0.339*	0.775*	-0.262	.	1.000	0.825*	0.687*	0.695*	-0.404*	-0.430*
	Sig. (2-tailed)	0.180	0.180	0.892	0.002	0.003	.	0.052	0.000	0.181	.	.	0.000	0.000	0.000	0.033	0.009
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.283*	-0.291*	-0.041	0.716*	0.720*	-0.170	-0.142	0.914*	0.038	0.836*	0.825*	1.000	0.545*	0.706*	-0.205*	-0.219*
	Sig. (2-tailed)	0.009	0.009	0.682	0.000	0.000	0.306	0.371	0.000	0.751	0.000	0.000	.	0.000	0.000	0.081	0.033
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Sulfate, Total (mg/L)	Correlation Coefficient	-0.317*	-0.344*	0.149	0.564*	0.547*	-0.056	-0.071	0.562*	0.140	0.614*	0.687*	0.545*	1.000	0.526*	-0.151	-0.200*
	Sig. (2-tailed)	0.006	0.004	0.167	0.000	0.000	0.753	0.673	0.000	0.277	0.000	0.000	0.000	.	0.000	0.228	0.068
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Dissolved Solids, Total (mg/L)	Correlation Coefficient	-0.373*	-0.387*	0.038	0.658*	0.651*	-0.096	-0.040	0.741*	0.081	0.672*	0.695*	0.706*	0.526*	1.000	0.003	-0.075
	Sig. (2-tailed)	0.000	0.000	0.702	0.000	0.000	0.562	0.799	0.000	0.499	0.000	0.000	0.000	0.000	.	0.979	0.457
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.154	-0.187	-0.018	-0.071	-0.080	0.450*	0.341*	-0.152	0.084	-0.097	-0.404*	-0.205*	-0.151	0.003	1.000	0.579*
	Sig. (2-tailed)	0.214	0.144	0.875	0.546	0.495	0.017	0.058	0.198	0.543	0.602	0.033	0.081	0.228	0.979	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Turbidity (NTU)	Correlation Coefficient	-0.024	-0.046	0.165	-0.095	-0.095	0.389*	0.302*	-0.188*	0.093	-0.147	-0.430*	-0.219*	-0.200*	-0.075	0.579*	1.000
	Sig. (2-tailed)	0.822	0.683	0.103	0.353	0.353	0.023	0.053	0.068	0.446	0.380	0.009	0.033	0.068	0.457	0.000	.
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	-0.294*	-0.314*	-0.054	0.707*	0.701*	-0.188	-0.100	0.919*	0.026	0.806*	0.788*	0.904*	0.543*	0.735*	-0.171	-0.234*
	Sig. (2-tailed)	0.006	0.005	0.587	0.000	0.000	0.257	0.524	0.000	0.825	0.000	0.000	0.000	0.000	0.000	0.142	0.021
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Cadmium, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Copper, Total (mg/L)	Correlation Coefficient	0.229	0.175	0.229	-0.018	0.000	0.000	.	-0.071	-0.215	-0.157	.	-0.123	-0.076	0.071	0.623*	0.758*
	Sig. (2-tailed)	0.336	0.491	0.336	0.941	1.000	1.000	.	0.766	0.438	0.537	.	0.604	0.761	0.767	0.022	0.003
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Iron, Total (mg/L)	Correlation Coefficient	-0.049	-0.054	-0.049	0.115	0.134	0.120	.	0.017	-0.280	0.018	.	-0.049	-0.018	0.164	0.607*	0.344
	Sig. (2-tailed)	0.832	0.827	0.832	0.620	0.569	0.641	.	0.943	0.299	0.941	.	0.832	0.942	0.479	0.021	0.167
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Lead, Total (mg/L)	Correlation Coefficient	-0.260	-0.369	-0.260	0.262	0.266	-0.091	.	0.302	0.091	0.248	.	0.260	0.443	0.262	-0.132	-0.391
	Sig. (2-tailed)	0.311	0.180	0.311	0.310	0.308	0.752	.	0.245	0.763	0.367	.	0.311	0.103	0.310	0.656	0.153
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Manganese, Total (mg/L)	Correlation Coefficient	-0.081	-0.178	-0.081	0.081	0.082	0.526*	.	-0.055	0.132	-0.030	.	-0.134	0.087	-0.027	1.000	0.599*
	Sig. (2-tailed)	0.749	0.509	0.749	0.748	0.747	0.062	.	0.830	0.656	0.912	.	0.593	0.743	0.915	.	0.025
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.487*	-0.487*	-0.167	0.213*	0.204	-0.139	0.043	0.160	-0.045	-0.021	0.133	0.131	0.039	0.197	0.193	-0.003
	Sig. (2-tailed)	0.000	0.000	0.171	0.086	0.102	0.581	0.795	0.202	0.761	0.933	0.441	0.292	0.766	0.109	0.172	0.978
	N	36	36	36	36	36	12	24	36	36	12	24	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	-0.605*	-0.686*	-0.605*	0.625*	0.603*	0.000	.	0.724*	0.228	0.692*	.	0.667*	0.673*	0.656*	0.082	0.019
	Sig. (2-tailed)	0.007	0.004	0.007	0.006	0.008	1.000	.	0.001	0.382	0.004	.	0.003	0.004	0.004	0.747	0.937
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.222*	-0.240*	-0.027	0.179*	0.167	0.000	0.123	0.143	-0.031	0.288*	-0.133	0.093	0.028	0.199*	0.178	0.167
	Sig. (2-tailed)	0.042	0.034	0.789	0.084	0.107	1.000	0.441	0.171	0.803	0.087	0.429	0.371	0.798	0.053	0.134	0.107
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.229*	-0.251*	-0.204*	0.127	0.138	0.315*	0.306*	0.055	0.060	0.342*	-0.238	0.021	-0.024	0.092	0.571*	0.323*
	Sig. (2-tailed)	0.034	0.025	0.043	0.215	0.178	0.060	0.052	0.592	0.619	0.037	0.151	0.837	0.827	0.364	0.000	0.002
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.019	-0.035	0.205*	0.357*	0.347*	-0.336*	-0.095	0.355*	-0.100	0.265	0.376*	0.348*	0.403*	0.308*	-0.200	-0.184*
	Sig. (2-tailed)	0.872	0.771	0.059	0.001	0.002	0.091	0.541	0.001	0.446	0.188	0.022	0.002	0.001	0.005	0.113	0.090
	N	41	41	41	41	41	17	24	41	41	17	24	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	0.057	0.070	0.276*	-0.069	-0.108	0.128	-0.111	-0.122	-0.240*	-0.456*	0.049	-0.162	0.154	-0.064	-0.074	0.028
	Sig. (2-tailed)	0.627	0.560	0.011	0.528	0.327	0.522	0.475	0.274	0.066	0.024	0.766	0.143	0.189	0.559	0.558	0.796
	N	41	41	41	41	41	17	24	41	41	17	24	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	0.050	0.067	-0.125	-0.096	-0.104	0.169	0.091	-0.079	-0.195	0.038	-0.133	-0.105	-0.047	-0.147	-0.096	0.030
	Sig. (2-tailed)	0.646	0.550	0.216	0.349	0.312	0.324	0.558	0.445	0.110	0.821	0.417	0.308	0.665	0.147	0.413	0.769
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47
Specific Conductance (µS/cm)	Correlation Coefficient	-0.358*	-0.353*	-0.068	0.737*	0.733*	-0.239	-0.016	0.866*	0.076	0.827*	0.668*	0.854*	0.499*	0.706*	-0.164	-0.148
	Sig. (2-tailed)	0.001	0.002	0.503	0.000	0.000	0.160	0.919	0.000	0.530	0.000	0.000	0.000	0.000	0.000	0.159	0.142
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47
Water Temperature (°C)	Correlation Coefficient	0.200*	0.207*	0.047	-0.399*	-0.411*	0.432*	0.087	-0.409*	0.025	-0.326*	-0.394*	-0.418*	-0.322*	-0.370*	0.246*	0.252*
	Sig. (2-tailed)	0.065	0.063	0.640	0.000	0.000	0.011	0.575	0.000	0.834	0.051	0.016	0.000	0.003	0.000	0.035	0.013
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47
Flow (CFS)	Correlation Coefficient	-0.171	-0.221	-0.085	-0.175	-0.175	-0.041	0.193	-0.300*	0.092	-0.137	-0.605*	-0.351*	-0.239*	-0.120	0.580*	0.431*
	Sig. (2-tailed)	0.202	0.112	0.496	0.167	0.167	0.856	0.293	0.018	0.531	0.528	0.002	0.006	0.076	0.338	0.000	0.001
	N	32	32	32	32	32	14	18	32	32	14	18	32	32	32	32	31

*Correlation is significant at the 0.10 level (2-tailed).
Magnesium, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-106: Kendall's tau correlation matrix of water quality parameters collected at Station 3 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	-0.294*	.	0.229	-0.049	-0.260	-0.081	.	-0.487*	-0.605*	-0.222*	-0.229*	-0.019	0.057	0.050	-0.358*	0.200*	-0.171
	Sig. (2-tailed)	0.006	.	0.336	0.832	0.311	0.749	.	0.000	0.007	0.042	0.034	0.872	0.627	0.646	0.001	0.065	0.202
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Group by Quarter	Correlation Coefficient	-0.314*	.	0.175	-0.054	-0.369	-0.178	.	-0.487*	-0.686*	-0.240*	-0.251*	-0.035	0.070	0.067	-0.353*	0.207*	-0.221
	Sig. (2-tailed)	0.005	.	0.491	0.827	0.180	0.509	.	0.000	0.004	0.034	0.025	0.771	0.560	0.550	0.002	0.063	0.112
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Julian Date	Correlation Coefficient	-0.054	.	0.229	-0.049	-0.260	-0.081	.	-0.167	-0.605*	-0.027	-0.204*	0.205*	0.276*	-0.125	-0.068	0.047	-0.085
	Sig. (2-tailed)	0.587	.	0.336	0.832	0.311	0.749	.	0.171	0.007	0.789	0.043	0.059	0.011	0.216	0.503	0.640	0.496
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.707*	.	-0.018	0.115	0.262	0.081	.	0.213*	0.625*	0.179*	0.127	0.357*	-0.069	-0.096	0.737*	-0.399*	-0.175
	Sig. (2-tailed)	0.000	.	0.941	0.620	0.310	0.748	.	0.086	0.006	0.084	0.215	0.001	0.528	0.349	0.000	0.000	0.167
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.701*	.	0.000	0.134	0.266	0.082	.	0.204	0.603*	0.167	0.138	0.347*	-0.108	-0.104	0.733*	-0.411*	-0.175
	Sig. (2-tailed)	0.000	.	1.000	0.569	0.308	0.747	.	0.102	0.008	0.107	0.178	0.002	0.327	0.312	0.000	0.000	0.167
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Calcium, Total (mg/L)	Correlation Coefficient	-0.188	.	0.000	0.120	-0.091	0.526*	.	-0.139	0.000	0.000	0.315*	-0.336*	0.128	0.169	-0.239	0.432*	-0.041
	Sig. (2-tailed)	0.257	.	1.000	0.641	0.752	0.062	.	0.581	1.000	1.000	0.060	0.091	0.522	0.324	0.160	0.011	0.856
	N	24	12	12	12	12	12	12	12	12	24	24	17	17	23	23	23	14
Calcium, Dissolved (mg/L)	Correlation Coefficient	-0.100	.	.	.	.	.	.	0.043	.	0.123	0.306*	-0.095	-0.111	0.091	-0.016	0.087	0.193
	Sig. (2-tailed)	0.524	.	.	.	.	.	.	0.795	.	0.441	0.052	0.541	0.475	0.558	0.919	0.575	0.293
	N	24	0	0	0	0	0	0	24	0	24	24	24	24	24	24	24	18
Chloride, Total (mg/L)	Correlation Coefficient	0.919*	.	-0.071	0.017	0.302	-0.055	.	0.160	0.724*	0.143	0.055	0.355*	-0.122	-0.079	0.866*	-0.409*	-0.300*
	Sig. (2-tailed)	0.000	.	0.766	0.943	0.245	0.830	.	0.202	0.001	0.171	0.592	0.001	0.274	0.445	0.000	0.000	0.018
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.026	.	-0.215	-0.280	0.091	0.132	.	-0.045	0.228	-0.031	0.060	-0.100	-0.240*	-0.195	0.076	0.025	0.092
	Sig. (2-tailed)	0.825	.	0.438	0.299	0.763	0.656	.	0.761	0.382	0.803	0.619	0.446	0.066	0.110	0.530	0.834	0.531
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Potassium, Total (mg/L)	Correlation Coefficient	0.806*	.	-0.157	0.018	0.248	-0.030	.	-0.021	0.692*	0.288*	0.342*	0.265	-0.456*	0.038	0.827*	-0.326*	-0.137
	Sig. (2-tailed)	0.000	.	0.537	0.941	0.367	0.912	.	0.933	0.004	0.087	0.037	0.188	0.024	0.821	0.000	0.051	0.528
	N	24	12	12	12	12	12	12	12	12	24	24	17	17	23	23	23	14
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.788*	.	.	.	.	.	.	0.133	.	-0.133	-0.238	0.376*	0.049	-0.133	0.668*	-0.394*	-0.605*
	Sig. (2-tailed)	0.000	.	.	.	.	.	.	0.441	.	0.429	0.151	0.022	0.766	0.417	0.000	0.016	0.002
	N	24	0	0	0	0	0	0	24	0	24	24	24	24	24	24	24	18
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.904*	.	-0.123	-0.049	0.260	-0.134	.	0.131	0.667*	0.093	0.021	0.348*	-0.162	-0.105	0.854*	-0.418*	-0.351*
	Sig. (2-tailed)	0.000	.	0.604	0.832	0.311	0.593	.	0.292	0.003	0.371	0.837	0.002	0.143	0.308	0.000	0.000	0.006
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Sulfate, Total (mg/L)	Correlation Coefficient	0.543*	.	-0.076	-0.018	0.443	0.087	.	0.039	0.673*	0.028	-0.024	0.403*	0.154	-0.047	0.499*	-0.322*	-0.239*
	Sig. (2-tailed)	0.000	.	0.761	0.942	0.103	0.743	.	0.766	0.004	0.798	0.827	0.001	0.189	0.665	0.000	0.003	0.076
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.735*	.	0.071	0.164	0.262	-0.027	.	0.197	0.656*	0.199*	0.092	0.308*	-0.064	-0.147	0.706*	-0.370*	-0.120
	Sig. (2-tailed)	0.000	.	0.767	0.479	0.310	0.915	.	0.109	0.004	0.053	0.364	0.005	0.559	0.147	0.000	0.000	0.338
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.171	.	0.623*	0.607*	-0.132	1.000	.	0.193	0.082	0.178	0.571*	-0.200	-0.074	-0.096	-0.164	0.246*	0.580*
	Sig. (2-tailed)	0.142	.	0.022	0.021	0.656	.	.	0.172	0.747	0.134	0.000	0.113	0.558	0.413	0.159	0.035	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Turbidity (NTU)	Correlation Coefficient	-0.234*	.	0.758*	0.344	-0.391	0.599*	.	-0.003	0.019	0.167	0.323*	-0.184*	0.028	0.030	-0.148	0.252*	0.431*
	Sig. (2-tailed)	0.021	.	0.003	0.167	0.153	0.025	.	0.978	0.937	0.107	0.002	0.090	0.796	0.769	0.142	0.013	0.001
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	31

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	.	-0.123	-0.016	0.408	-0.081	.	0.173	0.667*	0.144	0.034	0.373*	-0.115	-0.101	0.821*	-0.434*	-0.319*
	Sig. (2-tailed)	.	.	0.604	0.944	0.111	0.749	.	0.158	0.003	0.161	0.735	0.001	0.291	0.322	0.000	0.000	0.011
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Cadmium, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	8
Copper, Total (mg/L)	Correlation Coefficient	-0.123	.	1.000	0.643*	-0.258	0.623*	.	.	-0.018	0.357	0.270	0.837*	-0.837*	-0.331	-0.044	-0.044	0.780*
	Sig. (2-tailed)	0.604	.	.	0.010	0.352	0.022	.	.	0.941	0.161	0.264	0.052	0.052	0.195	0.863	0.863	0.011
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	8
Iron, Total (mg/L)	Correlation Coefficient	-0.016	.	0.643*	1.000	0.040	0.607*	.	.	0.067	0.165	0.501*	0.224	-0.224	-0.060	0.119	0.239	0.741*
	Sig. (2-tailed)	0.944	.	0.010	.	0.882	0.021	.	.	0.776	0.504	0.033	0.602	0.602	0.808	0.627	0.331	0.012
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	8
Lead, Total (mg/L)	Correlation Coefficient	0.408	.	-0.258	0.040	1.000	-0.132	.	.	0.304	0.042	0.266	.	.	0.430	0.341	-0.085	-0.364
	Sig. (2-tailed)	0.111	.	0.352	0.882	.	0.656	.	.	0.244	0.879	0.308	.	.	0.113	0.206	0.752	0.272
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	8
Manganese, Total (mg/L)	Correlation Coefficient	-0.081	.	0.623*	0.607*	-0.132	1.000	.	.	0.082	0.303	0.550*	.	.	-0.094	-0.217	0.278	0.587*
	Sig. (2-tailed)	0.749	.	0.022	0.021	0.656	.	.	.	0.747	0.263	0.032	.	.	0.725	0.413	0.292	0.069
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	8
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	8
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	0.173	.	.	.	.	.	.	1.000	.	0.463*	0.369*	0.157	-0.230*	-0.332*	0.191	-0.309*	0.267*
	Sig. (2-tailed)	0.158	.	.	.	.	.	.	.	.	0.000	0.003	0.199	0.060	0.007	0.118	0.011	0.085
	N	36	0	0	0	0	0	0	36	0	36	36	36	36	36	36	36	24
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.667*	.	-0.018	0.067	0.304	0.082	.	.	1.000	0.332	0.540*	0.105	-0.105	0.299	0.685*	-0.241	0.074
	Sig. (2-tailed)	0.003	.	0.941	0.776	0.244	0.747	.	.	.	0.167	0.018	0.801	0.801	0.209	0.004	0.309	0.802
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	8
Nitrogen, Total (mg/L)	Correlation Coefficient	0.144	.	0.357	0.165	0.042	0.303	.	0.463*	0.332	1.000	0.254*	0.128	-0.020	0.006	0.103	-0.152	0.154
	Sig. (2-tailed)	0.161	.	0.161	0.504	0.879	0.263	.	0.000	0.167	.	0.014	0.250	0.857	0.956	0.320	0.141	0.228
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Phosphorus, Total (mg/L)	Correlation Coefficient	0.034	.	0.270	0.501*	0.266	0.550*	.	0.369*	0.540*	0.254*	1.000	-0.009	-0.190*	-0.072	0.085	0.013	0.446*
	Sig. (2-tailed)	0.735	.	0.264	0.033	0.308	0.032	.	0.003	0.018	0.014	.	0.937	0.085	0.485	0.408	0.898	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	32
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.373*	.	0.837*	0.224	.	.	.	0.157	0.105	0.128	-0.009	1.000	0.105	-0.215*	0.266*	-0.705*	0.023
	Sig. (2-tailed)	0.001	.	0.052	0.602	.	.	.	0.199	0.801	0.250	0.937	.	0.334	0.048	0.014	0.000	0.867
	N	41	5	5	5	5	5	5	36	5	41	41	41	41	41	41	41	27
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.115	.	-0.837*	-0.224	.	.	.	-0.230*	-0.105	-0.020	-0.190*	0.105	1.000	0.200*	-0.190*	0.186*	-0.155
	Sig. (2-tailed)	0.291	.	0.052	0.602	.	.	.	0.060	0.801	0.857	0.085	0.334	.	0.065	0.080	0.088	0.260
	N	41	5	5	5	5	5	5	36	5	41	41	41	41	41	41	41	27
pH, Taken in field	Correlation Coefficient	-0.101	.	-0.331	-0.060	0.430	-0.094	.	-0.332*	0.299	0.006	-0.072	-0.215*	0.200*	1.000	-0.068	0.294*	-0.267*
	Sig. (2-tailed)	0.322	.	0.195	0.808	0.113	0.725	.	0.007	0.209	0.956	0.485	0.048	0.065	.	0.503	0.004	0.036
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	31
Specific Conductance (µS/cm)	Correlation Coefficient	0.821*	.	-0.044	0.119	0.341	-0.217	.	0.191	0.685*	0.103	0.085	0.266*	-0.190*	-0.068	1.000	-0.365*	-0.266*
	Sig. (2-tailed)	0.000	.	0.863	0.627	0.206	0.413	.	0.118	0.004	0.320	0.408	0.014	0.080	0.503	.	0.000	0.036
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	31
Water Temperature (°C)	Correlation Coefficient	-0.434*	.	-0.044	0.239	-0.085	0.278	.	-0.309*	-0.241	-0.152	0.013	-0.705*	0.186*	0.294*	-0.365*	1.000	0.024
	Sig. (2-tailed)	0.000	.	0.863	0.331	0.752	0.292	.	0.011	0.309	0.141	0.898	0.000	0.088	0.004	0.000	.	0.852
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	31
Flow (CFS)	Correlation Coefficient	-0.319*	.	0.780*	0.741*	-0.364	0.587*	.	0.267*	0.074	0.154	0.446*	0.023	-0.155	-0.267*	-0.266*	0.024	1.000
	Sig. (2-tailed)	0.011	.	0.011	0.012	0.272	0.069	.	0.085	0.802	0.228	0.000	0.867	0.260	0.036	0.036	0.852	.
	N	32	8	8	8	8	8	8	24	8	32	32	27	27	31	31	31	32

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-107: Kendall's tau correlation matrix of water quality parameters collected at Station 4 from 2011 to 2022.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.955*	0.116	-0.175	-0.178	0.004	-0.118	-0.349*	0.035	-0.342*	-0.262	-0.364*	-0.126	-0.355*	0.224*	0.249*
	Sig. (2-tailed)	.	0.000	0.276	0.106	0.101	0.979	0.491	0.001	0.777	0.043	0.162	0.001	0.266	0.001	0.073	0.021
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Group by Quarter	Correlation Coefficient	0.955*	1.000	0.109	-0.178	-0.185	0.022	-0.118	-0.361*	0.034	-0.330*	-0.262	-0.379*	-0.143	-0.376*	0.235*	0.246*
	Sig. (2-tailed)	0.000	.	0.320	0.113	0.100	0.895	0.491	0.001	0.790	0.065	0.162	0.001	0.221	0.001	0.069	0.027
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Julian Date	Correlation Coefficient	0.116	0.109	1.000	-0.101	-0.091	0.016	-0.176	-0.075	0.075	0.057	-0.166	-0.081	0.070	0.004	-0.051	-0.022
	Sig. (2-tailed)	0.276	0.320	.	0.318	0.372	0.919	0.260	0.459	0.518	0.729	0.331	0.428	0.504	0.972	0.660	0.826
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	-0.175	-0.178	-0.101	1.000	0.884*	0.457*	0.645*	0.577*	0.508*	0.668*	0.327*	0.542*	0.601*	0.573*	0.054	-0.125
	Sig. (2-tailed)	0.106	0.113	0.318	.	0.000	0.003	0.000	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.649	0.225
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	-0.178	-0.185	-0.091	0.884*	1.000	0.462*	0.615*	0.571*	0.536*	0.686*	0.417*	0.544*	0.610*	0.580*	0.056	-0.112
	Sig. (2-tailed)	0.101	0.100	0.372	0.000	.	0.003	0.000	0.000	0.000	0.000	0.021	0.000	0.000	0.000	0.639	0.277
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Calcium, Total (mg/L)	Correlation Coefficient	0.004	0.022	0.016	0.457*	0.462*	1.000	.	0.194	0.662*	0.253	.	0.149	0.406*	0.232	-0.013	-0.117
	Sig. (2-tailed)	0.979	0.895	0.919	0.003	0.003	.	.	0.219	0.000	0.146	.	0.344	0.013	0.138	0.942	0.462
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	23
Calcium, Dissolved (mg/L)	Correlation Coefficient	-0.118	-0.118	-0.176	0.645*	0.615*	.	1.000	0.243	0.671*	.	0.095	0.169	0.451*	0.246	-0.008	0.064
	Sig. (2-tailed)	0.491	0.491	0.260	0.000	0.000	.	.	0.129	0.000	.	0.606	0.291	0.006	0.118	0.964	0.682
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	-0.349*	-0.361*	-0.075	0.577*	0.571*	0.194	0.243	1.000	0.328*	0.802*	0.648*	0.876*	0.473*	0.769*	0.041	-0.191*
	Sig. (2-tailed)	0.001	0.001	0.459	0.000	0.000	0.219	0.129	.	0.006	0.000	0.000	0.000	0.000	0.000	0.730	0.064
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.035	0.034	0.075	0.508*	0.536*	0.662*	0.671*	0.328*	1.000	0.325*	0.231	0.284*	0.581*	0.336*	0.004	-0.168
	Sig. (2-tailed)	0.777	0.790	0.518	0.000	0.000	0.000	0.000	0.006	.	0.082	0.245	0.016	0.000	0.004	0.976	0.154
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Potassium, Total (mg/L)	Correlation Coefficient	-0.342*	-0.330*	0.057	0.668*	0.686*	0.253	.	0.802*	0.325*	1.000	.	0.818*	0.619*	0.693*	0.121	-0.136
	Sig. (2-tailed)	0.043	0.065	0.729	0.000	0.000	0.146	.	0.000	0.082	.	.	0.000	0.000	0.000	0.522	0.421
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	23
Potassium, Dissolved (mg/L)	Correlation Coefficient	-0.262	-0.262	-0.166	0.327*	0.417*	.	0.095	0.648*	0.231	.	1.000	0.725*	0.203	0.594*	0.000	-0.156
	Sig. (2-tailed)	0.162	0.162	0.331	0.062	0.021	.	0.606	0.000	0.245	.	.	0.000	0.257	0.001	1.000	0.361
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.364*	-0.379*	-0.081	0.542*	0.544*	0.149	0.169	0.876*	0.284*	0.818*	0.725*	1.000	0.443*	0.764*	0.084	-0.177*
	Sig. (2-tailed)	0.001	0.001	0.428	0.000	0.000	0.344	0.291	0.000	0.016	0.000	0.000	.	0.000	0.000	0.482	0.085
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Sulfate, Total (mg/L)	Correlation Coefficient	-0.126	-0.143	0.070	0.601*	0.610*	0.406*	0.451*	0.473*	0.581*	0.619*	0.203	0.443*	1.000	0.499*	-0.002	-0.249*
	Sig. (2-tailed)	0.266	0.221	0.504	0.000	0.000	0.013	0.006	0.000	0.000	0.000	0.257	0.000	.	0.000	0.989	0.020
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Dissolved Solids, Total (mg/L)	Correlation Coefficient	-0.355*	-0.376*	0.004	0.573*	0.580*	0.232	0.246	0.769*	0.336*	0.693*	0.594*	0.764*	0.499*	1.000	0.052	-0.149
	Sig. (2-tailed)	0.001	0.001	0.972	0.000	0.000	0.138	0.118	0.000	0.004	0.000	0.001	0.000	0.000	.	0.660	0.142
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Suspended Solids, Total (mg/L)	Correlation Coefficient	0.224*	0.235*	-0.051	0.054	0.056	-0.013	-0.008	0.041	0.004	0.121	0.000	0.084	-0.002	0.052	1.000	0.505*
	Sig. (2-tailed)	0.073	0.069	0.660	0.649	0.639	0.942	0.964	0.730	0.976	0.522	1.000	0.482	0.989	0.660	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Turbidity (NTU)	Correlation Coefficient	0.249*	0.246*	-0.022	-0.125	-0.112	-0.117	0.064	-0.191*	-0.168	-0.136	-0.156	-0.177*	-0.249*	-0.149	0.505*	1.000
	Sig. (2-tailed)	0.021	0.027	0.826	0.225	0.277	0.462	0.682	0.064	0.154	0.421	0.361	0.085	0.020	0.142	0.000	.
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	-0.415*	-0.434*	-0.045	0.378*	0.369*	0.040	-0.092	0.746*	0.099	0.749*	0.505*	0.778*	0.319*	0.643*	0.031	-0.229*
	Sig. (2-tailed)	0.000	0.000	0.657	0.000	0.000	0.798	0.556	0.000	0.393	0.000	0.003	0.000	0.003	0.000	0.794	0.024
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Cadmium, Total (mg/L)	Correlation Coefficient	0.111	0.123	0.111	-0.262	-0.262	0.172	.	-0.339	-0.182	-0.253	.	-0.337	-0.290	-0.334	-0.132	-0.171
	Sig. (2-tailed)	0.664	0.655	0.664	0.310	0.310	0.535	.	0.191	0.527	0.364	.	0.192	0.289	0.192	0.656	0.527
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Copper, Total (mg/L)	Correlation Coefficient	-0.288	-0.404	-0.288	0.194	0.194	-0.268	.	0.332	-0.377	0.241	.	0.252	0.043	0.250	-0.034	0.180
	Sig. (2-tailed)	0.241	0.126	0.241	0.434	0.434	0.314	.	0.182	0.171	0.368	.	0.309	0.870	0.310	0.904	0.486
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Iron, Total (mg/L)	Correlation Coefficient	0.062	0.051	0.062	-0.047	-0.047	-0.607*	.	0.000	-0.302	-0.158	.	-0.016	-0.189	-0.062	0.546*	0.796*
	Sig. (2-tailed)	0.783	0.830	0.783	0.836	0.836	0.011	.	1.000	0.224	0.514	.	0.945	0.426	0.783	0.032	0.001
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Lead, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Manganese, Total (mg/L)	Correlation Coefficient	0.104	0.096	0.104	-0.088	-0.053	-0.141	.	-0.159	-0.384	-0.099	.	-0.175	-0.097	-0.174	0.093	0.125
	Sig. (2-tailed)	0.661	0.706	0.661	0.714	0.826	0.582	.	0.509	0.149	0.702	.	0.464	0.702	0.465	0.735	0.618
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.159	-0.159	-0.058	0.352*	0.339*	0.222	0.269	0.517*	0.419*	0.350	0.400*	0.482*	0.326*	0.402*	0.102	-0.279*
	Sig. (2-tailed)	0.248	0.248	0.641	0.006	0.008	0.351	0.109	0.000	0.004	0.175	0.029	0.000	0.013	0.001	0.485	0.026
	N	36	36	36	36	36	12	24	36	36	12	24	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	-0.286	-0.334	-0.286	0.272	0.272	0.369	.	0.484*	0.564*	0.398	.	0.368	0.443*	0.381*	-0.169	-0.411*
	Sig. (2-tailed)	0.208	0.169	0.208	0.233	0.233	0.131	.	0.035	0.025	0.105	.	0.107	0.066	0.093	0.514	0.083
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	11
Nitrogen, Total (mg/L)	Correlation Coefficient	0.089	0.102	-0.127	0.027	0.001	0.051	0.017	-0.055	-0.083	0.103	-0.099	-0.039	-0.145	-0.074	0.134	0.072
	Sig. (2-tailed)	0.412	0.365	0.215	0.795	0.993	0.754	0.918	0.597	0.485	0.548	0.574	0.707	0.180	0.469	0.264	0.484
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Phosphorus, Total (mg/L)	Correlation Coefficient	0.057	0.050	-0.269*	-0.065	-0.088	-0.146	-0.073	-0.024	-0.266*	0.178	-0.328*	-0.016	-0.252*	-0.158	0.400*	0.351*
	Sig. (2-tailed)	0.598	0.652	0.008	0.526	0.391	0.355	0.644	0.816	0.023	0.283	0.059	0.879	0.018	0.119	0.001	0.001
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.008	-0.032	0.129	0.335*	0.379*	0.324*	0.232	0.235*	0.463*	0.134	0.045	0.186*	0.470*	0.294*	0.007	-0.116
	Sig. (2-tailed)	0.945	0.789	0.234	0.003	0.001	0.088	0.138	0.035	0.000	0.508	0.791	0.095	0.000	0.007	0.959	0.286
	N	41	41	41	41	41	17	24	41	41	17	24	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.019	-0.021	0.168	-0.133	-0.181	-0.130	-0.160	-0.112	-0.194	-0.345*	-0.297*	-0.168	0.073	-0.050	-0.203	-0.248*
	Sig. (2-tailed)	0.872	0.861	0.121	0.232	0.104	0.495	0.306	0.315	0.127	0.088	0.082	0.131	0.523	0.645	0.109	0.023
	N	41	41	41	41	41	17	24	41	41	17	24	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	0.168	0.189*	-0.060	-0.231*	-0.278*	-0.380*	-0.216	-0.198*	-0.381*	-0.097	-0.267	-0.178*	-0.231*	-0.247*	-0.148	0.085
	Sig. (2-tailed)	0.120	0.089	0.551	0.024	0.007	0.018	0.167	0.056	0.001	0.565	0.118	0.084	0.031	0.015	0.211	0.399
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47
Specific Conductance (µS/cm)	Correlation Coefficient	-0.323*	-0.311*	-0.130	0.633*	0.631*	0.265*	0.352*	0.824*	0.376*	0.766*	0.619*	0.793*	0.501*	0.724*	0.050	-0.163
	Sig. (2-tailed)	0.003	0.005	0.196	0.000	0.000	0.096	0.024	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.673	0.107
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47
Water Temperature (°C)	Correlation Coefficient	0.165	0.163	0.055	-0.395*	-0.443*	-0.352*	-0.448*	-0.311*	-0.534*	-0.204	-0.257	-0.290*	-0.456*	-0.346*	-0.139	0.067
	Sig. (2-tailed)	0.127	0.144	0.588	0.000	0.000	0.027	0.004	0.003	0.000	0.228	0.133	0.005	0.000	0.001	0.237	0.509
	N	47	47	47	47	47	23	24	47	47	23	24	47	47	47	47	47
Flow (CFS)	Correlation Coefficient	0.033	0.014	-0.126	-0.177*	-0.191*	-0.314*	-0.056	-0.178*	-0.248*	-0.231	-0.364*	-0.213*	-0.239*	-0.116	0.113	0.280*
	Sig. (2-tailed)	0.758	0.897	0.207	0.081	0.061	0.044	0.720	0.082	0.033	0.157	0.034	0.036	0.024	0.247	0.336	0.006
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	47

*Correlation is significant at the 0.10 level (2-tailed).
Magnesium, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-108: Kendall's tau correlation matrix of water quality parameters collected at Station 4 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	-0.415*	0.111	-0.288	0.062	.	0.104	.	-0.159	-0.286	0.089	0.057	-0.008	-0.019	0.168	-0.323*	0.165	0.033
	Sig. (2-tailed)	0.000	0.664	0.241	0.783	.	0.661	.	0.248	0.208	0.412	0.598	0.945	0.872	0.120	0.003	0.127	0.758
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Group by Quarter	Correlation Coefficient	-0.434*	0.123	-0.404	0.051	.	0.096	.	-0.159	-0.334	0.102	0.050	-0.032	-0.021	0.189*	-0.311*	0.163	0.014
	Sig. (2-tailed)	0.000	0.655	0.126	0.830	.	0.706	.	0.248	0.169	0.365	0.652	0.789	0.861	0.089	0.005	0.144	0.897
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Julian Date	Correlation Coefficient	-0.045	0.111	-0.288	0.062	.	0.104	.	-0.058	-0.286	-0.127	-0.269*	0.129	0.168	-0.060	-0.130	0.055	-0.126
	Sig. (2-tailed)	0.657	0.664	0.241	0.783	.	0.661	.	0.641	0.208	0.215	0.008	0.234	0.121	0.551	0.196	0.588	0.207
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.378*	-0.262	0.194	-0.047	.	-0.088	.	0.352*	0.272	0.027	-0.065	0.335*	-0.133	-0.231*	0.633*	-0.395*	-0.177*
	Sig. (2-tailed)	0.000	0.310	0.434	0.836	.	0.714	.	0.006	0.233	0.795	0.526	0.003	0.232	0.024	0.000	0.000	0.081
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.369*	-0.262	0.194	-0.047	.	-0.053	.	0.339*	0.272	0.001	-0.088	0.379*	-0.181	-0.278*	0.631*	-0.443*	-0.191*
	Sig. (2-tailed)	0.000	0.310	0.434	0.836	.	0.826	.	0.008	0.233	0.993	0.391	0.001	0.104	0.007	0.000	0.000	0.061
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Calcium, Total (mg/L)	Correlation Coefficient	0.040	0.172	-0.268	-0.607*	.	-0.141	.	0.222	0.369	0.051	-0.146	0.324*	-0.130	-0.380*	0.265*	-0.352*	-0.314*
	Sig. (2-tailed)	0.798	0.535	0.314	0.011	.	0.582	.	0.351	0.131	0.754	0.355	0.088	0.495	0.018	0.096	0.027	0.044
	N	24	12	12	12	12	12	12	12	12	24	24	17	17	23	23	23	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	-0.092	.	.	.	.	.	.	0.269	.	0.017	-0.073	0.232	-0.160	-0.216	0.352*	-0.448*	-0.056
	Sig. (2-tailed)	0.556	.	.	.	.	.	.	0.109	.	0.918	0.644	0.138	0.306	0.167	0.024	0.004	0.720
	N	24	0	0	0	0	0	0	24	0	24	24	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	0.746*	-0.339	0.332	0.000	.	-0.159	.	0.517*	0.484*	-0.055	-0.024	0.235*	-0.112	-0.198*	0.824*	-0.311*	-0.178*
	Sig. (2-tailed)	0.000	0.191	0.182	1.000	.	0.509	.	0.000	0.035	0.597	0.816	0.035	0.315	0.056	0.000	0.003	0.082
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.099	-0.182	-0.377	-0.302	.	-0.384	.	0.419*	0.564*	-0.083	-0.266*	0.463*	-0.194	-0.381*	0.376*	-0.534*	-0.248*
	Sig. (2-tailed)	0.393	0.527	0.171	0.224	.	0.149	.	0.004	0.025	0.485	0.023	0.000	0.127	0.001	0.001	0.000	0.033
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Potassium, Total (mg/L)	Correlation Coefficient	0.749*	-0.253	0.241	-0.158	.	-0.099	.	0.350	0.398	0.103	0.178	0.134	-0.345*	-0.097	0.766*	-0.204	-0.231
	Sig. (2-tailed)	0.000	0.364	0.368	0.514	.	0.702	.	0.175	0.105	0.548	0.283	0.508	0.088	0.565	0.000	0.228	0.157
	N	24	12	12	12	12	12	12	12	12	24	24	17	17	23	23	23	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.505*	.	.	.	.	.	.	0.400*	.	-0.099	-0.328*	0.045	-0.297*	-0.267	0.619*	-0.257	-0.364*
	Sig. (2-tailed)	0.003	.	.	.	.	.	.	0.029	.	0.574	0.059	0.791	0.082	0.118	0.000	0.133	0.034
	N	24	0	0	0	0	0	0	24	0	24	24	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.778*	-0.337	0.252	-0.016	.	-0.175	.	0.482*	0.368	-0.039	-0.016	0.186*	-0.168	-0.178*	0.793*	-0.290*	-0.213*
	Sig. (2-tailed)	0.000	0.192	0.309	0.945	.	0.464	.	0.000	0.107	0.707	0.879	0.095	0.131	0.084	0.000	0.005	0.036
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.319*	-0.290	0.043	-0.189	.	-0.097	.	0.326*	0.443*	-0.145	-0.252*	0.470*	0.073	-0.231*	0.501*	-0.456*	-0.239*
	Sig. (2-tailed)	0.003	0.289	0.870	0.426	.	0.702	.	0.013	0.066	0.180	0.018	0.000	0.523	0.031	0.000	0.000	0.024
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.643*	-0.334	0.250	-0.062	.	-0.174	.	0.402*	0.381*	-0.074	-0.158	0.294*	-0.050	-0.247*	0.724*	-0.346*	-0.116
	Sig. (2-tailed)	0.000	0.192	0.310	0.783	.	0.465	.	0.001	0.093	0.469	0.119	0.007	0.645	0.015	0.000	0.001	0.247
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	0.031	-0.132	-0.034	0.546*	.	0.093	.	0.102	-0.169	0.134	0.400*	0.007	-0.203	-0.148	0.050	-0.139	0.113
	Sig. (2-tailed)	0.794	0.656	0.904	0.032	.	0.735	.	0.485	0.514	0.264	0.001	0.959	0.109	0.211	0.673	0.237	0.336
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Turbidity (NTU)	Correlation Coefficient	-0.229*	-0.171	0.180	0.796*	.	0.125	.	-0.279*	-0.411*	0.072	0.351*	-0.116	-0.248*	0.085	-0.163	0.067	0.280*
	Sig. (2-tailed)	0.024	0.527	0.486	0.001	.	0.618	.	0.026	0.083	0.484	0.001	0.286	0.023	0.399	0.107	0.509	0.006
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	47

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	-0.337	0.310	0.140	.	-0.088	.	0.325*	0.368	0.001	0.057	0.017	-0.106	-0.051	0.643*	-0.103	-0.248*
	Sig. (2-tailed)	.	0.192	0.210	0.534	.	0.714	.	0.010	0.107	0.993	0.575	0.875	0.334	0.614	0.000	0.308	0.013
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Cadmium, Total (mg/L)	Correlation Coefficient	-0.337	1.000	-0.235	-0.377	.	-0.213	.	.	-0.311	0.409	-0.277	-0.316	0.632	0.426	-0.341	0.426	-0.334
	Sig. (2-tailed)	0.192	.	0.414	0.146	.	0.444	.	.	0.238	0.145	0.300	0.480	0.157	0.114	0.206	0.114	0.192
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Copper, Total (mg/L)	Correlation Coefficient	0.310	-0.235	1.000	0.176	.	0.243	.	.	-0.020	-0.330	0.615*	-0.632	-0.316	0.090	0.090	0.270	-0.058
	Sig. (2-tailed)	0.210	0.414	.	0.480	.	0.362	.	.	0.937	0.220	0.016	0.157	0.480	0.728	0.728	0.296	0.815
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Iron, Total (mg/L)	Correlation Coefficient	0.140	-0.377	0.176	1.000	.	0.124	.	.	-0.194	-0.264	0.492*	0.000	-0.400	0.019	-0.167	-0.019	0.462*
	Sig. (2-tailed)	0.534	0.146	0.480	.	.	0.608	.	.	0.399	0.277	0.034	1.000	0.327	0.938	0.481	0.938	0.039
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Lead, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Manganese, Total (mg/L)	Correlation Coefficient	-0.088	-0.213	0.243	0.124	.	1.000	.	.	-0.256	0.064	0.409*	-0.120	-0.120	0.042	-0.125	0.208	0.348
	Sig. (2-tailed)	0.714	0.444	0.362	0.608	.	.	.	.	0.297	0.806	0.100	0.782	0.782	0.868	0.618	0.406	0.144
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	0.325*	.	.	.	.	.	.	1.000	.	0.101	-0.162	0.386*	-0.111	-0.407*	0.460*	-0.520*	-0.251*
	Sig. (2-tailed)	0.010	.	.	.	.	.	.	.	.	0.427	0.198	0.002	0.373	0.001	0.000	0.000	0.045
	N	36	0	0	0	0	0	0	36	0	36	36	36	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.368	-0.311	-0.020	-0.194	.	-0.256	.	.	1.000	0.117	-0.170	0.949*	0.105	-0.486*	0.374	-0.561*	-0.127
	Sig. (2-tailed)	0.107	0.238	0.937	0.399	.	0.297	.	.	.	0.636	0.473	0.023	0.801	0.041	0.115	0.018	0.575
	N	12	12	12	12	12	12	12	0	12	12	12	5	5	11	11	11	12
Nitrogen, Total (mg/L)	Correlation Coefficient	0.001	0.409	-0.330	-0.264	.	0.064	.	0.101	0.117	1.000	0.221*	-0.188*	-0.163	0.088	0.003	0.054	-0.153
	Sig. (2-tailed)	0.993	0.145	0.220	0.277	.	0.806	.	0.427	0.636	.	0.033	0.089	0.140	0.392	0.978	0.600	0.134
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Phosphorus, Total (mg/L)	Correlation Coefficient	0.057	-0.277	0.615*	0.492*	.	0.409*	.	-0.162	-0.170	0.221*	1.000	-0.346*	-0.244*	0.180*	-0.017	0.225*	0.096
	Sig. (2-tailed)	0.575	0.300	0.016	0.034	.	0.100	.	0.198	0.473	0.033	.	0.002	0.026	0.078	0.869	0.028	0.341
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.017	-0.316	-0.632	0.000	.	-0.120	.	0.386*	0.949*	-0.188*	-0.346*	1.000	0.317*	-0.431*	0.171	-0.641*	0.077
	Sig. (2-tailed)	0.875	0.480	0.157	1.000	.	0.782	.	0.002	0.023	0.089	0.002	.	0.003	0.000	0.116	0.000	0.479
	N	41	5	5	5	5	5	5	36	5	41	41	41	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.106	0.632	-0.316	-0.400	.	-0.120	.	-0.111	0.105	-0.163	-0.244*	0.317*	1.000	0.067	-0.239*	0.032	0.214*
	Sig. (2-tailed)	0.334	0.157	0.480	0.327	.	0.782	.	0.373	0.801	0.140	0.026	0.003	.	0.537	0.028	0.770	0.049
	N	41	5	5	5	5	5	5	36	5	41	41	41	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	-0.051	0.426	0.090	0.019	.	0.042	.	-0.407*	-0.486*	0.088	0.180*	-0.431*	0.067	1.000	-0.184*	0.547*	-0.029
	Sig. (2-tailed)	0.614	0.114	0.728	0.938	.	0.868	.	0.001	0.041	0.392	0.078	0.000	0.537	.	0.068	0.000	0.776
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	47
Specific Conductance (µS/cm)	Correlation Coefficient	0.643*	-0.341	0.090	-0.167	.	-0.125	.	0.460*	0.374	0.003	-0.017	0.171	-0.239*	-0.184*	1.000	-0.325*	-0.244*
	Sig. (2-tailed)	0.000	0.206	0.728	0.481	.	0.618	.	0.000	0.115	0.978	0.869	0.116	0.028	0.068	.	0.001	0.016
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	47
Water Temperature (°C)	Correlation Coefficient	-0.103	0.426	0.270	-0.019	.	0.208	.	-0.520*	-0.561*	0.054	0.225*	-0.641*	0.032	0.547*	-0.325*	1.000	0.057
	Sig. (2-tailed)	0.308	0.114	0.296	0.938	.	0.406	.	0.000	0.018	0.600	0.028	0.000	0.770	0.000	0.001	.	0.576
	N	47	11	11	11	11	11	11	36	11	47	47	41	41	47	47	47	47
Flow (CFS)	Correlation Coefficient	-0.248*	-0.334	-0.058	0.462*	.	0.348	.	-0.251*	-0.127	-0.153	0.096	0.077	0.214*	-0.029	-0.244*	0.057	1.000
	Sig. (2-tailed)	0.013	0.192	0.815	0.039	.	0.144	.	0.045	0.575	0.134	0.341	0.479	0.049	0.776	0.016	0.576	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	47	47	47	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-109: Kendall's tau correlation matrix of water quality parameters collected at Station 5 from 2011 to 2020.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.955*	0.116	0.213*	0.224*	0.253	0.130	-0.096	0.147	-0.067	-0.254	-0.115	0.153	0.066	-0.191*	-0.191*
	Sig. (2-tailed)	.	0.000	0.276	0.050	0.039	0.101	0.424	0.386	0.199	0.702	0.161	0.295	0.161	0.537	0.090	0.074
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Group by Quarter	Correlation Coefficient	0.955*	1.000	0.109	0.200*	0.210*	0.244	0.130	-0.107	0.143	-0.078	-0.254	-0.128	0.148	0.071	-0.179	-0.171
	Sig. (2-tailed)	0.000	.	0.320	0.075	0.062	0.134	0.424	0.349	0.227	0.673	0.161	0.259	0.190	0.519	0.123	0.120
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Julian Date	Correlation Coefficient	0.116	0.109	1.000	-0.028	-0.025	0.089	0.041	0.021	-0.059	0.000	-0.058	0.031	0.015	0.029	-0.181*	-0.141
	Sig. (2-tailed)	0.276	0.320	.	0.782	0.802	0.549	0.784	0.837	0.581	1.000	0.724	0.761	0.886	0.769	0.086	0.158
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.213*	0.200*	-0.028	1.000	0.934*	0.766*	0.818*	0.424*	0.735*	0.519*	0.294*	0.391*	0.782*	0.666*	-0.486*	-0.481*
	Sig. (2-tailed)	0.050	0.075	0.782	.	0.000	0.000	0.000	0.000	0.000	0.002	0.085	0.000	0.000	0.000	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.224*	0.210*	-0.025	0.934*	1.000	0.773*	0.806*	0.430*	0.749*	0.516*	0.288*	0.413*	0.766*	0.710*	-0.493*	-0.457*
	Sig. (2-tailed)	0.039	0.062	0.802	0.000	.	0.000	0.000	0.000	0.000	0.002	0.094	0.000	0.000	0.000	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	0.253	0.244	0.089	0.766*	0.773*	1.000	.	0.405*	0.807*	0.484*	.	0.478*	0.768*	0.666*	-0.545*	-0.451*
	Sig. (2-tailed)	0.101	0.134	0.549	0.000	0.000	.	.	0.008	0.000	0.005	.	0.002	0.000	0.000	0.000	0.003
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.130	0.130	0.041	0.818*	0.806*	.	1.000	0.396*	0.870*	.	0.331*	0.350*	0.796*	0.733*	-0.537*	-0.536*
	Sig. (2-tailed)	0.424	0.424	0.784	0.000	0.000	.	.	0.011	0.000	.	0.050	0.021	0.000	0.000	0.001	0.000
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	-0.096	-0.107	0.021	0.424*	0.430*	0.405*	0.396*	1.000	0.457*	0.591*	0.715*	0.876*	0.479*	0.510*	-0.482*	-0.416*
	Sig. (2-tailed)	0.386	0.349	0.837	0.000	0.000	0.008	0.011	.	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.147	0.143	-0.059	0.735*	0.749*	0.807*	0.870*	0.457*	1.000	0.547*	0.434*	0.465*	0.733*	0.703*	-0.501*	-0.518*
	Sig. (2-tailed)	0.199	0.227	0.581	0.000	0.000	0.000	0.000	0.000	.	0.003	0.014	0.000	0.000	0.000	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	-0.067	-0.078	0.000	0.519*	0.516*	0.484*	.	0.591*	0.547*	1.000	.	0.621*	0.492*	0.539*	-0.402*	-0.487*
	Sig. (2-tailed)	0.702	0.673	1.000	0.002	0.002	0.005	.	0.001	0.003	.	.	0.000	0.004	0.001	0.022	0.004
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	-0.254	-0.254	-0.058	0.294*	0.288*	.	0.331*	0.715*	0.434*	.	1.000	0.722*	0.326*	0.446*	-0.461*	-0.472*
	Sig. (2-tailed)	0.161	0.161	0.724	0.085	0.094	.	0.050	0.000	0.014	.	.	0.000	0.053	0.007	0.009	0.004
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.115	-0.128	0.031	0.391*	0.413*	0.478*	0.350*	0.876*	0.465*	0.621*	0.722*	1.000	0.407*	0.498*	-0.497*	-0.432*
	Sig. (2-tailed)	0.295	0.259	0.761	0.000	0.000	0.002	0.021	0.000	0.000	0.000	0.000	.	0.000	0.000	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.153	0.148	0.015	0.782*	0.766*	0.768*	0.796*	0.479*	0.733*	0.492*	0.326*	0.407*	1.000	0.727*	-0.441*	-0.402*
	Sig. (2-tailed)	0.161	0.190	0.886	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.053	0.000	.	0.000	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.066	0.071	0.029	0.666*	0.710*	0.666*	0.733*	0.510*	0.703*	0.539*	0.446*	0.498*	0.727*	1.000	-0.447*	-0.385*
	Sig. (2-tailed)	0.537	0.519	0.769	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.000	0.000	.	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.191*	-0.179	-0.181*	-0.486*	-0.493*	-0.545*	-0.537*	-0.482*	-0.501*	-0.402*	-0.461*	-0.497*	-0.441*	-0.447*	1.000	0.799*
	Sig. (2-tailed)	0.090	0.123	0.086	0.000	0.000	0.000	0.001	0.000	0.000	0.022	0.009	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	-0.191*	-0.171	-0.141	-0.481*	-0.457*	-0.451*	-0.536*	-0.416*	-0.518*	-0.487*	-0.472*	-0.432*	-0.402*	-0.385*	0.799*	1.000
	Sig. (2-tailed)	0.074	0.120	0.158	0.000	0.000	0.003	0.000	0.000	0.000	0.004	0.004	0.000	0.000	0.000	0.000	.
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	-0.127	-0.152	0.079	0.118	0.132	0.125	0.139	0.672*	0.164	0.390*	0.678*	0.694*	0.156	0.256*	-0.405*	-0.321*
	Sig. (2-tailed)	0.238	0.173	0.433	0.253	0.201	0.409	0.355	0.000	0.131	0.022	0.000	0.000	0.131	0.011	0.000	0.001
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	-0.349	-0.386	-0.349	-0.135	-0.244	-0.335	.	0.000	-0.370	-0.162	.	-0.055	-0.055	-0.242	0.352	0.379
	Sig. (2-tailed)	0.165	0.153	0.165	0.593	0.336	0.195	.	1.000	0.170	0.573	.	0.830	0.830	0.336	0.164	0.134
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	-0.391	-0.393	-0.391	-0.680*	-0.591*	-0.628*	.	-0.164	-0.612*	-0.616*	.	-0.180	-0.379	-0.249	0.716*	0.734*
	Sig. (2-tailed)	0.102	0.125	0.102	0.005	0.014	0.010	.	0.501	0.017	0.024	.	0.455	0.117	0.298	0.003	0.002
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	-0.382*	-0.354	-0.382*	-0.738*	-0.646*	-0.572*	.	-0.188	-0.649*	-0.530*	.	-0.202	-0.326	-0.290	0.846*	0.831*
	Sig. (2-tailed)	0.086	0.135	0.086	0.001	0.004	0.012	.	0.406	0.006	0.035	.	0.369	0.147	0.192	0.000	0.000
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	-0.080	-0.155	-0.080	-0.644*	-0.684*	-0.582*	.	-0.491*	-0.505*	-0.422	.	-0.466*	-0.608*	-0.599*	0.483*	0.443*
	Sig. (2-tailed)	0.742	0.552	0.742	0.008	0.005	0.020	.	0.047	0.052	0.127	.	0.057	0.013	0.013	0.048	0.069
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	-0.313	-0.269	-0.313	-0.702*	-0.737*	-0.797*	.	-0.445*	-0.720*	-0.551*	.	-0.442*	-0.654*	-0.661*	0.737*	0.684*
	Sig. (2-tailed)	0.184	0.285	0.184	0.003	0.002	0.001	.	0.063	0.004	0.040	.	0.064	0.006	0.005	0.002	0.004
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	-0.134	-0.178	-0.134	-0.514*	-0.514*	-0.559*	.	-0.412	-0.555*	-0.648*	.	-0.409	-0.464*	-0.457*	0.568*	0.568*
	Sig. (2-tailed)	0.593	0.509	0.593	0.042	0.042	0.031	.	0.107	0.040	0.024	.	0.108	0.068	0.069	0.025	0.025
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.206	-0.206	0.063	0.480*	0.487*	0.450*	0.536*	0.324*	0.478*	0.429*	0.242	0.272*	0.493*	0.517*	-0.258*	-0.237*
	Sig. (2-tailed)	0.113	0.113	0.594	0.000	0.000	0.045	0.000	0.009	0.000	0.088	0.150	0.025	0.000	0.000	0.041	0.045
	N	36	36	36	36	36	12	24	36	36	12	24	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	-0.308	-0.306	-0.308	0.202	0.295	0.208	.	0.709*	0.283	0.418*	.	0.688*	0.656*	0.523*	-0.078	-0.016
	Sig. (2-tailed)	0.168	0.199	0.168	0.369	0.189	0.364	.	0.002	0.235	0.099	.	0.002	0.004	0.019	0.730	0.945
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.237*	-0.223*	-0.063	0.048	0.050	0.150	-0.011	-0.048	0.060	0.125	-0.140	-0.085	0.114	0.114	0.277*	0.218*
	Sig. (2-tailed)	0.029	0.047	0.533	0.642	0.628	0.336	0.940	0.647	0.580	0.477	0.400	0.415	0.271	0.265	0.010	0.032
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.335*	-0.335*	-0.244*	-0.477*	-0.492*	-0.575*	-0.481*	-0.309*	-0.435*	-0.429*	-0.270	-0.325*	-0.420*	-0.465*	0.699*	0.646*
	Sig. (2-tailed)	0.002	0.003	0.015	0.000	0.000	0.000	0.001	0.003	0.000	0.011	0.109	0.002	0.000	0.000	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.058	0.046	0.173	0.468*	0.468*	0.460*	0.493*	0.236*	0.425*	0.396*	0.098	0.212*	0.590*	0.491*	-0.250*	-0.234*
	Sig. (2-tailed)	0.620	0.701	0.111	0.000	0.000	0.009	0.001	0.036	0.000	0.043	0.565	0.057	0.000	0.000	0.030	0.031
	N	41	41	41	41	41	18	23	41	41	18	23	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	0.179	0.190	0.160	0.065	0.042	-0.033	-0.069	-0.217*	-0.061	-0.017	-0.205	-0.251*	0.075	0.027	-0.026	-0.070
	Sig. (2-tailed)	0.128	0.113	0.141	0.557	0.709	0.849	0.652	0.054	0.600	0.930	0.227	0.024	0.498	0.805	0.823	0.522
	N	41	41	41	41	41	18	23	41	41	18	23	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	0.194*	0.205*	-0.024	-0.147	-0.168*	-0.123	-0.248*	-0.067	-0.117	-0.153	-0.022	-0.038	-0.143	-0.146	-0.071	-0.112
	Sig. (2-tailed)	0.068	0.063	0.810	0.148	0.098	0.410	0.095	0.519	0.274	0.365	0.892	0.714	0.161	0.145	0.502	0.263
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	0.101	0.093	-0.031	0.748*	0.714*	0.662*	0.751*	0.570*	0.711*	0.570*	0.364*	0.491*	0.742*	0.689*	-0.460*	-0.465*
	Sig. (2-tailed)	0.346	0.397	0.756	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.028	0.000	0.000	0.000	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	0.222*	0.221*	0.071	-0.365*	-0.376*	-0.350*	-0.492*	-0.361*	-0.452*	-0.423*	-0.148	-0.297*	-0.466*	-0.490*	0.158	0.132
	Sig. (2-tailed)	0.037	0.045	0.477	0.000	0.000	0.019	0.001	0.000	0.000	0.012	0.371	0.004	0.000	0.000	0.134	0.185
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.075	-0.088	-0.147	-0.244*	-0.249*	-0.302*	-0.218	-0.532*	-0.299*	-0.399*	-0.607*	-0.578*	-0.189*	-0.263*	0.608*	0.560*
	Sig. (2-tailed)	0.485	0.423	0.140	0.016	0.014	0.043	0.142	0.000	0.005	0.018	0.000	0.000	0.063	0.009	0.000	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesium, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-110: Kendall's tau correlation matrix of water quality parameters collected at Station 5 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	-0.127	-0.349	-0.391	-0.382*	-0.080	-0.313	-0.134	-0.206	-0.308	-0.237*	-0.335*	0.058	0.179	0.194*	0.101	0.222*	-0.075
	Sig. (2-tailed)	0.238	0.165	0.102	0.086	0.742	0.184	0.593	0.113	0.168	0.029	0.002	0.620	0.128	0.068	0.346	0.037	0.485
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Group by Quarter	Correlation Coefficient	-0.152	-0.386	-0.393	-0.354	-0.155	-0.269	-0.178	-0.206	-0.306	-0.223*	-0.335*	0.046	0.190	0.205*	0.093	0.221*	-0.088
	Sig. (2-tailed)	0.173	0.153	0.125	0.135	0.552	0.285	0.509	0.113	0.199	0.047	0.003	0.701	0.113	0.063	0.397	0.045	0.423
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Julian Date	Correlation Coefficient	0.079	-0.349	-0.391	-0.382*	-0.080	-0.313	-0.134	0.063	-0.308	-0.063	-0.244*	0.173	0.160	-0.024	-0.031	0.071	-0.147
	Sig. (2-tailed)	0.433	0.165	0.102	0.086	0.742	0.184	0.593	0.594	0.168	0.533	0.015	0.111	0.141	0.810	0.756	0.477	0.140
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.118	-0.135	-0.680*	-0.738*	-0.644*	-0.702*	-0.514*	0.480*	0.202	0.048	-0.477*	0.468*	0.065	-0.147	0.748*	-0.365*	-0.244*
	Sig. (2-tailed)	0.253	0.593	0.005	0.001	0.008	0.003	0.042	0.000	0.369	0.642	0.000	0.000	0.557	0.148	0.000	0.000	0.016
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.132	-0.244	-0.591*	-0.646*	-0.684*	-0.737*	-0.514*	0.487*	0.295	0.050	-0.492*	0.468*	0.042	-0.168*	0.714*	-0.376*	-0.249*
	Sig. (2-tailed)	0.201	0.336	0.014	0.004	0.005	0.002	0.042	0.000	0.189	0.628	0.000	0.000	0.709	0.098	0.000	0.000	0.014
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	0.125	-0.335	-0.628*	-0.572*	-0.582*	-0.797*	-0.559*	0.450*	0.208	0.150	-0.575*	0.460*	-0.033	-0.123	0.662*	-0.350*	-0.302*
	Sig. (2-tailed)	0.409	0.195	0.010	0.012	0.020	0.001	0.031	0.045	0.364	0.336	0.000	0.009	0.849	0.410	0.000	0.019	0.043
	N	24	12	12	12	12	12	12	12	12	24	24	18	18	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.139	.	.	.	.	.	.	0.536*	.	-0.011	-0.481*	0.493*	-0.069	-0.248*	0.751*	-0.492*	-0.218
	Sig. (2-tailed)	0.355	.	.	.	.	.	.	0.000	.	0.940	0.001	0.001	0.652	0.095	0.000	0.001	0.142
	N	24	0	0	0	0	0	0	24	0	24	24	23	23	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	0.672*	0.000	-0.164	-0.188	-0.491*	-0.445*	-0.412	0.324*	0.709*	-0.048	-0.309*	0.236*	-0.217*	-0.067	0.570*	-0.361*	-0.532*
	Sig. (2-tailed)	0.000	1.000	0.501	0.406	0.047	0.063	0.107	0.009	0.002	0.647	0.003	0.036	0.054	0.519	0.000	0.000	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.164	-0.370	-0.612*	-0.649*	-0.505*	-0.720*	-0.555*	0.478*	0.283	0.060	-0.435*	0.425*	-0.061	-0.117	0.711*	-0.452*	-0.299*
	Sig. (2-tailed)	0.131	0.170	0.017	0.006	0.052	0.004	0.040	0.000	0.235	0.580	0.000	0.000	0.600	0.274	0.000	0.000	0.005
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	0.390*	-0.162	-0.616*	-0.530*	-0.422	-0.551*	-0.648*	0.429*	0.418*	0.125	-0.429*	0.396*	-0.017	-0.153	0.570*	-0.423*	-0.399*
	Sig. (2-tailed)	0.022	0.573	0.024	0.035	0.127	0.040	0.024	0.088	0.099	0.477	0.011	0.043	0.930	0.365	0.001	0.012	0.018
	N	24	12	12	12	12	12	12	12	12	24	24	18	18	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.678*	.	.	.	.	.	.	0.242	.	-0.140	-0.270	0.098	-0.205	-0.022	0.364*	-0.148	-0.607*
	Sig. (2-tailed)	0.000	.	.	.	.	.	.	0.150	.	0.400	0.109	0.565	0.227	0.892	0.028	0.371	0.000
	N	24	0	0	0	0	0	0	24	0	24	24	23	23	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.694*	-0.055	-0.180	-0.202	-0.466*	-0.442*	-0.409	0.272*	0.688*	-0.085	-0.325*	0.212*	-0.251*	-0.038	0.491*	-0.297*	-0.578*
	Sig. (2-tailed)	0.000	0.830	0.455	0.369	0.057	0.064	0.108	0.025	0.002	0.415	0.002	0.057	0.024	0.714	0.000	0.004	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.156	-0.055	-0.379	-0.326	-0.608*	-0.654*	-0.464*	0.493*	0.656*	0.114	-0.420*	0.590*	0.075	-0.143	0.742*	-0.466*	-0.189*
	Sig. (2-tailed)	0.131	0.830	0.117	0.147	0.013	0.006	0.068	0.000	0.004	0.271	0.000	0.000	0.498	0.161	0.000	0.000	0.063
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.256*	-0.242	-0.249	-0.290	-0.599*	-0.661*	-0.457*	0.517*	0.523*	0.114	-0.465*	0.491*	0.027	-0.146	0.689*	-0.490*	-0.263*
	Sig. (2-tailed)	0.011	0.336	0.298	0.192	0.013	0.005	0.069	0.000	0.019	0.265	0.000	0.000	0.805	0.145	0.000	0.000	0.009
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.405*	0.352	0.716*	0.846*	0.483*	0.737*	0.568*	-0.258*	-0.078	0.277*	0.699*	-0.250*	-0.026	-0.071	-0.460*	0.158	0.608*
	Sig. (2-tailed)	0.000	0.164	0.003	0.000	0.048	0.002	0.025	0.041	0.730	0.010	0.000	0.030	0.823	0.502	0.000	0.134	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	-0.321*	0.379	0.734*	0.831*	0.443*	0.684*	0.568*	-0.237*	-0.016	0.218*	0.646*	-0.234*	-0.070	-0.112	-0.465*	0.132	0.560*
	Sig. (2-tailed)	0.001	0.134	0.002	0.000	0.069	0.004	0.025	0.045	0.945	0.032	0.000	0.031	0.522	0.263	0.000	0.185	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	0.189	-0.072	-0.062	-0.342	-0.298	-0.244	-0.013	0.729*	-0.202*	-0.283*	0.017	-0.190*	0.055	0.236*	-0.115	-0.599*
	Sig. (2-tailed)	.	0.454	0.766	0.783	0.161	0.208	0.336	0.913	0.001	0.049	0.005	0.875	0.085	0.587	0.019	0.255	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	0.189	1.000	0.126	0.189	0.142	0.370	0.381	.	0.164	0.240	0.349	.	.	-0.295	0.027	-0.188	0.134
	Sig. (2-tailed)	0.454	.	0.645	0.454	0.611	0.170	0.188	.	0.520	0.374	0.165	.	.	0.240	0.915	0.455	0.593
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	-0.072	0.126	1.000	0.859*	0.492*	0.592*	0.661*	.	-0.036	0.159	0.782*	-0.346	0.577	-0.142	-0.355	0.178	0.604*
	Sig. (2-tailed)	0.766	0.645	.	0.000	0.062	0.021	0.016	.	0.881	0.535	0.001	0.380	0.143	0.552	0.137	0.457	0.011
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	-0.062	0.189	0.859*	1.000	0.483*	0.631*	0.568*	.	-0.047	0.239	0.840*	-0.138	0.552	-0.137	-0.382*	0.137	0.595*
	Sig. (2-tailed)	0.783	0.454	0.000	.	0.048	0.008	0.025	.	0.836	0.314	0.000	0.702	0.126	0.536	0.086	0.536	0.007
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	-0.342	0.142	0.492*	0.483*	1.000	0.665*	0.673*	.	-0.365	0.134	0.519*	-0.577	0.346	0.080	-0.599*	0.479*	0.359
	Sig. (2-tailed)	0.161	0.611	0.062	0.048	.	0.010	0.016	.	0.137	0.607	0.032	0.143	0.380	0.742	0.013	0.048	0.138
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	-0.298	0.370	0.592*	0.631*	0.665*	1.000	0.586*	.	-0.247	0.039	0.766*	-0.602	0.775*	-0.035	-0.592*	0.313	0.453*
	Sig. (2-tailed)	0.208	0.170	0.021	0.008	0.010	.	0.030	.	0.299	0.878	0.001	0.114	0.042	0.883	0.012	0.184	0.055
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	-0.244	0.381	0.661*	0.568*	0.673*	0.586*	1.000	.	-0.164	0.150	0.564*	.	.	-0.081	-0.457*	0.242	0.510*
	Sig. (2-tailed)	0.336	0.188	0.016	0.025	0.016	0.030	.	.	0.520	0.579	0.025	.	.	0.749	0.069	0.336	0.042
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.013	.	.	.	.	.	.	1.000	.	0.384*	-0.186	0.602*	-0.038	-0.482*	0.487*	-0.785*	0.032
	Sig. (2-tailed)	0.913	.	.	.	.	.	.	.	.	0.001	0.119	0.000	0.754	0.000	0.000	0.000	0.785
	N	36	0	0	0	0	0	0	36	0	36	36	35	35	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.729*	0.164	-0.036	-0.047	-0.365	-0.247	-0.164	.	1.000	0.275	-0.092	0.867*	-0.733*	-0.554*	0.462*	-0.862*	-0.123
	Sig. (2-tailed)	0.001	0.520	0.881	0.836	0.137	0.299	0.520	.	.	0.249	0.679	0.015	0.039	0.013	0.039	0.000	0.582
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.202*	0.240	0.159	0.239	0.134	0.039	0.150	0.384*	0.275	1.000	0.262*	0.170	-0.050	-0.307*	0.072	-0.333*	0.351*
	Sig. (2-tailed)	0.049	0.374	0.535	0.314	0.607	0.878	0.579	0.001	0.249	.	0.010	0.123	0.653	0.003	0.481	0.001	0.001
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.283*	0.349	0.782*	0.840*	0.519*	0.766*	0.564*	-0.186	-0.092	0.262*	1.000	-0.302*	-0.126	-0.066	-0.415*	0.122	0.481*
	Sig. (2-tailed)	0.005	0.165	0.001	0.000	0.032	0.001	0.025	0.119	0.679	0.010	.	0.006	0.251	0.510	0.000	0.223	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.017	.	-0.346	-0.138	-0.577	-0.602	.	0.602*	0.867*	0.170	-0.302*	1.000	0.289*	-0.314*	0.387*	-0.598*	0.089
	Sig. (2-tailed)	0.875	.	0.380	0.702	0.143	0.114	.	0.000	0.015	0.123	0.006	.	0.008	0.004	0.000	0.000	0.412
	N	41	6	6	6	6	6	6	35	6	41	41	41	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.190*	.	0.577	0.552	0.346	0.775*	.	-0.038	-0.733*	-0.050	-0.126	0.289*	1.000	0.139	-0.071	0.109	0.125
	Sig. (2-tailed)	0.085	.	0.143	0.126	0.380	0.042	.	0.754	0.039	0.653	0.251	0.008	.	0.200	0.515	0.317	0.252
	N	41	6	6	6	6	6	6	35	6	41	41	41	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	0.055	-0.295	-0.142	-0.137	0.080	-0.035	-0.081	-0.482*	-0.554*	-0.307*	-0.066	-0.314*	0.139	1.000	-0.151	0.487*	-0.207*
	Sig. (2-tailed)	0.587	0.240	0.552	0.536	0.742	0.883	0.749	0.000	0.013	0.003	0.510	0.004	0.200	.	0.131	0.000	0.038
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	0.236*	0.027	-0.355	-0.382*	-0.599*	-0.592*	-0.457*	0.487*	0.462*	0.072	-0.415*	0.387*	-0.071	-0.151	1.000	-0.450*	-0.322*
	Sig. (2-tailed)	0.019	0.915	0.137	0.086	0.013	0.012	0.069	0.000	0.039	0.481	0.000	0.000	0.515	0.131	.	0.000	0.001
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	-0.115	-0.188	0.178	0.137	0.479*	0.313	0.242	-0.785*	-0.862*	-0.333*	0.122	-0.598*	0.109	0.487*	-0.450*	1.000	-0.002
	Sig. (2-tailed)	0.255	0.455	0.457	0.536	0.048	0.184	0.336	0.000	0.000	0.001	0.223	0.000	0.317	0.000	0.000	.	0.986
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.599*	0.134	0.604*	0.595*	0.359	0.453*	0.510*	0.032	-0.123	0.351*	0.481*	0.089	0.125	-0.207*	-0.322*	-0.002	1.000
	Sig. (2-tailed)	0.000	0.593	0.011	0.007	0.138	0.055	0.042	0.785	0.582	0.001	0.000	0.412	0.252	0.038	0.001	0.986	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-111: Kendall's tau correlation matrix of water quality parameters collected at Station 6 from 2011 to 2020.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.955*	0.116	-0.391*	-0.396*	-0.387*	-0.520*	-0.321*	-0.445*	-0.535*	-0.393*	-0.338*	-0.398*	-0.526*	.	0.577*
	Sig. (2-tailed)	.	0.000	0.276	0.000	0.000	0.013	0.002	0.005	0.000	0.003	0.039	0.002	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Group by Quarter	Correlation Coefficient	0.955*	1.000	0.109	-0.396*	-0.403*	-0.405*	-0.520*	-0.328*	-0.457*	-0.577*	-0.393*	-0.348*	-0.416*	-0.526*	.	0.630*
	Sig. (2-tailed)	0.000	.	0.320	0.000	0.000	0.013	0.002	0.005	0.000	0.002	0.039	0.003	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Julian Date	Correlation Coefficient	0.116	0.109	1.000	-0.091	-0.117	0.045	-0.195	0.035	-0.088	-0.223	-0.104	0.053	-0.005	0.005	.	-0.067
	Sig. (2-tailed)	0.276	0.320	.	0.368	0.247	0.765	0.200	0.745	0.416	0.198	0.549	0.614	0.957	0.957	.	0.505
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	-0.391*	-0.396*	-0.091	1.000	0.872*	0.732*	0.711*	0.628*	0.773*	0.425*	0.510*	0.633*	0.721*	0.570*	.	-0.427*
	Sig. (2-tailed)	0.000	0.000	0.368	.	0.000	0.000	0.000	0.000	0.000	0.015	0.005	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	-0.396*	-0.403*	-0.117	0.872*	1.000	0.728*	0.729*	0.601*	0.767*	0.460*	0.368*	0.596*	0.725*	0.511*	.	-0.405*
	Sig. (2-tailed)	0.000	0.000	0.247	0.000	.	0.000	0.000	0.000	0.000	0.008	0.040	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	-0.387*	-0.405*	0.045	0.732*	0.728*	1.000	.	0.637*	0.836*	0.433*	.	0.774*	0.685*	0.552*	.	-0.502*
	Sig. (2-tailed)	0.013	0.013	0.765	0.000	0.000	.	.	0.000	0.000	0.015	.	0.000	0.000	0.000	.	0.001
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	-0.520*	-0.520*	-0.195	0.711*	0.729*	.	1.000	0.635*	0.733*	.	0.490*	0.649*	0.616*	0.716*	.	-0.433*
	Sig. (2-tailed)	0.002	0.002	0.200	0.000	0.000	.	.	0.000	0.000	.	0.007	0.000	0.000	0.000	.	0.004
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	-0.321*	-0.328*	0.035	0.628*	0.601*	0.637*	0.635*	1.000	0.654*	0.499*	0.543*	0.826*	0.657*	0.525*	.	-0.265*
	Sig. (2-tailed)	0.005	0.005	0.745	0.000	0.000	0.000	0.000	.	0.000	0.006	0.003	0.000	0.000	0.000	.	0.013
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	-0.445*	-0.457*	-0.088	0.773*	0.767*	0.836*	0.733*	0.654*	1.000	0.448*	0.489*	0.714*	0.745*	0.572*	.	-0.464*
	Sig. (2-tailed)	0.000	0.000	0.416	0.000	0.000	0.000	0.000	0.000	.	0.016	0.009	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	-0.535*	-0.577*	-0.223	0.425*	0.460*	0.433*	.	0.499*	0.448*	1.000	.	0.490*	0.543*	0.546*	.	-0.352*
	Sig. (2-tailed)	0.003	0.002	0.198	0.015	0.008	0.015	.	0.006	0.016	.	.	0.007	0.002	0.002	.	0.043
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	-0.393*	-0.393*	-0.104	0.510*	0.368*	.	0.490*	0.543*	0.489*	.	1.000	0.626*	0.418*	0.571*	.	-0.463*
	Sig. (2-tailed)	0.039	0.039	0.549	0.005	0.040	.	0.007	0.003	0.009	.	.	0.001	0.019	0.001	.	0.008
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.338*	-0.348*	0.053	0.633*	0.596*	0.774*	0.649*	0.826*	0.714*	0.490*	0.626*	1.000	0.599*	0.498*	.	-0.291*
	Sig. (2-tailed)	0.002	0.003	0.614	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.001	.	0.000	0.000	.	0.005
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	-0.398*	-0.416*	-0.005	0.721*	0.725*	0.685*	0.616*	0.657*	0.745*	0.543*	0.418*	0.599*	1.000	0.627*	.	-0.424*
	Sig. (2-tailed)	0.000	0.000	0.957	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.019	0.000	.	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	-0.526*	-0.526*	0.005	0.570*	0.511*	0.552*	0.716*	0.525*	0.572*	0.546*	0.571*	0.498*	0.627*	1.000	.	-0.482*
	Sig. (2-tailed)	0.000	0.000	0.957	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.000	0.000	.	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	0.577*	0.630*	-0.067	-0.427*	-0.405*	-0.502*	-0.433*	-0.265*	-0.464*	-0.352*	-0.463*	-0.291*	-0.424*	-0.482*	.	1.000
	Sig. (2-tailed)	0.000	0.000	0.505	0.000	0.000	0.001	0.004	0.013	0.000	0.043	0.008	0.005	0.000	0.000	.	.
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	-0.054	-0.058	0.199*	0.284*	0.250*	0.422*	0.277*	0.494*	0.323*	0.077	0.308*	0.490*	0.223*	0.141	.	-0.103
	Sig. (2-tailed)	0.628	0.610	0.055	0.007	0.017	0.006	0.082	0.000	0.004	0.666	0.091	0.000	0.036	0.176	.	0.320
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	-0.334	-0.369	-0.334	0.186	0.037	0.190	.	0.040	0.198	-0.255	.	0.039	0.116	0.187	.	-0.299
	Sig. (2-tailed)	0.192	0.180	0.192	0.469	0.885	0.467	.	0.883	0.461	0.398	.	0.884	0.661	0.468	.	0.246
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	-0.018	0.081	-0.018	-0.349	-0.296	-0.413*	.	-0.117	-0.294	-0.050	.	-0.210	-0.229	-0.166	.	0.499*
	Sig. (2-tailed)	0.940	0.756	0.940	0.152	0.226	0.095	.	0.644	0.249	0.860	.	0.401	0.360	0.496	.	0.041
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	0.406*	0.536*	0.406*	-0.532*	-0.488*	-0.528*	.	-0.334	-0.667*	-0.408	.	-0.439*	-0.504*	-0.488*	.	0.945*
	Sig. (2-tailed)	0.071	0.026	0.071	0.018	0.031	0.021	.	0.156	0.005	0.120	.	0.058	0.029	0.031	.	0.000
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	0.045	-0.025	0.045	-0.045	-0.023	-0.069	.	0.144	-0.192	0.216	.	0.023	0.023	0.000	.	0.272
	Sig. (2-tailed)	0.856	0.925	0.856	0.856	0.927	0.784	.	0.578	0.458	0.456	.	0.927	0.927	1.000	.	0.274
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	0.296	0.291	0.296	-0.428*	-0.431*	-0.421*	.	-0.368	-0.561*	-0.407	.	-0.462*	-0.530*	-0.547*	.	0.481*
	Sig. (2-tailed)	0.202	0.241	0.202	0.066	0.065	0.075	.	0.129	0.021	0.133	.	0.053	0.026	0.019	.	0.040
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.186	-0.186	-0.003	-0.159	-0.144	-0.318	-0.165	-0.397*	-0.192	-0.144	-0.178	-0.340*	-0.211*	-0.057	.	-0.070
	Sig. (2-tailed)	0.157	0.157	0.978	0.192	0.237	0.164	0.289	0.002	0.138	0.578	0.316	0.007	0.085	0.632	.	0.556
	N	36	36	36	36	36	12	24	36	36	12	24	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	-0.031	-0.068	-0.031	0.062	0.016	0.126	.	-0.033	0.230	-0.169	.	0.112	0.112	0.047	.	-0.264
	Sig. (2-tailed)	0.890	0.775	0.890	0.783	0.945	0.579	.	0.888	0.324	0.514	.	0.625	0.625	0.836	.	0.240
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	0.162	0.166	-0.205*	-0.186*	-0.171	-0.234	-0.349*	-0.405*	-0.253*	-0.236	-0.314*	-0.386*	-0.194*	-0.175*	.	0.142
	Sig. (2-tailed)	0.141	0.143	0.047	0.074	0.102	0.137	0.025	0.000	0.023	0.199	0.076	0.000	0.066	0.090	.	0.168
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	0.388*	0.423*	-0.157	-0.473*	-0.436*	-0.483*	-0.493*	-0.433*	-0.464*	-0.470*	-0.487*	-0.438*	-0.549*	-0.524*	.	0.491*
	Sig. (2-tailed)	0.000	0.000	0.119	0.000	0.000	0.002	0.001	0.000	0.000	0.008	0.006	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.277*	-0.305*	0.193*	0.385*	0.365*	0.548*	0.351*	0.235*	0.423*	0.301	0.174	0.212*	0.501*	0.460*	.	-0.465*
	Sig. (2-tailed)	0.018	0.011	0.076	0.000	0.001	0.002	0.024	0.042	0.000	0.139	0.327	0.061	0.000	0.000	.	0.000
	N	41	41	41	41	41	18	23	41	41	18	23	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.147	-0.174	0.193*	0.358*	0.322*	0.466*	0.293*	0.246*	0.393*	0.181	0.199	0.215*	0.486*	0.413*	.	-0.372*
	Sig. (2-tailed)	0.209	0.145	0.076	0.001	0.004	0.008	0.061	0.034	0.001	0.374	0.263	0.058	0.000	0.000	.	0.001
	N	41	41	41	41	41	18	23	41	41	18	23	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	-0.063	-0.051	-0.106	0.279*	0.243*	0.352*	0.257*	0.275*	0.326*	0.216	-0.012	0.234*	0.341*	0.246*	.	-0.082
	Sig. (2-tailed)	0.555	0.645	0.290	0.006	0.017	0.020	0.092	0.010	0.003	0.220	0.947	0.026	0.001	0.014	.	0.413
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	-0.419*	-0.423*	-0.106	0.691*	0.684*	0.702*	0.679*	0.747*	0.718*	0.511*	0.464*	0.702*	0.691*	0.591*	.	-0.348*
	Sig. (2-tailed)	0.000	0.000	0.290	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.008	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	0.474*	0.470*	-0.009	-0.446*	-0.458*	-0.567*	-0.456*	-0.292*	-0.509*	-0.383*	-0.185	-0.314*	-0.463*	-0.486*	.	0.537*
	Sig. (2-tailed)	0.000	0.000	0.929	0.000	0.000	0.000	0.003	0.006	0.000	0.027	0.286	0.003	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.234*	-0.251*	-0.168*	0.026	0.013	-0.015	0.088	-0.015	-0.011	0.351*	0.070	-0.056	0.130	0.248*	.	-0.134
	Sig. (2-tailed)	0.028	0.022	0.091	0.796	0.901	0.920	0.563	0.885	0.920	0.043	0.689	0.589	0.205	0.013	.	0.180
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesium, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-112: Kendall's tau correlation matrix of water quality parameters collected at Station 6 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	-0.054	-0.334	-0.018	0.406*	0.045	0.296	.	-0.186	-0.031	0.162	0.388*	-0.277*	-0.147	-0.063	-0.419*	0.474*	-0.234*
	Sig. (2-tailed)	0.628	0.192	0.940	0.071	0.856	0.202	.	0.157	0.890	0.141	0.000	0.018	0.209	0.555	0.000	0.000	0.028
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Group by Quarter	Correlation Coefficient	-0.058	-0.369	0.081	0.536*	-0.025	0.291	.	-0.186	-0.068	0.166	0.423*	-0.305*	-0.174	-0.051	-0.423*	0.470*	-0.251*
	Sig. (2-tailed)	0.610	0.180	0.756	0.026	0.925	0.241	.	0.157	0.775	0.143	0.000	0.011	0.145	0.645	0.000	0.000	0.022
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Julian Date	Correlation Coefficient	0.199*	-0.334	-0.018	0.406*	0.045	0.296	.	-0.003	-0.031	-0.205*	-0.157	0.193*	0.193*	-0.106	-0.106	-0.009	-0.168*
	Sig. (2-tailed)	0.055	0.192	0.940	0.071	0.856	0.202	.	0.978	0.890	0.047	0.119	0.076	0.076	0.290	0.290	0.929	0.091
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.284*	0.186	-0.349	-0.532*	-0.045	-0.428*	.	-0.159	0.062	-0.186*	-0.473*	0.385*	0.358*	0.279*	0.691*	-0.446*	0.026
	Sig. (2-tailed)	0.007	0.469	0.152	0.018	0.856	0.066	.	0.192	0.783	0.074	0.000	0.000	0.001	0.006	0.000	0.000	0.796
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.250*	0.037	-0.296	-0.488*	-0.023	-0.431*	.	-0.144	0.016	-0.171	-0.436*	0.365*	0.322*	0.243*	0.684*	-0.458*	0.013
	Sig. (2-tailed)	0.017	0.885	0.226	0.031	0.927	0.065	.	0.237	0.945	0.102	0.000	0.001	0.004	0.017	0.000	0.000	0.901
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	0.422*	0.190	-0.413*	-0.528*	-0.069	-0.421*	.	-0.318	0.126	-0.234	-0.483*	0.548*	0.466*	0.352*	0.702*	-0.567*	-0.015
	Sig. (2-tailed)	0.006	0.467	0.095	0.021	0.784	0.075	.	0.164	0.579	0.137	0.002	0.002	0.008	0.020	0.000	0.000	0.920
	N	24	12	12	12	12	12	12	12	12	24	24	18	18	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.277*	.	.	.	.	.	.	-0.165	.	-0.349*	-0.493*	0.351*	0.293*	0.257*	0.679*	-0.456*	0.088
	Sig. (2-tailed)	0.082	.	.	.	.	.	.	0.289	.	0.025	0.001	0.024	0.061	0.092	0.000	0.003	0.563
	N	24	0	0	0	0	0	0	24	0	24	24	23	23	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	0.494*	0.040	-0.117	-0.334	0.144	-0.368	.	-0.397*	-0.033	-0.405*	-0.433*	0.235*	0.246*	0.275*	0.747*	-0.292*	-0.015
	Sig. (2-tailed)	0.000	0.883	0.644	0.156	0.578	0.129	.	0.002	0.888	0.000	0.000	0.042	0.034	0.010	0.000	0.006	0.885
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.323*	0.198	-0.294	-0.667*	-0.192	-0.561*	.	-0.192	0.230	-0.253*	-0.464*	0.423*	0.393*	0.326*	0.718*	-0.509*	-0.011
	Sig. (2-tailed)	0.004	0.461	0.249	0.005	0.458	0.021	.	0.138	0.324	0.023	0.000	0.000	0.001	0.003	0.000	0.000	0.920
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	0.077	-0.255	-0.050	-0.408	0.216	-0.407	.	-0.144	-0.169	-0.236	-0.470*	0.301	0.181	0.216	0.511*	-0.383*	0.351*
	Sig. (2-tailed)	0.666	0.398	0.860	0.120	0.456	0.133	.	0.578	0.514	0.199	0.008	0.139	0.374	0.220	0.003	0.027	0.043
	N	24	12	12	12	12	12	12	12	12	24	24	18	18	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.308*	.	.	.	.	.	.	-0.178	.	-0.314*	-0.487*	0.174	0.199	-0.012	0.464*	-0.185	0.070
	Sig. (2-tailed)	0.091	.	.	.	.	.	.	0.316	.	0.076	0.006	0.327	0.263	0.947	0.008	0.286	0.689
	N	24	0	0	0	0	0	0	24	0	24	24	23	23	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.490*	0.039	-0.210	-0.439*	0.023	-0.462*	.	-0.340*	0.112	-0.386*	-0.438*	0.212*	0.215*	0.234*	0.702*	-0.314*	-0.056
	Sig. (2-tailed)	0.000	0.884	0.401	0.058	0.927	0.053	.	0.007	0.625	0.000	0.000	0.061	0.058	0.026	0.000	0.003	0.589
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.223*	0.116	-0.229	-0.504*	0.023	-0.530*	.	-0.211*	0.112	-0.194*	-0.549*	0.501*	0.486*	0.341*	0.691*	-0.463*	0.130
	Sig. (2-tailed)	0.036	0.661	0.360	0.029	0.927	0.026	.	0.085	0.625	0.066	0.000	0.000	0.000	0.001	0.000	0.000	0.205
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.141	0.187	-0.166	-0.488*	0.000	-0.547*	.	-0.057	0.047	-0.175*	-0.524*	0.460*	0.413*	0.246*	0.591*	-0.486*	0.248*
	Sig. (2-tailed)	0.176	0.468	0.496	0.031	1.000	0.019	.	0.632	0.836	0.090	0.000	0.000	0.000	0.014	0.000	0.000	0.013
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	-0.103	-0.299	0.499*	0.945*	0.272	0.481*	.	-0.070	-0.264	0.142	0.491*	-0.465*	-0.372*	-0.082	-0.348*	0.537*	-0.134
	Sig. (2-tailed)	0.320	0.246	0.041	0.000	0.274	0.040	.	0.556	0.240	0.168	0.000	0.000	0.001	0.413	0.000	0.000	0.180
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	0.198	-0.489*	-0.550*	-0.240	-0.298	.	-0.287*	0.016	-0.451*	-0.077	0.052	0.040	0.115	0.359*	-0.161	-0.302*
	Sig. (2-tailed)	.	0.459	0.054	0.019	0.352	0.217	.	0.022	0.944	0.000	0.462	0.642	0.725	0.267	0.001	0.119	0.004
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	0.198	1.000	-0.180	-0.345	-0.165	0.040	.	.	0.264	-0.283	-0.076	.	.	0.000	0.186	-0.334	0.111
	Sig. (2-tailed)	0.459	.	0.528	0.188	0.568	0.882	.	.	0.309	0.334	0.771	.	.	1.000	0.469	0.192	0.664
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	-0.489*	-0.180	1.000	0.511*	0.272	0.319	.	.	-0.261	0.047	0.432*	-0.430	-0.430	-0.115	-0.239	0.239	0.202
	Sig. (2-tailed)	0.054	0.528	.	0.040	0.320	0.214	.	.	0.289	0.866	0.081	0.275	0.275	0.645	0.327	0.327	0.407
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	-0.550*	-0.345	0.511*	1.000	0.325	0.526*	.	.	-0.286	0.357	0.592*	-0.276	-0.276	-0.262	-0.500*	0.688*	-0.063
	Sig. (2-tailed)	0.019	0.188	0.040	.	0.198	0.027	.	.	0.210	0.161	0.010	0.444	0.444	0.258	0.027	0.002	0.782
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	-0.240	-0.165	0.272	0.325	1.000	0.195	.	.	-0.479*	0.029	0.115	-0.577	-0.577	-0.189	-0.090	0.315	0.360
	Sig. (2-tailed)	0.352	0.568	0.320	0.198	.	0.454	.	.	0.055	0.919	0.647	0.143	0.143	0.458	0.716	0.202	0.145
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	-0.298	0.040	0.319	0.526*	0.195	1.000	.	.	-0.367	0.104	0.606*	-0.414	-0.414	-0.086	-0.428*	0.592*	-0.099
	Sig. (2-tailed)	0.217	0.882	0.214	0.027	0.454	.	.	.	0.118	0.691	0.010	0.251	0.251	0.718	0.066	0.011	0.671
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.287*	.	.	.	.	.	.	1.000	.	0.398*	0.089	-0.050	-0.171	-0.346*	-0.217*	-0.088	0.065
	Sig. (2-tailed)	0.022	.	.	.	.	.	.	.	.	0.001	0.459	0.679	0.158	0.004	0.069	0.460	0.584
	N	36	0	0	0	0	0	0	36	0	36	36	35	35	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.016	0.264	-0.261	-0.286	-0.479*	-0.367	.	.	1.000	0.293	-0.142	0.552	0.552	-0.258	0.123	-0.369*	-0.092
	Sig. (2-tailed)	0.944	0.309	0.289	0.210	0.055	0.118	.	.	.	0.245	0.532	0.126	0.126	0.260	0.582	0.098	0.679
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.451*	-0.283	0.047	0.357	0.029	0.104	.	0.398*	0.293	1.000	0.223*	-0.044	-0.011	-0.075	-0.272*	0.044	0.206*
	Sig. (2-tailed)	0.000	0.334	0.866	0.161	0.919	0.691	.	0.001	0.245	.	0.032	0.693	0.919	0.468	0.008	0.667	0.045
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.077	-0.076	0.432*	0.592*	0.115	0.606*	.	0.089	-0.142	0.223*	1.000	-0.375*	-0.365*	-0.141	-0.394*	0.324*	-0.204*
	Sig. (2-tailed)	0.462	0.771	0.081	0.010	0.647	0.010	.	0.459	0.532	0.032	.	0.001	0.001	0.165	0.000	0.001	0.043
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.052	.	-0.430	-0.276	-0.577	-0.414	.	-0.050	0.552	-0.044	-0.375*	1.000	0.849*	0.348*	0.243*	-0.678*	0.212*
	Sig. (2-tailed)	0.642	.	0.275	0.444	0.143	0.251	.	0.679	0.126	0.693	0.001	.	0.000	0.001	0.025	0.000	0.051
	N	41	6	6	6	6	6	6	35	6	41	41	41	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	0.040	.	-0.430	-0.276	-0.577	-0.414	.	-0.171	0.552	-0.011	-0.365*	0.849*	1.000	0.431*	0.209*	-0.527*	0.232*
	Sig. (2-tailed)	0.725	.	0.275	0.444	0.143	0.251	.	0.158	0.126	0.919	0.001	0.000	.	0.000	0.055	0.000	0.033
	N	41	6	6	6	6	6	6	35	6	41	41	41	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	0.115	0.000	-0.115	-0.262	-0.189	-0.086	.	-0.346*	-0.258	-0.075	-0.141	0.348*	0.431*	1.000	0.206*	-0.170*	0.099
	Sig. (2-tailed)	0.267	1.000	0.645	0.258	0.458	0.718	.	0.004	0.260	0.468	0.165	0.001	0.000	.	0.039	0.089	0.324
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	0.359*	0.186	-0.239	-0.500*	-0.090	-0.428*	.	-0.217*	0.123	-0.272*	-0.394*	0.243*	0.209*	0.206*	1.000	-0.400*	0.043
	Sig. (2-tailed)	0.001	0.469	0.327	0.027	0.716	0.066	.	0.069	0.582	0.008	0.000	0.025	0.055	0.039	.	0.000	0.663
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	-0.161	-0.334	0.239	0.688*	0.315	0.592*	.	-0.088	-0.369*	0.044	0.324*	-0.678*	-0.527*	-0.170*	-0.400*	1.000	-0.117
	Sig. (2-tailed)	0.119	0.192	0.327	0.002	0.202	0.011	.	0.460	0.098	0.667	0.001	0.000	0.000	0.089	0.000	.	0.241
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.302*	0.111	0.202	-0.063	0.360	-0.099	.	0.065	-0.092	0.206*	-0.204*	0.212*	0.232*	0.099	0.043	-0.117	1.000
	Sig. (2-tailed)	0.004	0.664	0.407	0.782	0.145	0.671	.	0.584	0.679	0.045	0.043	0.051	0.033	0.324	0.663	0.241	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-113: Kendall's tau correlation matrix of water quality parameters collected at Station 7 from 2011 to 2020.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.955*	0.116	-0.297*	-0.322*	-0.294*	-0.452*	-0.316*	-0.339*	-0.420*	-0.450*	-0.294*	-0.354*	-0.406*	.	0.558*
	Sig. (2-tailed)	.	0.000	0.276	0.006	0.003	0.058	0.006	0.005	0.003	0.017	0.021	0.009	0.001	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Group by Quarter	Correlation Coefficient	0.955*	1.000	0.109	-0.302*	-0.332*	-0.326*	-0.452*	-0.334*	-0.356*	-0.422*	-0.450*	-0.305*	-0.374*	-0.398*	.	0.595*
	Sig. (2-tailed)	0.000	.	0.320	0.007	0.003	0.046	0.006	0.005	0.003	0.023	0.021	0.008	0.001	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Julian Date	Correlation Coefficient	0.116	0.109	1.000	-0.060	-0.052	0.180	-0.207	0.028	-0.031	-0.238	-0.149	0.094	0.017	0.108	.	-0.083
	Sig. (2-tailed)	0.276	0.320	.	0.556	0.605	0.231	0.168	0.793	0.777	0.162	0.401	0.369	0.865	0.282	.	0.403
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	-0.297*	-0.302*	-0.060	1.000	0.849*	0.764*	0.658*	0.705*	0.670*	0.508*	0.376*	0.681*	0.681*	0.565*	.	-0.320*
	Sig. (2-tailed)	0.006	0.007	0.556	.	0.000	0.000	0.000	0.000	0.000	0.003	0.045	0.000	0.000	0.000	.	0.002
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	-0.322*	-0.332*	-0.052	0.849*	1.000	0.740*	0.758*	0.645*	0.733*	0.531*	0.375*	0.644*	0.715*	0.568*	.	-0.365*
	Sig. (2-tailed)	0.003	0.003	0.605	0.000	.	0.000	0.000	0.000	0.000	0.002	0.045	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	-0.294*	-0.326*	0.180	0.764*	0.740*	1.000	.	0.686*	0.759*	0.437*	.	0.793*	0.704*	0.604*	.	-0.369*
	Sig. (2-tailed)	0.058	0.046	0.231	0.000	0.000	.	.	0.000	0.000	0.014	.	0.000	0.000	0.000	.	0.014
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	-0.452*	-0.452*	-0.207	0.658*	0.758*	.	1.000	0.612*	0.780*	.	0.390*	0.561*	0.700*	0.602*	.	-0.381*
	Sig. (2-tailed)	0.006	0.006	0.168	0.000	0.000	.	.	0.000	0.000	.	0.034	0.000	0.000	0.000	.	0.011
	N	24	24	24	24	24	0	24	24	24	1	23	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	-0.316*	-0.334*	0.028	0.705*	0.645*	0.686*	0.612*	1.000	0.653*	0.461*	0.498*	0.814*	0.705*	0.612*	.	-0.286*
	Sig. (2-tailed)	0.005	0.005	0.793	0.000	0.000	0.000	0.000	.	0.000	0.010	0.009	0.000	0.000	0.000	.	0.007
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	-0.339*	-0.356*	-0.031	0.670*	0.733*	0.759*	0.780*	0.653*	1.000	0.508*	0.452*	0.683*	0.714*	0.567*	.	-0.403*
	Sig. (2-tailed)	0.003	0.003	0.777	0.000	0.000	0.000	0.000	0.000	.	0.005	0.019	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	-0.420*	-0.422*	-0.238	0.508*	0.531*	0.437*	.	0.461*	0.508*	1.000	.	0.443*	0.591*	0.466*	.	-0.288*
	Sig. (2-tailed)	0.017	0.023	0.162	0.003	0.002	0.014	.	0.010	0.005	.	.	0.012	0.001	0.006	.	0.092
	N	25	25	25	25	25	24	1	25	25	25	0	25	25	25	25	25
Potassium, Dissolved (mg/L)	Correlation Coefficient	-0.450*	-0.450*	-0.149	0.376*	0.375*	.	0.390*	0.498*	0.452*	.	1.000	0.562*	0.355*	0.590*	.	-0.311*
	Sig. (2-tailed)	0.021	0.021	0.401	0.045	0.045	.	0.034	0.009	0.019	.	.	0.003	0.056	0.001	.	0.080
	N	23	23	23	23	23	0	23	23	23	0	23	23	23	23	23	23
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.294*	-0.305*	0.094	0.681*	0.644*	0.793*	0.561*	0.814*	0.683*	0.443*	0.562*	1.000	0.584*	0.579*	.	-0.299*
	Sig. (2-tailed)	0.009	0.008	0.369	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.003	.	0.000	0.000	.	0.004
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	-0.354*	-0.374*	0.017	0.681*	0.715*	0.704*	0.700*	0.705*	0.714*	0.591*	0.355*	0.584*	1.000	0.623*	.	-0.378*
	Sig. (2-tailed)	0.001	0.001	0.865	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.056	0.000	.	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	-0.406*	-0.398*	0.108	0.565*	0.568*	0.604*	0.602*	0.612*	0.567*	0.466*	0.590*	0.579*	0.623*	1.000	.	-0.434*
	Sig. (2-tailed)	0.000	0.000	0.282	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.001	0.000	0.000	.	.	0.000
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	0.558*	0.595*	-0.083	-0.320*	-0.365*	-0.369*	-0.381*	-0.286*	-0.403*	-0.288*	-0.311*	-0.299*	-0.378*	-0.434*	.	1.000
	Sig. (2-tailed)	0.000	0.000	0.403	0.002	0.000	0.014	0.011	0.007	0.000	0.092	0.080	0.004	0.000	0.000	.	.
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	-0.046	-0.052	0.145	0.360*	0.340*	0.436*	0.317*	0.525*	0.407*	0.229	0.206	0.580*	0.270*	0.286*	.	-0.117
	Sig. (2-tailed)	0.680	0.649	0.164	0.001	0.001	0.005	0.046	0.000	0.000	0.190	0.270	0.000	0.012	0.006	.	0.262
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	-0.349	-0.386	-0.349	0.349	0.295	0.302	.	0.401	0.146	0.116	.	0.292	0.405	0.352	.	-0.352
	Sig. (2-tailed)	0.165	0.153	0.165	0.165	0.240	0.237	.	0.126	0.583	0.695	.	0.272	0.126	0.164	.	0.164
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	0.000	0.021	0.000	-0.408*	-0.371	-0.399	.	-0.257	-0.302	-0.107	.	-0.302	-0.399	-0.299	.	0.243
	Sig. (2-tailed)	1.000	0.938	1.000	0.096	0.130	0.110	.	0.314	0.243	0.711	.	0.243	0.121	0.225	.	0.324
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	0.351	0.456*	0.351	-0.565*	-0.534*	-0.688*	.	-0.342	-0.680*	-0.526*	.	-0.514*	-0.559*	-0.369*	.	0.862*
	Sig. (2-tailed)	0.114	0.055	0.114	0.011	0.016	0.002	.	0.139	0.004	0.041	.	0.028	0.016	0.098	.	0.000
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	0.171	0.151	0.171	-0.205	-0.205	-0.314	.	-0.219	-0.445*	-0.196	.	-0.334	-0.312	-0.275	.	0.464*
	Sig. (2-tailed)	0.470	0.550	0.470	0.386	0.386	0.190	.	0.374	0.074	0.477	.	0.180	0.207	0.246	.	0.050
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.017	-0.017	-0.023	-0.104	-0.010	-0.222	0.012	-0.309*	-0.087	-0.292	-0.305*	-0.273*	-0.152	-0.137	.	-0.120
	Sig. (2-tailed)	0.899	0.899	0.848	0.393	0.934	0.329	0.940	0.015	0.498	0.236	0.092	0.028	0.215	0.251	.	0.312
	N	36	36	36	36	36	12	24	36	36	13	23	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.000	-0.070	0.000	0.286	0.254	0.342	.	-0.017	0.293	0.000	.	0.121	0.154	0.080	.	-0.400*
	Sig. (2-tailed)	1.000	0.773	1.000	0.209	0.264	0.140	.	0.943	0.221	1.000	.	0.614	0.519	0.727	.	0.080
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	0.175	0.174	-0.134	-0.259*	-0.247*	-0.322*	-0.247	-0.415*	-0.315*	-0.203	-0.295	-0.405*	-0.285*	-0.288*	.	0.271*
	Sig. (2-tailed)	0.113	0.127	0.195	0.014	0.019	0.040	0.111	0.000	0.005	0.256	0.105	0.000	0.007	0.006	.	0.009
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	0.357*	0.379*	-0.163	-0.396*	-0.370*	-0.498*	-0.389*	-0.422*	-0.437*	-0.371*	-0.441*	-0.448*	-0.496*	-0.546*	.	0.402*
	Sig. (2-tailed)	0.001	0.001	0.105	0.000	0.000	0.001	0.010	0.000	0.000	0.030	0.014	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.271*	-0.290*	0.214*	0.216*	0.238*	0.335*	0.367*	0.163	0.290*	0.105	0.081	0.107	0.413*	0.359*	.	-0.333*
	Sig. (2-tailed)	0.021	0.015	0.049	0.053	0.031	0.057	0.018	0.159	0.013	0.595	0.658	0.346	0.000	0.001	.	0.002
	N	41	41	41	41	41	18	23	41	41	19	22	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.220*	-0.225*	0.180*	0.123	0.085	0.027	0.251	0.111	0.123	0.079	0.148	0.036	0.333*	0.281*	.	-0.139
	Sig. (2-tailed)	0.060	0.061	0.096	0.268	0.443	0.879	0.104	0.337	0.293	0.690	0.417	0.751	0.003	0.010	.	0.200
	N	41	41	41	41	41	18	23	41	41	19	22	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	-0.077	-0.057	-0.181*	0.243*	0.165	0.188	0.117	0.244*	0.168	0.282*	0.050	0.160	0.229*	0.203*	.	0.004
	Sig. (2-tailed)	0.474	0.606	0.070	0.017	0.105	0.211	0.438	0.022	0.120	0.098	0.779	0.127	0.026	0.043	.	0.972
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	-0.383*	-0.397*	-0.060	0.681*	0.645*	0.675*	0.566*	0.765*	0.653*	0.508*	0.405*	0.708*	0.639*	0.612*	.	-0.368*
	Sig. (2-tailed)	0.000	0.000	0.546	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.023	0.000	0.000	0.000	.	0.000
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	0.320*	0.339*	-0.045	-0.334*	-0.402*	-0.439*	-0.418*	-0.175*	-0.379*	-0.255	-0.062	-0.189*	-0.347*	-0.291*	.	0.447*
	Sig. (2-tailed)	0.003	0.002	0.650	0.001	0.000	0.003	0.005	0.099	0.000	0.135	0.726	0.071	0.001	0.004	.	0.000
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.193*	-0.210*	-0.140	-0.082	-0.103	-0.210	0.072	-0.083	-0.132	0.249	0.181	-0.177*	0.047	0.049	.	0.027
	Sig. (2-tailed)	0.071	0.057	0.160	0.422	0.310	0.162	0.634	0.436	0.221	0.143	0.310	0.091	0.649	0.625	.	0.790
	N	48	48	48	48	48	24	24	48	48	25	23	48	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesium, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-114: Kendall's tau correlation matrix of water quality parameters collected at Station 7 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	-0.046	-0.349	0.000	0.351	.	0.171	.	-0.017	0.000	0.175	0.357*	-0.271*	-0.220*	-0.077	-0.383*	0.320*	-0.193*
	Sig. (2-tailed)	0.680	0.165	1.000	0.114	.	0.470	.	0.899	1.000	0.113	0.001	0.021	0.060	0.474	0.000	0.003	0.071
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Group by Quarter	Correlation Coefficient	-0.052	-0.386	0.021	0.456*	.	0.151	.	-0.017	-0.070	0.174	0.379*	-0.290*	-0.225*	-0.057	-0.397*	0.339*	-0.210*
	Sig. (2-tailed)	0.649	0.153	0.938	0.055	.	0.550	.	0.899	0.773	0.127	0.001	0.015	0.061	0.606	0.000	0.002	0.057
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Julian Date	Correlation Coefficient	0.145	-0.349	0.000	0.351	.	0.171	.	-0.023	0.000	-0.134	-0.163	0.214*	0.180*	-0.181*	-0.060	-0.045	-0.140
	Sig. (2-tailed)	0.164	0.165	1.000	0.114	.	0.470	.	0.848	1.000	0.195	0.105	0.049	0.096	0.070	0.546	0.650	0.160
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.360*	0.349	-0.408*	-0.565*	.	-0.205	.	-0.104	0.286	-0.259*	-0.396*	0.216*	0.123	0.243*	0.681*	-0.334*	-0.082
	Sig. (2-tailed)	0.001	0.165	0.096	0.011	.	0.386	.	0.393	0.209	0.014	0.000	0.053	0.268	0.017	0.000	0.001	0.422
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.340*	0.295	-0.371	-0.534*	.	-0.205	.	-0.010	0.254	-0.247*	-0.370*	0.238*	0.085	0.165	0.645*	-0.402*	-0.103
	Sig. (2-tailed)	0.001	0.240	0.130	0.016	.	0.386	.	0.934	0.264	0.019	0.000	0.031	0.443	0.105	0.000	0.000	0.310
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	0.436*	0.302	-0.399	-0.688*	.	-0.314	.	-0.222	0.342	-0.322*	-0.498*	0.335*	0.027	0.188	0.675*	-0.439*	-0.210
	Sig. (2-tailed)	0.005	0.237	0.110	0.002	.	0.190	.	0.329	0.140	0.040	0.001	0.057	0.879	0.211	0.000	0.003	0.162
	N	24	12	12	12	12	12	12	12	12	24	24	18	18	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.317*	.	.	.	.	.	.	0.012	.	-0.247	-0.389*	0.367*	0.251	0.117	0.566*	-0.418*	0.072
	Sig. (2-tailed)	0.046	.	.	.	.	.	.	0.940	.	0.111	0.010	0.018	0.104	0.438	0.000	0.005	0.634
	N	24	0	0	0	0	0	0	24	0	24	24	23	23	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	0.525*	0.401	-0.257	-0.342	.	-0.219	.	-0.309*	-0.017	-0.415*	-0.422*	0.163	0.111	0.244*	0.765*	-0.175*	-0.083
	Sig. (2-tailed)	0.000	0.126	0.314	0.139	.	0.374	.	0.015	0.943	0.000	0.000	0.159	0.337	0.022	0.000	0.099	0.436
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.407*	0.146	-0.302	-0.680*	.	-0.445*	.	-0.087	0.293	-0.315*	-0.437*	0.290*	0.123	0.168	0.653*	-0.379*	-0.132
	Sig. (2-tailed)	0.000	0.583	0.243	0.004	.	0.074	.	0.498	0.221	0.005	0.000	0.013	0.293	0.120	0.000	0.000	0.221
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	0.229	0.116	-0.107	-0.526*	.	-0.196	.	-0.292	0.000	-0.203	-0.371*	0.105	0.079	0.282*	0.508*	-0.255	0.249
	Sig. (2-tailed)	0.190	0.695	0.711	0.041	.	0.477	.	0.236	1.000	0.256	0.030	0.595	0.690	0.098	0.003	0.135	0.143
	N	25	12	12	12	12	12	12	13	12	25	25	19	19	25	25	25	25
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.206	.	.	.	.	.	.	-0.305*	.	-0.295	-0.441*	0.081	0.148	0.050	0.405*	-0.062	0.181
	Sig. (2-tailed)	0.270	.	.	.	.	.	.	0.092	.	0.105	0.014	0.658	0.417	0.779	0.023	0.726	0.310
	N	23	0	0	0	0	0	0	23	0	23	23	22	22	23	23	23	23
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.580*	0.292	-0.302	-0.514*	.	-0.334	.	-0.273*	0.121	-0.405*	-0.448*	0.107	0.036	0.160	0.708*	-0.189*	-0.177*
	Sig. (2-tailed)	0.000	0.272	0.243	0.028	.	0.180	.	0.028	0.614	0.000	0.000	0.346	0.751	0.127	0.000	0.071	0.091
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.270*	0.405	-0.399	-0.559*	.	-0.312	.	-0.152	0.154	-0.285*	-0.496*	0.413*	0.333*	0.229*	0.639*	-0.347*	0.047
	Sig. (2-tailed)	0.012	0.126	0.121	0.016	.	0.207	.	0.215	0.519	0.007	0.000	0.000	0.003	0.026	0.000	0.001	0.649
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.286*	0.352	-0.299	-0.369*	.	-0.275	.	-0.137	0.080	-0.288*	-0.546*	0.359*	0.281*	0.203*	0.612*	-0.291*	0.049
	Sig. (2-tailed)	0.006	0.164	0.225	0.098	.	0.246	.	0.251	0.727	0.006	0.000	0.001	0.010	0.043	0.000	0.004	0.625
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	-0.117	-0.352	0.243	0.862*	.	0.464*	.	-0.120	-0.400*	0.271*	0.402*	-0.333*	-0.139	0.004	-0.368*	0.447*	0.027
	Sig. (2-tailed)	0.262	0.164	0.324	0.000	.	0.050	.	0.312	0.080	0.009	0.000	0.002	0.200	0.972	0.000	0.000	0.790
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	0.192	-0.342	-0.438*	.	0.175	.	-0.278*	0.114	-0.394*	-0.137	-0.050	-0.193*	0.031	0.435*	-0.065	-0.343*
	Sig. (2-tailed)	.	0.452	0.171	0.053	.	0.467	.	0.025	0.623	0.000	0.192	0.658	0.088	0.767	0.000	0.530	0.001
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	0.192	1.000	-0.526*	-0.298	.	-0.303	.	.	0.028	0.065	-0.273	.	.	0.081	0.403	-0.242	0.242
	Sig. (2-tailed)	0.452	.	0.062	0.239	.	0.263	.	.	0.914	0.817	0.284	.	.	0.748	0.109	0.336	0.336
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	-0.342	-0.526*	1.000	0.318	.	0.167	.	.	-0.058	-0.315	0.339	-0.086	0.775*	0.131	-0.445*	0.186	-0.074
	Sig. (2-tailed)	0.171	0.062	.	0.197	.	0.526	.	.	0.818	0.249	0.172	0.822	0.042	0.596	0.069	0.449	0.762
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	-0.438*	-0.298	0.318	1.000	.	0.310	.	.	-0.464*	0.240	0.481*	-0.333	0.200	-0.062	-0.534*	0.626*	0.076
	Sig. (2-tailed)	0.053	0.239	0.197	.	.	0.192	.	.	0.043	0.328	0.032	0.348	0.573	0.783	0.016	0.005	0.731
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	0.175	-0.303	0.167	0.310	.	1.000	.	.	0.036	-0.145	0.537*	-0.501	-0.215	-0.189	-0.273	0.307	-0.341
	Sig. (2-tailed)	0.467	0.263	0.526	0.192	.	.	.	.	0.883	0.581	0.024	0.173	0.559	0.426	0.247	0.193	0.148
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.278*	.	.	.	.	.	.	1.000	.	0.366*	0.291*	0.072	-0.147	-0.310*	-0.179	-0.301*	-0.113
	Sig. (2-tailed)	0.025	.	.	.	.	.	.	.	.	0.003	0.015	0.550	0.221	0.009	0.130	0.011	0.339
	N	36	0	0	0	0	0	0	36	0	36	36	35	35	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.114	0.028	-0.058	-0.464*	.	0.036	.	.	1.000	-0.308	-0.194	0.552	-0.414	-0.208	0.222	-0.604*	-0.413*
	Sig. (2-tailed)	0.623	0.914	0.818	0.043	.	0.883	.	.	.	0.222	0.400	0.126	0.251	0.363	0.329	0.008	0.070
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.394*	0.065	-0.315	0.240	.	-0.145	.	0.366*	-0.308	1.000	0.256*	-0.036	-0.035	-0.083	-0.317*	0.025	0.214*
	Sig. (2-tailed)	0.000	0.817	0.249	0.328	.	0.581	.	0.003	0.222	.	0.014	0.743	0.752	0.423	0.002	0.808	0.038
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.137	-0.273	0.339	0.481*	.	0.537*	.	0.291*	-0.194	0.256*	1.000	-0.368*	-0.374*	-0.261*	-0.390*	0.184*	-0.169*
	Sig. (2-tailed)	0.192	0.284	0.172	0.032	.	0.024	.	0.015	0.400	0.014	.	0.001	0.001	0.010	0.000	0.068	0.094
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.050	.	-0.086	-0.333	.	-0.501	.	0.072	0.552	-0.036	-0.368*	1.000	0.611*	0.159	0.122	-0.545*	0.275*
	Sig. (2-tailed)	0.658	.	0.822	0.348	.	0.173	.	0.550	0.126	0.743	0.001	.	0.000	0.144	0.261	0.000	0.011
	N	41	6	6	6	6	6	6	35	6	41	41	41	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.193*	.	0.775*	0.200	.	-0.215	.	-0.147	-0.414	-0.035	-0.374*	0.611*	1.000	0.314*	0.031	-0.156	0.440*
	Sig. (2-tailed)	0.088	.	0.042	0.573	.	0.559	.	0.221	0.251	0.752	0.001	0.000	.	0.004	0.779	0.151	0.000
	N	41	6	6	6	6	6	6	35	6	41	41	41	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	0.031	0.081	0.131	-0.062	.	-0.189	.	-0.310*	-0.208	-0.083	-0.261*	0.159	0.314*	1.000	0.128	0.065	0.199*
	Sig. (2-tailed)	0.767	0.748	0.596	0.783	.	0.426	.	0.009	0.363	0.423	0.010	0.144	0.004	.	0.200	0.516	0.046
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	0.435*	0.403	-0.445*	-0.534*	.	-0.273	.	-0.179	0.222	-0.317*	-0.390*	0.122	0.031	0.128	1.000	-0.223*	-0.067
	Sig. (2-tailed)	0.000	0.109	0.069	0.016	.	0.247	.	0.130	0.329	0.002	0.000	0.261	0.779	0.200	.	0.026	0.499
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	-0.065	-0.242	0.186	0.626*	.	0.307	.	-0.301*	-0.604*	0.025	0.184*	-0.545*	-0.156	0.065	-0.223*	1.000	-0.008
	Sig. (2-tailed)	0.530	0.336	0.449	0.005	.	0.193	.	0.011	0.008	0.808	0.068	0.000	0.151	0.516	0.026	.	0.936
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.343*	0.242	-0.074	0.076	.	-0.341	.	-0.113	-0.413*	0.214*	-0.169*	0.275*	0.440*	0.199*	-0.067	-0.008	1.000
	Sig. (2-tailed)	0.001	0.336	0.762	0.731	.	0.148	.	0.339	0.070	0.038	0.094	0.011	0.000	0.046	0.499	0.936	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-115: Kendall's tau correlation matrix of water quality parameters collected at Station 8 from 2011 to 2020.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.955*	0.116	-0.273*	-0.258*	-0.244	-0.448*	-0.228*	-0.310*	-0.381*	-0.337*	-0.208*	-0.304*	-0.369*	.	0.337*
	Sig. (2-tailed)	.	0.000	0.276	0.012	0.017	0.117	0.007	0.047	0.008	0.034	0.077	0.062	0.005	0.001	.	0.002
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Group by Quarter	Correlation Coefficient	0.955*	1.000	0.109	-0.303*	-0.288*	-0.298*	-0.448*	-0.245*	-0.338*	-0.412*	-0.337*	-0.231*	-0.333*	-0.375*	.	0.341*
	Sig. (2-tailed)	0.000	.	0.320	0.007	0.010	0.070	0.007	0.039	0.005	0.031	0.077	0.045	0.003	0.001	.	0.002
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Julian Date	Correlation Coefficient	0.116	0.109	1.000	-0.082	-0.111	0.203	-0.286*	0.099	-0.039	-0.127	-0.160	0.139	0.032	0.062	.	-0.107
	Sig. (2-tailed)	0.276	0.320	.	0.422	0.273	0.177	0.060	0.356	0.719	0.465	0.357	0.181	0.755	0.534	.	0.286
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	-0.273*	-0.303*	-0.082	1.000	0.841*	0.566*	0.650*	0.546*	0.639*	0.213	0.326*	0.509*	0.629*	0.518*	.	-0.191*
	Sig. (2-tailed)	0.012	0.007	0.422	.	0.000	0.000	0.000	0.000	0.000	0.226	0.079	0.000	0.000	0.000	.	0.061
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	-0.258*	-0.288*	-0.111	0.841*	1.000	0.575*	0.614*	0.432*	0.590*	0.239	0.175	0.383*	0.574*	0.430*	.	-0.187*
	Sig. (2-tailed)	0.017	0.010	0.273	0.000	.	0.000	0.000	0.000	0.000	0.172	0.334	0.000	0.000	0.000	.	0.065
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	-0.244	-0.298*	0.203	0.566*	0.575*	1.000	.	0.679*	0.722*	0.355*	.	0.708*	0.664*	0.458*	.	-0.174
	Sig. (2-tailed)	0.117	0.070	0.177	0.000	0.000	.	.	0.000	0.000	0.048	.	0.000	0.000	0.002	.	0.250
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	-0.448*	-0.448*	-0.286*	0.650*	0.614*	.	1.000	0.385*	0.796*	.	0.290	0.462*	0.526*	0.514*	.	-0.130
	Sig. (2-tailed)	0.007	0.007	0.060	0.000	0.000	.	.	0.021	0.000	.	0.109	0.004	0.001	0.001	.	0.393
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	-0.228*	-0.245*	0.099	0.546*	0.432*	0.679*	0.385*	1.000	0.516*	0.457*	0.365*	0.823*	0.602*	0.474*	.	-0.168
	Sig. (2-tailed)	0.047	0.039	0.356	0.000	0.000	0.000	0.021	.	0.000	0.013	0.057	0.000	0.000	0.000	.	0.118
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	-0.310*	-0.338*	-0.039	0.639*	0.590*	0.722*	0.796*	0.516*	1.000	0.426*	0.206	0.543*	0.661*	0.544*	.	-0.232*
	Sig. (2-tailed)	0.008	0.005	0.719	0.000	0.000	0.000	0.000	0.000	.	0.023	0.285	0.000	0.000	0.000	.	0.034
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	-0.381*	-0.412*	-0.127	0.213	0.239	0.355*	.	0.457*	0.426*	1.000	.	0.385*	0.482*	0.499*	.	-0.116
	Sig. (2-tailed)	0.034	0.031	0.465	0.226	0.172	0.048	.	0.013	0.023	.	.	0.032	0.006	0.004	.	0.505
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	-0.337*	-0.337*	-0.160	0.326*	0.175	.	0.290	0.365*	0.206	.	1.000	0.458*	0.377*	0.399*	.	0.017
	Sig. (2-tailed)	0.077	0.077	0.357	0.079	0.334	.	0.109	0.057	0.285	.	.	0.012	0.035	0.022	.	0.924
	N	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.208*	-0.231*	0.139	0.509*	0.383*	0.708*	0.462*	0.823*	0.543*	0.385*	0.458*	1.000	0.549*	0.432*	.	-0.198*
	Sig. (2-tailed)	0.062	0.045	0.181	0.000	0.000	0.000	0.004	0.000	0.000	0.032	0.012	.	0.000	0.000	.	0.058
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	-0.304*	-0.333*	0.032	0.629*	0.574*	0.664*	0.526*	0.602*	0.661*	0.482*	0.377*	0.549*	1.000	0.599*	.	-0.158
	Sig. (2-tailed)	0.005	0.003	0.755	0.000	0.000	0.000	0.001	0.000	0.000	0.006	0.035	0.000	.	0.000	.	0.123
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	-0.369*	-0.375*	0.062	0.518*	0.430*	0.458*	0.514*	0.474*	0.544*	0.499*	0.399*	0.432*	0.599*	1.000	.	-0.193*
	Sig. (2-tailed)	0.001	0.001	0.534	0.000	0.000	0.002	0.001	0.000	0.000	0.004	0.022	0.000	0.000	.	.	0.055
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	0.337*	0.341*	-0.107	-0.191*	-0.187*	-0.174	-0.130	-0.168	-0.232*	-0.116	0.017	-0.198*	-0.158	-0.193*	.	1.000
	Sig. (2-tailed)	0.002	0.002	0.286	0.061	0.065	0.250	0.393	0.118	0.034	0.505	0.924	0.058	0.123	0.055	.	.
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	0.128	0.130	0.224*	0.239*	0.160	0.478*	0.036	0.497*	0.211*	0.253	-0.141	0.523*	0.177*	0.160	.	-0.012
	Sig. (2-tailed)	0.247	0.255	0.030	0.023	0.128	0.002	0.819	0.000	0.062	0.159	0.440	0.000	0.095	0.124	.	0.907
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	-0.334	-0.369	-0.334	0.264	0.264	0.077	.	0.084	-0.040	-0.213	.	0.079	0.113	0.111	.	-0.411
	Sig. (2-tailed)	0.192	0.180	0.192	0.309	0.309	0.770	.	0.762	0.882	0.480	.	0.767	0.663	0.664	.	0.110
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	-0.193	-0.233	-0.193	-0.232	-0.250	-0.345	.	-0.079	-0.322	-0.101	.	-0.169	-0.196	-0.299	.	-0.142
	Sig. (2-tailed)	0.420	0.364	0.420	0.339	0.303	0.161	.	0.758	0.202	0.719	.	0.500	0.418	0.213	.	0.557
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	0.485*	0.536*	0.485*	-0.230	-0.263	-0.233	.	-0.219	-0.400*	-0.325	.	-0.362	-0.263	-0.356	.	0.765*
	Sig. (2-tailed)	0.035	0.029	0.035	0.322	0.258	0.320	.	0.374	0.097	0.225	.	0.130	0.258	0.122	.	0.001
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	0.018	-0.020	0.018	0.109	0.146	0.167	.	0.040	0.039	-0.206	.	0.019	0.018	0.162	.	-0.253
	Sig. (2-tailed)	0.941	0.939	0.941	0.653	0.549	0.499	.	0.876	0.879	0.464	.	0.939	0.940	0.502	.	0.295
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.031	-0.031	0.055	-0.236*	-0.101	-0.197	-0.093	-0.388*	-0.223*	-0.361	-0.135	-0.437*	-0.307*	-0.200*	.	-0.063
	Sig. (2-tailed)	0.810	0.810	0.642	0.054	0.402	0.396	0.546	0.002	0.088	0.164	0.445	0.000	0.012	0.093	.	0.594
	N	36	36	36	36	36	12	24	36	36	12	24	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.205	0.227	0.205	-0.080	-0.080	-0.146	.	-0.479*	-0.034	-0.181	.	-0.387	-0.336	-0.173	.	-0.095
	Sig. (2-tailed)	0.366	0.350	0.366	0.727	0.727	0.528	.	0.048	0.887	0.492	.	0.101	0.143	0.445	.	0.676
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	0.131	0.137	-0.175*	-0.299*	-0.211*	-0.307*	-0.345*	-0.501*	-0.361*	-0.292	-0.112	-0.530*	-0.325*	-0.276*	.	0.278*
	Sig. (2-tailed)	0.231	0.225	0.087	0.004	0.043	0.054	0.025	0.000	0.001	0.113	0.524	0.000	0.002	0.007	.	0.007
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	0.264*	0.287*	-0.155	-0.255*	-0.160	-0.356*	-0.203	-0.354*	-0.306*	-0.372*	-0.216	-0.347*	-0.361*	-0.348*	.	0.168*
	Sig. (2-tailed)	0.014	0.009	0.122	0.013	0.117	0.019	0.183	0.001	0.005	0.033	0.215	0.001	0.000	0.001	.	0.094
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.321*	-0.337*	0.264*	0.249*	0.291*	0.403*	0.196	0.071	0.272*	0.206	0.018	0.068	0.319*	0.259*	.	-0.013
	Sig. (2-tailed)	0.006	0.005	0.015	0.025	0.008	0.024	0.209	0.543	0.022	0.314	0.920	0.548	0.004	0.018	.	0.902
	N	41	41	41	41	41	18	23	41	41	18	23	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.169	-0.166	0.266*	0.145	0.080	0.266	-0.083	0.112	0.135	0.229	0.024	0.066	0.364*	0.251*	.	0.028
	Sig. (2-tailed)	0.150	0.166	0.014	0.190	0.471	0.135	0.593	0.335	0.258	0.260	0.894	0.563	0.001	0.021	.	0.796
	N	41	41	41	41	41	18	23	41	41	18	23	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	-0.141	-0.138	0.046	0.198*	0.145	0.332*	0.126	0.219*	0.279*	0.321*	-0.116	0.170	0.336*	0.325*	.	-0.007
	Sig. (2-tailed)	0.185	0.211	0.644	0.052	0.151	0.028	0.407	0.042	0.011	0.065	0.505	0.103	0.001	0.001	.	0.943
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	-0.270*	-0.287*	-0.084	0.638*	0.532*	0.707*	0.394*	0.723*	0.558*	0.480*	0.216	0.653*	0.614*	0.529*	.	-0.211*
	Sig. (2-tailed)	0.011	0.009	0.398	0.000	0.000	0.000	0.010	0.000	0.000	0.006	0.215	0.000	0.000	0.000	.	0.035
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	0.337*	0.340*	0.000	-0.193*	-0.270*	-0.226	-0.256*	0.030	-0.223*	-0.127	0.061	0.033	-0.143	-0.162	.	0.114
	Sig. (2-tailed)	0.002	0.002	1.000	0.058	0.008	0.134	0.093	0.777	0.042	0.465	0.727	0.754	0.161	0.106	.	0.255
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.209*	-0.225*	-0.183*	-0.007	0.017	-0.158	0.072	-0.132	-0.093	0.127	0.171	-0.213*	0.080	0.095	.	0.251*
	Sig. (2-tailed)	0.050	0.041	0.067	0.943	0.866	0.294	0.633	0.218	0.396	0.465	0.325	0.042	0.437	0.346	.	0.012
	N	48	48	48	48	48	24	24	48	48	24	24	48	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-116: Kendall's tau correlation matrix of water quality parameters collected at Station 8 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	0.128	-0.334	-0.193	0.485*	.	0.018	.	-0.031	0.205	0.131	0.264*	-0.321*	-0.169	-0.141	-0.270*	0.337*	-0.209*
	Sig. (2-tailed)	0.247	0.192	0.420	0.035	.	0.941	.	0.810	0.366	0.231	0.014	0.006	0.150	0.185	0.011	0.002	0.050
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Group by Quarter	Correlation Coefficient	0.130	-0.369	-0.233	0.536*	.	-0.020	.	-0.031	0.227	0.137	0.287*	-0.337*	-0.166	-0.138	-0.287*	0.340*	-0.225*
	Sig. (2-tailed)	0.255	0.180	0.364	0.029	.	0.939	.	0.810	0.350	0.225	0.009	0.005	0.166	0.211	0.009	0.002	0.041
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Julian Date	Correlation Coefficient	0.224*	-0.334	-0.193	0.485*	.	0.018	.	0.055	0.205	-0.175*	-0.155	0.264*	0.266*	0.046	-0.084	0.000	-0.183*
	Sig. (2-tailed)	0.030	0.192	0.420	0.035	.	0.941	.	0.642	0.366	0.087	0.122	0.015	0.014	0.644	0.398	1.000	0.067
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.239*	0.264	-0.232	-0.230	.	0.109	.	-0.236*	-0.080	-0.299*	-0.255*	0.249*	0.145	0.198*	0.638*	-0.193*	-0.007
	Sig. (2-tailed)	0.023	0.309	0.339	0.322	.	0.653	.	0.054	0.727	0.004	0.013	0.025	0.190	0.052	0.000	0.058	0.943
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.160	0.264	-0.250	-0.263	.	0.146	.	-0.101	-0.080	-0.211*	-0.160	0.291*	0.080	0.145	0.532*	-0.270*	0.017
	Sig. (2-tailed)	0.128	0.309	0.303	0.258	.	0.549	.	0.402	0.727	0.043	0.117	0.008	0.471	0.151	0.000	0.008	0.866
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	0.478*	0.077	-0.345	-0.233	.	0.167	.	-0.197	-0.146	-0.307*	-0.356*	0.403*	0.266	0.332*	0.707*	-0.226	-0.158
	Sig. (2-tailed)	0.002	0.770	0.161	0.320	.	0.499	.	0.396	0.528	0.054	0.019	0.024	0.135	0.028	0.000	0.134	0.294
	N	24	12	12	12	12	12	12	12	12	24	24	18	18	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.036	.	.	.	.	.	.	-0.093	.	-0.345*	-0.203	0.196	-0.083	0.126	0.394*	-0.256*	0.072
	Sig. (2-tailed)	0.819	.	.	.	.	.	.	0.546	.	0.025	0.183	0.209	0.593	0.407	0.010	0.093	0.633
	N	24	0	0	0	0	0	0	24	0	24	24	23	23	24	24	24	24
Chloride, Total (mg/L)	Correlation Coefficient	0.497*	0.084	-0.079	-0.219	.	0.040	.	-0.388*	-0.479*	-0.501*	-0.354*	0.071	0.112	0.219*	0.723*	0.030	-0.132
	Sig. (2-tailed)	0.000	0.762	0.758	0.374	.	0.876	.	0.002	0.048	0.000	0.001	0.543	0.335	0.042	0.000	0.777	0.218
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.211*	-0.040	-0.322	-0.400*	.	0.039	.	-0.223*	-0.034	-0.361*	-0.306*	0.272*	0.135	0.279*	0.558*	-0.223*	-0.093
	Sig. (2-tailed)	0.062	0.882	0.202	0.097	.	0.879	.	0.088	0.887	0.001	0.005	0.022	0.258	0.011	0.000	0.042	0.396
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	0.253	-0.213	-0.101	-0.325	.	-0.206	.	-0.361	-0.181	-0.292	-0.372*	0.206	0.229	0.321*	0.480*	-0.127	0.127
	Sig. (2-tailed)	0.159	0.480	0.719	0.225	.	0.464	.	0.164	0.492	0.113	0.033	0.314	0.260	0.065	0.006	0.465	0.465
	N	24	12	12	12	12	12	12	12	12	24	24	18	18	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	-0.141	.	.	.	.	.	.	-0.135	.	-0.112	-0.216	0.018	0.024	-0.116	0.216	0.061	0.171
	Sig. (2-tailed)	0.440	.	.	.	.	.	.	0.445	.	0.524	0.215	0.920	0.894	0.505	0.215	0.727	0.325
	N	24	0	0	0	0	0	0	24	0	24	24	23	23	24	24	24	24
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.523*	0.079	-0.169	-0.362	.	0.019	.	-0.437*	-0.387	-0.530*	-0.347*	0.068	0.066	0.170	0.653*	0.033	-0.213*
	Sig. (2-tailed)	0.000	0.767	0.500	0.130	.	0.939	.	0.000	0.101	0.000	0.001	0.548	0.563	0.103	0.000	0.754	0.042
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.177*	0.113	-0.196	-0.263	.	0.018	.	-0.307*	-0.336	-0.325*	-0.361*	0.319*	0.364*	0.336*	0.614*	-0.143	0.080
	Sig. (2-tailed)	0.095	0.663	0.418	0.258	.	0.940	.	0.012	0.143	0.002	0.000	0.004	0.001	0.001	0.000	0.161	0.437
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.160	0.111	-0.299	-0.356	.	0.162	.	-0.200*	-0.173	-0.276*	-0.348*	0.259*	0.251*	0.325*	0.529*	-0.162	0.095
	Sig. (2-tailed)	0.124	0.664	0.213	0.122	.	0.502	.	0.093	0.445	0.007	0.001	0.018	0.021	0.001	0.000	0.106	0.346
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	-0.012	-0.411	-0.142	0.765*	.	-0.253	.	-0.063	-0.095	0.278*	0.168*	-0.013	0.028	-0.007	-0.211*	0.114	0.251*
	Sig. (2-tailed)	0.907	0.110	0.557	0.001	.	0.295	.	0.594	0.676	0.007	0.094	0.902	0.796	0.943	0.035	0.255	0.012
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	-0.039	-0.549*	-0.235	.	0.467*	.	-0.144	-0.033	-0.300*	-0.042	-0.020	-0.109	0.048	0.349*	0.018	-0.363*
	Sig. (2-tailed)	.	0.884	0.026	0.318	.	0.059	.	0.241	0.888	0.005	0.687	0.856	0.331	0.642	0.001	0.865	0.000
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	-0.039	1.000	0.474*	-0.238	.	0.132	.	.	0.193	-0.204	-0.038	.	.	0.037	0.186	-0.334	0.037
	Sig. (2-tailed)	0.884	.	0.092	0.375	.	0.639	.	.	0.464	0.486	0.884	.	.	0.885	0.469	0.192	0.885
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Copper, Total (mg/L)	Correlation Coefficient	-0.549*	0.474*	1.000	0.094	.	-0.438*	.	.	0.073	-0.193	0.071	-0.078	0.545	-0.071	-0.229	-0.018	0.123
	Sig. (2-tailed)	0.026	0.092	.	0.708	.	0.096	.	.	0.767	0.479	0.769	0.837	0.150	0.769	0.341	0.942	0.608
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Iron, Total (mg/L)	Correlation Coefficient	-0.235	-0.238	0.094	1.000	.	-0.287	.	.	0.034	0.266	0.230	0.690*	0.552	-0.179	-0.291	0.356	0.291
	Sig. (2-tailed)	0.318	0.375	0.708	.	.	0.252	.	.	0.887	0.306	0.322	0.056	0.126	0.438	0.205	0.122	0.205
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Lead, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Manganese, Total (mg/L)	Correlation Coefficient	0.467*	0.132	-0.438*	-0.287	.	1.000	.	.	0.205	-0.025	0.146	-0.234	-0.701*	-0.109	0.126	-0.054	-0.377
	Sig. (2-tailed)	0.059	0.639	0.096	0.252	.	.	.	.	0.406	0.928	0.549	0.537	0.064	0.654	0.602	0.823	0.117
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Zinc, Total (mg/L)	Correlation Coefficient	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.144	.	.	.	.	.	.	1.000	.	0.608*	0.291*	0.252*	-0.204*	-0.372*	-0.348*	-0.505*	0.041
	Sig. (2-tailed)	0.241	.	.	.	.	.	.	.	.	0.000	0.014	0.036	0.090	0.002	0.003	0.000	0.733
	N	36	0	0	0	0	0	0	36	0	36	36	35	35	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	-0.033	0.193	0.073	0.034	.	0.205	.	.	1.000	0.303	0.400*	0.414	-0.276	-0.318	-0.236	-0.362	-0.520*
	Sig. (2-tailed)	0.888	0.464	0.767	0.887	.	0.406	.	.	.	0.238	0.081	0.251	0.444	0.164	0.297	0.110	0.022
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.300*	-0.204	-0.193	0.266	.	-0.025	.	0.608*	0.303	1.000	0.392*	0.067	-0.122	-0.320*	-0.374*	-0.212*	0.216*
	Sig. (2-tailed)	0.005	0.486	0.479	0.306	.	0.928	.	0.000	0.238	.	0.000	0.543	0.270	0.002	0.000	0.039	0.035
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.042	-0.038	0.071	0.230	.	0.146	.	0.291*	0.400*	0.392*	1.000	-0.059	-0.294*	-0.368*	-0.310*	-0.098	-0.134
	Sig. (2-tailed)	0.687	0.884	0.769	0.322	.	0.549	.	0.014	0.081	0.000	.	0.590	0.007	0.000	0.002	0.328	0.182
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.020	.	-0.078	0.690*	.	-0.234	.	0.252*	0.414	0.067	-0.059	1.000	0.366*	0.136	0.040	-0.591*	0.181*
	Sig. (2-tailed)	0.856	.	0.837	0.056	.	0.537	.	0.036	0.251	0.543	0.590	.	0.001	0.212	0.711	0.000	0.096
	N	41	6	6	6	6	6	6	35	6	41	41	41	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.109	.	0.545	0.552	.	-0.701*	.	-0.204*	-0.276	-0.122	-0.294*	0.366*	1.000	0.443*	0.070	0.044	0.254*
	Sig. (2-tailed)	0.331	.	0.150	0.126	.	0.064	.	0.090	0.444	0.270	0.007	0.001	.	0.000	0.522	0.686	0.019
	N	41	6	6	6	6	6	6	35	6	41	41	41	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	0.048	0.037	-0.071	-0.179	.	-0.109	.	-0.372*	-0.318	-0.320*	-0.368*	0.136	0.443*	1.000	0.184*	0.119	0.110
	Sig. (2-tailed)	0.642	0.885	0.769	0.438	.	0.654	.	0.002	0.164	0.002	0.000	0.212	0.000	.	0.066	0.234	0.270
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	0.349*	0.186	-0.229	-0.291	.	0.126	.	-0.348*	-0.236	-0.374*	-0.310*	0.040	0.070	0.184*	1.000	-0.022	-0.077
	Sig. (2-tailed)	0.001	0.469	0.341	0.205	.	0.602	.	0.003	0.297	0.000	0.002	0.711	0.522	0.066	.	0.824	0.439
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	0.018	-0.334	-0.018	0.356	.	-0.054	.	-0.505*	-0.362	-0.212*	-0.098	-0.591*	0.044	0.119	-0.022	1.000	-0.055
	Sig. (2-tailed)	0.865	0.192	0.942	0.122	.	0.823	.	0.000	0.110	0.039	0.328	0.000	0.686	0.234	0.824	.	0.582
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.363*	0.037	0.123	0.291	.	-0.377	.	0.041	-0.520*	0.216*	-0.134	0.181*	0.254*	0.110	-0.077	-0.055	1.000
	Sig. (2-tailed)	0.000	0.885	0.608	0.205	.	0.117	.	0.733	0.022	0.035	0.182	0.096	0.019	0.270	0.439	0.582	.
	N	48	12	12	12	12	12	12	36	12	48	48	41	41	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-117: Kendall's tau correlation matrix of water quality parameters collected at Station 9 from 2011 to 2020.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.954*	0.145	-0.013	-0.035	0.004	-0.201	-0.146	0.019	-0.294	-0.235	-0.126	-0.003	-0.148	-0.219*	-0.204*
	Sig. (2-tailed)	.	0.000	0.178	0.910	0.750	0.980	0.245	0.212	0.870	0.102	0.222	0.265	0.978	0.174	0.053	0.059
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Group by Quarter	Correlation Coefficient	0.954*	1.000	0.140	-0.031	-0.063	-0.017	-0.201	-0.139	0.026	-0.369*	-0.235	-0.136	-0.015	-0.161	-0.230*	-0.214*
	Sig. (2-tailed)	0.000	.	0.210	0.789	0.580	0.917	0.245	0.250	0.830	0.052	0.222	0.242	0.894	0.151	0.049	0.055
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Julian Date	Correlation Coefficient	0.145	0.140	1.000	0.060	0.027	0.062	-0.104	0.111	0.084	-0.363*	-0.240	0.191*	0.147	0.171*	-0.034	-0.050
	Sig. (2-tailed)	0.178	0.210	.	0.567	0.789	0.687	0.511	0.309	0.443	0.037	0.172	0.071	0.154	0.093	0.749	0.620
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	-0.013	-0.031	0.060	1.000	0.792*	0.612*	0.346*	0.399*	0.534*	-0.092	0.198	0.506*	0.393*	0.297*	-0.153	-0.185*
	Sig. (2-tailed)	0.910	0.789	0.567	.	0.000	0.000	0.041	0.000	0.000	0.600	0.294	0.000	0.000	0.005	0.160	0.074
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	-0.035	-0.063	0.027	0.792*	1.000	0.563*	0.289*	0.367*	0.379*	-0.037	0.253	0.400*	0.337*	0.251*	-0.252*	-0.293*
	Sig. (2-tailed)	0.750	0.580	0.789	0.000	.	0.000	0.085	0.001	0.001	0.834	0.175	0.000	0.001	0.015	0.019	0.004
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Calcium, Total (mg/L)	Correlation Coefficient	0.004	-0.017	0.062	0.612*	0.563*	1.000	.	0.380*	0.409*	0.077	.	0.518*	0.324*	0.222	-0.120	-0.181
	Sig. (2-tailed)	0.980	0.917	0.687	0.000	0.000	.	.	0.020	0.013	0.672	.	0.001	0.038	0.150	0.452	0.236
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	-0.201	-0.201	-0.104	0.346*	0.289*	.	1.000	0.233	0.548*	.	0.307*	0.448*	0.376*	0.297*	-0.272*	-0.278*
	Sig. (2-tailed)	0.245	0.245	0.511	0.041	0.085	.	.	0.174	0.001	.	0.100	0.007	0.020	0.062	0.098	0.080
	N	23	23	23	23	23	0	23	23	23	0	23	23	23	23	23	23
Chloride, Total (mg/L)	Correlation Coefficient	-0.146	-0.139	0.111	0.399*	0.367*	0.380*	0.233	1.000	0.336*	0.149	0.429*	0.587*	0.257*	0.314*	-0.154	-0.203*
	Sig. (2-tailed)	0.212	0.250	0.309	0.000	0.001	0.020	0.174	.	0.005	0.424	0.024	0.000	0.021	0.004	0.179	0.063
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.019	0.026	0.084	0.534*	0.379*	0.409*	0.548*	0.336*	1.000	0.281	0.099	0.663*	0.683*	0.452*	-0.150	-0.209*
	Sig. (2-tailed)	0.870	0.830	0.443	0.000	0.001	0.013	0.001	0.005	.	0.133	0.604	0.000	0.000	0.000	0.193	0.057
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Potassium, Total (mg/L)	Correlation Coefficient	-0.294	-0.369*	-0.363*	-0.092	-0.037	0.077	.	0.149	0.281	1.000	.	0.365*	0.410*	0.294*	0.166	0.055
	Sig. (2-tailed)	0.102	0.052	0.037	0.600	0.834	0.672	.	0.424	0.133	.	.	0.045	0.021	0.094	0.362	0.754
	N	24	24	24	24	24	24	0	24	24	24	0	24	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	-0.235	-0.235	-0.240	0.198	0.253	.	0.307*	0.429*	0.099	.	1.000	0.154	0.016	-0.016	-0.187	-0.192
	Sig. (2-tailed)	0.222	0.222	0.172	0.294	0.175	.	0.100	0.024	0.604	.	.	0.403	0.927	0.927	0.306	0.275
	N	23	23	23	23	23	0	23	23	23	0	23	23	23	23	23	23
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.126	-0.136	0.191*	0.506*	0.400*	0.518*	0.448*	0.587*	0.663*	0.365*	0.154	1.000	0.546*	0.492*	-0.121	-0.173
	Sig. (2-tailed)	0.265	0.242	0.071	0.000	0.000	0.001	0.007	0.000	0.000	0.045	0.403	.	0.000	0.000	0.274	0.101
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Sulfate, Total (mg/L)	Correlation Coefficient	-0.003	-0.015	0.147	0.393*	0.337*	0.324*	0.376*	0.257*	0.683*	0.410*	0.016	0.546*	1.000	0.546*	-0.172	-0.209*
	Sig. (2-tailed)	0.978	0.894	0.154	0.000	0.001	0.038	0.020	0.021	0.000	0.021	0.927	0.000	.	0.000	0.111	0.043
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Dissolved Solids, Total (mg/L)	Correlation Coefficient	-0.148	-0.161	0.171*	0.297*	0.251*	0.222	0.297*	0.314*	0.452*	0.294*	-0.016	0.492*	0.546*	1.000	-0.016	-0.084
	Sig. (2-tailed)	0.174	0.151	0.093	0.005	0.015	0.150	0.062	0.004	0.000	0.094	0.927	0.000	0.000	.	0.880	0.409
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.219*	-0.230*	-0.034	-0.153	-0.252*	-0.120	-0.272*	-0.154	-0.150	0.166	-0.187	-0.121	-0.172	-0.016	1.000	0.839*
	Sig. (2-tailed)	0.053	0.049	0.749	0.160	0.019	0.452	0.098	0.179	0.193	0.362	0.306	0.274	0.111	0.880	.	0.000
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Turbidity (NTU)	Correlation Coefficient	-0.204*	-0.214*	-0.050	-0.185*	-0.293*	-0.181	-0.278*	-0.203*	-0.209*	0.055	-0.192	-0.173	-0.209*	-0.084	0.839*	1.000
	Sig. (2-tailed)	0.059	0.055	0.620	0.074	0.004	0.236	0.080	0.063	0.057	0.754	0.275	0.101	0.043	0.409	0.000	.
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	0.164	0.199*	0.162	0.194*	0.217*	0.202	0.018	0.515*	0.199*	-0.229	0.175	0.327*	0.071	0.052	-0.462*	-0.481*
	Sig. (2-tailed)	0.142	0.085	0.123	0.072	0.042	0.203	0.912	0.000	0.081	0.206	0.335	0.003	0.505	0.624	0.000	0.000
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Cadmium, Total (mg/L)	Correlation Coefficient	-0.178	-0.187	-0.203	-0.212	-0.198	-0.160	.	-0.006	0.150	0.692*	.	0.136	0.208	0.145	0.156	0.124
	Sig. (2-tailed)	0.186	0.180	0.106	0.104	0.123	0.380	.	0.968	0.274	0.001	.	0.302	0.105	0.253	0.239	0.325
	N	44	44	44	44	44	24	20	44	44	24	20	44	44	44	44	44
Copper, Total (mg/L)	Correlation Coefficient	-0.009	-0.032	-0.254*	-0.311*	-0.303*	-0.229	-0.277	-0.305*	-0.289*	0.106	-0.337	-0.326*	-0.285*	-0.138	0.394*	0.373*
	Sig. (2-tailed)	0.940	0.801	0.026	0.009	0.009	0.173	0.137	0.014	0.020	0.581	0.105	0.006	0.014	0.231	0.001	0.001
	N	44	44	44	44	44	24	20	44	44	24	20	44	44	44	44	44
Iron, Total (mg/L)	Correlation Coefficient	-0.199*	-0.216*	-0.137	-0.203*	-0.288*	-0.181	-0.224	-0.213*	-0.229*	0.036	-0.192	-0.217*	-0.259*	-0.136	0.788*	0.868*
	Sig. (2-tailed)	0.076	0.062	0.192	0.062	0.007	0.236	0.193	0.061	0.045	0.834	0.315	0.049	0.016	0.198	0.000	0.000
	N	44	44	44	44	44	24	20	44	44	24	20	44	44	44	44	44
Lead, Total (mg/L)	Correlation Coefficient	-0.191	-0.188	-0.184*	-0.198*	-0.220*	-0.236	0.170	0.069	-0.050	0.117	0.210	0.024	-0.037	-0.062	0.053	0.105
	Sig. (2-tailed)	0.105	0.124	0.096	0.084	0.051	0.143	0.349	0.567	0.678	0.523	0.298	0.835	0.740	0.577	0.647	0.342
	N	44	44	44	44	44	24	20	44	44	24	20	44	44	44	44	44
Manganese, Total (mg/L)	Correlation Coefficient	-0.062	-0.076	-0.103	-0.111	-0.194*	-0.059	-0.289*	-0.123	-0.147	0.084	-0.223	-0.125	-0.229*	-0.163	0.715*	0.662*
	Sig. (2-tailed)	0.583	0.521	0.335	0.315	0.074	0.704	0.094	0.287	0.205	0.637	0.245	0.264	0.036	0.130	0.000	0.000
	N	44	44	44	44	44	24	20	44	44	24	20	44	44	44	44	44
Zinc, Total (mg/L)	Correlation Coefficient	-0.059	-0.062	0.193	0.021	-0.091	.	0.090	-0.121	0.239*	.	-0.567*	0.225*	0.218*	0.215*	0.232*	0.213*
	Sig. (2-tailed)	0.659	0.655	0.125	0.874	0.477	.	0.657	0.374	0.081	.	0.012	0.088	0.090	0.090	0.081	0.090
	N	44	44	44	44	44	24	20	44	44	24	20	44	44	44	44	44
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.055	-0.055	0.050	0.076	0.279*	0.032	0.129	-0.205	0.058	.	-0.033	-0.022	0.169	0.048	-0.447*	-0.360*
	Sig. (2-tailed)	0.680	0.680	0.680	0.544	0.024	0.889	0.425	0.116	0.657	.	0.855	0.863	0.170	0.690	0.000	0.003
	N	35	35	35	35	35	12	23	35	35	12	23	35	35	35	35	35
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.339	0.306	0.339	-0.233	-0.188	-0.112	.	-0.438*	0.000	0.028	.	-0.120	0.079	-0.092	-0.286	-0.369*
	Sig. (2-tailed)	0.130	0.199	0.130	0.300	0.406	0.625	.	0.069	1.000	0.914	.	0.612	0.729	0.679	0.210	0.098
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	0.088	0.081	-0.075	-0.195*	-0.099	-0.253	-0.031	-0.433*	-0.118	0.109	-0.242	-0.220*	0.077	0.009	-0.096	-0.091
	Sig. (2-tailed)	0.429	0.479	0.471	0.068	0.349	0.120	0.848	0.000	0.299	0.556	0.171	0.043	0.470	0.934	0.378	0.380
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Phosphorus, Total (mg/L)	Correlation Coefficient	0.094	0.118	-0.154	-0.337*	-0.281*	-0.333*	-0.159	-0.271*	-0.255*	0.000	-0.261	-0.268*	-0.239*	-0.226*	0.252*	0.270*
	Sig. (2-tailed)	0.384	0.291	0.130	0.001	0.007	0.030	0.322	0.014	0.021	1.000	0.144	0.012	0.021	0.027	0.018	0.008
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.016	-0.007	0.128	0.204*	0.386*	0.336*	0.197	-0.004	0.061	.	-0.026	0.099	0.219*	0.147	-0.383*	-0.394*
	Sig. (2-tailed)	0.895	0.952	0.244	0.074	0.001	0.060	0.222	0.971	0.611	.	0.886	0.390	0.052	0.184	0.001	0.000
	N	40	40	40	40	40	18	22	40	40	18	22	40	40	40	40	40
Dissolved Oxygen (% Sat.)	Correlation Coefficient	0.112	0.113	-0.015	0.040	-0.005	-0.103	-0.103	-0.219*	-0.003	.	-0.214	-0.161	0.193*	0.052	0.060	0.104
	Sig. (2-tailed)	0.345	0.352	0.889	0.724	0.963	0.565	0.523	0.064	0.981	.	0.233	0.161	0.087	0.641	0.604	0.345
	N	40	40	40	40	40	18	22	40	40	18	22	40	40	40	40	40
pH, Taken in field	Correlation Coefficient	0.020	0.030	-0.009	0.022	-0.142	-0.066	-0.269*	0.100	0.059	0.000	-0.096	0.073	-0.006	0.030	0.264*	0.297*
	Sig. (2-tailed)	0.852	0.790	0.927	0.832	0.167	0.668	0.090	0.361	0.590	1.000	0.585	0.487	0.956	0.769	0.013	0.003
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Specific Conductance (µS/cm)	Correlation Coefficient	-0.077	-0.082	0.053	0.497*	0.349*	0.301*	0.338*	0.522*	0.639*	0.363*	0.224	0.709*	0.540*	0.440*	-0.058	-0.109
	Sig. (2-tailed)	0.477	0.459	0.601	0.000	0.001	0.049	0.033	0.000	0.000	0.037	0.202	0.000	0.000	0.000	0.585	0.279
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Water Temperature (°C)	Correlation Coefficient	0.216*	0.218*	0.073	-0.046	-0.224*	-0.177	-0.304*	-0.029	-0.026	-0.145	-0.112	-0.069	-0.071	-0.078	0.374*	0.396*
	Sig. (2-tailed)	0.045	0.050	0.469	0.657	0.029	0.246	0.055	0.792	0.813	0.403	0.524	0.511	0.490	0.446	0.000	0.000
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47
Flow (CFS)	Correlation Coefficient	-0.182*	-0.210*	-0.167*	-0.321*	-0.226*	-0.170	-0.118	-0.408*	-0.382*	0.127	-0.281	-0.397*	-0.270*	-0.120	0.428*	0.405*
	Sig. (2-tailed)	0.092	0.060	0.099	0.002	0.028	0.267	0.459	0.000	0.001	0.465	0.111	0.000	0.009	0.240	0.000	0.000
	N	47	47	47	47	47	24	23	47	47	24	23	47	47	47	47	47

*Correlation is significant at the 0.10 level (2-tailed).
Magnesium, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-118: Kendall's tau correlation matrix of water quality parameters collected at Station 9 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	0.164	-0.178	-0.009	-0.199*	-0.191	-0.062	-0.059	-0.055	0.339	0.088	0.094	0.016	0.112	0.020	-0.077	0.216*	-0.182*
	Sig. (2-tailed)	0.142	0.186	0.940	0.076	0.105	0.583	0.659	0.680	0.130	0.429	0.384	0.895	0.345	0.852	0.477	0.045	0.092
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Group by Quarter	Correlation Coefficient	0.199*	-0.187	-0.032	-0.216*	-0.188	-0.076	-0.062	-0.055	0.306	0.081	0.118	-0.007	0.113	0.030	-0.082	0.218*	-0.210*
	Sig. (2-tailed)	0.085	0.180	0.801	0.062	0.124	0.521	0.655	0.680	0.199	0.479	0.291	0.952	0.352	0.790	0.459	0.050	0.060
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Julian Date	Correlation Coefficient	0.162	-0.203	-0.254*	-0.137	-0.184*	-0.103	0.193	0.050	0.339	-0.075	-0.154	0.128	-0.015	-0.009	0.053	0.073	-0.167*
	Sig. (2-tailed)	0.123	0.106	0.026	0.192	0.096	0.335	0.125	0.680	0.130	0.471	0.130	0.244	0.889	0.927	0.601	0.469	0.099
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.194*	-0.212	-0.311*	-0.203*	-0.198*	-0.111	0.021	0.076	-0.233	-0.195*	-0.337*	0.204*	0.040	0.022	0.497*	-0.046	-0.321*
	Sig. (2-tailed)	0.072	0.104	0.009	0.062	0.084	0.315	0.874	0.544	0.300	0.068	0.001	0.074	0.724	0.832	0.000	0.657	0.002
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.217*	-0.198	-0.303*	-0.288*	-0.220*	-0.194*	-0.091	0.279*	-0.188	-0.099	-0.281*	0.386*	-0.005	-0.142	0.349*	-0.224*	-0.226*
	Sig. (2-tailed)	0.042	0.123	0.009	0.007	0.051	0.074	0.477	0.024	0.406	0.349	0.007	0.001	0.963	0.167	0.001	0.029	0.028
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Calcium, Total (mg/L)	Correlation Coefficient	0.202	-0.160	-0.229	-0.181	-0.236	-0.059	.	0.032	-0.112	-0.253	-0.333*	0.336*	-0.103	-0.066	0.301*	-0.177	-0.170
	Sig. (2-tailed)	0.203	0.380	0.173	0.236	0.143	0.704	.	0.889	0.625	0.120	0.030	0.060	0.565	0.668	0.049	0.246	0.267
	N	24	24	24	24	24	24	24	12	12	24	24	18	18	24	24	24	24
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.018	.	-0.277	-0.224	0.170	-0.289*	0.090	0.129	.	-0.031	-0.159	0.197	-0.103	-0.269*	0.338*	-0.304*	-0.118
	Sig. (2-tailed)	0.912	.	0.137	0.193	0.349	0.094	0.657	0.425	.	0.848	0.322	0.222	0.523	0.090	0.033	0.055	0.459
	N	23	20	20	20	20	20	20	23	0	23	23	22	22	23	23	23	23
Chloride, Total (mg/L)	Correlation Coefficient	0.515*	-0.006	-0.305*	-0.213*	0.069	-0.123	-0.121	-0.205	-0.438*	-0.433*	-0.271*	-0.004	-0.219*	0.100	0.522*	-0.029	-0.408*
	Sig. (2-tailed)	0.000	0.968	0.014	0.061	0.567	0.287	0.374	0.116	0.069	0.000	0.014	0.971	0.064	0.361	0.000	0.792	0.000
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.199*	0.150	-0.289*	-0.229*	-0.050	-0.147	0.239*	0.058	0.000	-0.118	-0.255*	0.061	-0.003	0.059	0.639*	-0.026	-0.382*
	Sig. (2-tailed)	0.081	0.274	0.020	0.045	0.678	0.205	0.081	0.657	1.000	0.299	0.021	0.611	0.981	0.590	0.000	0.813	0.001
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Potassium, Total (mg/L)	Correlation Coefficient	-0.229	0.692*	0.106	0.036	0.117	0.084	.	.	0.028	0.109	0.000	.	.	0.000	0.363*	-0.145	0.127
	Sig. (2-tailed)	0.206	0.001	0.581	0.834	0.523	0.637	.	.	0.914	0.556	1.000	.	.	1.000	0.037	0.403	0.465
	N	24	24	24	24	24	24	24	12	12	24	24	18	18	24	24	24	24
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.175	.	-0.337	-0.192	0.210	-0.223	-0.567*	-0.033	.	-0.242	-0.261	-0.026	-0.214	-0.096	0.224	-0.112	-0.281
	Sig. (2-tailed)	0.335	.	0.105	0.315	0.298	0.245	0.012	0.855	.	0.171	0.144	0.886	0.233	0.585	0.202	0.524	0.111
	N	23	20	20	20	20	20	20	23	0	23	23	22	22	23	23	23	23
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.327*	0.136	-0.326*	-0.217*	0.024	-0.125	0.225*	-0.022	-0.120	-0.220*	-0.268*	0.099	-0.161	0.073	0.709*	-0.069	-0.397*
	Sig. (2-tailed)	0.003	0.302	0.006	0.049	0.835	0.264	0.088	0.863	0.612	0.043	0.012	0.390	0.161	0.487	0.000	0.511	0.000
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Sulfate, Total (mg/L)	Correlation Coefficient	0.071	0.208	-0.285*	-0.259*	-0.037	-0.229*	0.218*	0.169	0.079	0.077	-0.239*	0.219*	0.193*	-0.006	0.540*	-0.071	-0.270*
	Sig. (2-tailed)	0.505	0.105	0.014	0.016	0.740	0.036	0.090	0.170	0.729	0.470	0.021	0.052	0.087	0.956	0.000	0.490	0.009
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.052	0.145	-0.138	-0.136	-0.062	-0.163	0.215*	0.048	-0.092	0.009	-0.226*	0.147	0.052	0.030	0.440*	-0.078	-0.120
	Sig. (2-tailed)	0.624	0.253	0.231	0.198	0.577	0.130	0.090	0.690	0.679	0.934	0.027	0.184	0.641	0.769	0.000	0.446	0.240
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.462*	0.156	0.394*	0.788*	0.053	0.715*	0.232*	-0.447*	-0.286	-0.096	0.252*	-0.383*	0.060	0.264*	-0.058	0.374*	0.428*
	Sig. (2-tailed)	0.000	0.239	0.001	0.000	0.647	0.000	0.081	0.000	0.210	0.378	0.018	0.001	0.604	0.013	0.585	0.000	0.000
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Turbidity (NTU)	Correlation Coefficient	-0.481*	0.124	0.373*	0.868*	0.105	0.662*	0.213*	-0.360*	-0.369*	-0.091	0.270*	-0.394*	0.104	0.297*	-0.109	0.396*	0.405*
	Sig. (2-tailed)	0.000	0.325	0.001	0.000	0.342	0.000	0.090	0.003	0.098	0.380	0.008	0.000	0.345	0.003	0.279	0.000	0.000
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	-0.151	-0.454*	-0.510*	-0.029	-0.322*	-0.224*	-0.034	0.202	-0.272*	-0.264*	0.088	-0.300*	-0.022	0.192*	-0.134	-0.552*
	Sig. (2-tailed)	.	0.250	0.000	0.000	0.803	0.004	0.088	0.785	0.392	0.012	0.012	0.438	0.009	0.832	0.066	0.199	0.000
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Cadmium, Total (mg/L)	Correlation Coefficient	-0.151	1.000	-0.045	0.095	0.102	0.137	-0.023	.	0.226	0.145	0.155	.	.	-0.104	0.203	-0.134	0.069
	Sig. (2-tailed)	0.250	.	0.742	0.454	0.446	0.286	0.879	.	0.383	0.267	0.222	.	.	0.408	0.106	0.288	0.581
	N	44	44	44	44	44	44	44	32	12	44	44	37	37	44	44	44	44
Copper, Total (mg/L)	Correlation Coefficient	-0.454*	-0.045	1.000	0.411*	0.228*	0.241*	0.193	-0.292*	-0.221	0.082	0.296*	-0.356*	0.062	0.041	-0.264*	0.218*	0.399*
	Sig. (2-tailed)	0.000	0.742	.	0.000	0.060	0.039	0.162	0.036	0.350	0.487	0.010	0.004	0.622	0.718	0.021	0.056	0.000
	N	44	44	44	44	44	44	44	32	12	44	44	37	37	44	44	44	44
Iron, Total (mg/L)	Correlation Coefficient	-0.510*	0.095	0.411*	1.000	0.128	0.677*	0.204	-0.390*	-0.388*	-0.053	0.309*	-0.433*	0.082	0.247*	-0.154	0.358*	0.469*
	Sig. (2-tailed)	0.000	0.454	0.000	.	0.252	0.000	0.106	0.002	0.084	0.624	0.003	0.000	0.480	0.019	0.142	0.001	0.000
	N	44	44	44	44	44	44	44	32	12	44	44	37	37	44	44	44	44
Lead, Total (mg/L)	Correlation Coefficient	-0.029	0.102	0.228*	0.128	1.000	0.069	0.070	-0.222	-0.054	-0.093	0.069	-0.256*	-0.089	0.034	0.065	0.063	0.015
	Sig. (2-tailed)	0.803	0.446	0.060	0.252	.	0.541	0.602	0.101	0.823	0.417	0.535	0.036	0.468	0.757	0.556	0.570	0.893
	N	44	44	44	44	44	44	44	32	12	44	44	37	37	44	44	44	44
Manganese, Total (mg/L)	Correlation Coefficient	-0.322*	0.137	0.241*	0.677*	0.069	1.000	0.219*	-0.421*	-0.170	-0.061	0.390*	-0.344*	0.049	0.256*	-0.083	0.318*	0.364*
	Sig. (2-tailed)	0.004	0.286	0.039	0.000	0.541	.	0.089	0.001	0.471	0.580	0.000	0.003	0.674	0.017	0.434	0.003	0.001
	N	44	44	44	44	44	44	44	32	12	44	44	37	37	44	44	44	44
Zinc, Total (mg/L)	Correlation Coefficient	-0.224*	-0.023	0.193	0.204	0.070	0.219*	1.000	-0.016	.	0.192	0.215*	-0.026	0.142	0.074	0.124	0.055	0.144
	Sig. (2-tailed)	0.088	0.879	0.162	0.106	0.602	0.089	.	0.914	.	0.142	0.090	0.851	0.303	0.555	0.325	0.665	0.253
	N	44	44	44	44	44	44	44	32	12	44	44	37	37	44	44	44	44
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.034	.	-0.292*	-0.390*	-0.222	-0.421*	-0.016	1.000	.	0.591*	0.057	0.539*	0.089	-0.354*	-0.135	-0.509*	-0.026
	Sig. (2-tailed)	0.785	.	0.036	0.002	0.101	0.001	0.914	.	.	0.000	0.638	0.000	0.466	0.003	0.261	0.000	0.831
	N	35	32	32	32	32	32	32	35	0	35	35	34	34	35	35	35	35
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.202	0.226	-0.221	-0.388*	-0.054	-0.170	.	.	1.000	0.268	-0.031	0.867*	-0.467	-0.677*	-0.215	-0.400*	-0.339
	Sig. (2-tailed)	0.392	0.383	0.350	0.084	0.823	0.471	.	.	.	0.270	0.890	0.015	0.188	0.002	0.335	0.073	0.130
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.272*	0.145	0.082	-0.053	-0.093	-0.061	0.192	0.591*	0.268	1.000	0.220*	0.252*	0.186*	-0.289*	-0.271*	-0.202*	0.215*
	Sig. (2-tailed)	0.012	0.267	0.487	0.624	0.417	0.580	0.142	0.000	0.270	.	0.036	0.025	0.099	0.006	0.009	0.052	0.039
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.264*	0.155	0.296*	0.309*	0.069	0.390*	0.215*	0.057	-0.031	0.220*	1.000	-0.023	0.049	-0.021	-0.234*	0.023	0.295*
	Sig. (2-tailed)	0.012	0.222	0.010	0.003	0.535	0.000	0.090	0.638	0.890	0.036	.	0.834	0.658	0.840	0.021	0.819	0.004
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Dissolved Oxygen (mg/L)	Correlation Coefficient	0.088	.	-0.356*	-0.433*	-0.256*	-0.344*	-0.026	0.539*	0.867*	0.252*	-0.023	1.000	0.195*	-0.366*	-0.033	-0.703*	-0.042
	Sig. (2-tailed)	0.438	.	0.004	0.000	0.036	0.003	0.851	0.000	0.015	0.025	0.834	.	0.077	0.001	0.762	0.000	0.701
	N	40	37	37	37	37	37	37	34	6	40	40	40	40	40	40	40	40
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.300*	.	0.062	0.082	-0.089	0.049	0.142	0.089	-0.467	0.186*	0.049	0.195*	1.000	0.081	-0.033	0.097	0.153
	Sig. (2-tailed)	0.009	.	0.622	0.480	0.468	0.674	0.303	0.466	0.188	0.099	0.658	0.077	.	0.463	0.762	0.376	0.166
	N	40	37	37	37	37	37	37	34	6	40	40	40	40	40	40	40	40
pH, Taken in field	Correlation Coefficient	-0.022	-0.104	0.041	0.247*	0.034	0.256*	0.074	-0.354*	-0.677*	-0.289*	-0.021	-0.366*	0.081	1.000	0.172*	0.443*	-0.012
	Sig. (2-tailed)	0.832	0.408	0.718	0.019	0.757	0.017	0.555	0.003	0.002	0.006	0.840	0.001	0.463	.	0.088	0.000	0.905
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Specific Conductance (µS/cm)	Correlation Coefficient	0.192*	0.203	-0.264*	-0.154	0.065	-0.083	0.124	-0.135	-0.215	-0.271*	-0.234*	-0.033	-0.033	0.172*	1.000	0.055	-0.395*
	Sig. (2-tailed)	0.066	0.106	0.021	0.142	0.556	0.434	0.325	0.261	0.335	0.009	0.021	0.762	0.762	0.088	.	0.588	0.000
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Water Temperature (°C)	Correlation Coefficient	-0.134	-0.134	0.218*	0.358*	0.063	0.318*	0.055	-0.509*	-0.400*	-0.202*	0.023	-0.703*	0.097	0.443*	0.055	1.000	0.015
	Sig. (2-tailed)	0.199	0.288	0.056	0.001	0.570	0.003	0.665	0.000	0.073	0.052	0.819	0.000	0.376	0.000	0.588	.	0.883
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47
Flow (CFS)	Correlation Coefficient	-0.552*	0.069	0.399*	0.469*	0.015	0.364*	0.144	-0.026	-0.339	0.215*	0.295*	-0.042	0.153	-0.012	-0.395*	0.015	1.000
	Sig. (2-tailed)	0.000	0.581	0.000	0.000	0.893	0.001	0.253	0.831	0.130	0.039	0.004	0.701	0.166	0.905	0.000	0.883	.
	N	47	44	44	44	44	44	44	35	12	47	47	40	40	47	47	47	47

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-119: Kendall's tau correlation matrix of water quality parameters collected at Station 10 from 2011 to 2020.

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Month	Correlation Coefficient	1.000	0.955*	0.116	0.062	0.086	0.238	0.041	-0.099	0.174	-0.324*	0.105	-0.086	0.072	-0.035	-0.105	-0.045
	Sig. (2-tailed)	.	0.000	0.276	0.579	0.433	0.138	0.804	0.395	0.128	0.078	0.570	0.442	0.507	0.744	0.359	0.677
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Group by Quarter	Correlation Coefficient	0.955*	1.000	0.109	0.051	0.069	0.229	0.041	-0.094	0.178	-0.395*	0.105	-0.101	0.067	-0.038	-0.118	-0.051
	Sig. (2-tailed)	0.000	.	0.320	0.659	0.541	0.175	0.804	0.431	0.132	0.043	0.570	0.383	0.549	0.733	0.318	0.645
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Julian Date	Correlation Coefficient	0.116	0.109	1.000	0.098	0.106	0.368*	-0.152	0.086	0.020	-0.369*	-0.244	0.126	0.072	0.230*	-0.019	-0.042
	Sig. (2-tailed)	0.276	0.320	.	0.350	0.303	0.017	0.315	0.425	0.849	0.038	0.147	0.229	0.476	0.022	0.859	0.676
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.062	0.051	0.098	1.000	0.778*	0.494*	0.485*	0.529*	0.492*	-0.099	0.245	0.597*	0.457*	0.523*	-0.145	-0.144
	Sig. (2-tailed)	0.579	0.659	0.350	.	0.000	0.002	0.003	0.000	0.000	0.584	0.186	0.000	0.000	0.000	0.193	0.168
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.086	0.069	0.106	0.778*	1.000	0.493*	0.514*	0.494*	0.460*	-0.079	0.268	0.495*	0.430*	0.574*	-0.330*	-0.297*
	Sig. (2-tailed)	0.433	0.541	0.303	0.000	.	0.002	0.001	0.000	0.000	0.661	0.135	0.000	0.000	0.000	0.003	0.004
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	0.238	0.229	0.368*	0.494*	0.493*	1.000	.	0.321*	0.616*	-0.020	.	0.438*	0.427*	0.358*	-0.212	-0.224
	Sig. (2-tailed)	0.138	0.175	0.017	0.002	0.002	.	.	0.054	0.000	0.912	.	0.007	0.007	0.021	0.198	0.149
	N	23	23	23	23	23	23	0	23	23	23	0	23	23	23	23	23
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.041	0.041	-0.152	0.485*	0.514*	.	1.000	0.385*	0.687*	.	0.346*	0.469*	0.401*	0.308*	-0.242	-0.130
	Sig. (2-tailed)	0.804	0.804	0.315	0.003	0.001	.	.	0.018	0.000	.	0.052	0.003	0.009	0.042	0.134	0.389
	N	25	25	25	25	25	0	25	25	25	0	25	25	25	25	25	25
Chloride, Total (mg/L)	Correlation Coefficient	-0.099	-0.094	0.086	0.529*	0.494*	0.321*	0.385*	1.000	0.338*	0.151	0.340*	0.586*	0.367*	0.464*	-0.159	-0.241*
	Sig. (2-tailed)	0.395	0.431	0.425	0.000	0.000	0.054	0.018	.	0.004	0.433	0.062	0.000	0.001	0.000	0.170	0.027
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.174	0.178	0.020	0.492*	0.460*	0.616*	0.687*	0.338*	1.000	0.251	0.186	0.619*	0.663*	0.429*	-0.208*	-0.162
	Sig. (2-tailed)	0.128	0.132	0.849	0.000	0.000	0.000	0.000	0.004	.	0.183	0.305	0.000	0.000	0.000	0.070	0.131
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	-0.324*	-0.395*	-0.369*	-0.099	-0.079	-0.020	.	0.151	0.251	1.000	.	0.400*	0.417*	0.254	0.194	0.039
	Sig. (2-tailed)	0.078	0.043	0.038	0.584	0.661	0.912	.	0.433	0.183	.	.	0.031	0.021	0.156	0.305	0.827
	N	23	23	23	23	23	23	0	23	23	23	0	23	23	23	23	23
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.105	0.105	-0.244	0.245	0.268	.	0.346*	0.340*	0.186	.	1.000	0.278	0.069	0.229	-0.086	-0.076
	Sig. (2-tailed)	0.570	0.570	0.147	0.186	0.135	.	0.052	0.062	0.305	.	.	0.116	0.687	0.177	0.633	0.653
	N	25	25	25	25	25	0	25	25	25	0	25	25	25	25	25	25
Sodium, Dissolved (mg/L)	Correlation Coefficient	-0.086	-0.101	0.126	0.597*	0.495*	0.438*	0.469*	0.586*	0.619*	0.400*	0.278	1.000	0.621*	0.561*	-0.071	-0.115
	Sig. (2-tailed)	0.442	0.383	0.229	0.000	0.000	0.007	0.003	0.000	0.000	0.031	0.116	.	0.000	0.000	0.526	0.270
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.072	0.067	0.072	0.457*	0.430*	0.427*	0.401*	0.367*	0.663*	0.417*	0.069	0.621*	1.000	0.529*	-0.233*	-0.221*
	Sig. (2-tailed)	0.507	0.549	0.476	0.000	0.000	0.007	0.009	0.001	0.000	0.021	0.687	0.000	.	0.000	0.032	0.030
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	-0.035	-0.038	0.230*	0.523*	0.574*	0.358*	0.308*	0.464*	0.429*	0.254	0.229	0.561*	0.529*	1.000	-0.220*	-0.228*
	Sig. (2-tailed)	0.744	0.733	0.022	0.000	0.000	0.021	0.042	0.000	0.000	0.156	0.177	0.000	0.000	.	0.041	0.023
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.105	-0.118	-0.019	-0.145	-0.330*	-0.212	-0.242	-0.159	-0.208*	0.194	-0.086	-0.071	-0.233*	-0.220*	1.000	0.806*
	Sig. (2-tailed)	0.359	0.318	0.859	0.193	0.003	0.198	0.134	0.170	0.070	0.305	0.633	0.526	0.032	0.041	.	0.000
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	-0.045	-0.051	-0.042	-0.144	-0.297*	-0.224	-0.130	-0.241*	-0.162	0.039	-0.076	-0.115	-0.221*	-0.228*	0.806*	1.000
	Sig. (2-tailed)	0.677	0.645	0.676	0.168	0.004	0.149	0.389	0.027	0.131	0.827	0.653	0.270	0.030	0.023	0.000	.
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48

Parameter	Statistic	Month	Year quarter	Date	Alkalinity as CaCO3, Total (mg/L)	Bicarbonate as HCO3, Total (mg/L)	Calcium, Total (mg/L)	Calcium, Dissolved (mg/L)	Chloride, Total (mg/L)	Magnesium, Dissolved (mg/L)	Potassium, Total (mg/L)	Potassium, Dissolved (mg/L)	Sodium, Dissolved (mg/L)	Sulfate, Total (mg/L)	Dissolved Solids, Total (mg/L)	Suspended Solids, Total (mg/L)	Turbidity (NTU)
Arsenic, Total (mg/L)	Correlation Coefficient	0.164	0.193*	0.212*	0.361*	0.345*	0.367*	0.174	0.512*	0.222*	-0.207	0.265	0.319*	0.126	0.223*	-0.241*	-0.273*
	Sig. (2-tailed)	0.143	0.094	0.042	0.001	0.001	0.024	0.266	0.000	0.048	0.269	0.130	0.004	0.238	0.034	0.032	0.009
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	0.044	0.046	-0.047	-0.055	-0.076	-0.246	-0.037	-0.179	-0.249*	-0.120	0.085	-0.181	-0.311*	-0.184	0.330*	0.295*
	Sig. (2-tailed)	0.735	0.731	0.702	0.670	0.546	0.182	0.845	0.176	0.059	0.575	0.692	0.158	0.012	0.134	0.012	0.016
	N	45	45	45	45	45	23	22	45	45	23	22	45	45	45	45	45
Copper, Total (mg/L)	Correlation Coefficient	-0.007	-0.014	-0.293*	-0.225*	-0.301*	-0.236	-0.276	-0.244*	-0.295*	0.132	-0.119	-0.309*	-0.319*	-0.350*	0.569*	0.491*
	Sig. (2-tailed)	0.957	0.913	0.011	0.063	0.011	0.171	0.123	0.050	0.017	0.506	0.557	0.011	0.006	0.003	0.000	0.000
	N	45	45	45	45	45	23	22	45	45	23	22	45	45	45	45	45
Iron, Total (mg/L)	Correlation Coefficient	-0.080	-0.093	-0.202*	-0.189*	-0.329*	-0.250	-0.213	-0.254*	-0.235*	0.059	-0.247	-0.219*	-0.319*	-0.331*	0.744*	0.841*
	Sig. (2-tailed)	0.472	0.417	0.053	0.084	0.002	0.109	0.192	0.024	0.036	0.743	0.180	0.045	0.003	0.002	0.000	0.000
	N	45	45	45	45	45	23	22	45	45	23	22	45	45	45	45	45
Lead, Total (mg/L)	Correlation Coefficient	-0.008	-0.010	-0.140	-0.081	-0.111	-0.053	-0.099	-0.097	-0.118	-0.052	-0.048	-0.154	-0.238*	-0.210*	0.336*	0.339*
	Sig. (2-tailed)	0.943	0.934	0.204	0.485	0.328	0.744	0.567	0.416	0.320	0.782	0.806	0.182	0.034	0.058	0.005	0.002
	N	45	45	45	45	45	23	22	45	45	23	22	45	45	45	45	45
Manganese, Total (mg/L)	Correlation Coefficient	-0.020	-0.020	-0.030	0.000	-0.173	-0.115	-0.227	-0.041	-0.138	0.080	-0.251	-0.049	-0.196*	-0.169	0.687*	0.711*
	Sig. (2-tailed)	0.857	0.863	0.776	1.000	0.109	0.468	0.172	0.716	0.224	0.661	0.178	0.656	0.067	0.110	0.000	0.000
	N	45	45	45	45	45	23	22	45	45	23	22	45	45	45	45	45
Zinc, Total (mg/L)	Correlation Coefficient	-0.052	-0.055	0.115	-0.196	-0.159	.	-0.326*	-0.123	-0.222*	.	0.048	-0.117	-0.216*	-0.126	0.243*	0.201
	Sig. (2-tailed)	0.695	0.691	0.355	0.134	0.215	.	0.091	0.363	0.098	.	0.827	0.372	0.089	0.317	0.071	0.106
	N	45	45	45	45	45	23	22	45	45	23	22	45	45	45	45	45
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	-0.052	-0.052	0.010	0.034	0.286*	0.212	0.117	-0.013	0.110	.	0.017	0.036	0.209*	0.280*	-0.519*	-0.483*
	Sig. (2-tailed)	0.692	0.692	0.935	0.787	0.020	0.382	0.443	0.921	0.385	.	0.920	0.771	0.084	0.019	0.000	0.000
	N	36	36	36	36	36	11	25	36	36	11	25	36	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	0.215	0.187	0.215	-0.246	-0.202	0.000	.	-0.280	0.234	0.168	.	0.000	0.331	-0.031	-0.200	-0.062
	Sig. (2-tailed)	0.335	0.432	0.335	0.270	0.369	1.000	.	0.244	0.321	0.518	.	1.000	0.145	0.890	0.389	0.783
	N	12	12	12	12	12	12	0	12	12	12	0	12	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	0.081	0.072	-0.134	-0.283*	-0.087	-0.155	-0.184	-0.333*	-0.056	0.093	-0.206	-0.201*	0.026	-0.124	-0.234*	-0.211*
	Sig. (2-tailed)	0.459	0.523	0.191	0.008	0.412	0.341	0.230	0.003	0.614	0.618	0.229	0.061	0.801	0.230	0.033	0.040
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	0.163	0.181	-0.146	-0.260*	-0.235*	-0.344*	-0.214	-0.241*	-0.136	0.010	-0.136	-0.207*	-0.155	-0.257*	0.305*	0.342*
	Sig. (2-tailed)	0.129	0.103	0.147	0.013	0.023	0.028	0.158	0.028	0.209	0.956	0.423	0.050	0.131	0.011	0.005	0.001
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.050	-0.066	0.190*	-0.021	0.151	0.171	-0.020	-0.030	-0.073	.	-0.242	-0.055	0.029	0.124	-0.381*	-0.377*
	Sig. (2-tailed)	0.670	0.584	0.080	0.854	0.175	0.356	0.899	0.800	0.532	.	0.159	0.625	0.795	0.256	0.001	0.001
	N	41	41	41	41	41	17	24	41	41	17	24	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	0.004	0.015	0.054	-0.258*	-0.305*	-0.279	-0.240	-0.317*	-0.270*	.	-0.332*	-0.293*	-0.114	-0.178	0.053	0.048
	Sig. (2-tailed)	0.972	0.898	0.621	0.023	0.006	0.131	0.120	0.007	0.021	.	0.054	0.010	0.305	0.103	0.649	0.661
	N	41	41	41	41	41	17	24	41	41	17	24	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	0.084	0.085	-0.148	0.009	-0.064	0.096	-0.202	-0.059	-0.051	0.000	-0.042	-0.066	-0.044	-0.021	0.155	0.203*
	Sig. (2-tailed)	0.430	0.439	0.138	0.928	0.531	0.538	0.180	0.589	0.636	1.000	0.803	0.530	0.662	0.838	0.146	0.043
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Specific Conductance (μS/cm)	Correlation Coefficient	0.000	-0.002	-0.018	0.563*	0.522*	0.310*	0.411*	0.554*	0.598*	0.349*	0.379*	0.670*	0.614*	0.559*	-0.169	-0.187*
	Sig. (2-tailed)	1.000	0.985	0.859	0.000	0.000	0.045	0.006	0.000	0.000	0.050	0.024	0.000	0.000	0.000	0.113	0.061
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	0.246*	0.245*	0.062	0.022	-0.135	-0.029	-0.036	-0.055	-0.001	-0.233	0.109	-0.047	-0.083	-0.102	0.441*	0.478*
	Sig. (2-tailed)	0.021	0.026	0.534	0.835	0.188	0.852	0.811	0.614	0.993	0.190	0.516	0.654	0.412	0.311	0.000	0.000
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.187*	-0.202*	-0.180*	-0.470*	-0.518*	-0.558*	-0.481*	-0.422*	-0.546*	0.155	-0.312*	-0.455*	-0.474*	-0.383*	0.394*	0.378*
	Sig. (2-tailed)	0.080	0.067	0.071	0.000	0.000	0.000	0.001	0.000	0.000	0.383	0.064	0.000	0.000	0.000	0.000	0.000
	N	48	48	48	48	48	23	25	48	48	23	25	48	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesium, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Table B-120: Kendall's tau correlation matrix of water quality parameters collected at Station 10 from 2011 to 2020 (cont.).

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Month	Correlation Coefficient	0.164	0.044	-0.007	-0.080	-0.008	-0.020	-0.052	-0.052	0.215	0.081	0.163	-0.050	0.004	0.084	0.000	0.246*	-0.187*
	Sig. (2-tailed)	0.143	0.735	0.957	0.472	0.943	0.857	0.695	0.692	0.335	0.459	0.129	0.670	0.972	0.430	1.000	0.021	0.080
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Group by Quarter	Correlation Coefficient	0.193*	0.046	-0.014	-0.093	-0.010	-0.020	-0.055	-0.052	0.187	0.072	0.181	-0.066	0.015	0.085	-0.002	0.245*	-0.202*
	Sig. (2-tailed)	0.094	0.731	0.913	0.417	0.934	0.863	0.691	0.692	0.432	0.523	0.103	0.584	0.898	0.439	0.985	0.026	0.067
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Julian Date	Correlation Coefficient	0.212*	-0.047	-0.293*	-0.202*	-0.140	-0.030	0.115	0.010	0.215	-0.134	-0.146	0.190*	0.054	-0.148	-0.018	0.062	-0.180*
	Sig. (2-tailed)	0.042	0.702	0.011	0.053	0.204	0.776	0.355	0.935	0.335	0.191	0.147	0.080	0.621	0.138	0.859	0.534	0.071
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Alkalinity as CaCO3, Total (mg/L)	Correlation Coefficient	0.361*	-0.055	-0.225*	-0.189*	-0.081	0.000	-0.196	0.034	-0.246	-0.283*	-0.260*	-0.021	-0.258*	0.009	0.563*	0.022	-0.470*
	Sig. (2-tailed)	0.001	0.670	0.063	0.084	0.485	1.000	0.134	0.787	0.270	0.008	0.013	0.854	0.023	0.928	0.000	0.835	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Bicarbonate as HCO3, Total (mg/L)	Correlation Coefficient	0.345*	-0.076	-0.301*	-0.329*	-0.111	-0.173	-0.159	0.286*	-0.202	-0.087	-0.235*	0.151	-0.305*	-0.064	0.522*	-0.135	-0.518*
	Sig. (2-tailed)	0.001	0.546	0.011	0.002	0.328	0.109	0.215	0.020	0.369	0.412	0.023	0.175	0.006	0.531	0.000	0.188	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Calcium, Total (mg/L)	Correlation Coefficient	0.367*	-0.246	-0.236	-0.250	-0.053	-0.115	.	0.212	0.000	-0.155	-0.344*	0.171	-0.279	0.096	0.310*	-0.029	-0.558*
	Sig. (2-tailed)	0.024	0.182	0.171	0.109	0.744	0.468	.	0.382	1.000	0.341	0.028	0.356	0.131	0.538	0.045	0.852	0.000
	N	23	23	23	23	23	23	23	11	12	23	23	17	17	23	23	23	23
Calcium, Dissolved (mg/L)	Correlation Coefficient	0.174	-0.037	-0.276	-0.213	-0.099	-0.227	-0.326*	0.117	.	-0.184	-0.214	-0.020	-0.240	-0.202	0.411*	-0.036	-0.481*
	Sig. (2-tailed)	0.266	0.845	0.123	0.192	0.567	0.172	0.091	0.443	.	0.230	0.158	0.899	0.120	0.180	0.006	0.811	0.001
	N	25	22	22	22	22	22	22	25	0	25	25	24	24	25	25	25	25
Chloride, Total (mg/L)	Correlation Coefficient	0.512*	-0.179	-0.244*	-0.254*	-0.097	-0.041	-0.123	-0.013	-0.280	-0.333*	-0.241*	-0.030	-0.317*	-0.059	0.554*	-0.055	-0.422*
	Sig. (2-tailed)	0.000	0.176	0.050	0.024	0.416	0.716	0.363	0.921	0.244	0.003	0.028	0.800	0.007	0.589	0.000	0.614	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Magnesium, Dissolved (mg/L)	Correlation Coefficient	0.222*	-0.249*	-0.295*	-0.235*	-0.118	-0.138	-0.222*	0.110	0.234	-0.056	-0.136	-0.073	-0.270*	-0.051	0.598*	-0.001	-0.546*
	Sig. (2-tailed)	0.048	0.059	0.017	0.036	0.320	0.224	0.098	0.385	0.321	0.614	0.209	0.532	0.021	0.636	0.000	0.993	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Potassium, Total (mg/L)	Correlation Coefficient	-0.207	-0.120	0.132	0.059	-0.052	0.080	.	.	0.168	0.093	0.010	.	.	0.000	0.349*	-0.233	0.155
	Sig. (2-tailed)	0.269	0.575	0.506	0.743	0.782	0.661	.	.	0.518	0.618	0.956	.	.	1.000	0.050	0.190	0.383
	N	23	23	23	23	23	23	23	11	12	23	23	17	17	23	23	23	23
Potassium, Dissolved (mg/L)	Correlation Coefficient	0.265	0.085	-0.119	-0.247	-0.048	-0.251	0.048	0.017	.	-0.206	-0.136	-0.242	-0.332*	-0.042	0.379*	0.109	-0.312*
	Sig. (2-tailed)	0.130	0.692	0.557	0.180	0.806	0.178	0.827	0.920	.	0.229	0.423	0.159	0.054	0.803	0.024	0.516	0.064
	N	25	22	22	22	22	22	22	25	0	25	25	24	24	25	25	25	25
Sodium, Dissolved (mg/L)	Correlation Coefficient	0.319*	-0.181	-0.309*	-0.219*	-0.154	-0.049	-0.117	0.036	0.000	-0.201*	-0.207*	-0.055	-0.293*	-0.066	0.670*	-0.047	-0.455*
	Sig. (2-tailed)	0.004	0.158	0.011	0.045	0.182	0.656	0.372	0.771	1.000	0.061	0.050	0.625	0.010	0.530	0.000	0.654	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Sulfate, Total (mg/L)	Correlation Coefficient	0.126	-0.311*	-0.319*	-0.319*	-0.238*	-0.196*	-0.216*	0.209*	0.331	0.026	-0.155	0.029	-0.114	-0.044	0.614*	-0.083	-0.474*
	Sig. (2-tailed)	0.238	0.012	0.006	0.003	0.034	0.067	0.089	0.084	0.145	0.801	0.131	0.795	0.305	0.662	0.000	0.412	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Dissolved Solids, Total (mg/L)	Correlation Coefficient	0.223*	-0.184	-0.350*	-0.331*	-0.210*	-0.169	-0.126	0.280*	-0.031	-0.124	-0.257*	0.124	-0.178	-0.021	0.559*	-0.102	-0.383*
	Sig. (2-tailed)	0.034	0.134	0.003	0.002	0.058	0.110	0.317	0.019	0.890	0.230	0.011	0.256	0.103	0.838	0.000	0.311	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Suspended Solids, Total (mg/L)	Correlation Coefficient	-0.241*	0.330*	0.569*	0.744*	0.336*	0.687*	0.243*	-0.519*	-0.200	-0.234*	0.305*	-0.381*	0.053	0.155	-0.169	0.441*	0.394*
	Sig. (2-tailed)	0.032	0.012	0.000	0.000	0.005	0.000	0.071	0.000	0.389	0.033	0.005	0.001	0.649	0.146	0.113	0.000	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Turbidity (NTU)	Correlation Coefficient	-0.273*	0.295*	0.491*	0.841*	0.339*	0.711*	0.201	-0.483*	-0.062	-0.211*	0.342*	-0.377*	0.048	0.203*	-0.187*	0.478*	0.378*
	Sig. (2-tailed)	0.009	0.016	0.000	0.000	0.002	0.000	0.106	0.000	0.783	0.040	0.001	0.001	0.661	0.043	0.061	0.000	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48

Parameter	Statistic	Arsenic, Total (mg/L)	Cadmium, Total (mg/L)	Copper, Total (mg/L)	Iron, Total (mg/L)	Lead, Total (mg/L)	Manganese, Total (mg/L)	Zinc, Total (mg/L)	Nitrite Nitrate, Total (mg/L)	Nitrite Nitrate, Dissolved (mg/L)	Nitrogen, Total (mg/L)	Phosphorus, Total (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH, Taken in field	Specific Conductance (µS/cm)	Water Temperature (°C)	Flow (CFS)
Arsenic, Total (mg/L)	Correlation Coefficient	1.000	-0.132	-0.268*	-0.356*	-0.177	-0.092	-0.041	0.010	-0.152	-0.225*	-0.224*	-0.071	-0.351*	-0.043	0.255*	-0.004	-0.489*
	Sig. (2-tailed)	.	0.305	0.026	0.001	0.126	0.405	0.756	0.934	0.521	0.037	0.034	0.532	0.002	0.679	0.015	0.971	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Cadmium, Total (mg/L)	Correlation Coefficient	-0.132	1.000	0.222	0.277*	0.330*	0.327*	-0.058	-0.203	0.096	-0.059	0.138	-0.072	0.123	-0.006	-0.197	0.193	0.230*
	Sig. (2-tailed)	0.305	.	0.103	0.025	0.011	0.008	0.696	0.168	0.711	0.639	0.264	0.591	0.355	0.960	0.107	0.114	0.060
	N	45	45	45	45	45	45	45	33	12	45	45	38	38	45	45	45	45
Copper, Total (mg/L)	Correlation Coefficient	-0.268*	0.222	1.000	0.574*	0.336*	0.406*	0.236*	-0.308*	-0.457*	-0.078	0.255*	-0.328*	0.033	0.113	-0.225*	0.315*	0.452*
	Sig. (2-tailed)	0.026	0.103	.	0.000	0.006	0.001	0.089	0.027	0.062	0.510	0.028	0.009	0.796	0.326	0.051	0.006	0.000
	N	45	45	45	45	45	45	45	33	12	45	45	38	38	45	45	45	45
Iron, Total (mg/L)	Correlation Coefficient	-0.356*	0.277*	0.574*	1.000	0.379*	0.674*	0.213*	-0.465*	-0.185	-0.168	0.336*	-0.401*	0.047	0.182*	-0.220*	0.402*	0.509*
	Sig. (2-tailed)	0.001	0.025	0.000	.	0.001	0.000	0.090	0.000	0.408	0.117	0.001	0.000	0.678	0.081	0.034	0.000	0.000
	N	45	45	45	45	45	45	45	33	12	45	45	38	38	45	45	45	45
Lead, Total (mg/L)	Correlation Coefficient	-0.177	0.330*	0.336*	0.379*	1.000	0.334*	0.078	-0.193	-0.141	-0.034	0.238*	-0.287*	-0.199*	-0.062	-0.122	0.202*	0.218*
	Sig. (2-tailed)	0.126	0.011	0.006	0.001	.	0.003	0.555	0.148	0.553	0.762	0.032	0.018	0.099	0.575	0.267	0.067	0.048
	N	45	45	45	45	45	45	45	33	12	45	45	38	38	45	45	45	45
Manganese, Total (mg/L)	Correlation Coefficient	-0.092	0.327*	0.406*	0.674*	0.334*	1.000	0.215*	-0.574*	-0.084	-0.290*	0.332*	-0.304*	0.003	0.180*	-0.102	0.409*	0.344*
	Sig. (2-tailed)	0.405	0.008	0.001	0.000	0.003	.	0.090	0.000	0.721	0.007	0.002	0.008	0.980	0.088	0.332	0.000	0.001
	N	45	45	45	45	45	45	45	33	12	45	45	38	38	45	45	45	45
Zinc, Total (mg/L)	Correlation Coefficient	-0.041	-0.058	0.236*	0.213*	0.078	0.215*	1.000	-0.031	.	0.070	0.213*	-0.056	-0.217	-0.010	-0.182	0.057	0.201
	Sig. (2-tailed)	0.756	0.696	0.089	0.090	0.555	0.090	.	0.833	.	0.588	0.090	0.682	0.111	0.939	0.143	0.644	0.106
	N	45	45	45	45	45	45	45	33	12	45	45	38	38	45	45	45	45
Nitrite Nitrate, Total (mg/L)	Correlation Coefficient	0.010	-0.203	-0.308*	-0.465*	-0.193	-0.574*	-0.031	1.000	.	0.684*	0.026	0.496*	0.007	-0.348*	0.055	-0.569*	-0.183
	Sig. (2-tailed)	0.934	0.168	0.027	0.000	0.148	0.000	0.833	.	.	0.000	0.827	0.000	0.955	0.003	0.642	0.000	0.123
	N	36	33	33	33	33	33	33	36	0	36	36	35	35	36	36	36	36
Nitrite Nitrate, Dissolved (mg/L)	Correlation Coefficient	-0.152	0.096	-0.457*	-0.185	-0.141	-0.084	.	.	1.000	0.416*	0.078	0.828*	-0.828*	-0.646*	-0.031	-0.462*	-0.308
	Sig. (2-tailed)	0.521	0.711	0.062	0.408	0.553	0.721	.	.	.	0.081	0.730	0.022	0.022	0.004	0.890	0.039	0.168
	N	12	12	12	12	12	12	12	0	12	12	12	6	6	12	12	12	12
Nitrogen, Total (mg/L)	Correlation Coefficient	-0.225*	-0.059	-0.078	-0.168	-0.034	-0.290*	0.070	0.684*	0.416*	1.000	0.255*	0.375*	0.082	-0.242*	-0.197*	-0.358*	0.064
	Sig. (2-tailed)	0.037	0.639	0.510	0.117	0.762	0.007	0.588	0.000	0.081	.	0.014	0.001	0.463	0.019	0.055	0.000	0.531
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Phosphorus, Total (mg/L)	Correlation Coefficient	-0.224*	0.138	0.255*	0.336*	0.238*	0.332*	0.213*	0.026	0.078	0.255*	1.000	0.002	0.054	-0.007	-0.270*	0.056	0.237*
	Sig. (2-tailed)	0.034	0.264	0.028	0.001	0.032	0.002	0.090	0.827	0.730	0.014	.	0.982	0.621	0.943	0.007	0.575	0.019
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Dissolved Oxygen (mg/L)	Correlation Coefficient	-0.071	-0.072	-0.328*	-0.401*	-0.287*	-0.304*	-0.056	0.496*	0.828*	0.375*	0.002	1.000	0.312*	-0.227*	-0.178	-0.668*	0.043
	Sig. (2-tailed)	0.532	0.591	0.009	0.000	0.018	0.008	0.682	0.000	0.022	0.001	0.982	.	0.004	0.037	0.101	0.000	0.694
	N	41	38	38	38	38	38	38	35	6	41	41	41	41	41	41	41	41
Dissolved Oxygen (% Sat.)	Correlation Coefficient	-0.351*	0.123	0.033	0.047	-0.199*	0.003	-0.217	0.007	-0.828*	0.082	0.054	0.312*	1.000	0.166	-0.363*	0.000	0.367*
	Sig. (2-tailed)	0.002	0.355	0.796	0.678	0.099	0.980	0.111	0.955	0.022	0.463	0.621	0.004	.	0.127	0.001	1.000	0.001
	N	41	38	38	38	38	38	38	35	6	41	41	41	41	41	41	41	41
pH, Taken in field	Correlation Coefficient	-0.043	-0.006	0.113	0.182*	-0.062	0.180*	-0.010	-0.348*	-0.646*	-0.242*	-0.007	-0.227*	0.166	1.000	-0.022	0.307*	0.187*
	Sig. (2-tailed)	0.679	0.960	0.326	0.081	0.575	0.088	0.939	0.003	0.004	0.019	0.943	0.037	0.127	.	0.824	0.002	0.062
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Specific Conductance (µS/cm)	Correlation Coefficient	0.255*	-0.197	-0.225*	-0.220*	-0.122	-0.102	-0.182	0.055	-0.031	-0.197*	-0.270*	-0.178	-0.363*	-0.022	1.000	0.002	-0.501*
	Sig. (2-tailed)	0.015	0.107	0.051	0.034	0.267	0.332	0.143	0.642	0.890	0.055	0.007	0.101	0.001	0.824	.	0.986	0.000
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Water Temperature (°C)	Correlation Coefficient	-0.004	0.193	0.315*	0.402*	0.202*	0.409*	0.057	-0.569*	-0.462*	-0.358*	0.056	-0.668*	0.000	0.307*	0.002	1.000	0.045
	Sig. (2-tailed)	0.971	0.114	0.006	0.000	0.067	0.000	0.644	0.000	0.039	0.000	0.575	0.000	1.000	0.002	0.986	.	0.650
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48
Flow (CFS)	Correlation Coefficient	-0.489*	0.230*	0.452*	0.509*	0.218*	0.344*	0.201	-0.183	-0.308	0.064	0.237*	0.043	0.367*	0.187*	-0.501*	0.045	1.000
	Sig. (2-tailed)	0.000	0.060	0.000	0.000	0.048	0.001	0.106	0.123	0.168	0.531	0.019	0.694	0.001	0.062	0.000	0.650	.
	N	48	45	45	45	45	45	45	36	12	48	48	41	41	48	48	48	48

*Correlation is significant at the 0.10 level (2-tailed).
Magnesisum, Total (mg/L) and Sulfate, Dissolved (mg/L) were not included because N=0 in all years at all stations.

Appendix B.3 Upstream-Downstream Comparisons

Table B-121: Rank comparisons of water quality analytes between Stations 1 and 2 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Alkalinity as CaCO3, Total (mg/L)	1	48	61.65	2,959.00
	2	48	35.35	1,697.00
	Total	96		
Bicarbonate as HCO3, Total (mg/L)	1	48	61.69	2,961.00
	2	48	35.31	1,695.00
	Total	96		
Calcium, Total (mg/L)	1	24	12.58	302.00
	2	24	36.42	874.00
	Total	48		
Calcium, Dissolved (mg/L)	1	24	12.50	300.00
	2	24	36.50	876.00
	Total	48		
Chloride, Total (mg/L)	1	48	67.92	3,260.00
	2	48	29.08	1,396.00
	Total	96		
Magnesium, Dissolved (mg/L)	1	48	24.50	1,176.00
	2	48	72.50	3,480.00
	Total	96		
Potassium, Total (mg/L)	1	24	34.17	820.00
	2	24	14.83	356.00
	Total	48		
Potassium, Dissolved (mg/L)	1	24	34.33	824.00
	2	24	14.67	352.00
	Total	48		
Sodium, Dissolved (mg/L)	1	48	67.89	3,258.50
	2	48	29.11	1,397.50
	Total	96		
Sulfate, Total (mg/L)	1	48	63.23	3,035.00
	2	48	33.77	1,621.00
	Total	96		
Dissolved Solids, Total (mg/L)	1	48	67.17	3,224.00
	2	48	29.83	1,432.00
	Total	96		
Suspended Solids, Total (mg/L)	1	48	55.00	2,640.00
	2	48	42.00	2,016.00
	Total	96		
Turbidity (NTU)	1	48	65.97	3,166.50
	2	47	29.65	1,393.50
	Total	95		
Arsenic, Total (mg/L)	1	48	69.47	3,334.50
	2	48	27.53	1,321.50
	Total	96		
Cadmium, Total (mg/L)	1	12	12.50	150.00
	2	12	12.50	150.00
	Total	24		

Analyte	Station	N	Mean Rank	Sum of Ranks
Copper, Total (mg/L)	1	12	16.21	194.50
	2	12	8.79	105.50
	Total	24		
Iron, Total (mg/L)	1	12	16.75	201.00
	2	12	8.25	99.00
	Total	24		
Lead, Total (mg/L)	1	12	13.00	156.00
	2	12	12.00	144.00
	Total	24		
Manganese, Total (mg/L)	1	12	13.71	164.50
	2	12	11.29	135.50
	Total	24		
Zinc, Total (mg/L)	1	12	12.50	150.00
	2	12	12.50	150.00
	Total	24		
Nitrite Nitrate, Total (mg/L)	1	36	43.57	1,568.50
	2	36	29.43	1,059.50
	Total	72		
Nitrite Nitrate, Dissolved (mg/L)	1	12	14.88	178.50
	2	12	10.13	121.50
	Total	24		
Nitrogen, Total (mg/L)	1	48	43.18	2,072.50
	2	48	53.82	2,583.50
	Total	96		
Phosphorus, Total (mg/L)	1	48	45.20	2,169.50
	2	48	51.80	2,486.50
	Total	96		
Dissolved Oxygen (mg/L)	1	42	34.26	1,439.00
	2	41	49.93	2,047.00
	Total	83		
Dissolved Oxygen (% Sat.)	1	42	29.11	1,222.50
	2	41	55.21	2,263.50
	Total	83		
pH, Taken in field	1	48	39.55	1,898.50
	2	47	56.63	2,661.50
	Total	95		
Specific Conductance (µS/cm)	1	48	64.27	3,085.00
	2	47	31.38	1,475.00
	Total	95		
Water Temperature (°C)	1	48	50.41	2,419.50
	2	47	45.54	2,140.50
	Total	95		
Flow (CFS)	1	48	29.67	1,424.00
	2	48	67.33	3,232.00
	Total	96		
Flow (probability)	1	48	47.97	2,302.50
	2	48	49.03	2,353.50
	Total	96		

Table B-122: Mann–Whitney *U* test results for water quality analytes at Stations 1 and 2 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Alkalinity as CaCO3, Total (mg/L)	521.000	1,697.000	-4.626	0.000
Bicarbonate as HCO3, Total (mg/L)	519.000	1,695.000	-4.640	0.000
Calcium, Total (mg/L)	2.000	302.000	-6.058	0.000
Calcium, Dissolved (mg/L)	0.000	300.000	-6.096	0.000
Chloride, Total (mg/L)	220.000	1,396.000	-6.833	0.000
Magnesium, Dissolved (mg/L)	0.000	1,176.000	-9.368	0.000
Potassium, Total (mg/L)	56.000	356.000	-4.872	0.000
Potassium, Dissolved (mg/L)	52.000	352.000	-4.957	0.000
Sodium, Dissolved (mg/L)	221.500	1,397.500	-6.821	0.000
Sulfate, Total (mg/L)	445.000	1,621.000	-5.217	0.000
Dissolved Solids, Total (mg/L)	256.000	1,432.000	-6.566	0.000
Suspended Solids, Total (mg/L)	840.000	2,016.000	-3.844	0.000
Turbidity (NTU)	265.500	1,393.500	-6.420	0.000
Arsenic, Total (mg/L)	145.500	1,321.500	-7.376	0.000
Cadmium, Total (mg/L)	72.000	150.000	0.000	1.000
Copper, Total (mg/L)	27.500	105.500	-2.980	0.003
Iron, Total (mg/L)	21.000	99.000	-2.956	0.003
Lead, Total (mg/L)	66.000	144.000	-1.000	0.317
Manganese, Total (mg/L)	57.500	135.500	-0.860	0.390
Zinc, Total (mg/L)	72.000	150.000	0.000	1.000
Nitrite Nitrate, Total (mg/L)	393.500	1,059.500	-2.916	0.004
Nitrite Nitrate, Dissolved (mg/L)	43.500	121.500	-1.663	0.096
Nitrogen, Total (mg/L)	896.500	2,072.500	-1.883	0.060
Phosphorus, Total (mg/L)	993.500	2,169.500	-1.163	0.245
Dissolved Oxygen (mg/L)	536.000	1,439.000	-2.960	0.003
Dissolved Oxygen (% Sat.)	319.500	1,222.500	-4.932	0.000
pH, Taken in field	722.500	1,898.500	-3.018	0.003
Specific Conductance (µS/cm)	347.000	1,475.000	-5.813	0.000
Water Temperature (°C)	1,012.500	2,140.500	-0.860	0.390
Flow (CFS)	248.000	1,424.000	-6.625	0.000
Flow (probability)	1,126.500	2,302.500	-0.187	0.852

Table B-123: Rank comparisons of water quality analytes between Stations 2 and 3 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Alkalinity as CaCO3, Total (mg/L)	2	48	39.81	1,911.00
	3	48	57.19	2,745.00
	Total	96		
Bicarbonate as HCO3, Total (mg/L)	2	48	39.97	1,918.50
	3	48	57.03	2,737.50
	Total	96		
Calcium, Total (mg/L)	2	24	12.54	301.00
	3	24	36.46	875.00
	Total	48		
Calcium, Dissolved (mg/L)	2	24	12.50	300.00
	3	24	36.50	876.00
	Total	48		
Chloride, Total (mg/L)	2	48	62.08	2,980.00
	3	48	34.92	1,676.00
	Total	96		
Magnesium, Dissolved (mg/L)	2	48	24.60	1,181.00
	3	48	72.40	3,475.00
	Total	96		
Potassium, Total (mg/L)	2	24	30.17	724.00
	3	24	18.83	452.00
	Total	48		
Potassium, Dissolved (mg/L)	2	24	31.54	757.00
	3	24	17.46	419.00
	Total	48		
Sodium, Dissolved (mg/L)	2	48	62.32	2,991.50
	3	48	34.68	1,664.50
	Total	96		
Sulfate, Total (mg/L)	2	48	40.10	1,925.00
	3	48	56.90	2,731.00
	Total	96		
Dissolved Solids, Total (mg/L)	2	48	56.31	2,703.00
	3	48	40.69	1,953.00
	Total	96		
Suspended Solids, Total (mg/L)	2	48	44.00	2,112.00
	3	48	53.00	2,544.00
	Total	96		
Turbidity (NTU)	2	47	28.80	1,353.50
	3	47	66.20	3,111.50
	Total	94		
Arsenic, Total (mg/L)	2	48	64.24	3,083.50
	3	48	32.76	1,572.50
	Total	96		
Cadmium, Total (mg/L)	2	12	12.50	150.00
	3	12	12.50	150.00
	Total	24		

Analyte	Station	N	Mean Rank	Sum of Ranks
Copper, Total (mg/L)	2	12	9.83	118.00
	3	12	15.17	182.00
	Total	24		
Iron, Total (mg/L)	2	12	11.08	133.00
	3	12	13.92	167.00
	Total	24		
Lead, Total (mg/L)	2	12	12.00	144.00
	3	12	13.00	156.00
	Total	24		
Manganese, Total (mg/L)	2	12	14.46	173.50
	3	12	10.54	126.50
	Total	24		
Zinc, Total (mg/L)	2	12	12.50	150.00
	3	12	12.50	150.00
	Total	24		
Nitrite Nitrate, Total (mg/L)	2	36	31.99	1,151.50
	3	36	41.01	1,476.50
	Total	72		
Nitrite Nitrate, Dissolved (mg/L)	2	12	9.08	109.00
	3	12	15.92	191.00
	Total	24		
Nitrogen, Total (mg/L)	2	48	49.78	2,389.50
	3	48	47.22	2,266.50
	Total	96		
Phosphorus, Total (mg/L)	2	48	50.09	2,404.50
	3	48	46.91	2,251.50
	Total	96		
Dissolved Oxygen (mg/L)	2	41	34.37	1,409.00
	3	41	48.63	1,994.00
	Total	82		
Dissolved Oxygen (% Sat.)	2	41	37.02	1,518.00
	3	41	45.98	1,885.00
	Total	82		
pH, Taken in field	2	47	42.30	1,988.00
	3	47	52.70	2,477.00
	Total	94		
Specific Conductance (µS/cm)	2	47	51.26	2,409.00
	3	47	43.74	2,056.00
	Total	94		
Water Temperature (°C)	2	47	51.15	2,404.00
	3	47	43.85	2,061.00
	Total	94		
Flow (CFS)	2	48	29.77	1,429.00
	3	32	56.59	1,811.00
	Total	80		
Flow (probability)	2	48	41.21	1,978.00
	3	32	39.44	1,262.00
	Total	80		

Table B-124: Mann–Whitney *U* test results for water quality analytes at Stations 2 and 3 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Alkalinity as CaCO3, Total (mg/L)	735.000	1,911.000	-3.058	0.002
Bicarbonate as HCO3, Total (mg/L)	742.500	1,918.500	-3.003	0.003
Calcium, Total (mg/L)	1.000	301.000	-6.085	0.000
Calcium, Dissolved (mg/L)	0.000	300.000	-6.055	0.000
Chloride, Total (mg/L)	500.000	1,676.000	-4.784	0.000
Magnesium, Dissolved (mg/L)	5.000	1,181.000	-9.043	0.000
Potassium, Total (mg/L)	152.000	452.000	-2.943	0.003
Potassium, Dissolved (mg/L)	119.000	419.000	-3.659	0.000
Sodium, Dissolved (mg/L)	488.500	1,664.500	-4.866	0.000
Sulfate, Total (mg/L)	749.000	1,925.000	-3.004	0.003
Dissolved Solids, Total (mg/L)	777.000	1,953.000	-2.748	0.006
Suspended Solids, Total (mg/L)	936.000	2,112.000	-3.130	0.002
Turbidity (NTU)	225.500	1,353.500	-6.647	0.000
Arsenic, Total (mg/L)	396.500	1,572.500	-5.537	0.000
Cadmium, Total (mg/L)	72.000	150.000	0.000	1.000
Copper, Total (mg/L)	40.000	118.000	-2.304	0.021
Iron, Total (mg/L)	55.000	133.000	-0.996	0.319
Lead, Total (mg/L)	66.000	144.000	-1.000	0.317
Manganese, Total (mg/L)	48.500	126.500	-1.562	0.118
Zinc, Total (mg/L)	72.000	150.000	0.000	1.000
Nitrite Nitrate, Total (mg/L)	485.500	1,151.500	-1.873	0.061
Nitrite Nitrate, Dissolved (mg/L)	31.000	109.000	-2.382	0.017
Nitrogen, Total (mg/L)	1,090.500	2,266.500	-0.453	0.650
Phosphorus, Total (mg/L)	1,075.500	2,251.500	-0.561	0.575
Dissolved Oxygen (mg/L)	548.000	1,409.000	-2.713	0.007
Dissolved Oxygen (% Sat.)	657.000	1,518.000	-1.702	0.089
pH, Taken in field	860.000	1,988.000	-1.849	0.064
Specific Conductance (µS/cm)	928.000	2,056.000	-1.335	0.182
Water Temperature (°C)	933.000	2,061.000	-1.297	0.195
Flow (CFS)	253.000	1,429.000	-5.058	0.000
Flow (probability)	734.000	1,262.000	-0.334	0.738

Table B-125: Rank comparisons of water quality analytes between Stations 3 and 4 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Alkalinity as CaCO3, Total (mg/L)	3	48	33.26	1,596.50
	4	48	63.74	3,059.50
	Total	96		
Bicarbonate as HCO3, Total (mg/L)	3	48	34.63	1,662.00
	4	48	62.38	2,994.00
	Total	96		
Calcium, Total (mg/L)	3	24	12.54	301.00
	4	24	36.46	875.00
	Total	48		
Calcium, Dissolved (mg/L)	3	24	13.17	316.00
	4	24	35.83	860.00
	Total	48		
Chloride, Total (mg/L)	3	48	53.85	2,585.00
	4	48	43.15	2,071.00
	Total	96		
Magnesium, Dissolved (mg/L)	3	48	26.94	1,293.00
	4	48	70.06	3,363.00
	Total	96		
Potassium, Total (mg/L)	3	24	25.69	616.50
	4	24	23.31	559.50
	Total	48		
Potassium, Dissolved (mg/L)	3	24	27.15	651.50
	4	24	21.85	524.50
	Total	48		
Sodium, Dissolved (mg/L)	3	48	53.74	2,579.50
	4	48	43.26	2,076.50
	Total	96		
Sulfate, Total (mg/L)	3	48	30.30	1,454.50
	4	48	66.70	3,201.50
	Total	96		
Dissolved Solids, Total (mg/L)	3	48	43.45	2,085.50
	4	48	53.55	2,570.50
	Total	96		
Suspended Solids, Total (mg/L)	3	48	49.52	2,377.00
	4	48	47.48	2,279.00
	Total	96		
Turbidity (NTU)	3	47	37.12	1,744.50
	4	47	57.88	2,720.50
	Total	94		
Arsenic, Total (mg/L)	3	48	55.88	2,682.00
	4	48	41.13	1,974.00
	Total	96		
Cadmium, Total (mg/L)	3	12	12.00	144.00
	4	12	13.00	156.00
	Total	24		

Analyte	Station	N	Mean Rank	Sum of Ranks
Copper, Total (mg/L)	3	12	13.58	163.00
	4	12	11.42	137.00
	Total	24		
Iron, Total (mg/L)	3	12	9.08	109.00
	4	12	15.92	191.00
	Total	24		
Lead, Total (mg/L)	3	12	13.00	156.00
	4	12	12.00	144.00
	Total	24		
Manganese, Total (mg/L)	3	12	8.92	107.00
	4	12	16.08	193.00
	Total	24		
Zinc, Total (mg/L)	3	12	12.50	150.00
	4	12	12.50	150.00
	Total	24		
Nitrite Nitrate, Total (mg/L)	3	36	39.32	1,415.50
	4	36	33.68	1,212.50
	Total	72		
Nitrite Nitrate, Dissolved (mg/L)	3	12	14.04	168.50
	4	12	10.96	131.50
	Total	24		
Nitrogen, Total (mg/L)	3	48	41.07	1,971.50
	4	48	55.93	2,684.50
	Total	96		
Phosphorus, Total (mg/L)	3	48	44.86	2,153.50
	4	48	52.14	2,502.50
	Total	96		
Dissolved Oxygen (mg/L)	3	41	46.12	1,891.00
	4	41	36.88	1,512.00
	Total	82		
Dissolved Oxygen (% Sat.)	3	41	48.93	2,006.00
	4	41	34.07	1,397.00
	Total	82		
pH, Taken in field	3	47	45.03	2,116.50
	4	47	49.97	2,348.50
	Total	94		
Specific Conductance (µS/cm)	3	47	39.89	1,875.00
	4	47	55.11	2,590.00
	Total	94		
Water Temperature (°C)	3	47	44.23	2,079.00
	4	47	50.77	2,386.00
	Total	94		
Flow (CFS)	3	32	33.33	1,066.50
	4	48	45.28	2,173.50
	Total	80		
Flow (probability)	3	32	37.84	1,211.00
	4	48	42.27	2,029.00
	Total	80		

Table B-126: Mann–Whitney *U* test results for water quality analytes at Stations 3 and 4 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Alkalinity as CaCO3, Total (mg/L)	420.500	1,596.500	-5.364	0.000
Bicarbonate as HCO3, Total (mg/L)	486.000	1,662.000	-4.889	0.000
Calcium, Total (mg/L)	1.000	301.000	-6.006	0.000
Calcium, Dissolved (mg/L)	16.000	316.000	-5.656	0.000
Chloride, Total (mg/L)	895.000	2,071.000	-1.887	0.059
Magnesium, Dissolved (mg/L)	117.000	1,293.000	-8.080	0.000
Potassium, Total (mg/L)	259.500	559.500	-0.625	0.532
Potassium, Dissolved (mg/L)	224.500	524.500	-1.468	0.142
Sodium, Dissolved (mg/L)	900.500	2,076.500	-1.845	0.065
Sulfate, Total (mg/L)	278.500	1,454.500	-6.464	0.000
Dissolved Solids, Total (mg/L)	909.500	2,085.500	-1.777	0.075
Suspended Solids, Total (mg/L)	1,103.000	2,279.000	-0.540	0.589
Turbidity (NTU)	616.500	1,744.500	-3.690	0.000
Arsenic, Total (mg/L)	798.000	1,974.000	-2.595	0.009
Cadmium, Total (mg/L)	66.000	144.000	-1.000	0.317
Copper, Total (mg/L)	59.000	137.000	-0.823	0.410
Iron, Total (mg/L)	31.000	109.000	-2.375	0.018
Lead, Total (mg/L)	66.000	144.000	-1.000	0.317
Manganese, Total (mg/L)	29.000	107.000	-2.630	0.009
Zinc, Total (mg/L)	72.000	150.000	0.000	1.000
Nitrite Nitrate, Total (mg/L)	546.500	1,212.500	-1.167	0.243
Nitrite Nitrate, Dissolved (mg/L)	53.500	131.500	-1.073	0.283
Nitrogen, Total (mg/L)	795.500	1,971.500	-2.620	0.009
Phosphorus, Total (mg/L)	977.500	2,153.500	-1.280	0.201
Dissolved Oxygen (mg/L)	651.000	1,512.000	-1.757	0.079
Dissolved Oxygen (% Sat.)	536.000	1,397.000	-2.824	0.005
pH, Taken in field	988.500	2,116.500	-0.877	0.380
Specific Conductance (µS/cm)	747.000	1,875.000	-2.703	0.007
Water Temperature (°C)	951.000	2,079.000	-1.161	0.246
Flow (CFS)	538.500	1,066.500	-2.254	0.024
Flow (probability)	683.000	1,211.000	-0.835	0.404

Table B-127: Kruskal-Wallis *H* rank results for dissolved oxygen by season at Station 3 from 2011 to 2020.

Analyte	Season	N	Mean Rank
Dissolved Oxygen (mg/L)	Jan-Mar	9	30.33
	Apr-Jun	9	16.67
	Jul-Sep	11	7.36
	Oct-Dec	12	29.75
	Total	41	
Dissolved Oxygen (% Sat.)	Jan-Mar	9	17.83
	Apr-Jun	9	20.00
	Jul-Sep	11	25.45
	Oct-Dec	12	20.04
	Total	41	

Table B-128: Kruskal-Wallis *H* test statistics for dissolved oxygen by season at Station 3 from 2011 to 2020.

Analyte	Chi-Square	df	Asymp. Sig. (2-tailed)
Dissolved Oxygen (mg/L)	27.298	3	0.000
Dissolved Oxygen (% Sat.)	2.290	3	0.514

Table B-129: Kruskal-Wallis *H* rank results for dissolved oxygen by season at Station 4 from 2011 to 2020.

Analyte	Season	N	Mean Rank
Dissolved Oxygen (mg/L)	Jan-Mar	9	31.00
	Apr-Jun	9	15.78
	Jul-Sep	11	7.64
	Oct-Dec	12	29.67
	Total	41	
Dissolved Oxygen (% Sat.)	Jan-Mar	9	21.44
	Apr-Jun	9	20.89
	Jul-Sep	11	21.91
	Oct-Dec	12	19.92
	Total	41	

Table B-130: Kruskal-Wallis *H* test statistics for dissolved oxygen by season at Station 4 from 2011 to 2020.

Analyte	Chi-Square	df	Asymp. Sig. (2-tailed)
Dissolved Oxygen (mg/L)	27.953	3	0.000
Dissolved Oxygen (% Sat.)	.175	3	0.982

Table B-131: Rank comparisons of water quality analytes between Stations 4 and 5 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Alkalinity as CaCO3, Total (mg/L)	4	48	34.47	1,654.50
	5	48	62.53	3,001.50
	Total	96		
Bicarbonate as HCO3, Total (mg/L)	4	48	33.98	1,631.00
	5	48	63.02	3,025.00
	Total	96		
Calcium, Total (mg/L)	4	24	12.54	301.00
	5	24	36.46	875.00
	Total	48		
Calcium, Dissolved (mg/L)	4	24	12.60	302.50
	5	24	36.40	873.50
	Total	48		
Chloride, Total (mg/L)	4	48	67.42	3,236.00
	5	48	29.58	1,420.00
	Total	96		
Magnesium, Dissolved (mg/L)	4	48	25.69	1,233.00
	5	48	71.31	3,423.00
	Total	96		
Potassium, Total (mg/L)	4	24	26.63	639.00
	5	24	22.38	537.00
	Total	48		
Potassium, Dissolved (mg/L)	4	24	27.90	669.50
	5	24	21.10	506.50
	Total	48		
Sodium, Dissolved (mg/L)	4	48	69.07	3,315.50
	5	48	27.93	1,340.50
	Total	96		
Sulfate, Total (mg/L)	4	48	24.98	1,199.00
	5	48	72.02	3,457.00
	Total	96		
Dissolved Solids, Total (mg/L)	4	48	38.91	1,867.50
	5	48	58.09	2,788.50
	Total	96		
Suspended Solids, Total (mg/L)	4	48	36.97	1,774.50
	5	48	60.03	2,881.50
	Total	96		
Turbidity (NTU)	4	47	37.04	1,741.00
	5	48	58.73	2,819.00
	Total	95		
Arsenic, Total (mg/L)	4	48	71.79	3,446.00
	5	48	25.21	1,210.00
	Total	96		
Cadmium, Total (mg/L)	4	12	12.00	144.00
	5	12	13.00	156.00
	Total	24		

Analyte	Station	N	Mean Rank	Sum of Ranks
Copper, Total (mg/L)	4	12	7.00	84.00
	5	12	18.00	216.00
	Total	24		
Iron, Total (mg/L)	4	12	9.33	112.00
	5	12	15.67	188.00
	Total	24		
Lead, Total (mg/L)	4	12	10.50	126.00
	5	12	14.50	174.00
	Total	24		
Manganese, Total (mg/L)	4	12	11.54	138.50
	5	12	13.46	161.50
	Total	24		
Zinc, Total (mg/L)	4	12	11.50	138.00
	5	12	13.50	162.00
	Total	24		
Nitrite Nitrate, Total (mg/L)	4	36	23.51	846.50
	5	36	49.49	1,781.50
	Total	72		
Nitrite Nitrate, Dissolved (mg/L)	4	12	9.00	108.00
	5	12	16.00	192.00
	Total	24		
Nitrogen, Total (mg/L)	4	48	29.96	1,438.00
	5	48	67.04	3,218.00
	Total	96		
Phosphorus, Total (mg/L)	4	48	45.73	2,195.00
	5	48	51.27	2,461.00
	Total	96		
Dissolved Oxygen (mg/L)	4	41	41.68	1,709.00
	5	41	41.32	1,694.00
	Total	82		
Dissolved Oxygen (% Sat.)	4	41	45.80	1,878.00
	5	41	37.20	1,525.00
	Total	82		
pH, Taken in field	4	47	47.19	2,218.00
	5	48	48.79	2,342.00
	Total	95		
Specific Conductance (µS/cm)	4	47	36.32	1,707.00
	5	48	59.44	2,853.00
	Total	95		
Water Temperature (°C)	4	47	49.26	2,315.00
	5	48	46.77	2,245.00
	Total	95		
Flow (CFS)	4	48	29.66	1,423.50
	5	48	67.34	3,232.50
	Total	96		
Flow (probability)	4	48	49.23	2,363.00
	5	48	47.77	2,293.00
	Total	96		

Table B-132: Mann–Whitney *U* test results for water quality analytes at Stations 4 and 5 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Alkalinity as CaCO3, Total (mg/L)	478.500	1,654.500	-4.939	0.000
Bicarbonate as HCO3, Total (mg/L)	455.000	1,631.000	-5.114	0.000
Calcium, Total (mg/L)	1.000	301.000	-5.940	0.000
Calcium, Dissolved (mg/L)	2.500	302.500	-5.910	0.000
Chloride, Total (mg/L)	244.000	1,420.000	-6.671	0.000
Magnesium, Dissolved (mg/L)	57.000	1,233.000	-8.188	0.000
Potassium, Total (mg/L)	237.000	537.000	-1.162	0.245
Potassium, Dissolved (mg/L)	206.500	506.500	-1.883	0.060
Sodium, Dissolved (mg/L)	164.500	1,340.500	-7.245	0.000
Sulfate, Total (mg/L)	23.000	1,199.000	-8.292	0.000
Dissolved Solids, Total (mg/L)	691.500	1,867.500	-3.375	0.001
Suspended Solids, Total (mg/L)	598.500	1,774.500	-4.629	0.000
Turbidity (NTU)	613.000	1,741.000	-3.834	0.000
Arsenic, Total (mg/L)	34.000	1,210.000	-8.194	0.000
Cadmium, Total (mg/L)	66.000	144.000	-0.603	0.547
Copper, Total (mg/L)	6.000	84.000	-3.939	0.000
Iron, Total (mg/L)	34.000	112.000	-2.197	0.028
Lead, Total (mg/L)	48.000	126.000	-2.134	0.033
Manganese, Total (mg/L)	60.500	138.500	-0.704	0.481
Zinc, Total (mg/L)	60.000	138.000	-1.445	0.149
Nitrite Nitrate, Total (mg/L)	180.500	846.500	-5.298	0.000
Nitrite Nitrate, Dissolved (mg/L)	30.000	108.000	-2.432	0.015
Nitrogen, Total (mg/L)	262.000	1,438.000	-6.532	0.000
Phosphorus, Total (mg/L)	1,019.000	2,195.000	-0.975	0.329
Dissolved Oxygen (mg/L)	833.000	1,694.000	-0.070	0.945
Dissolved Oxygen (% Sat.)	664.000	1,525.000	-1.637	0.102
pH, Taken in field	1,090.000	2,218.000	-0.283	0.777
Specific Conductance (µS/cm)	579.000	1,707.000	-4.087	0.000
Water Temperature (°C)	1,069.000	2,245.000	-0.439	0.661
Flow (CFS)	247.500	1,423.500	-6.628	0.000
Flow (probability)	1,117.000	2,293.000	-0.256	0.798

Table B-133: Rank comparisons of water quality analytes between Stations 5 and 6 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Alkalinity as CaCO3, Total (mg/L)	5	48	50.39	2,418.50
	6	48	46.61	2,237.50
	Total	96		
Bicarbonate as HCO3, Total (mg/L)	5	48	49.93	2,396.50
	6	48	47.07	2,259.50
	Total	96		
Calcium, Total (mg/L)	5	24	25.25	606.00
	6	24	23.75	570.00
	Total	48		
Calcium, Dissolved (mg/L)	5	24	24.31	583.50
	6	24	24.69	592.50
	Total	48		
Chloride, Total (mg/L)	5	48	57.26	2,748.50
	6	48	39.74	1,907.50
	Total	96		
Magnesium, Dissolved (mg/L)	5	48	51.01	2,448.50
	6	48	45.99	2,207.50
	Total	96		
Potassium, Total (mg/L)	5	24	28.33	680.00
	6	24	20.67	496.00
	Total	48		
Potassium, Dissolved (mg/L)	5	24	25.50	612.00
	6	24	23.50	564.00
	Total	48		
Sodium, Dissolved (mg/L)	5	48	56.43	2,708.50
	6	48	40.57	1,947.50
	Total	96		
Sulfate, Total (mg/L)	5	48	51.42	2,468.00
	6	48	45.58	2,188.00
	Total	96		
Dissolved Solids, Total (mg/L)	5	48	51.88	2,490.00
	6	48	45.13	2,166.00
	Total	96		
Suspended Solids, Total (mg/L)	5	48	63.00	3,024.00
	6	48	34.00	1,632.00
	Total	96		
Turbidity (NTU)	5	48	68.44	3,285.00
	6	48	28.56	1,371.00
	Total	96		
Arsenic, Total (mg/L)	5	48	58.76	2,820.50
	6	48	38.24	1,835.50
	Total	96		
Cadmium, Total (mg/L)	5	12	13.08	157.00
	6	12	11.92	143.00
	Total	24		

Analyte	Station	N	Mean Rank	Sum of Ranks
Copper, Total (mg/L)	5	12	14.00	168.00
	6	12	11.00	132.00
	Total	24		
Iron, Total (mg/L)	5	12	16.83	202.00
	6	12	8.17	98.00
	Total	24		
Lead, Total (mg/L)	5	12	13.08	157.00
	6	12	11.92	143.00
	Total	24		
Manganese, Total (mg/L)	5	12	15.04	180.50
	6	12	9.96	119.50
	Total	24		
Zinc, Total (mg/L)	5	12	13.50	162.00
	6	12	11.50	138.00
	Total	24		
Nitrite Nitrate, Total (mg/L)	5	36	30.50	1,098.00
	6	36	42.50	1,530.00
	Total	72		
Nitrite Nitrate, Dissolved (mg/L)	5	12	9.67	116.00
	6	12	15.33	184.00
	Total	24		
Nitrogen, Total (mg/L)	5	48	45.32	2,175.50
	6	48	51.68	2,480.50
	Total	96		
Phosphorus, Total (mg/L)	5	48	45.36	2,177.50
	6	48	51.64	2,478.50
	Total	96		
Dissolved Oxygen (mg/L)	5	41	47.66	1,954.00
	6	41	35.34	1,449.00
	Total	82		
Dissolved Oxygen (% Sat.)	5	41	51.67	2,118.50
	6	41	31.33	1,284.50
	Total	82		
pH, Taken in field	5	48	58.40	2,803.00
	6	48	38.60	1,853.00
	Total	96		
Specific Conductance (µS/cm)	5	48	53.85	2,585.00
	6	48	43.15	2,071.00
	Total	96		
Water Temperature (°C)	5	48	47.69	2,289.00
	6	48	49.31	2,367.00
	Total	96		
Flow (CFS)	5	48	45.75	2,196.00
	6	48	51.25	2,460.00
	Total	96		
Flow (probability)	5	48	47.63	2,286.00
	6	48	49.38	2,370.00
	Total	96		

Table B-134: Mann–Whitney *U* test results for water quality analytes at Stations 5 and 6 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Alkalinity as CaCO3, Total (mg/L)	1,061.500	2,237.500	-0.664	0.507
Bicarbonate as HCO3, Total (mg/L)	1,083.500	2,259.500	-0.503	0.615
Calcium, Total (mg/L)	270.000	570.000	-0.372	0.710
Calcium, Dissolved (mg/L)	283.500	583.500	-0.093	0.926
Chloride, Total (mg/L)	731.500	1,907.500	-3.103	0.002
Magnesium, Dissolved (mg/L)	1,031.500	2,207.500	-0.900	0.368
Potassium, Total (mg/L)	196.000	496.000	-2.148	0.032
Potassium, Dissolved (mg/L)	264.000	564.000	-0.561	0.575
Sodium, Dissolved (mg/L)	771.500	1,947.500	-2.799	0.005
Sulfate, Total (mg/L)	1,012.000	2,188.000	-1.027	0.304
Dissolved Solids, Total (mg/L)	990.000	2,166.000	-1.187	0.235
Suspended Solids, Total (mg/L)	456.000	1,632.000	-6.278	0.000
Turbidity (NTU)	195.000	1,371.000	-7.013	0.000
Arsenic, Total (mg/L)	659.500	1,835.500	-3.617	0.000
Cadmium, Total (mg/L)	65.000	143.000	-0.703	0.482
Copper, Total (mg/L)	54.000	132.000	-1.117	0.264
Iron, Total (mg/L)	20.000	98.000	-3.006	0.003
Lead, Total (mg/L)	65.000	143.000	-0.503	0.615
Manganese, Total (mg/L)	41.500	119.500	-1.818	0.069
Zinc, Total (mg/L)	60.000	138.000	-1.445	0.149
Nitrite Nitrate, Total (mg/L)	432.000	1,098.000	-2.436	0.015
Nitrite Nitrate, Dissolved (mg/L)	38.000	116.000	-1.966	0.049
Nitrogen, Total (mg/L)	999.500	2,175.500	-1.122	0.262
Phosphorus, Total (mg/L)	1,001.500	2,177.500	-1.103	0.270
Dissolved Oxygen (mg/L)	588.000	1,449.000	-2.342	0.019
Dissolved Oxygen (% Sat.)	423.500	1,284.500	-3.867	0.000
pH, Taken in field	677.000	1,853.000	-3.481	0.000
Specific Conductance (µS/cm)	895.000	2,071.000	-1.883	0.060
Water Temperature (°C)	1,113.000	2,289.000	-0.286	0.775
Flow (CFS)	1,020.000	2,196.000	-0.967	0.333
Flow (probability)	1,110.000	2,286.000	-0.308	0.758

Table B-135: Kruskal-Wallis *H* rank results for dissolved oxygen by season at Station 5 from 2011 to 2020.

Analyte	Season	N	Mean Rank
Dissolved Oxygen (mg/L)	Jan-Mar	9	29.67
	Apr-Jun	9	13.78
	Jul-Sep	11	9.64
	Oct-Dec	12	30.33
	Total	41	
Dissolved Oxygen (% Sat.)	Jan-Mar	9	14.56
	Apr-Jun	9	21.83
	Jul-Sep	11	22.64
	Oct-Dec	12	23.71
	Total	41	

Table B-136: Kruskal-Wallis *H* test statistics for dissolved oxygen by season at Station 5 from 2011 to 2020.

Analyte	Chi-Square	df	Asymp. Sig. (2-tailed)
Dissolved Oxygen (mg/L)	25.165	3	0.000
Dissolved Oxygen (% Sat.)	3.467	3	0.325

Table B-137: Kruskal-Wallis *H* rank results for dissolved oxygen by season at Station 6 from 2011 to 2020.

Analyte	Season	N	Mean Rank
Dissolved Oxygen (mg/L)	Jan-Mar	9	31.78
	Apr-Jun	9	28.44
	Jul-Sep	11	6.00
	Oct-Dec	12	21.08
	Total	41	
Dissolved Oxygen (% Sat.)	Jan-Mar	9	26.22
	Apr-Jun	9	32.00
	Jul-Sep	11	6.00
	Oct-Dec	12	22.58
	Total	41	

Table B-138: Kruskal-Wallis *H* test statistics for dissolved oxygen by season at Station 6 from 2011 to 2020.

Analyte	Chi-Square	df	Asymp. Sig. (2-tailed)
Dissolved Oxygen (mg/L)	28.009	3	0.000
Dissolved Oxygen (% Sat.)	26.756	3	0.000

Table B-139: Rank comparisons of water quality analytes between Stations 6 and 7 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Alkalinity as CaCO3, Total (mg/L)	6	48	48.04	2,306.00
	7	48	48.96	2,350.00
	Total	96		
Bicarbonate as HCO3, Total (mg/L)	6	48	47.51	2,280.50
	7	48	49.49	2,375.50
	Total	96		
Calcium, Total (mg/L)	6	24	23.10	554.50
	7	24	25.90	621.50
	Total	48		
Calcium, Dissolved (mg/L)	6	24	23.21	557.00
	7	24	25.79	619.00
	Total	48		
Chloride, Total (mg/L)	6	48	47.73	2,291.00
	7	48	49.27	2,365.00
	Total	96		
Magnesium, Dissolved (mg/L)	6	48	47.45	2,277.50
	7	48	49.55	2,378.50
	Total	96		
Potassium, Total (mg/L)	6	24	26.17	628.00
	7	25	23.88	597.00
	Total	49		
Potassium, Dissolved (mg/L)	6	24	23.88	573.00
	7	23	24.13	555.00
	Total	47		
Sodium, Dissolved (mg/L)	6	48	47.40	2,275.00
	7	48	49.60	2,381.00
	Total	96		
Sulfate, Total (mg/L)	6	48	45.72	2,194.50
	7	48	51.28	2,461.50
	Total	96		
Dissolved Solids, Total (mg/L)	6	48	47.23	2,267.00
	7	48	49.77	2,389.00
	Total	96		
Suspended Solids, Total (mg/L)	6	48	48.50	2,328.00
	7	48	48.50	2,328.00
	Total	96		
Turbidity (NTU)	6	48	43.41	2,083.50
	7	48	53.59	2,572.50
	Total	96		
Arsenic, Total (mg/L)	6	48	51.55	2,474.50
	7	48	45.45	2,181.50
	Total	96		
Cadmium, Total (mg/L)	6	12	12.00	144.00
	7	12	13.00	156.00
	Total	24		

Analyte	Station	N	Mean Rank	Sum of Ranks
Copper, Total (mg/L)	6	12	14.83	178.00
	7	12	10.17	122.00
	Total	24		
Iron, Total (mg/L)	6	12	11.83	142.00
	7	12	13.17	158.00
	Total	24		
Lead, Total (mg/L)	6	12	14.00	168.00
	7	12	11.00	132.00
	Total	24		
Manganese, Total (mg/L)	6	12	12.92	155.00
	7	12	12.08	145.00
	Total	24		
Zinc, Total (mg/L)	6	12	12.50	150.00
	7	12	12.50	150.00
	Total	24		
Nitrite Nitrate, Total (mg/L)	6	36	40.94	1,474.00
	7	36	32.06	1,154.00
	Total	72		
Nitrite Nitrate, Dissolved (mg/L)	6	12	13.17	158.00
	7	12	11.83	142.00
	Total	24		
Nitrogen, Total (mg/L)	6	48	46.86	2,249.50
	7	48	50.14	2,406.50
	Total	96		
Phosphorus, Total (mg/L)	6	48	47.89	2,298.50
	7	48	49.11	2,357.50
	Total	96		
Dissolved Oxygen (mg/L)	6	41	35.16	1,441.50
	7	41	47.84	1,961.50
	Total	82		
Dissolved Oxygen (% Sat.)	6	41	31.94	1,309.50
	7	41	51.06	2,093.50
	Total	82		
pH, Taken in field	6	48	41.15	1,975.00
	7	48	55.85	2,681.00
	Total	96		
Specific Conductance (µS/cm)	6	48	46.49	2,231.50
	7	48	50.51	2,424.50
	Total	96		
Water Temperature (°C)	6	48	47.86	2,297.50
	7	48	49.14	2,358.50
	Total	96		
Flow (CFS)	6	48	43.71	2,098.00
	7	48	53.29	2,558.00
	Total	96		
Flow (probability)	6	48	47.33	2,272.00
	7	48	49.67	2,384.00
	Total	96		

Table B-140: Mann–Whitney *U* test results for water quality analytes at Stations 6 and 7 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Alkalinity as CaCO3, Total (mg/L)	1,130.000	2,306.000	-0.162	0.872
Bicarbonate as HCO3, Total (mg/L)	1,104.500	2,280.500	-0.349	0.727
Calcium, Total (mg/L)	254.500	554.500	-0.694	0.488
Calcium, Dissolved (mg/L)	257.000	557.000	-0.643	0.520
Chloride, Total (mg/L)	1,115.000	2,291.000	-0.275	0.783
Magnesium, Dissolved (mg/L)	1,101.500	2,277.500	-0.379	0.704
Potassium, Total (mg/L)	272.000	597.000	-0.716	0.474
Potassium, Dissolved (mg/L)	273.000	573.000	-0.085	0.933
Sodium, Dissolved (mg/L)	1,099.000	2,275.000	-0.392	0.695
Sulfate, Total (mg/L)	1,018.500	2,194.500	-0.981	0.327
Dissolved Solids, Total (mg/L)	1,091.000	2,267.000	-0.447	0.655
Suspended Solids, Total (mg/L)	1,152.000	2,328.000	0.000	1.000
Turbidity (NTU)	907.500	2,083.500	-1.792	0.073
Arsenic, Total (mg/L)	1,005.500	2,181.500	-1.081	0.280
Cadmium, Total (mg/L)	66.000	144.000	-0.603	0.547
Copper, Total (mg/L)	44.000	122.000	-1.752	0.080
Iron, Total (mg/L)	64.000	142.000	-0.463	0.643
Lead, Total (mg/L)	54.000	132.000	-1.808	0.071
Manganese, Total (mg/L)	67.000	145.000	-0.300	0.765
Zinc, Total (mg/L)	72.000	150.000	0.000	1.000
Nitrite Nitrate, Total (mg/L)	488.000	1,154.000	-1.805	0.071
Nitrite Nitrate, Dissolved (mg/L)	64.000	142.000	-0.464	0.643
Nitrogen, Total (mg/L)	1,073.500	2,249.500	-0.580	0.562
Phosphorus, Total (mg/L)	1,122.500	2,298.500	-0.216	0.829
Dissolved Oxygen (mg/L)	580.500	1,441.500	-2.411	0.016
Dissolved Oxygen (% Sat.)	448.500	1,309.500	-3.635	0.000
pH, Taken in field	799.000	1,975.000	-2.587	0.010
Specific Conductance (µS/cm)	1,055.500	2,231.500	-0.707	0.479
Water Temperature (°C)	1,121.500	2,297.500	-0.223	0.823
Flow (CFS)	922.000	2,098.000	-1.685	0.092
Flow (probability)	1,096.000	2,272.000	-0.410	0.682

Table B-141: Rank comparisons of water quality analytes between Stations 7 and 8 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Alkalinity as CaCO3, Total (mg/L)	7	48	45.84	2,200.50
	8	48	51.16	2,455.50
	Total	96		
Bicarbonate as HCO3, Total (mg/L)	7	48	46.65	2,239.00
	8	48	50.35	2,417.00
	Total	96		
Calcium, Total (mg/L)	7	24	24.21	581.00
	8	24	24.79	595.00
	Total	48		
Calcium, Dissolved (mg/L)	7	24	23.29	559.00
	8	24	25.71	617.00
	Total	48		
Chloride, Total (mg/L)	7	48	49.08	2,356.00
	8	48	47.92	2,300.00
	Total	96		
Magnesium, Dissolved (mg/L)	7	48	46.04	2,210.00
	8	48	50.96	2,446.00
	Total	96		
Potassium, Total (mg/L)	7	25	24.38	609.50
	8	24	25.65	615.50
	Total	49		
Potassium, Dissolved (mg/L)	7	23	23.63	543.50
	8	24	24.35	584.50
	Total	47		
Sodium, Dissolved (mg/L)	7	48	48.60	2,333.00
	8	48	48.40	2,323.00
	Total	96		
Sulfate, Total (mg/L)	7	48	45.98	2,207.00
	8	48	51.02	2,449.00
	Total	96		
Dissolved Solids, Total (mg/L)	7	48	47.68	2,288.50
	8	48	49.32	2,367.50
	Total	96		
Suspended Solids, Total (mg/L)	7	48	48.50	2,328.00
	8	48	48.50	2,328.00
	Total	96		
Turbidity (NTU)	7	48	57.08	2,740.00
	8	48	39.92	1,916.00
	Total	96		
Arsenic, Total (mg/L)	7	48	50.07	2,403.50
	8	48	46.93	2,252.50
	Total	96		
Cadmium, Total (mg/L)	7	12	12.92	155.00
	8	12	12.08	145.00
	Total	24		

Analyte	Station	N	Mean Rank	Sum of Ranks
Copper, Total (mg/L)	7	12	12.50	150.00
	8	12	12.50	150.00
	Total	24		
Iron, Total (mg/L)	7	12	14.58	175.00
	8	12	10.42	125.00
	Total	24		
Lead, Total (mg/L)	7	12	12.50	150.00
	8	12	12.50	150.00
	Total	24		
Manganese, Total (mg/L)	7	12	15.08	181.00
	8	12	9.92	119.00
	Total	24		
Zinc, Total (mg/L)	7	12	12.50	150.00
	8	12	12.50	150.00
	Total	24		
Nitrite Nitrate, Total (mg/L)	7	36	40.49	1,457.50
	8	36	32.51	1,170.50
	Total	72		
Nitrite Nitrate, Dissolved (mg/L)	7	12	13.58	163.00
	8	12	11.42	137.00
	Total	24		
Nitrogen, Total (mg/L)	7	48	54.13	2,598.00
	8	48	42.88	2,058.00
	Total	96		
Phosphorus, Total (mg/L)	7	48	49.53	2,377.50
	8	48	47.47	2,278.50
	Total	96		
Dissolved Oxygen (mg/L)	7	41	41.07	1,684.00
	8	41	41.93	1,719.00
	Total	82		
Dissolved Oxygen (% Sat.)	7	41	39.44	1,617.00
	8	41	43.56	1,786.00
	Total	82		
pH, Taken in field	7	48	40.83	1,960.00
	8	48	56.17	2,696.00
	Total	96		
Specific Conductance (µS/cm)	7	48	47.79	2,294.00
	8	48	49.21	2,362.00
	Total	96		
Water Temperature (°C)	7	48	47.26	2,268.50
	8	48	49.74	2,387.50
	Total	96		
Flow (CFS)	7	48	48.86	2,345.50
	8	48	48.14	2,310.50
	Total	96		
Flow (probability)	7	48	48.73	2,339.00
	8	48	48.27	2,317.00
	Total	96		

Table B-142: Mann–Whitney *U* test results for water quality analytes at Stations 7 and 8 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Alkalinity as CaCO3, Total (mg/L)	1,024.500	2,200.500	-0.937	0.349
Bicarbonate as HCO3, Total (mg/L)	1,063.000	2,239.000	-0.653	0.514
Calcium, Total (mg/L)	281.000	581.000	-0.145	0.885
Calcium, Dissolved (mg/L)	259.000	559.000	-0.603	0.547
Chloride, Total (mg/L)	1,124.000	2,300.000	-0.209	0.834
Magnesium, Dissolved (mg/L)	1,034.000	2,210.000	-0.890	0.373
Potassium, Total (mg/L)	284.500	609.500	-0.405	0.685
Potassium, Dissolved (mg/L)	267.500	543.500	-0.233	0.815
Sodium, Dissolved (mg/L)	1,147.000	2,323.000	-0.037	0.971
Sulfate, Total (mg/L)	1,031.000	2,207.000	-0.890	0.374
Dissolved Solids, Total (mg/L)	1,112.500	2,288.500	-0.290	0.772
Suspended Solids, Total (mg/L)	1,152.000	2,328.000	0.000	1.000
Turbidity (NTU)	740.000	1,916.000	-3.019	0.003
Arsenic, Total (mg/L)	1,076.500	2,252.500	-0.556	0.578
Cadmium, Total (mg/L)	67.000	145.000	-0.502	0.616
Copper, Total (mg/L)	72.000	150.000	0.000	1.000
Iron, Total (mg/L)	47.000	125.000	-1.452	0.147
Lead, Total (mg/L)	72.000	150.000	0.000	1.000
Manganese, Total (mg/L)	41.000	119.000	-1.852	0.064
Zinc, Total (mg/L)	72.000	150.000	0.000	1.000
Nitrite Nitrate, Total (mg/L)	504.500	1,170.500	-1.619	0.106
Nitrite Nitrate, Dissolved (mg/L)	59.000	137.000	-0.756	0.449
Nitrogen, Total (mg/L)	882.000	2,058.000	-1.995	0.046
Phosphorus, Total (mg/L)	1,102.500	2,278.500	-0.363	0.717
Dissolved Oxygen (mg/L)	823.000	1,684.000	-0.162	0.871
Dissolved Oxygen (% Sat.)	756.000	1,617.000	-0.784	0.433
pH, Taken in field	784.000	1,960.000	-2.697	0.007
Specific Conductance (µS/cm)	1,118.000	2,294.000	-0.249	0.803
Water Temperature (°C)	1,092.500	2,268.500	-0.436	0.663
Flow (CFS)	1,134.500	2,310.500	-0.128	0.898
Flow (probability)	1,141.000	2,317.000	-0.081	0.936

Table B-143: Rank comparisons of water quality analytes between Stations 8 and 9 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Alkalinity as CaCO3, Total (mg/L)	8	48	36.95	1,773.50
	9	47	59.29	2,786.50
	Total	95		
Bicarbonate as HCO3, Total (mg/L)	8	48	37.49	1,799.50
	9	47	58.73	2,760.50
	Total	95		
Calcium, Total (mg/L)	8	24	20.42	490.00
	9	24	28.58	686.00
	Total	48		
Calcium, Dissolved (mg/L)	8	24	17.27	414.50
	9	23	31.02	713.50
	Total	47		
Chloride, Total (mg/L)	8	48	59.70	2,865.50
	9	47	36.05	1,694.50
	Total	95		
Magnesium, Dissolved (mg/L)	8	48	29.72	1,426.50
	9	47	66.67	3,133.50
	Total	95		
Potassium, Total (mg/L)	8	24	27.00	648.00
	9	24	22.00	528.00
	Total	48		
Potassium, Dissolved (mg/L)	8	24	27.56	661.50
	9	23	20.28	466.50
	Total	47		
Sodium, Dissolved (mg/L)	8	48	47.69	2,289.00
	9	47	48.32	2,271.00
	Total	95		
Sulfate, Total (mg/L)	8	48	30.72	1,474.50
	9	47	65.65	3,085.50
	Total	95		
Dissolved Solids, Total (mg/L)	8	48	39.14	1,878.50
	9	47	57.05	2,681.50
	Total	95		
Suspended Solids, Total (mg/L)	8	48	33.00	1,584.00
	9	47	63.32	2,976.00
	Total	95		
Turbidity (NTU)	8	48	25.55	1,226.50
	9	47	70.93	3,333.50
	Total	95		
Arsenic, Total (mg/L)	8	48	64.52	3,097.00
	9	47	31.13	1,463.00
	Total	95		
Cadmium, Total (mg/L)	8	12	29.88	358.50
	9	44	28.13	1,237.50
	Total	56		

Analyte	Station	N	Mean Rank	Sum of Ranks
Copper, Total (mg/L)	8	12	23.58	283.00
	9	44	29.84	1,313.00
	Total	56		
Iron, Total (mg/L)	8	12	10.00	120.00
	9	44	33.55	1,476.00
	Total	56		
Lead, Total (mg/L)	8	12	24.00	288.00
	9	44	29.73	1,308.00
	Total	56		
Manganese, Total (mg/L)	8	12	21.33	256.00
	9	44	30.45	1,340.00
	Total	56		
Zinc, Total (mg/L)	8	12	28.00	336.00
	9	44	28.64	1,260.00
	Total	56		
Nitrite Nitrate, Total (mg/L)	8	36	34.97	1,259.00
	9	35	37.06	1,297.00
	Total	71		
Nitrite Nitrate, Dissolved (mg/L)	8	12	11.83	142.00
	9	12	13.17	158.00
	Total	24		
Nitrogen, Total (mg/L)	8	48	46.18	2,216.50
	9	47	49.86	2,343.50
	Total	95		
Phosphorus, Total (mg/L)	8	48	40.99	1,967.50
	9	47	55.16	2,592.50
	Total	95		
Dissolved Oxygen (mg/L)	8	41	41.50	1,701.50
	9	40	40.49	1,619.50
	Total	81		
Dissolved Oxygen (% Sat.)	8	41	43.45	1,781.50
	9	40	38.49	1,539.50
	Total	81		
pH, Taken in field	8	48	49.34	2,368.50
	9	47	46.63	2,191.50
	Total	95		
Specific Conductance (µS/cm)	8	48	38.21	1,834.00
	9	47	58.00	2,726.00
	Total	95		
Water Temperature (°C)	8	48	48.69	2,337.00
	9	47	47.30	2,223.00
	Total	95		
Flow (CFS)	8	48	42.63	2,046.00
	9	47	53.49	2,514.00
	Total	95		
Flow (probability)	8	48	48.54	2,330.00
	9	47	47.45	2,230.00
	Total	95		

Table B-144: Mann–Whitney *U* test results for water quality analytes at Stations 8 and 9 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Alkalinity as CaCO3, Total (mg/L)	597.500	1,773.500	-3.961	0.000
Bicarbonate as HCO3, Total (mg/L)	623.500	1,799.500	-3.762	0.000
Calcium, Total (mg/L)	190.000	490.000	-2.037	0.042
Calcium, Dissolved (mg/L)	114.500	414.500	-3.470	0.001
Chloride, Total (mg/L)	566.500	1,694.500	-4.249	0.000
Magnesium, Dissolved (mg/L)	250.500	1,426.500	-6.650	0.000
Potassium, Total (mg/L)	228.000	528.000	-1.830	0.067
Potassium, Dissolved (mg/L)	190.500	466.500	-2.555	0.011
Sodium, Dissolved (mg/L)	1,113.000	2,289.000	-0.112	0.910
Sulfate, Total (mg/L)	298.500	1,474.500	-6.185	0.000
Dissolved Solids, Total (mg/L)	702.500	1,878.500	-3.168	0.002
Suspended Solids, Total (mg/L)	408.000	1,584.000	-6.501	0.000
Turbidity (NTU)	50.500	1,226.500	-8.021	0.000
Arsenic, Total (mg/L)	335.000	1,463.000	-5.923	0.000
Cadmium, Total (mg/L)	247.500	1,237.500	-1.025	0.306
Copper, Total (mg/L)	205.000	283.000	-1.229	0.219
Iron, Total (mg/L)	42.000	120.000	-4.436	0.000
Lead, Total (mg/L)	210.000	288.000	-1.116	0.264
Manganese, Total (mg/L)	178.000	256.000	-1.726	0.084
Zinc, Total (mg/L)	258.000	336.000	-0.522	0.602
Nitrite Nitrate, Total (mg/L)	593.000	1,259.000	-0.426	0.670
Nitrite Nitrate, Dissolved (mg/L)	64.000	142.000	-0.463	0.643
Nitrogen, Total (mg/L)	1,040.500	2,216.500	-0.655	0.512
Phosphorus, Total (mg/L)	791.500	1,967.500	-2.506	0.012
Dissolved Oxygen (mg/L)	799.500	1,619.500	-0.194	0.846
Dissolved Oxygen (% Sat.)	719.500	1,539.500	-0.949	0.342
pH, Taken in field	1,063.500	2,191.500	-0.480	0.631
Specific Conductance (µS/cm)	658.000	1,834.000	-3.499	0.000
Water Temperature (°C)	1,095.000	2,223.000	-0.246	0.806
Flow (CFS)	870.000	2,046.000	-1.921	0.055
Flow (probability)	1,102.000	2,230.000	-0.194	0.847

Table B-145: Rank comparisons of water quality analytes between Stations 9 and 10 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Alkalinity as CaCO3, Total (mg/L)	9	47	45.95	2,159.50
	10	48	50.01	2,400.50
	Total	95		
Bicarbonate as HCO3, Total (mg/L)	9	47	45.23	2,126.00
	10	48	50.71	2,434.00
	Total	95		
Calcium, Total (mg/L)	9	24	18.21	437.00
	10	23	30.04	691.00
	Total	47		
Calcium, Dissolved (mg/L)	9	23	17.24	396.50
	10	25	31.18	779.50
	Total	48		
Chloride, Total (mg/L)	9	47	47.88	2,250.50
	10	48	48.11	2,309.50
	Total	95		
Magnesium, Dissolved (mg/L)	9	47	39.10	1,837.50
	10	48	56.72	2,722.50
	Total	95		
Potassium, Total (mg/L)	9	24	23.96	575.00
	10	23	24.04	553.00
	Total	47		
Potassium, Dissolved (mg/L)	9	23	23.98	551.50
	10	25	24.98	624.50
	Total	48		
Sodium, Dissolved (mg/L)	9	47	51.86	2,437.50
	10	48	44.22	2,122.50
	Total	95		
Sulfate, Total (mg/L)	9	47	34.30	1,612.00
	10	48	61.42	2,948.00
	Total	95		
Dissolved Solids, Total (mg/L)	9	47	38.95	1,830.50
	10	48	56.86	2,729.50
	Total	95		
Suspended Solids, Total (mg/L)	9	47	51.35	2,413.50
	10	48	44.72	2,146.50
	Total	95		
Turbidity (NTU)	9	47	48.47	2,278.00
	10	48	47.54	2,282.00
	Total	95		
Arsenic, Total (mg/L)	9	47	54.90	2,580.50
	10	48	41.24	1,979.50
	Total	95		
Cadmium, Total (mg/L)	9	44	42.48	1,869.00
	10	45	47.47	2,136.00
	Total	89		

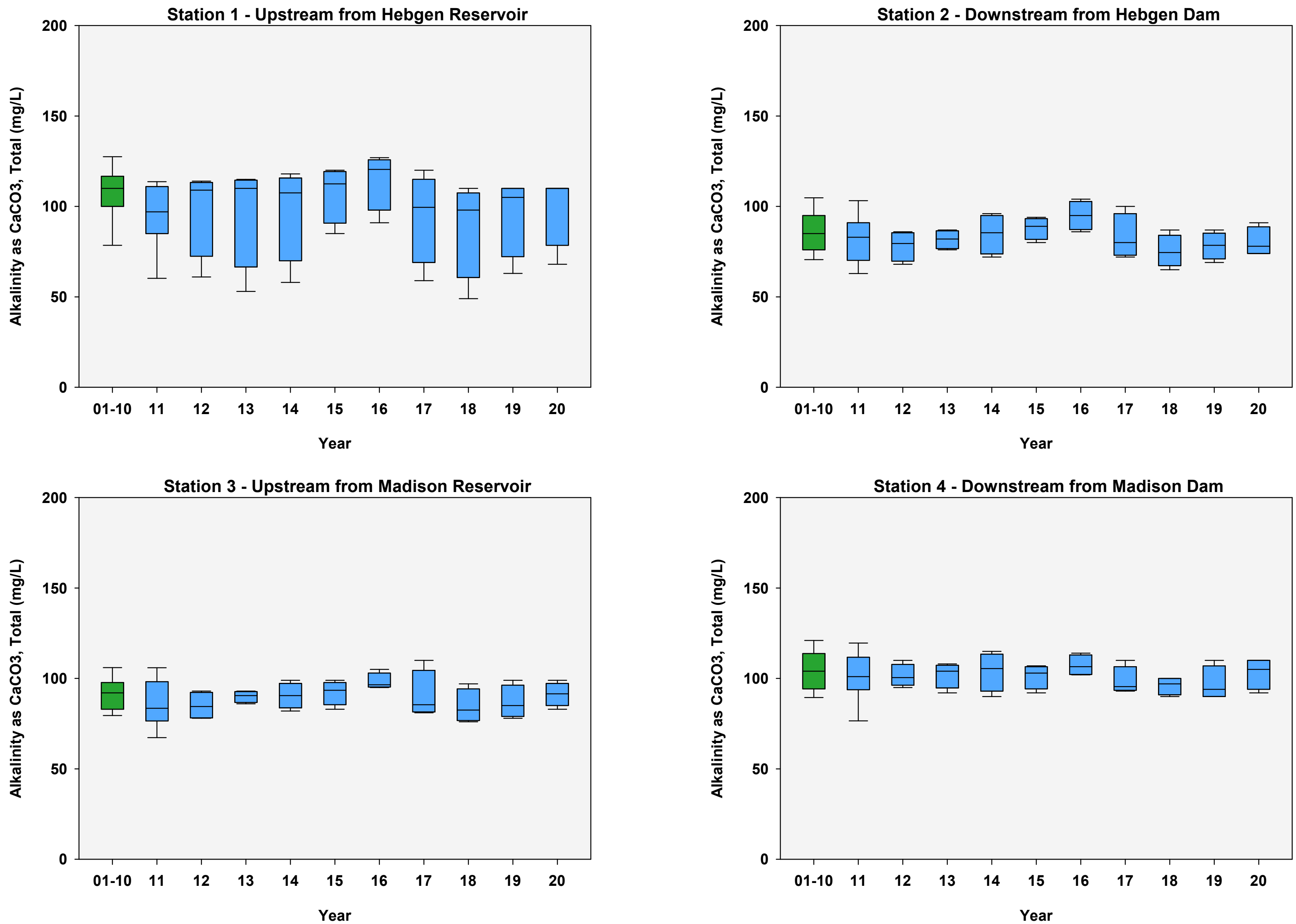
Analyte	Station	N	Mean Rank	Sum of Ranks
Copper, Total (mg/L)	9	44	49.27	2,168.00
	10	45	40.82	1,837.00
	Total	89		
Iron, Total (mg/L)	9	44	47.88	2,106.50
	10	45	42.19	1,898.50
	Total	89		
Lead, Total (mg/L)	9	44	46.00	2,024.00
	10	45	44.02	1,981.00
	Total	89		
Manganese, Total (mg/L)	9	44	47.66	2,097.00
	10	45	42.40	1,908.00
	Total	89		
Zinc, Total (mg/L)	9	44	45.01	1,980.50
	10	45	44.99	2,024.50
	Total	89		
Nitrite Nitrate, Total (mg/L)	9	35	32.16	1,125.50
	10	36	39.74	1,430.50
	Total	71		
Nitrite Nitrate, Dissolved (mg/L)	9	12	12.13	145.50
	10	12	12.88	154.50
	Total	24		
Nitrogen, Total (mg/L)	9	47	45.94	2,159.00
	10	48	50.02	2,401.00
	Total	95		
Phosphorus, Total (mg/L)	9	47	50.70	2,383.00
	10	48	45.35	2,177.00
	Total	95		
Dissolved Oxygen (mg/L)	9	40	39.83	1,593.00
	10	41	42.15	1,728.00
	Total	81		
Dissolved Oxygen (% Sat.)	9	40	41.28	1,651.00
	10	41	40.73	1,670.00
	Total	81		
pH, Taken in field	9	47	44.34	2,084.00
	10	48	51.58	2,476.00
	Total	95		
Specific Conductance (µS/cm)	9	47	37.47	1,761.00
	10	48	58.31	2,799.00
	Total	95		
Water Temperature (°C)	9	47	46.55	2,188.00
	10	48	49.42	2,372.00
	Total	95		
Flow (CFS)	9	47	40.11	1,885.00
	10	48	55.73	2,675.00
	Total	95		
Flow (probability)	9	47	48.50	2,279.50
	10	48	47.51	2,280.50
	Total	95		

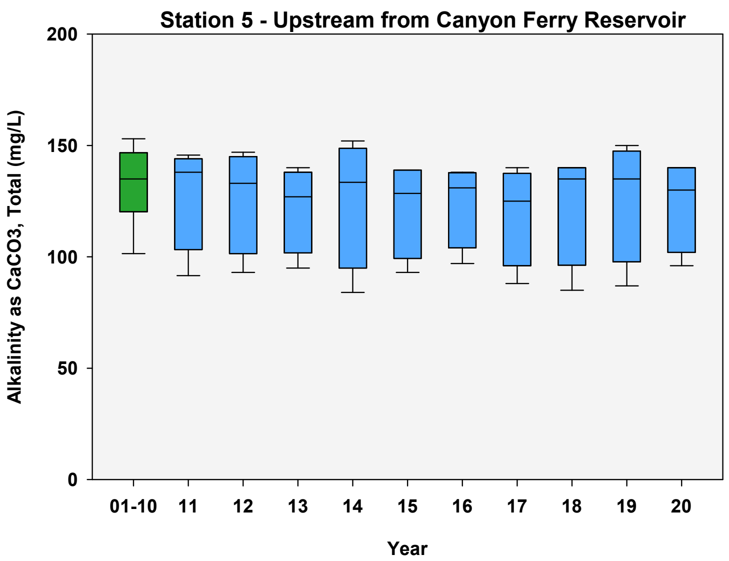
Table B-146: Mann–Whitney *U* test results for water quality analytes at Stations 9 and 10 from 2011 to 2020.

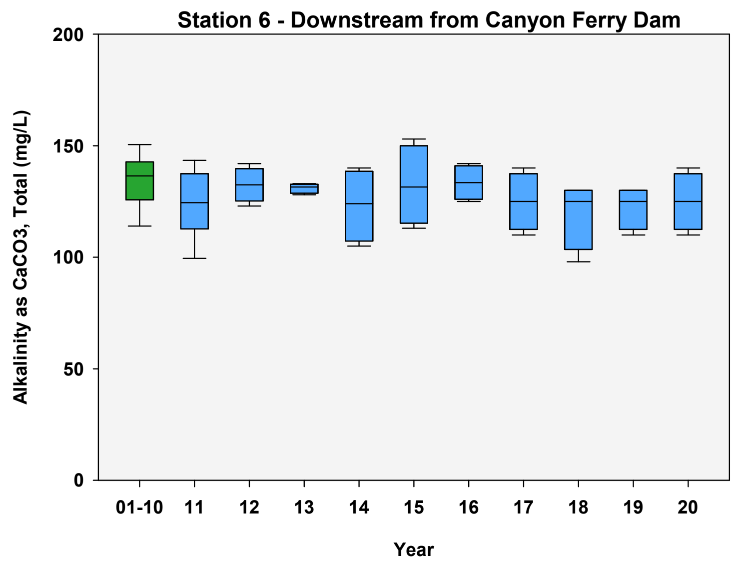
Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Alkalinity as CaCO3, Total (mg/L)	1,031.500	2,159.500	-0.726	0.468
Bicarbonate as HCO3, Total (mg/L)	998.000	2,126.000	-0.972	0.331
Calcium, Total (mg/L)	137.000	437.000	-2.980	0.003
Calcium, Dissolved (mg/L)	120.500	396.500	-3.481	0.000
Chloride, Total (mg/L)	1,122.500	2,250.500	-0.042	0.966
Magnesium, Dissolved (mg/L)	709.500	1,837.500	-3.185	0.001
Potassium, Total (mg/L)	275.000	575.000	-0.044	0.965
Potassium, Dissolved (mg/L)	275.500	551.500	-0.467	0.640
Sodium, Dissolved (mg/L)	946.500	2,122.500	-1.362	0.173
Sulfate, Total (mg/L)	484.000	1,612.000	-4.799	0.000
Dissolved Solids, Total (mg/L)	702.500	1,830.500	-3.168	0.002
Suspended Solids, Total (mg/L)	970.500	2,146.500	-1.216	0.224
Turbidity (NTU)	1,106.000	2,282.000	-0.164	0.870
Arsenic, Total (mg/L)	803.500	1,979.500	-2.430	0.015
Cadmium, Total (mg/L)	879.000	1,869.000	-1.952	0.051
Copper, Total (mg/L)	802.000	1,837.000	-1.630	0.103
Iron, Total (mg/L)	863.500	1,898.500	-1.039	0.299
Lead, Total (mg/L)	946.000	1,981.000	-0.368	0.713
Manganese, Total (mg/L)	873.000	1,908.000	-0.962	0.336
Zinc, Total (mg/L)	989.500	2,024.500	-0.016	0.987
Nitrite Nitrate, Total (mg/L)	495.500	1,125.500	-1.549	0.121
Nitrite Nitrate, Dissolved (mg/L)	67.500	145.500	-0.260	0.794
Nitrogen, Total (mg/L)	1,031.000	2,159.000	-0.727	0.468
Phosphorus, Total (mg/L)	1,001.000	2,177.000	-0.946	0.344
Dissolved Oxygen (mg/L)	773.000	1,593.000	-0.444	0.657
Dissolved Oxygen (% Sat.)	809.000	1,670.000	-0.104	0.917
pH, Taken in field	956.000	2,084.000	-1.280	0.200
Specific Conductance (µS/cm)	633.000	1,761.000	-3.685	0.000
Water Temperature (°C)	1,060.000	2,188.000	-0.506	0.613
Flow (CFS)	757.000	1,885.000	-2.762	0.006
Flow (probability)	1,104.500	2,280.500	-0.175	0.861

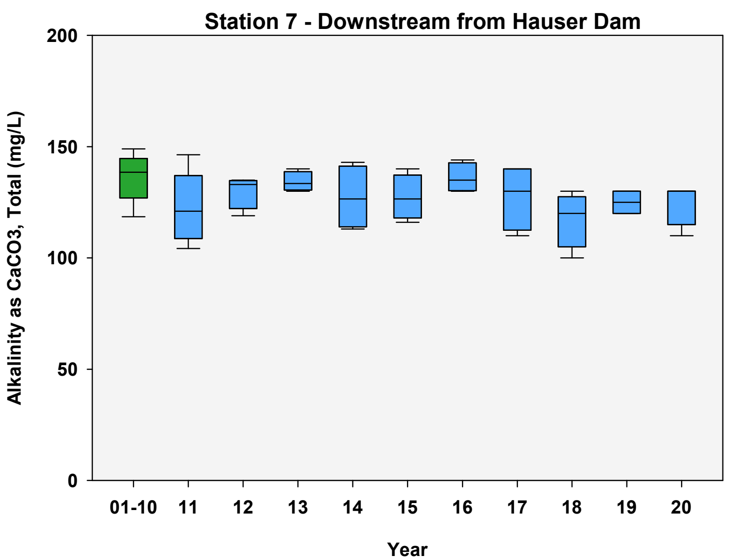
Appendix B.4 Temporal Graphs

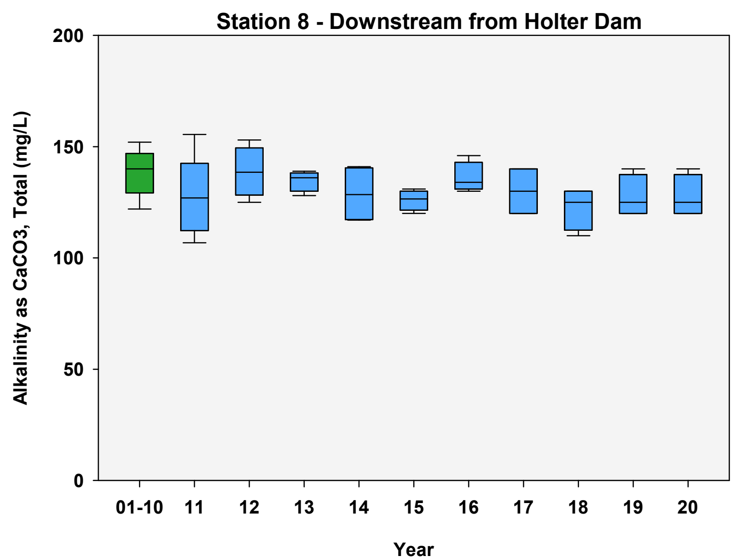
Figure B-1: Alkalinity as CaCO3, Total (mg/L) for Stations 1 to 10.

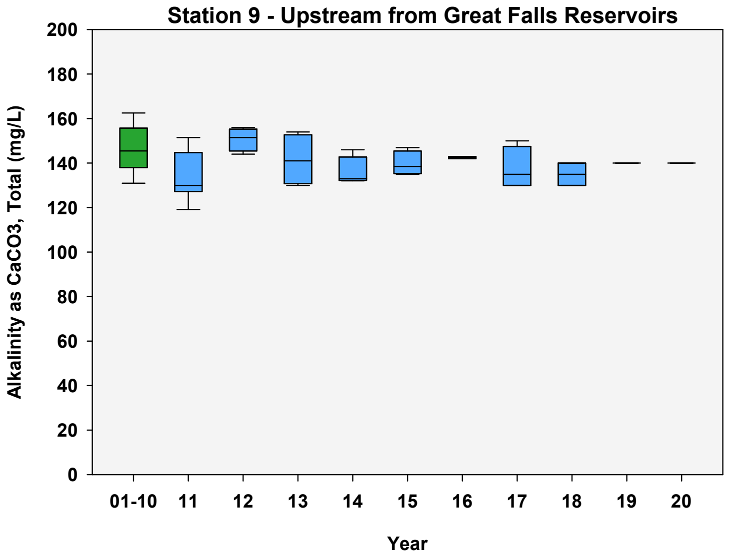



Station 5 - Upstream from Canyon Ferry Reservoir
Alkalinity as CaCO3, Total (mg/L)
0
50
100
150
200
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Alkalinity as CaCO3, Total (mg/L)
0
50
100
150
200
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Alkalinity as CaCO3, Total (mg/L)
0
50
100
150
200
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Alkalinity as CaCO3, Total (mg/L)
0
50
100
150
200
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Alkalinity as CaCO3, Total (mg/L)
0
20
40
60
80
100
120
140
160
180
200
01-10
11
12
13
14
15
16
17
18
19
20
Year

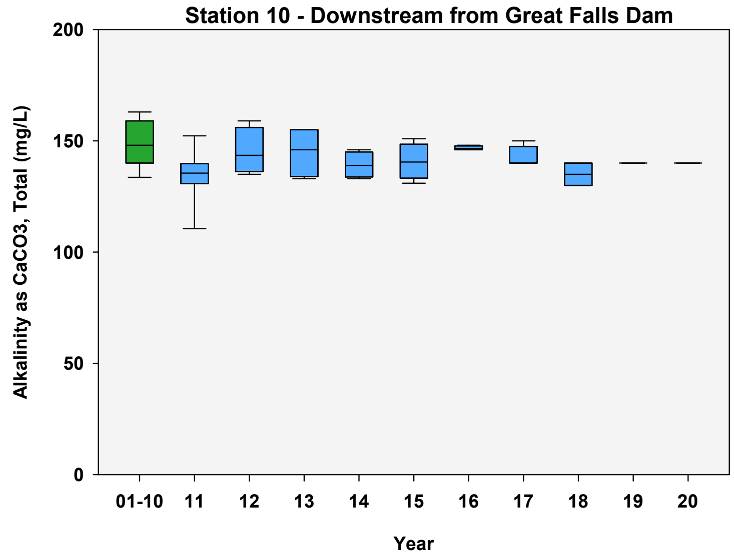
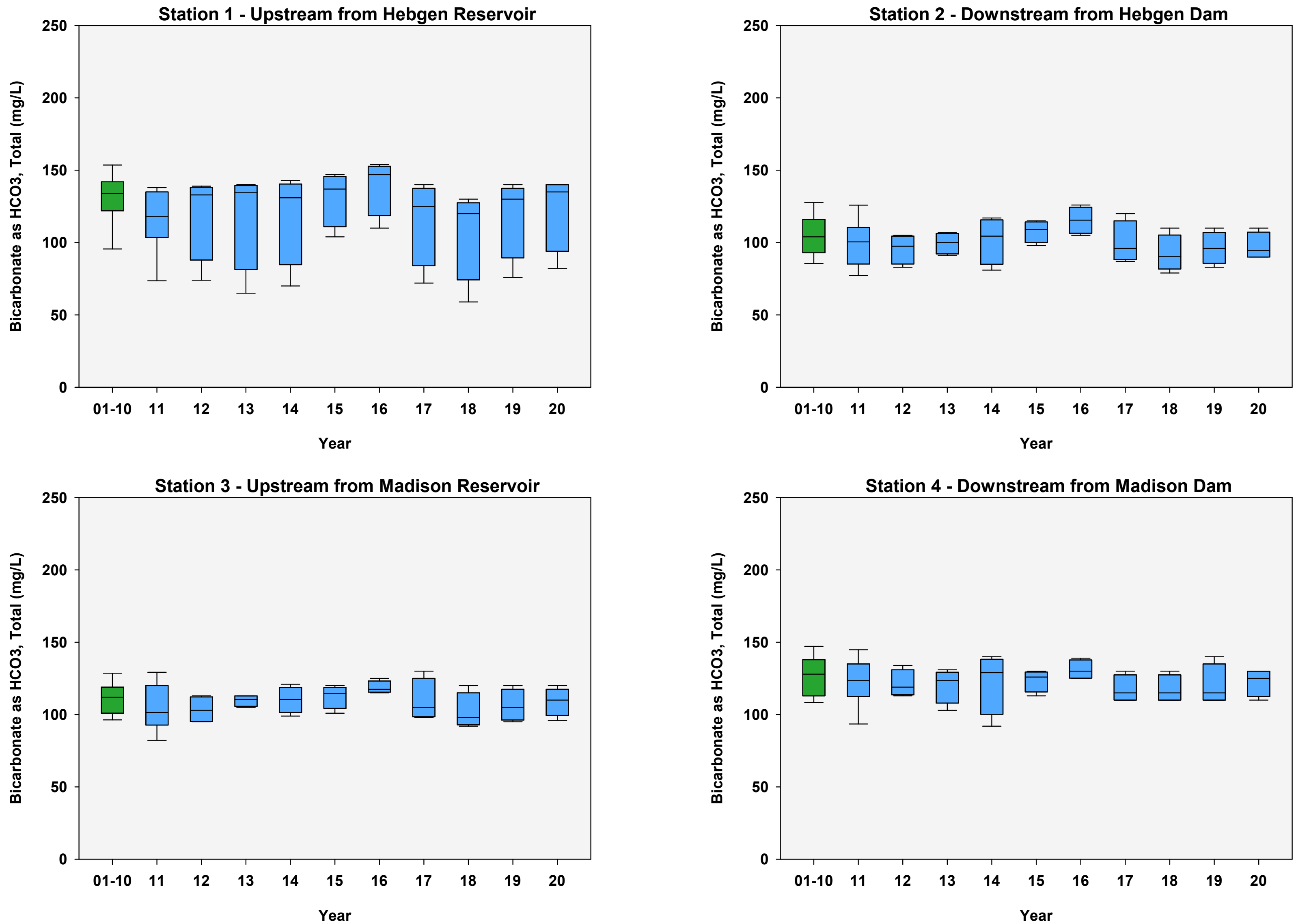
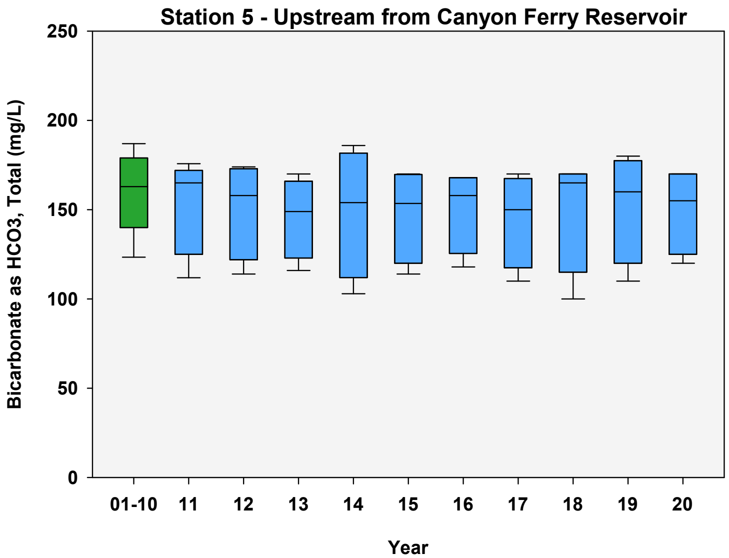
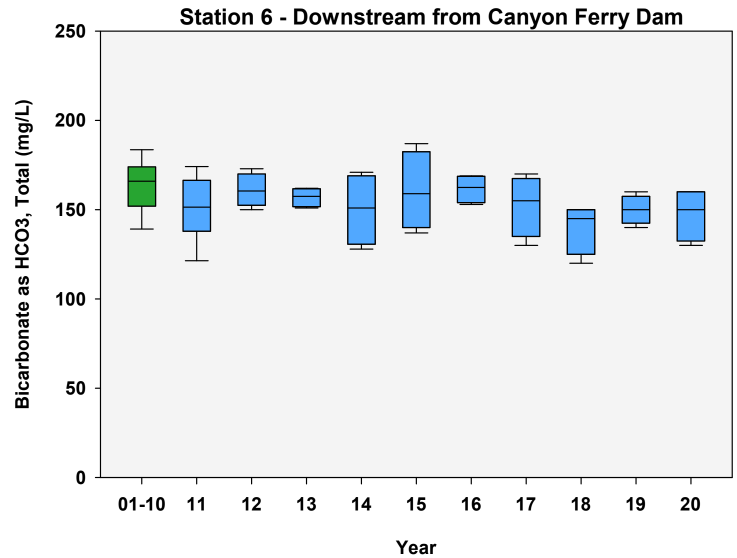
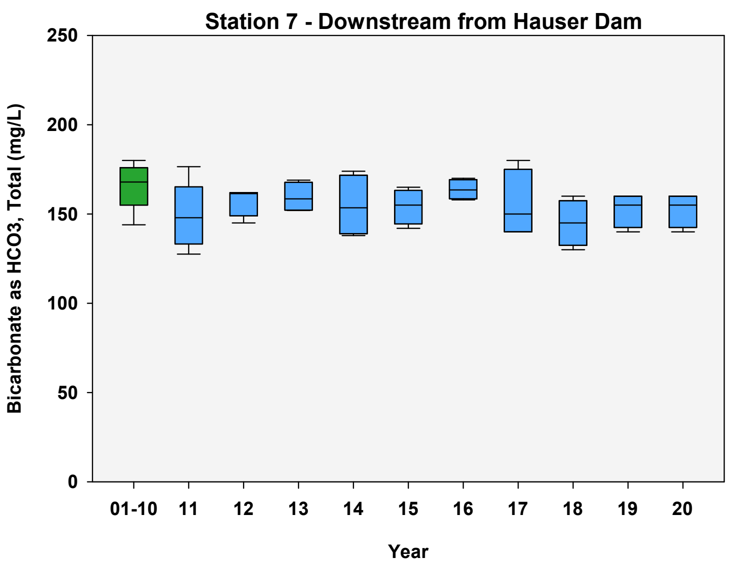

Station 10 - Downstream from Great Falls Dam
Alkalinity as CaCO3, Total (mg/L)
0
50
100
150
200
01-10
11
12
13
14
15
16
17
18
19
20
Year

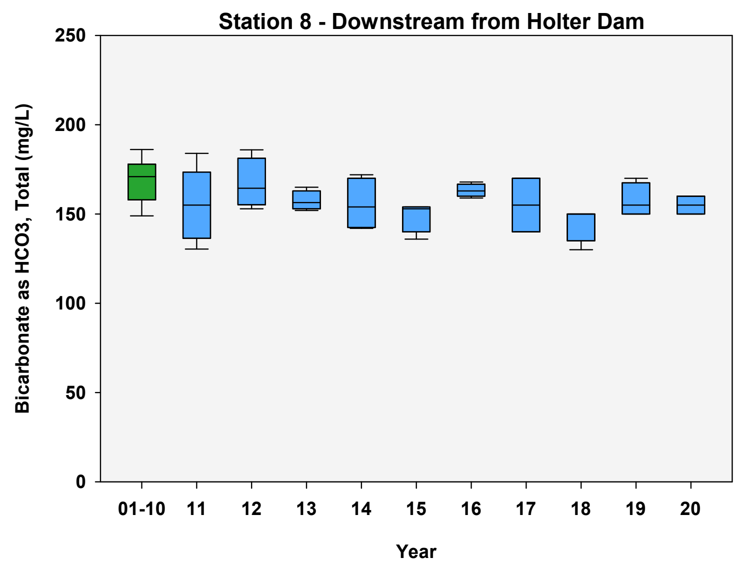
Figure B-2: Bicarbonate as HCO3, Total (mg/L) for Stations 1 to 10.

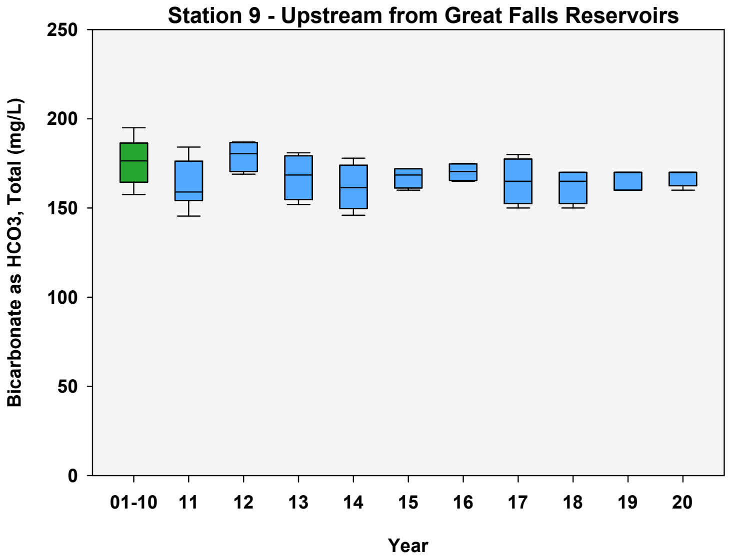



Station 5 - Upstream from Canyon Ferry Reservoir
Bicarbonate as HCO3, Total (mg/L)
250
200
150
100
50
0
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Bicarbonate as HCO3, Total (mg/L)
250
200
150
100
50
0
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Bicarbonate as HCO3, Total (mg/L)
250
200
150
100
50
0
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Bicarbonate as HCO3, Total (mg/L)
250
200
150
100
50
0
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Bicarbonate as HCO3, Total (mg/L)
250
200
150
100
50
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

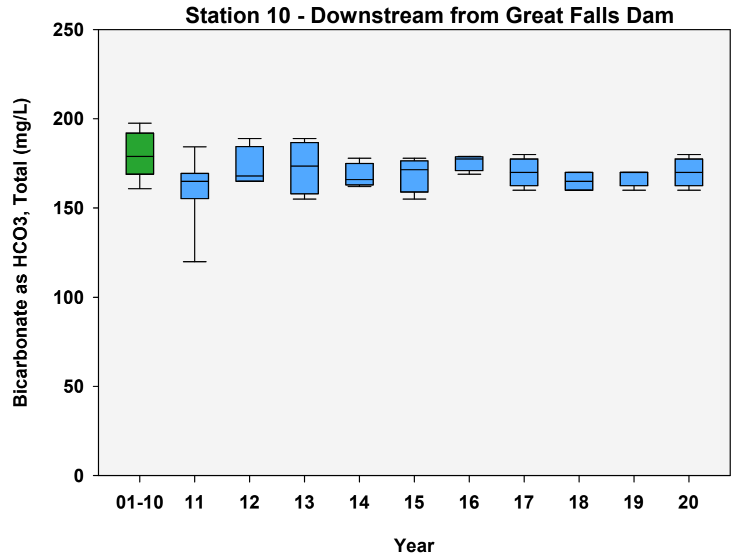
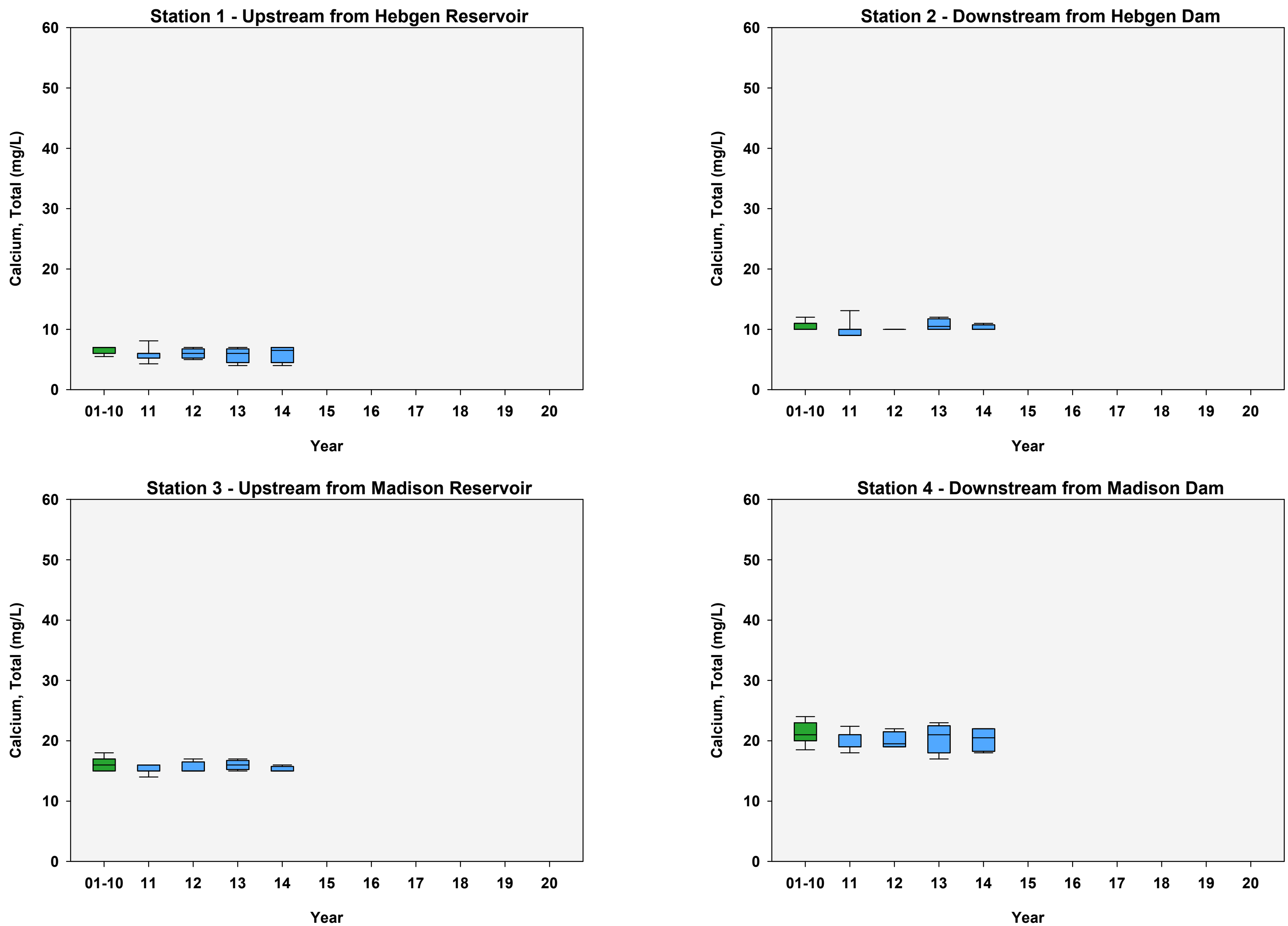
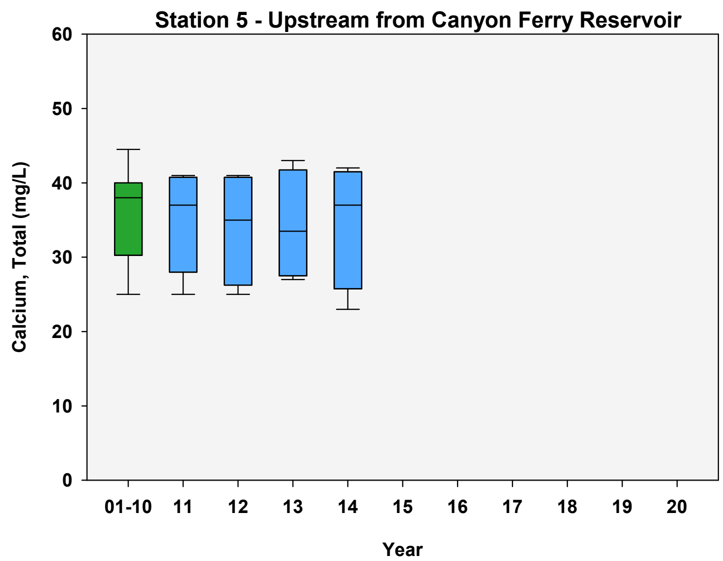
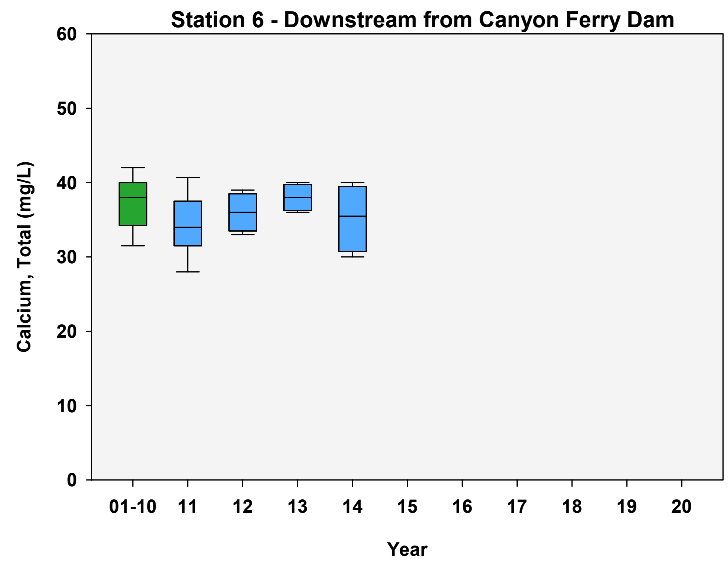
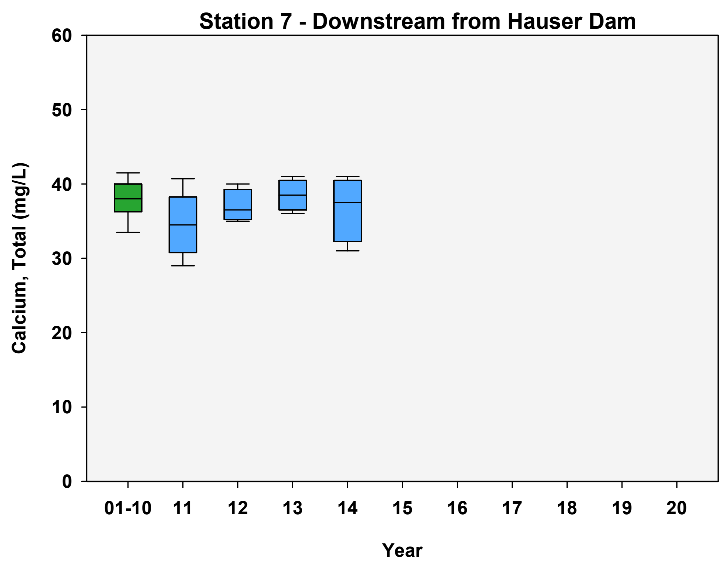

Station 10 - Downstream from Great Falls Dam
Bicarbonate as HCO3, Total (mg/L)
250
200
150
100
50
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

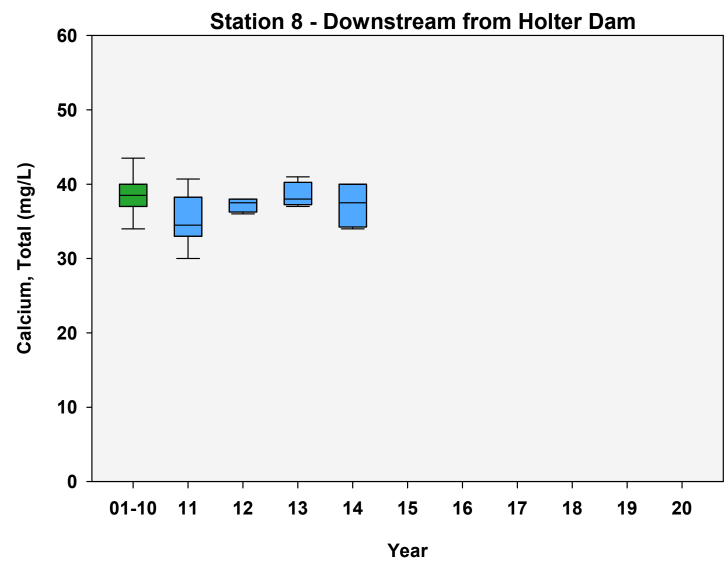
Figure B-3: Calcium, Total (mg/L) for Stations 1 to 10.

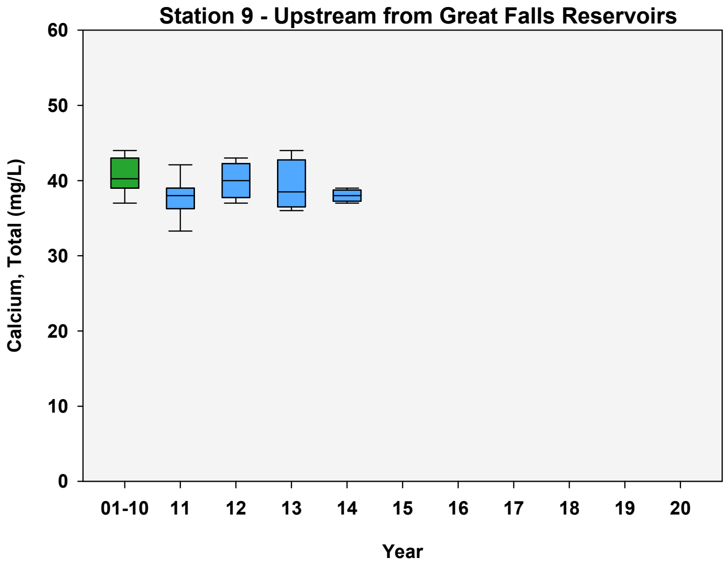



Station 5 - Upstream from Canyon Ferry Reservoir
Calcium, Total (mg/L)
0
10
20
30
40
50
60
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Calcium, Total (mg/L)
0
10
20
30
40
50
60
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Calcium, Total (mg/L)
0
10
20
30
40
50
60
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Calcium, Total (mg/L)
0
10
20
30
40
50
60
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Calcium, Total (mg/L)
60
50
40
30
20
10
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

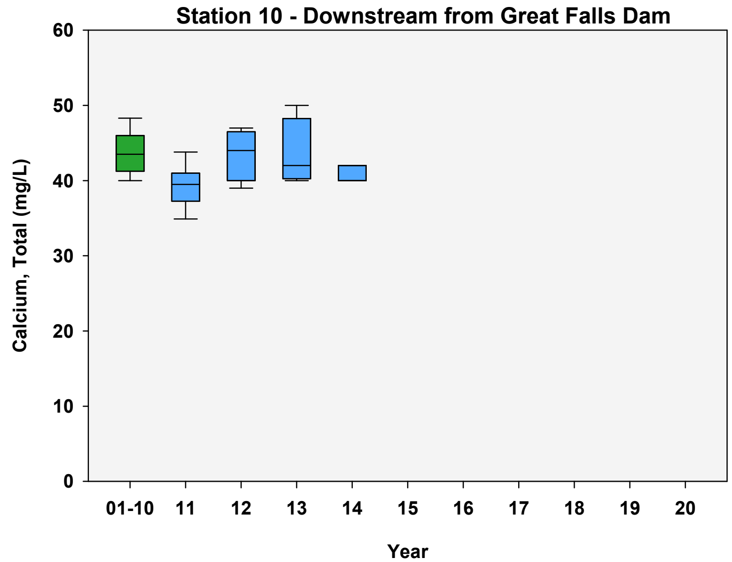
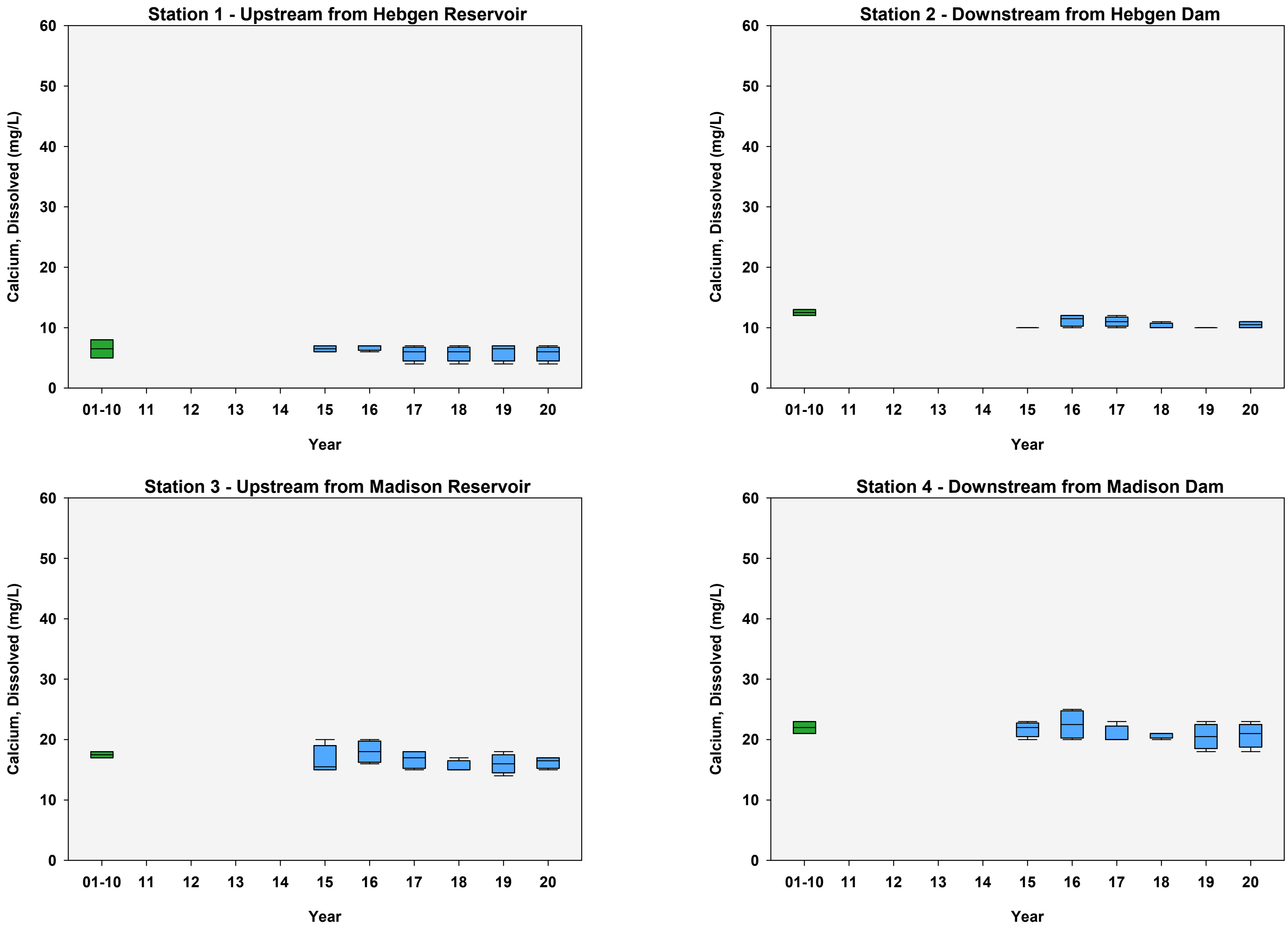
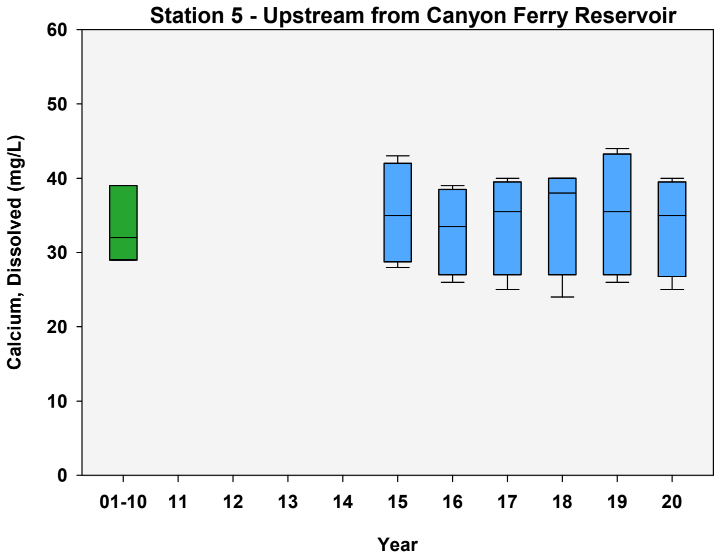
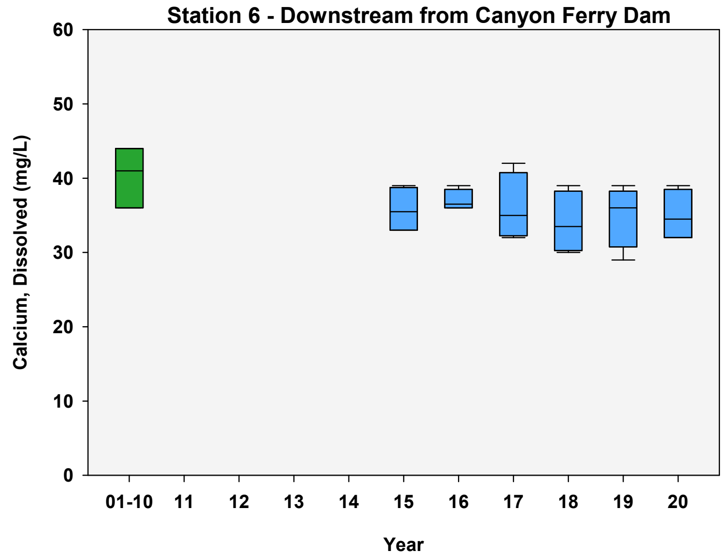
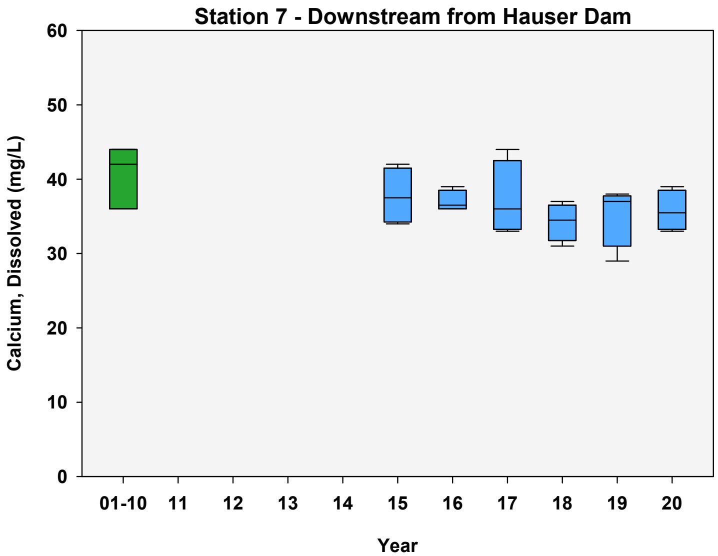

Station 10 - Downstream from Great Falls Dam
Calcium, Total (mg/L)
60
50
40
30
20
10
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

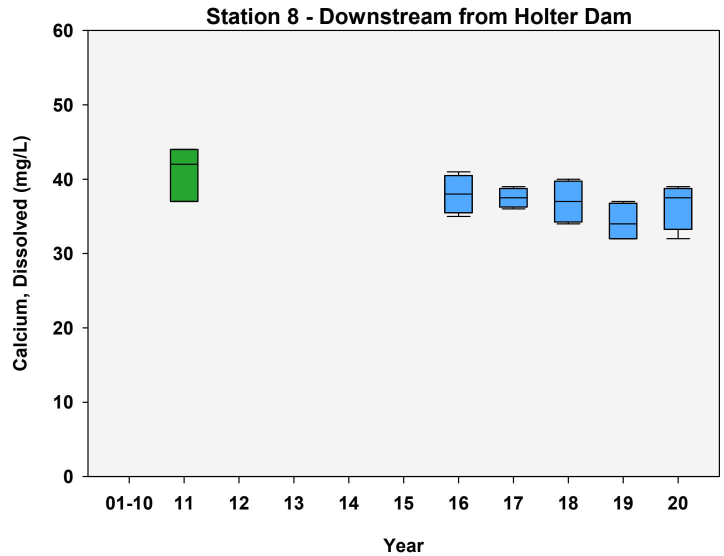
Figure B-4: Calcium, Dissolved (mg/L) for Stations 1 to 10.

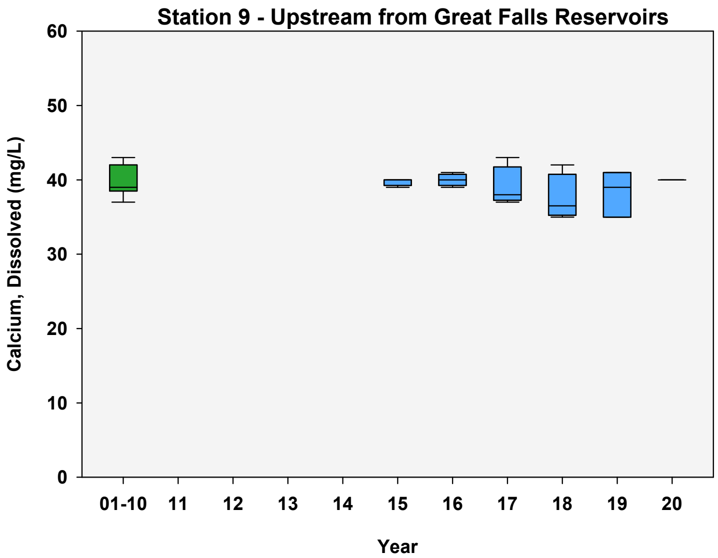



Station 5 - Upstream from Canyon Ferry Reservoir
60
50
40
30
20
10
0
Calcium, Dissolved (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year

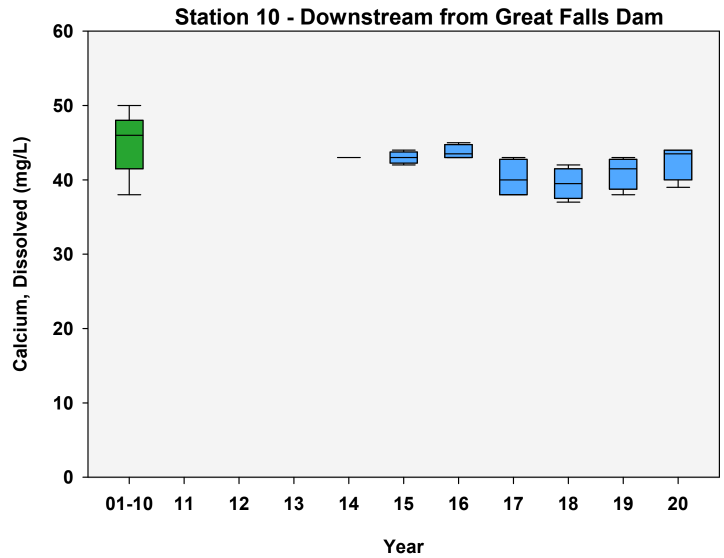

Station 6 - Downstream from Canyon Ferry Dam
60
50
40
30
20
10
0
Calcium, Dissolved (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
60
50
40
30
20
10
0
Calcium, Dissolved (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
60
50
40
30
20
10
0
Calcium, Dissolved (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year

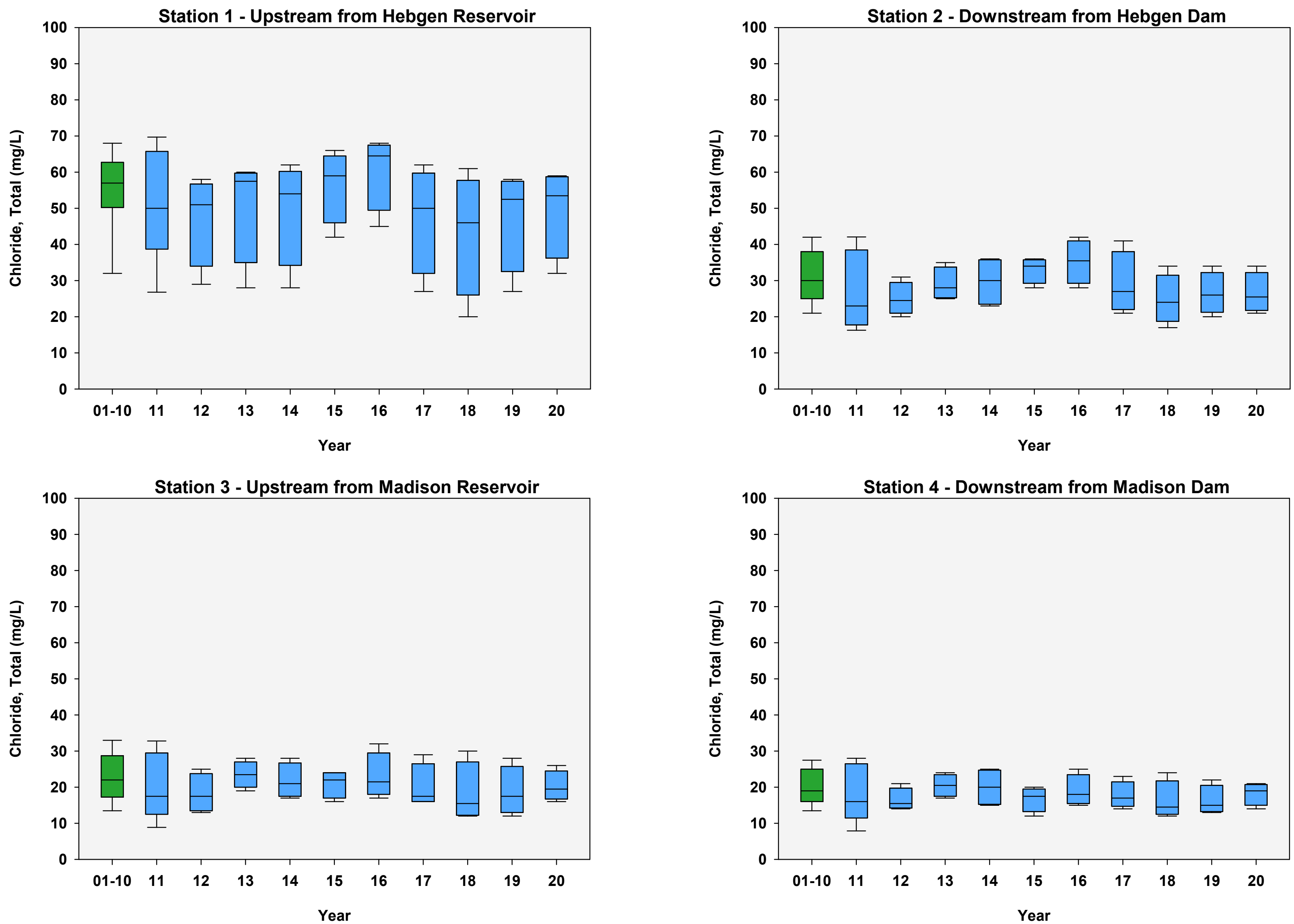


Station 9 - Upstream from Great Falls Reservoirs
Calcium, Dissolved (mg/L)
0
10
20
30
40
50
60
01-10
11
12
13
14
15
16
17
18
19
20
Year

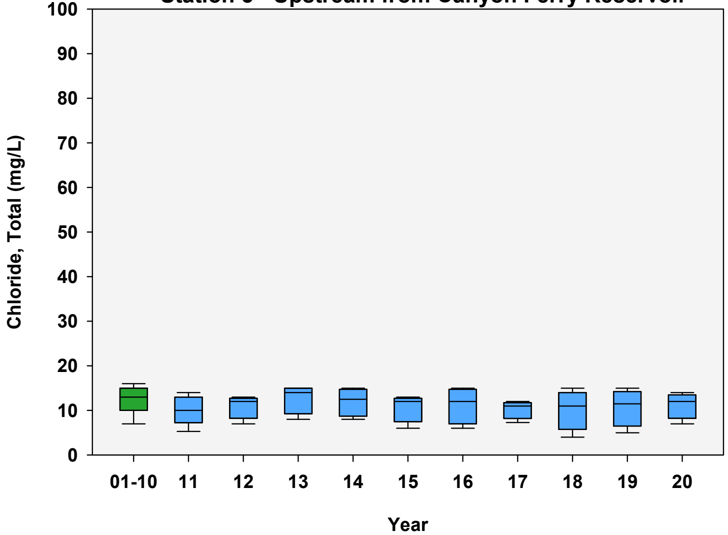


Station 10 - Downstream from Great Falls Dam
Calcium, Dissolved (mg/L)
0
10
20
30
40
50
60
01-10
11
12
13
14
15
16
17
18
19
20
Year

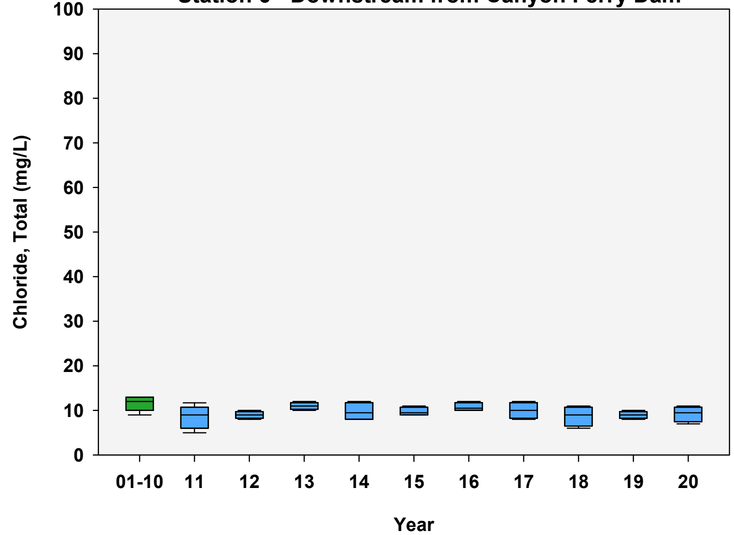
Figure B-5: Chloride, Total (mg/L) for Stations 1 to 10.



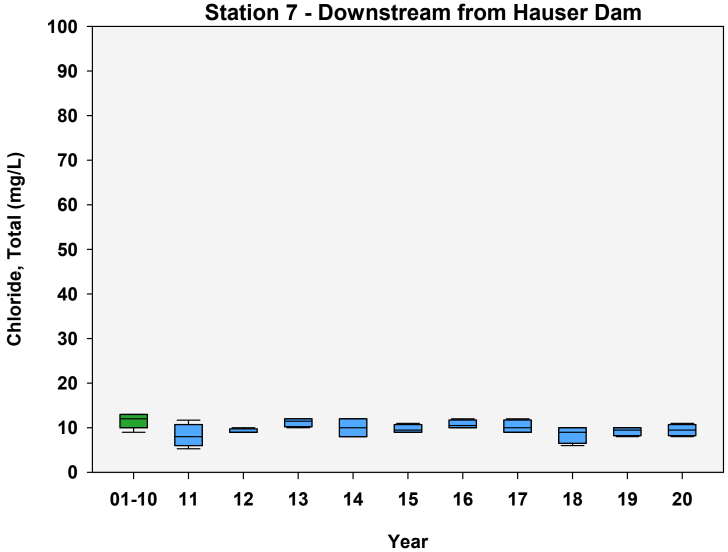
Station 5 - Upstream from Canyon Ferry Reservoir



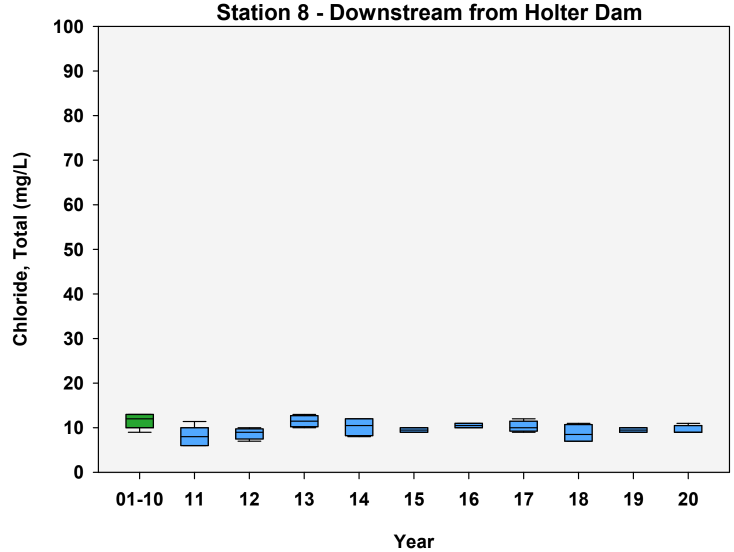
Station 6 - Downstream from Canyon Ferry Dam

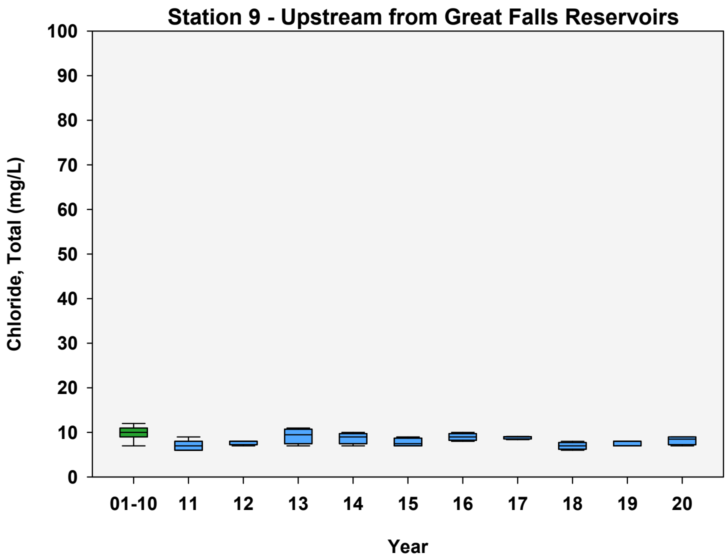


Station 7 - Downstream from Hauser Dam

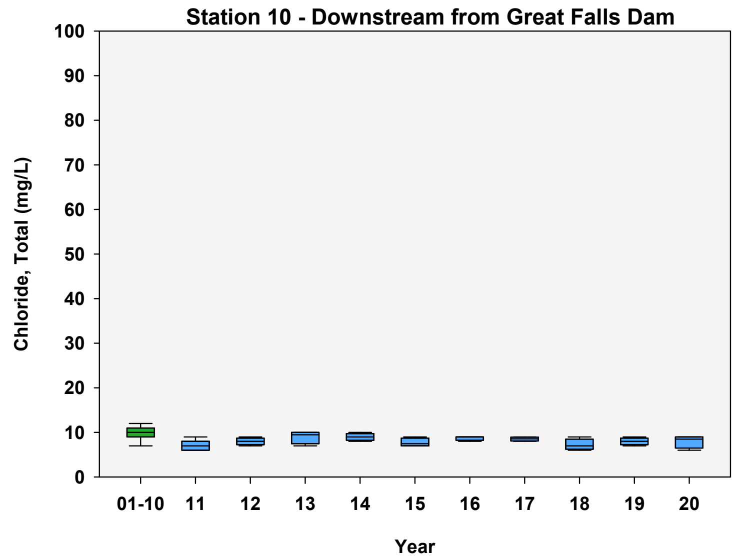


Station 8 - Downstream from Holter Dam



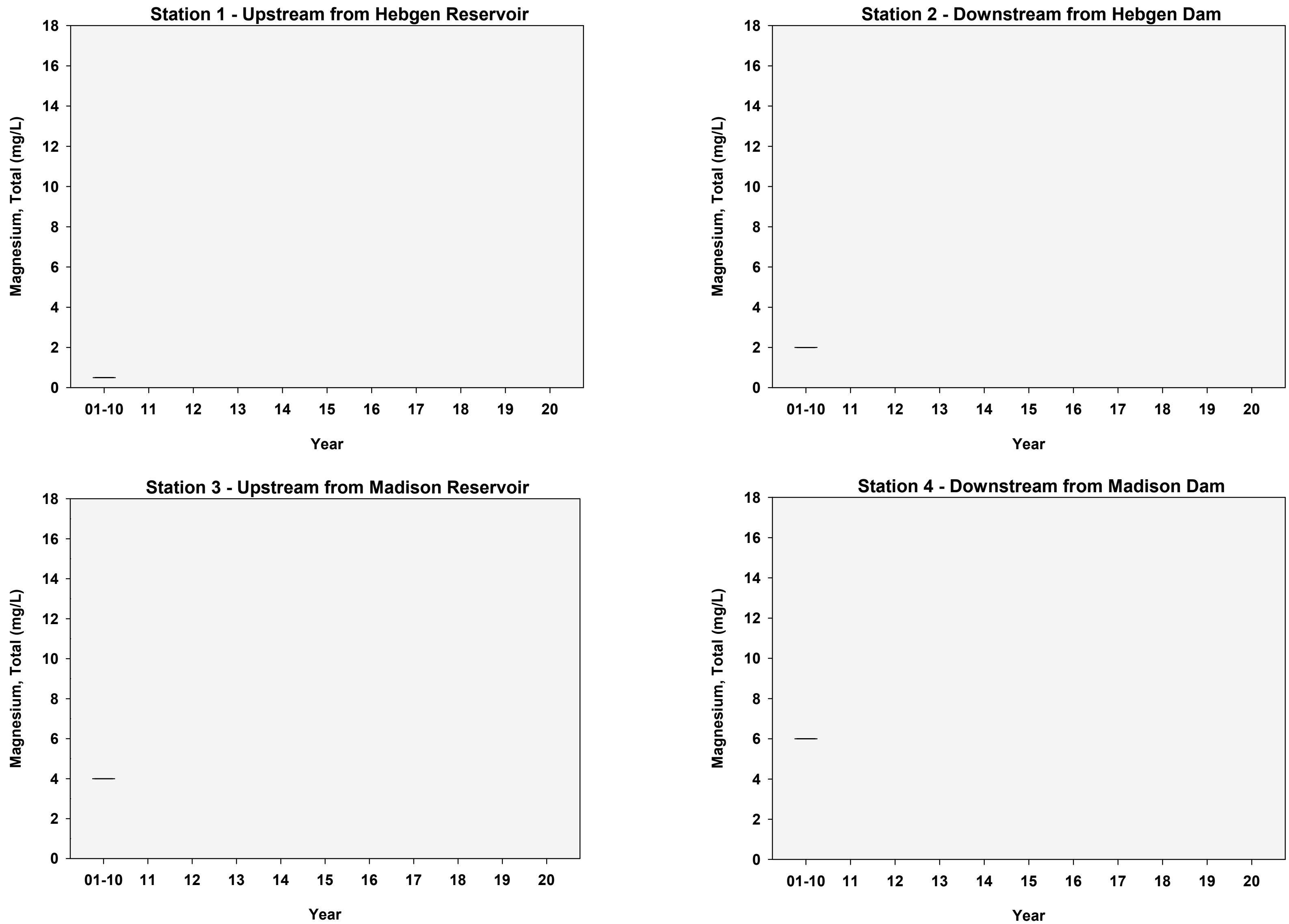


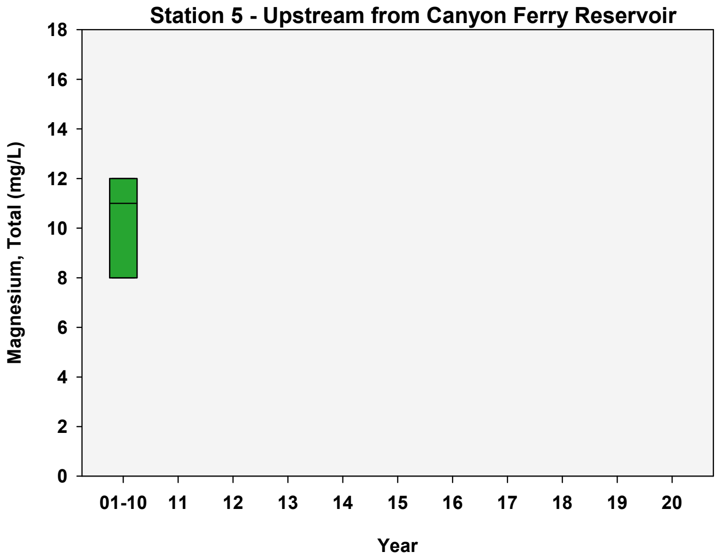
Station 9 - Upstream from Great Falls Reservoirs
100
90
80
70
60
50
40
30
20
10
0
Chloride, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year

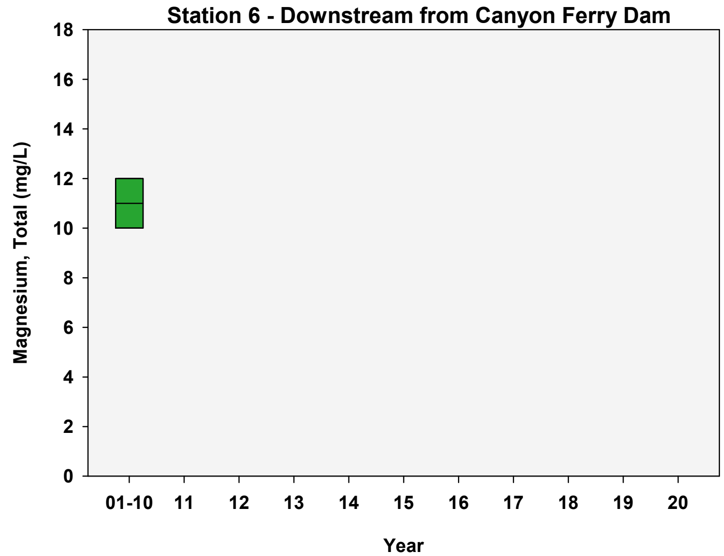


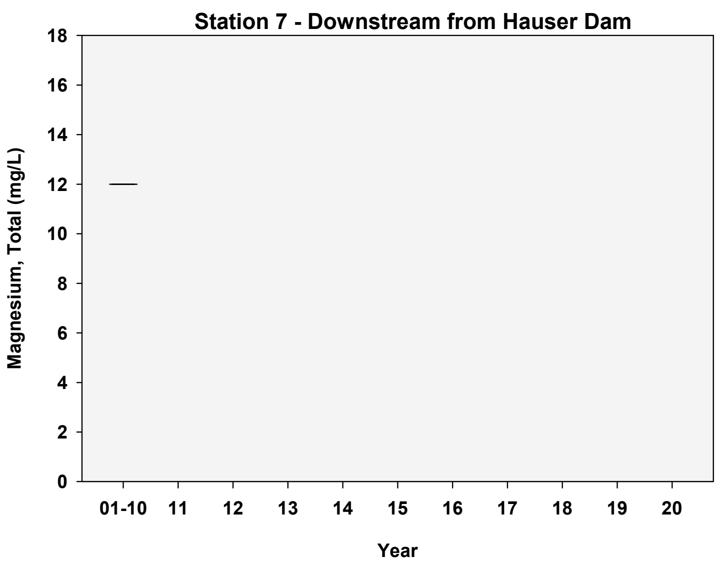
Station 10 - Downstream from Great Falls Dam
100
90
80
70
60
50
40
30
20
10
0
Chloride, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year

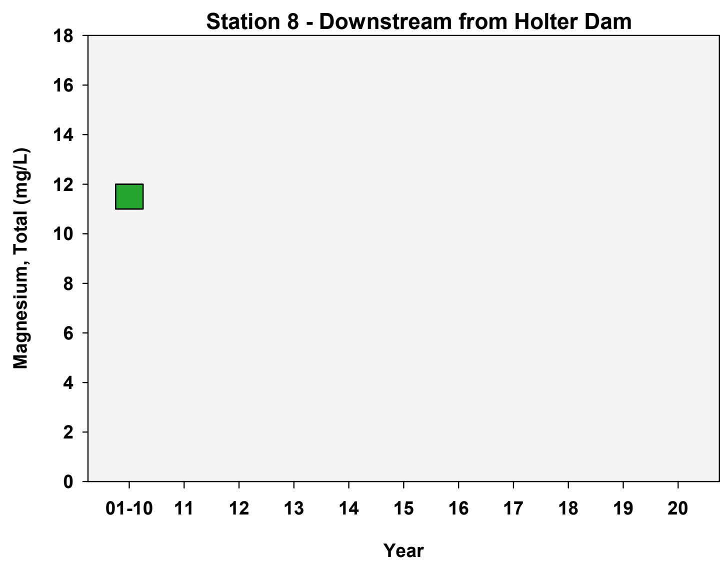
Figure B-6: Magnesium, Total (mg/L) for Stations 1 to 10.

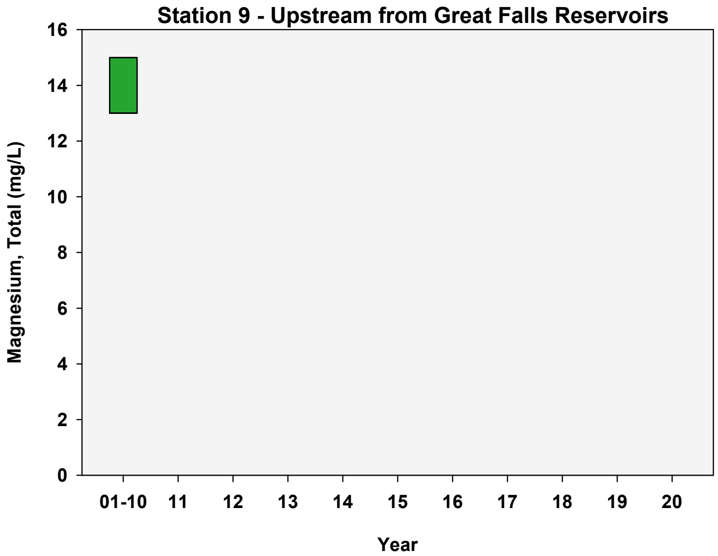



Station 5 - Upstream from Canyon Ferry Reservoir
Magnesium, Total (mg/L)
0
2
4
6
8
10
12
14
16
18
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Magnesium, Total (mg/L)
0
2
4
6
8
10
12
14
16
18
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Magnesium, Total (mg/L)
0
2
4
6
8
10
12
14
16
18
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Magnesium, Total (mg/L)
0
2
4
6
8
10
12
14
16
18
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Magnesium, Total (mg/L)
0
2
4
6
8
10
12
14
16
01-10
11
12
13
14
15
16
17
18
19
20
Year

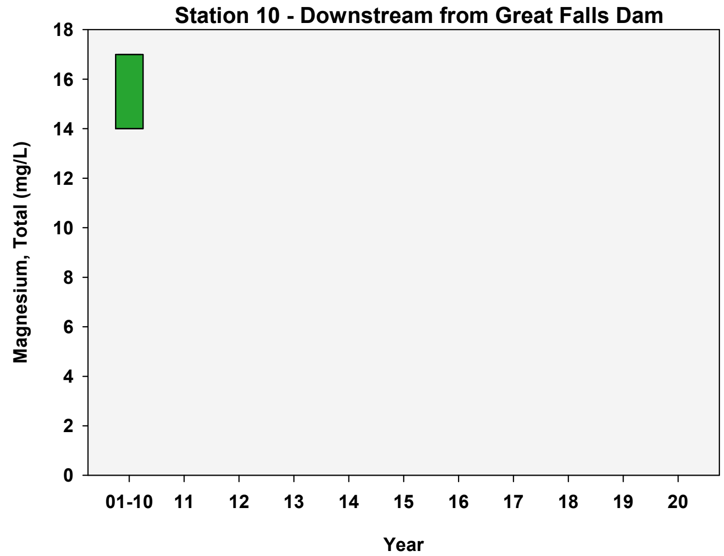
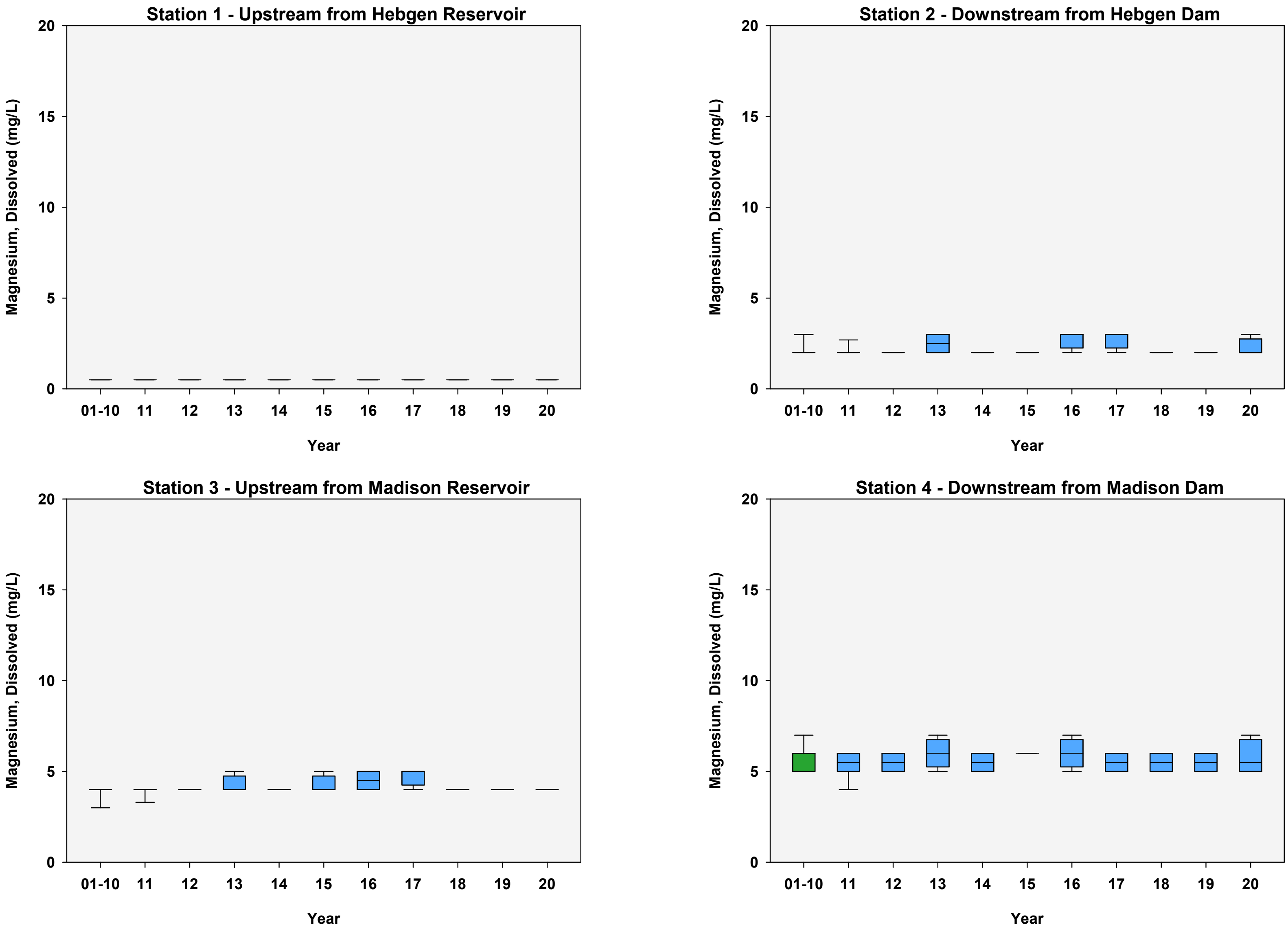
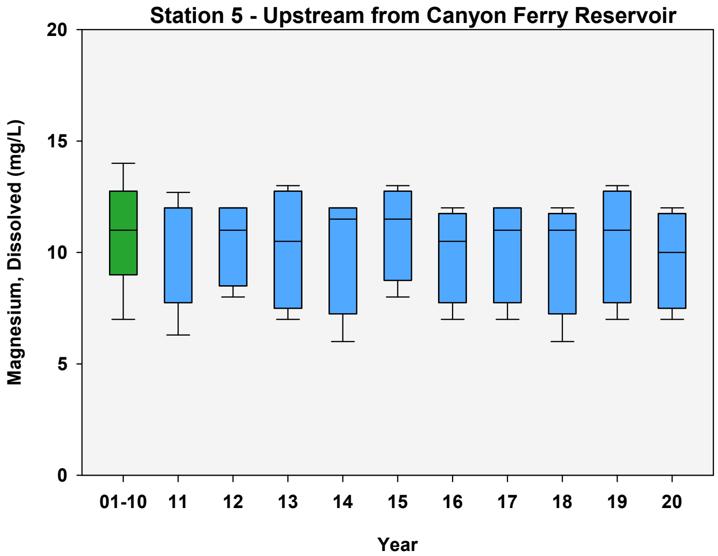
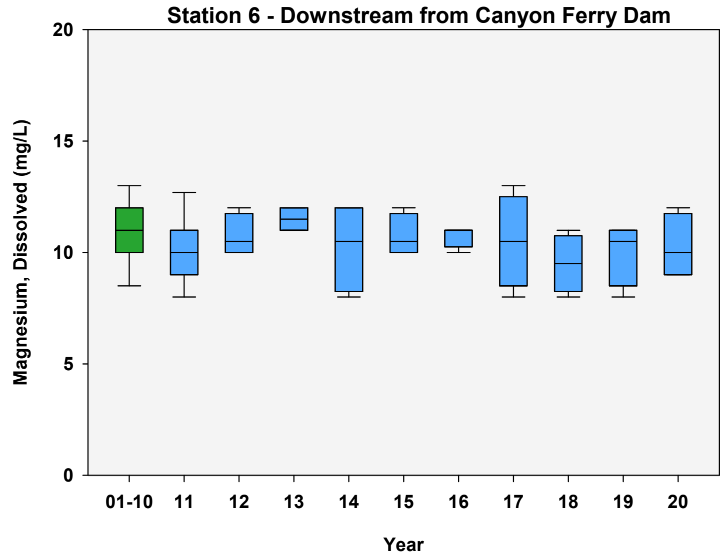
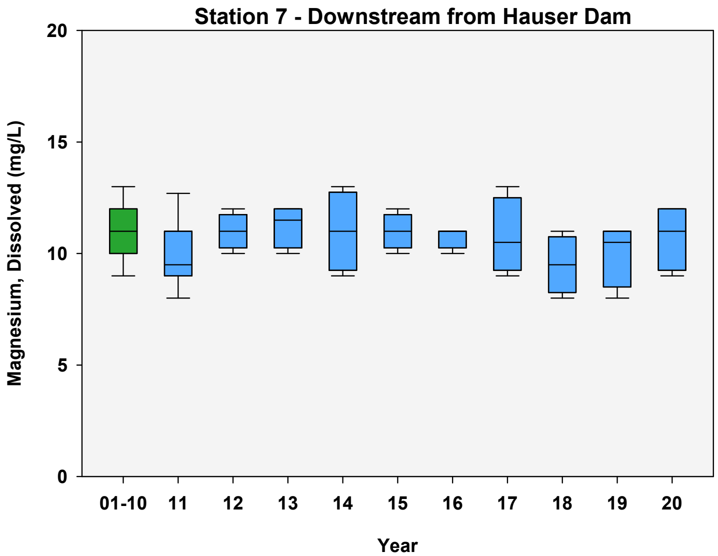

Station 10 - Downstream from Great Falls Dam
Magnesium, Total (mg/L)
0
2
4
6
8
10
12
14
16
18
01-10
11
12
13
14
15
16
17
18
19
20
Year

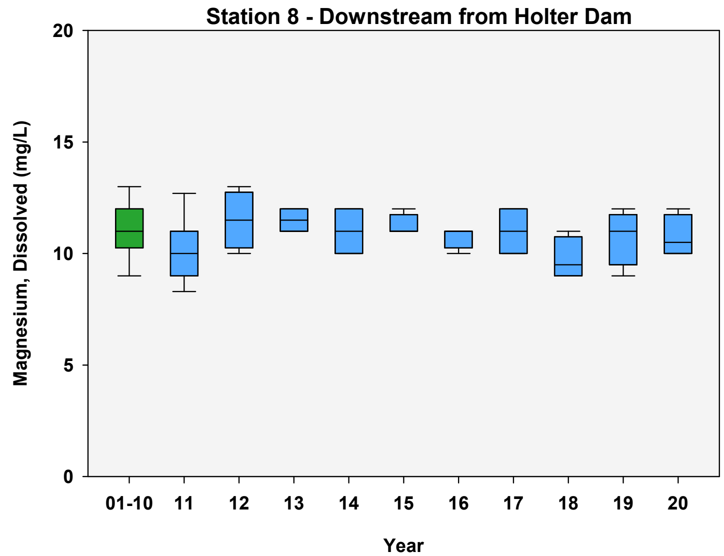
Figure B-7: Magnesium, Dissolved (mg/L) for Stations 1 to 10.

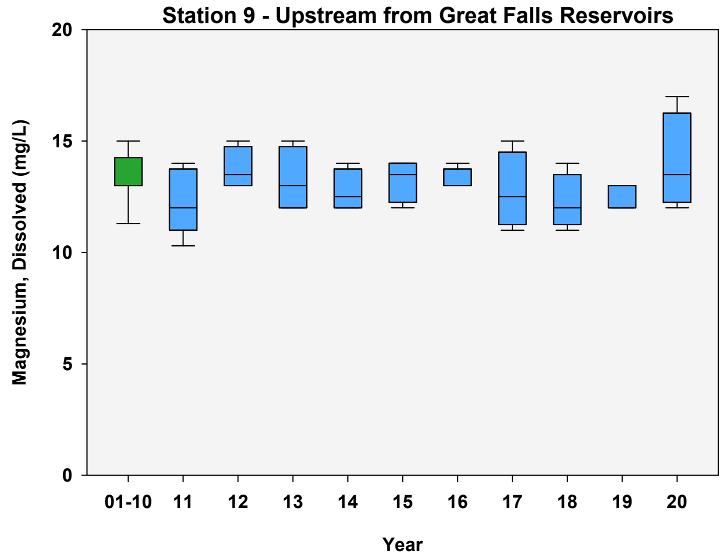



Station 5 - Upstream from Canyon Ferry Reservoir
Magnesium, Dissolved (mg/L)
0
5
10
15
20
01-10
11
12
13
14
15
16
17
18
19
20
Year

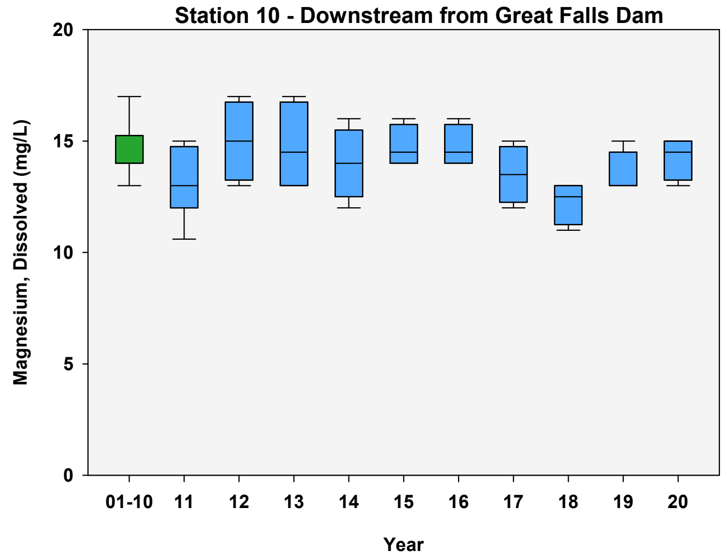

Station 6 - Downstream from Canyon Ferry Dam
Magnesium, Dissolved (mg/L)
0
5
10
15
20
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Magnesium, Dissolved (mg/L)
0
5
10
15
20
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Magnesium, Dissolved (mg/L)
0
5
10
15
20
01-10
11
12
13
14
15
16
17
18
19
20
Year

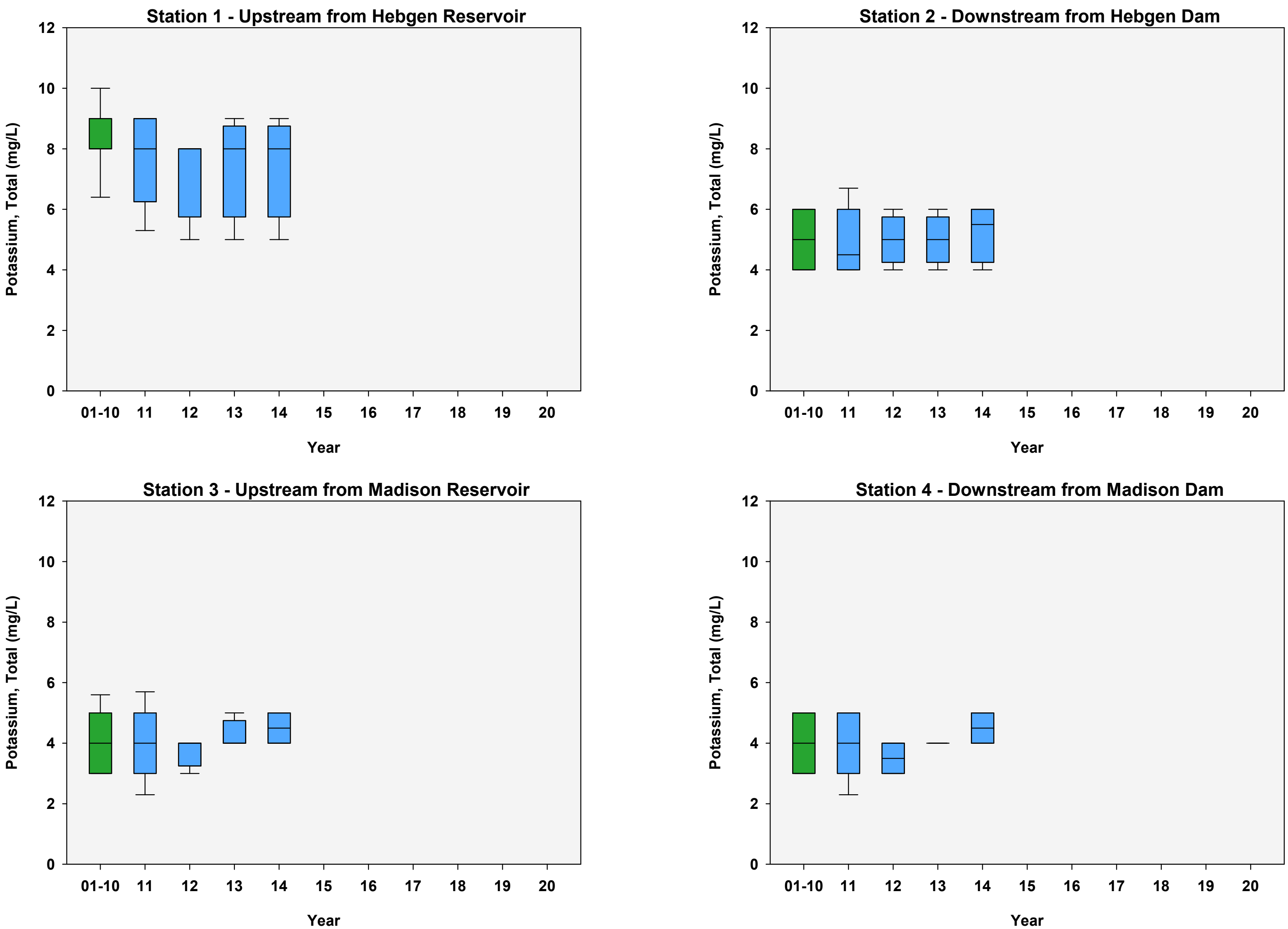


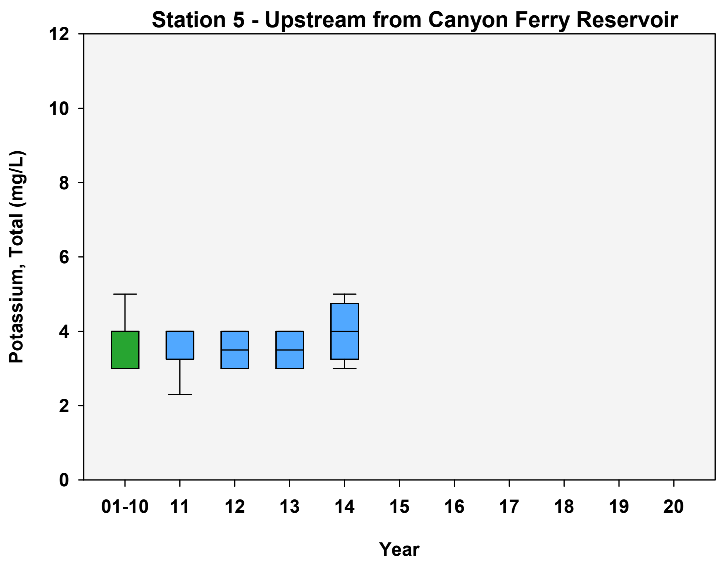
Station 9 - Upstream from Great Falls Reservoirs
Magnesium, Dissolved (mg/L)
20
15
10
5
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

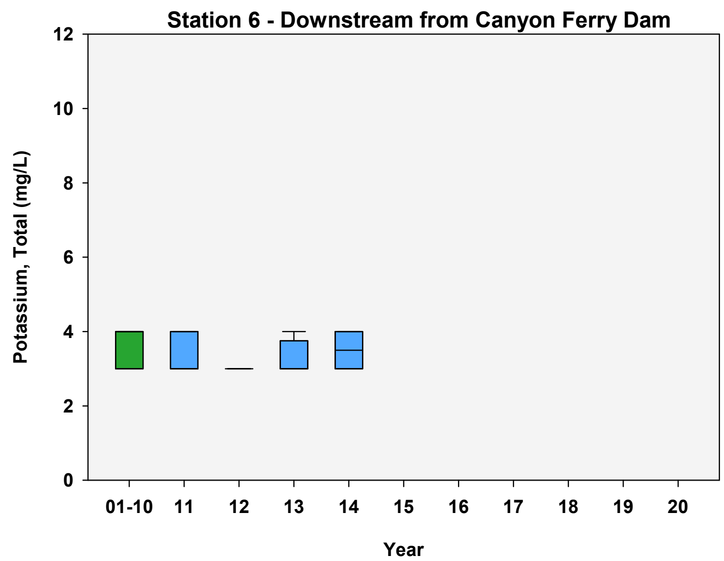


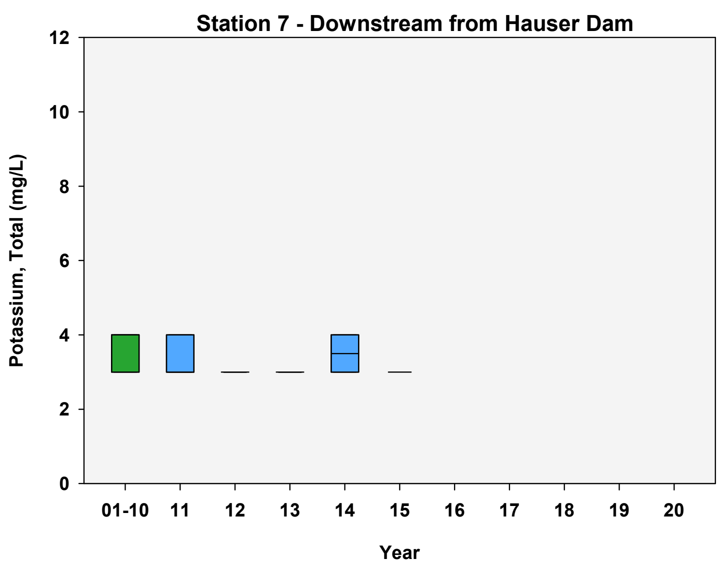
Station 10 - Downstream from Great Falls Dam
Magnesium, Dissolved (mg/L)
20
15
10
5
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

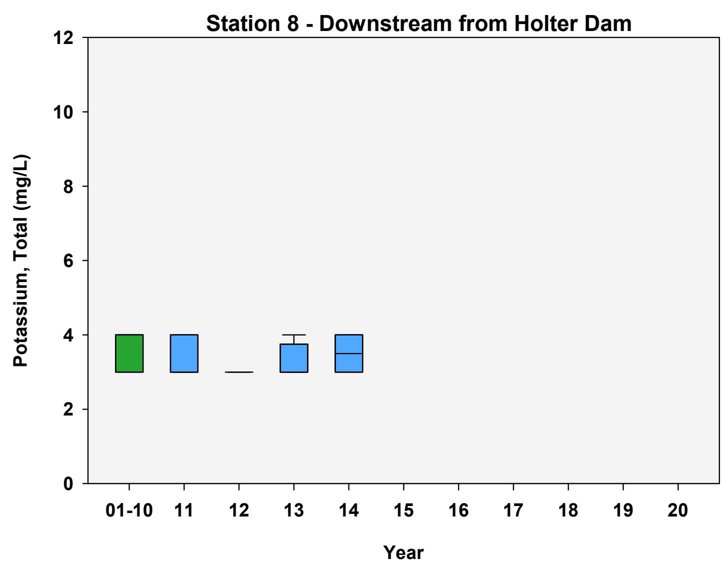
Figure B-8: Potassium, Total (mg/L) for Stations 1 to 10.

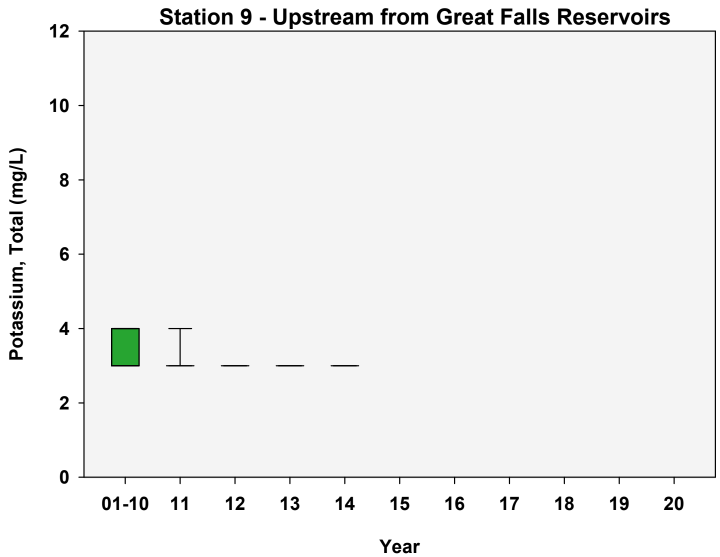



Station 5 - Upstream from Canyon Ferry Reservoir
Potassium, Total (mg/L)
0
2
4
6
8
10
12
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Potassium, Total (mg/L)
0
2
4
6
8
10
12
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Potassium, Total (mg/L)
0
2
4
6
8
10
12
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Potassium, Total (mg/L)
0
2
4
6
8
10
12
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Potassium, Total (mg/L)
0
2
4
6
8
10
12
01-10
11
12
13
14
15
16
17
18
19
20
Year

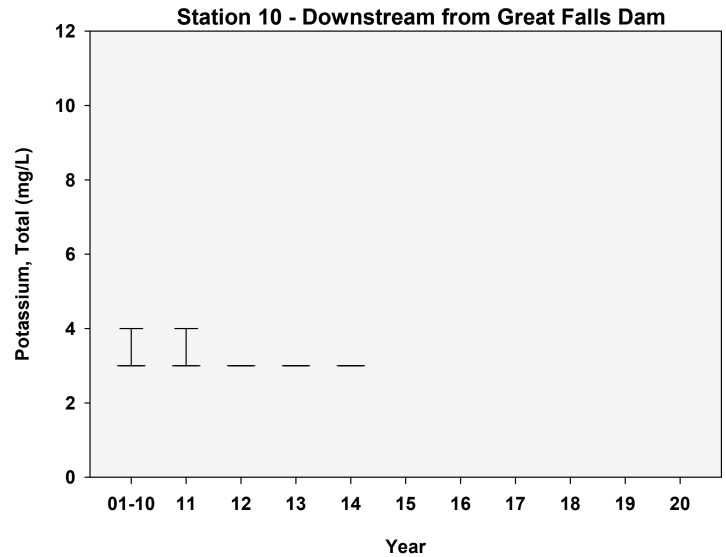
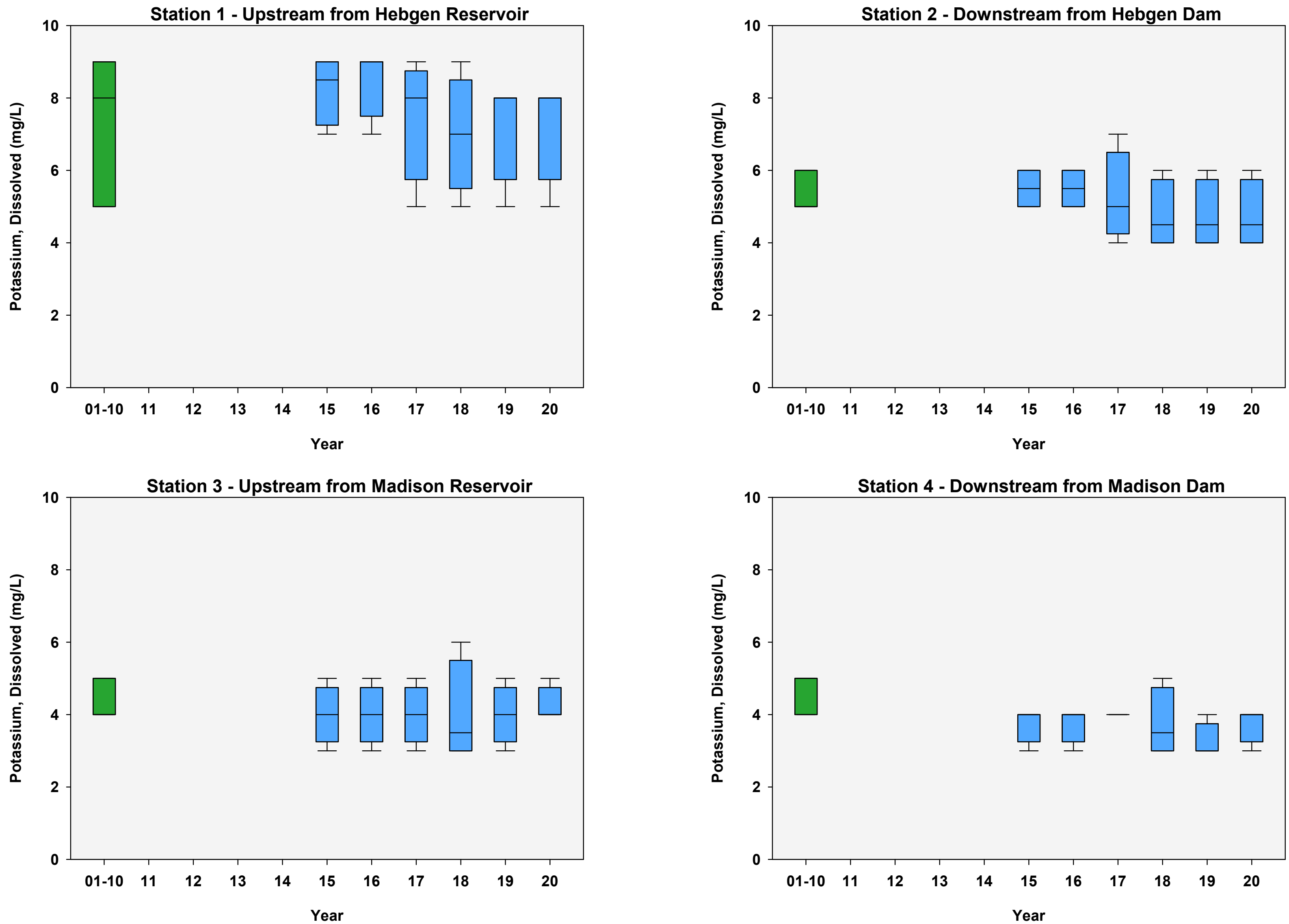
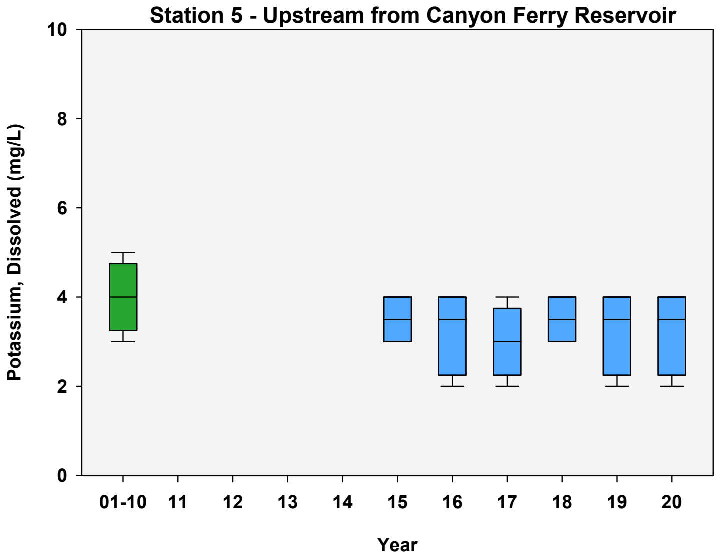
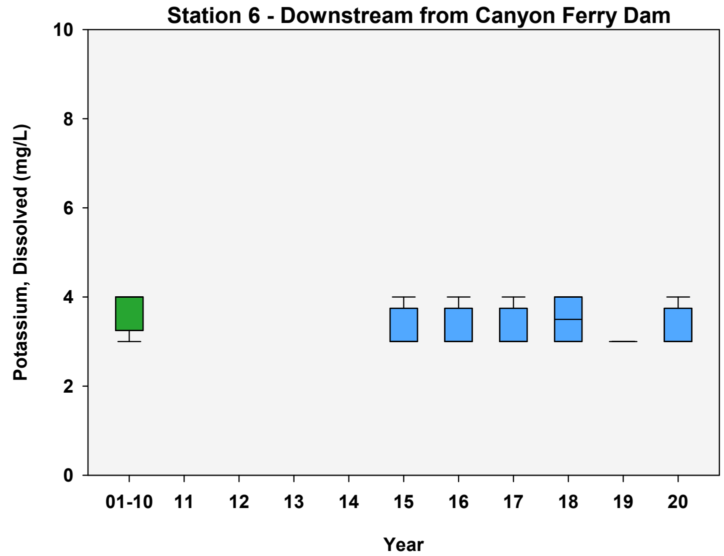

Station 10 - Downstream from Great Falls Dam
Potassium, Total (mg/L)
0
2
4
6
8
10
12
01-10
11
12
13
14
15
16
17
18
19
20
Year

Figure B-9: Potassium, Dissolved (mg/L) for Stations 1 to 10.

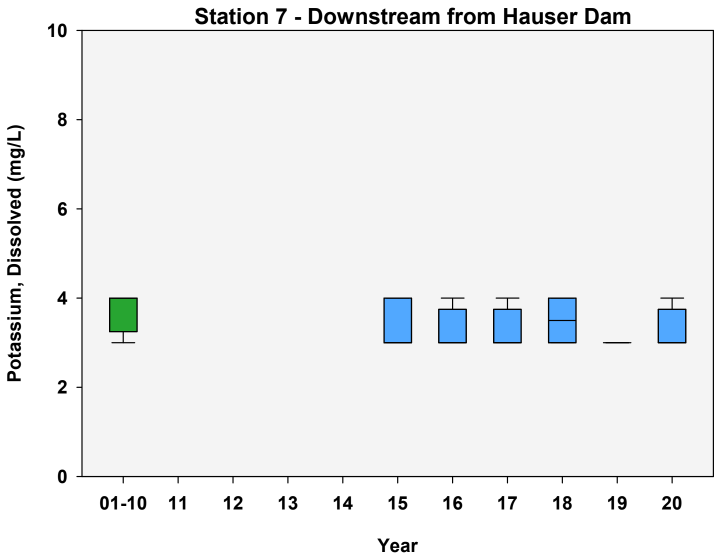




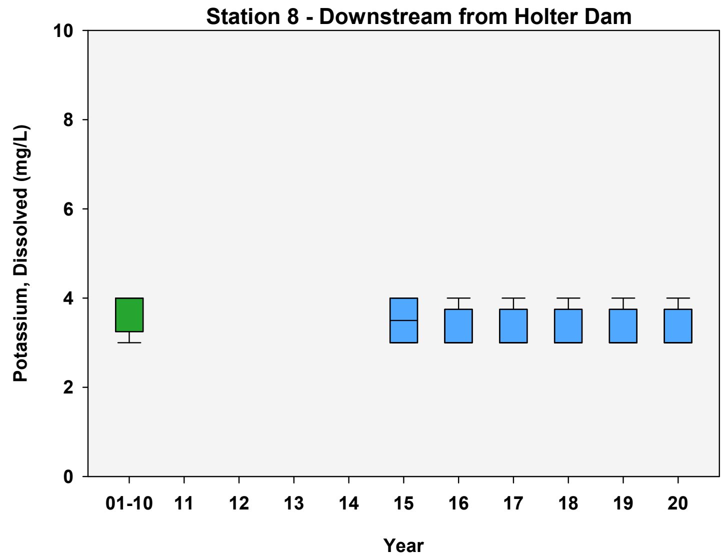
Station 5 - Upstream from Canyon Ferry Reservoir
Potassium, Dissolved (mg/L)
0
2
4
6
8
10
01-10
11
12
13
14
15
16
17
18
19
20
Year



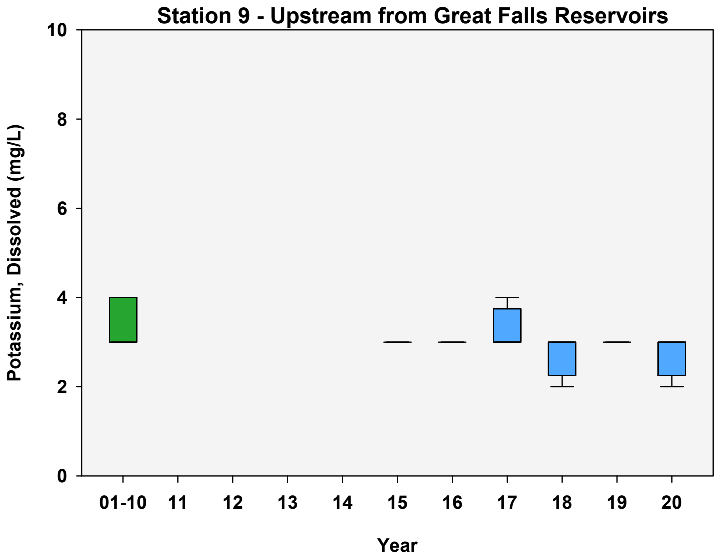
Station 6 - Downstream from Canyon Ferry Dam
Potassium, Dissolved (mg/L)
0
2
4
6
8
10
01-10
11
12
13
14
15
16
17
18
19
20
Year



Station 7 - Downstream from Hauser Dam
Potassium, Dissolved (mg/L)
0
2
4
6
8
10
01-10
11
12
13
14
15
16
17
18
19
20
Year



Station 8 - Downstream from Holter Dam
Potassium, Dissolved (mg/L)
0
2
4
6
8
10
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Potassium, Dissolved (mg/L)
0
2
4
6
8
10
01-10
11
12
13
14
15
16
17
18
19
20
Year

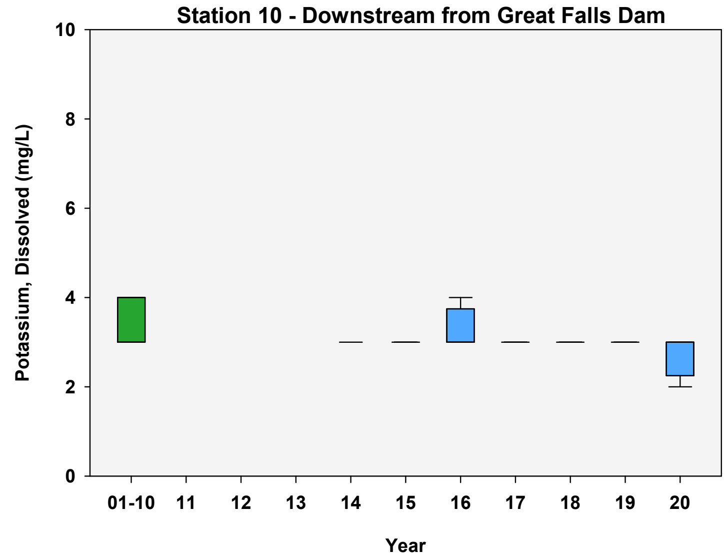
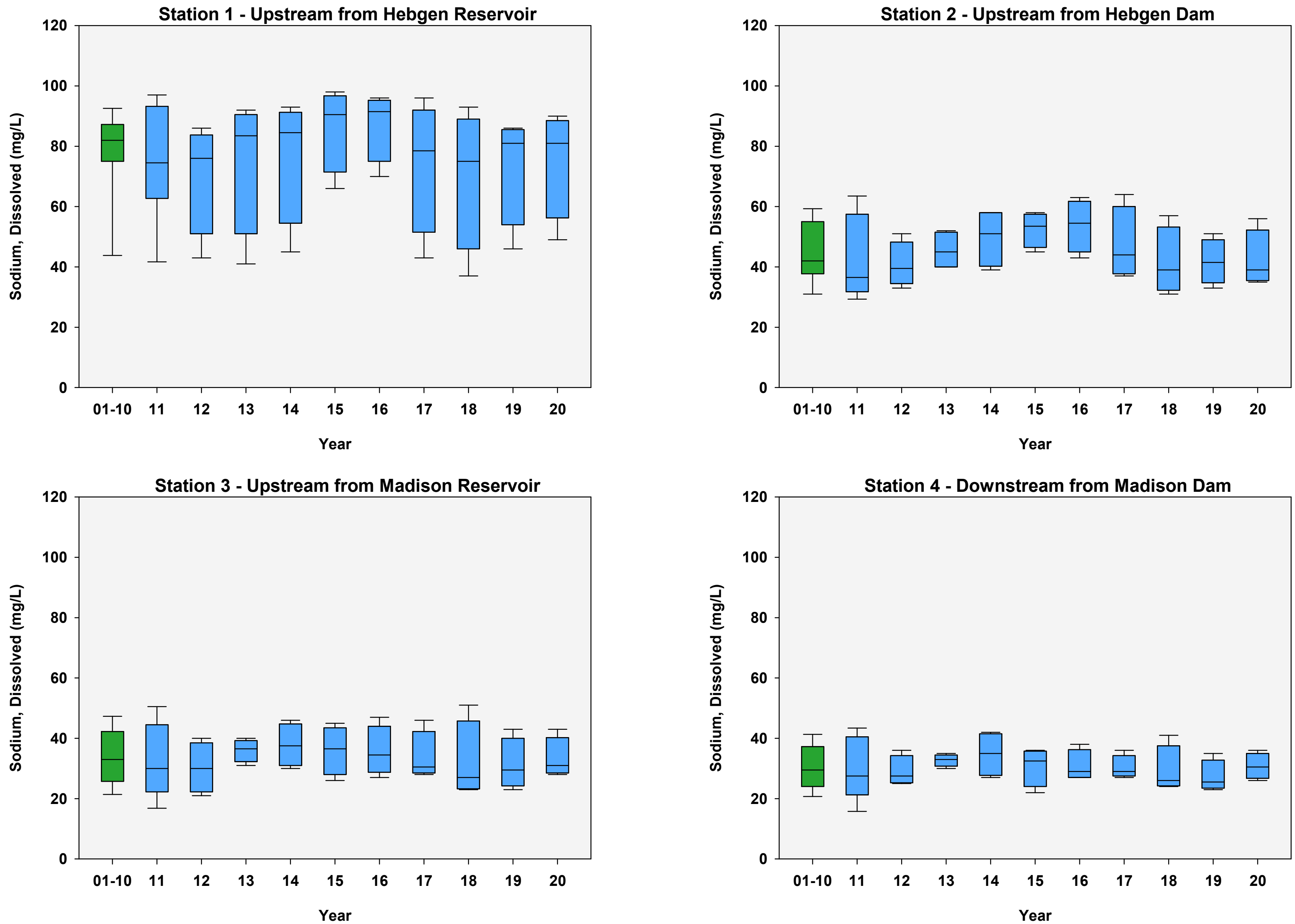
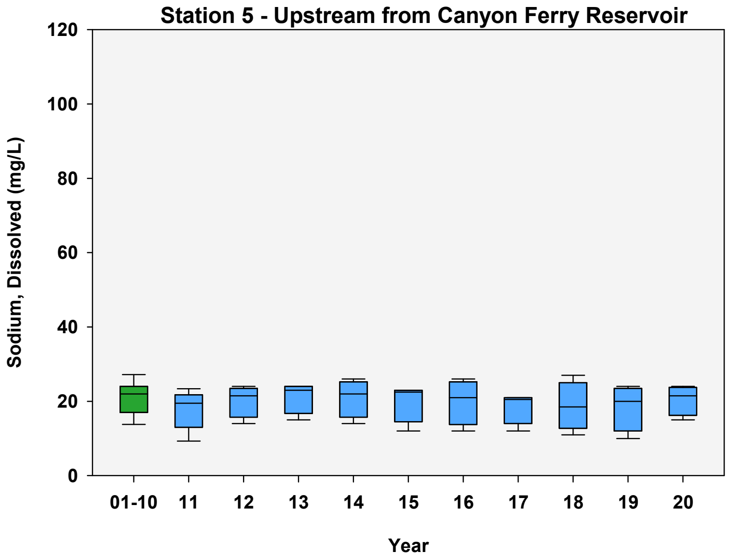
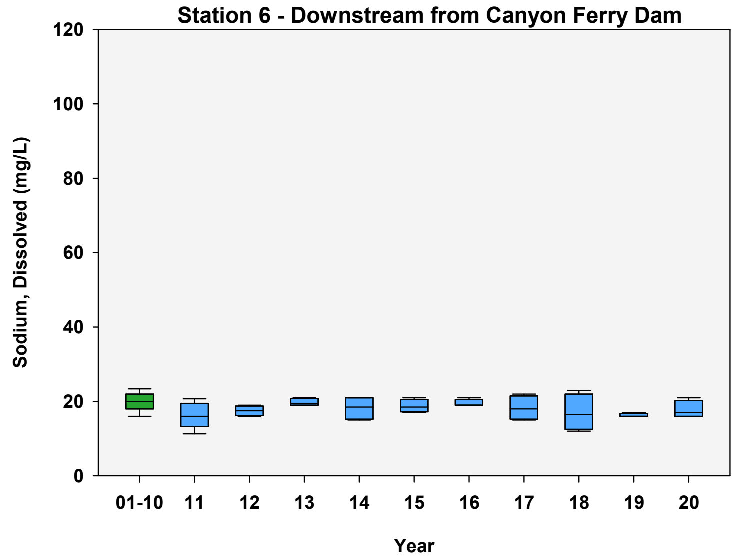

Station 10 - Downstream from Great Falls Dam
Potassium, Dissolved (mg/L)
0
2
4
6
8
10
01-10
11
12
13
14
15
16
17
18
19
20
Year

Figure B-10: Sodium, Dissolved (mg/L) for Stations 1 to 10.

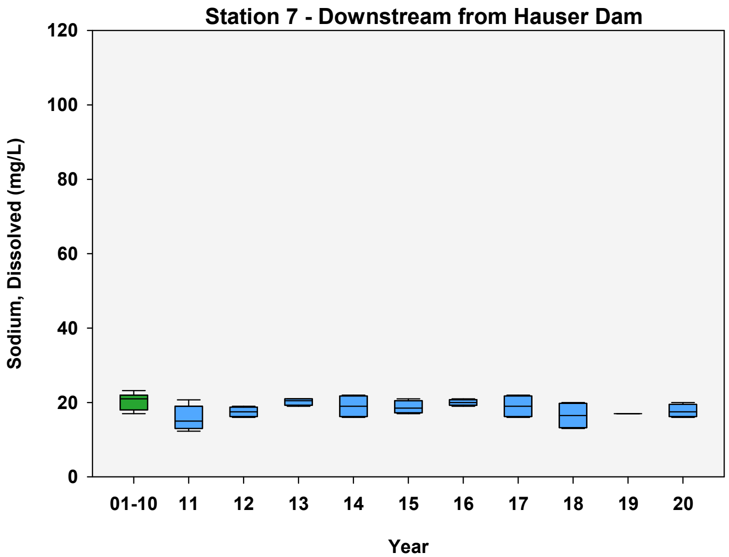




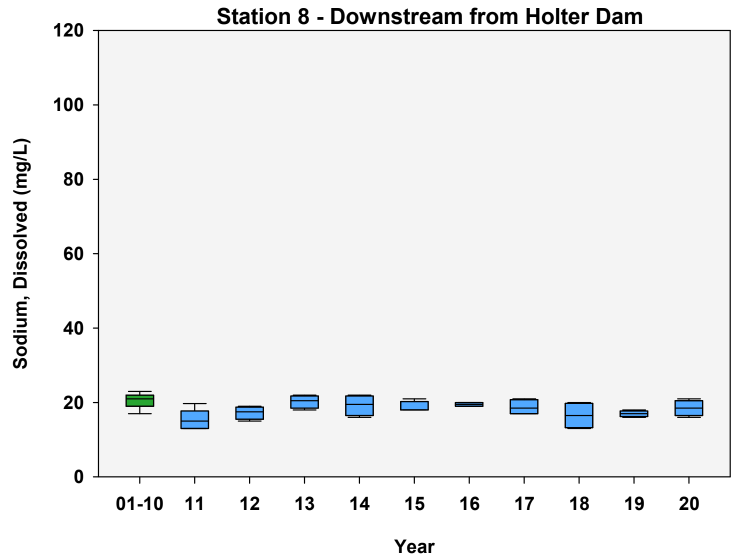
Station 5 - Upstream from Canyon Ferry Reservoir
Sodium, Dissolved (mg/L)
0
20
40
60
80
100
120
01-10
11
12
13
14
15
16
17
18
19
20
Year



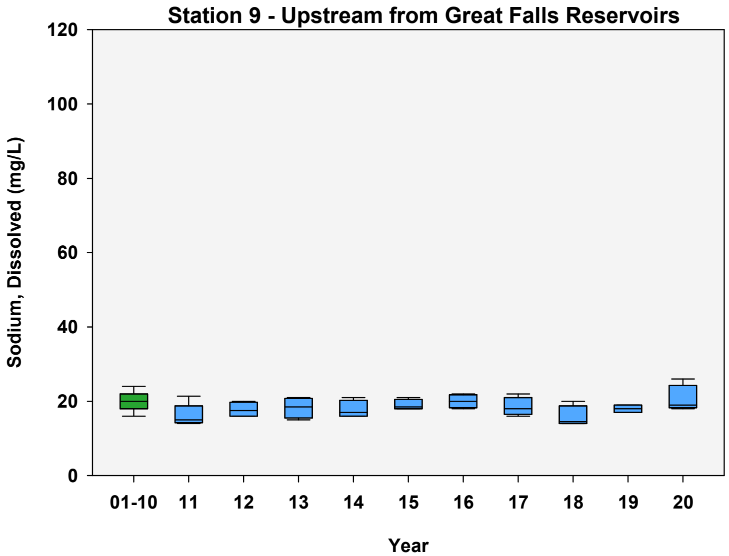
Station 6 - Downstream from Canyon Ferry Dam
Sodium, Dissolved (mg/L)
0
20
40
60
80
100
120
01-10
11
12
13
14
15
16
17
18
19
20
Year



Station 7 - Downstream from Hauser Dam
Sodium, Dissolved (mg/L)
0
20
40
60
80
100
120
01-10
11
12
13
14
15
16
17
18
19
20
Year



Station 8 - Downstream from Holter Dam
Sodium, Dissolved (mg/L)
0
20
40
60
80
100
120
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Sodium, Dissolved (mg/L)
0
20
40
60
80
100
120
01-10
11
12
13
14
15
16
17
18
19
20
Year

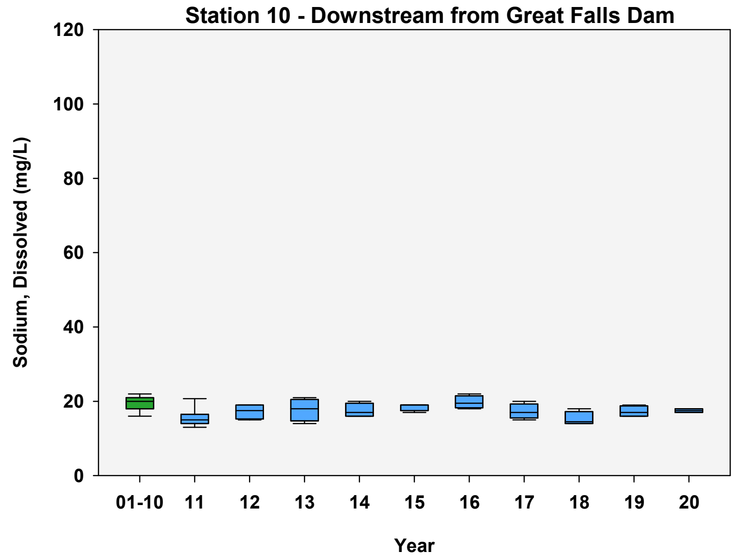
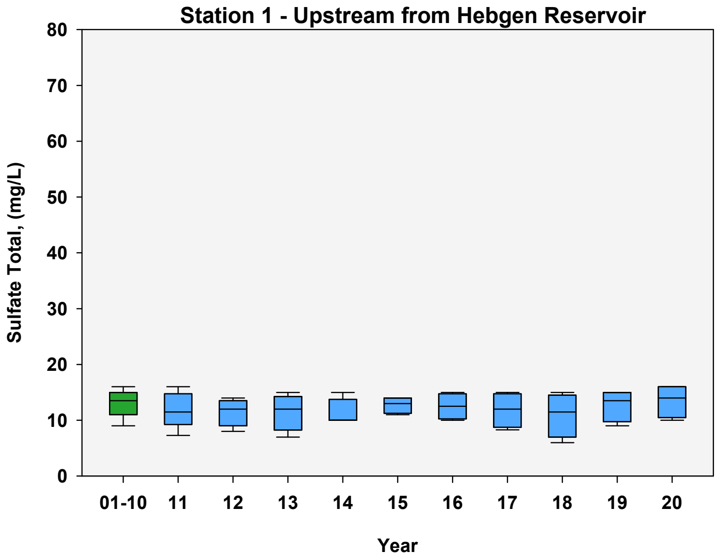
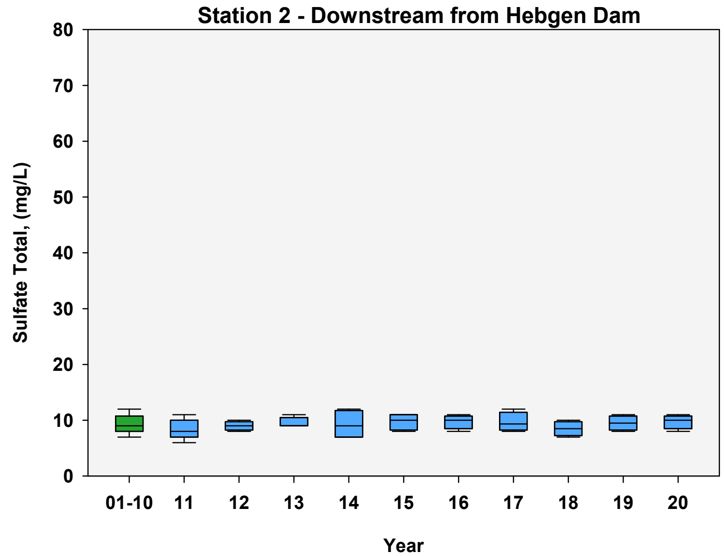
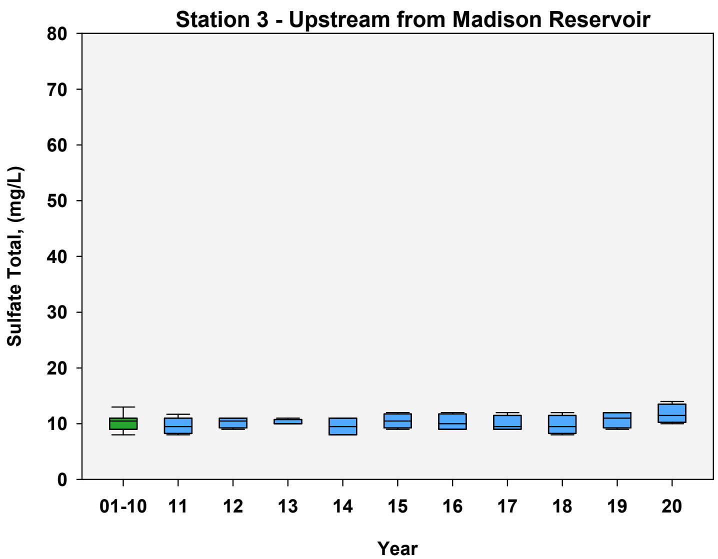
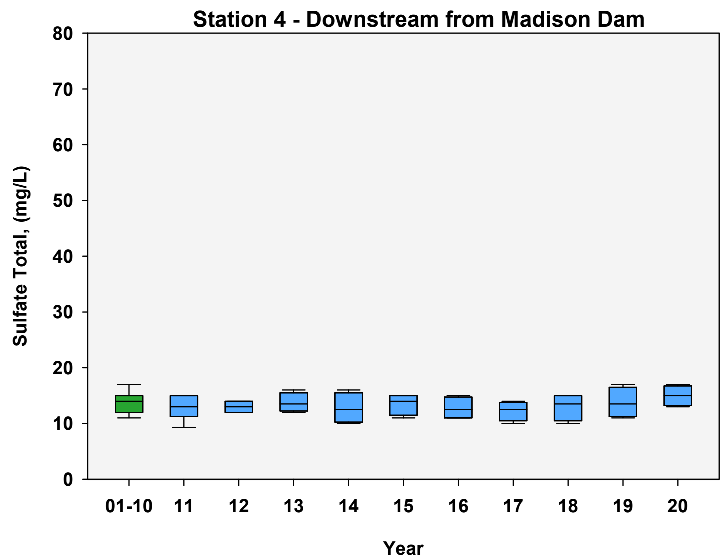

Station 10 - Downstream from Great Falls Dam
Sodium, Dissolved (mg/L)
0
20
40
60
80
100
120
01-10
11
12
13
14
15
16
17
18
19
20
Year

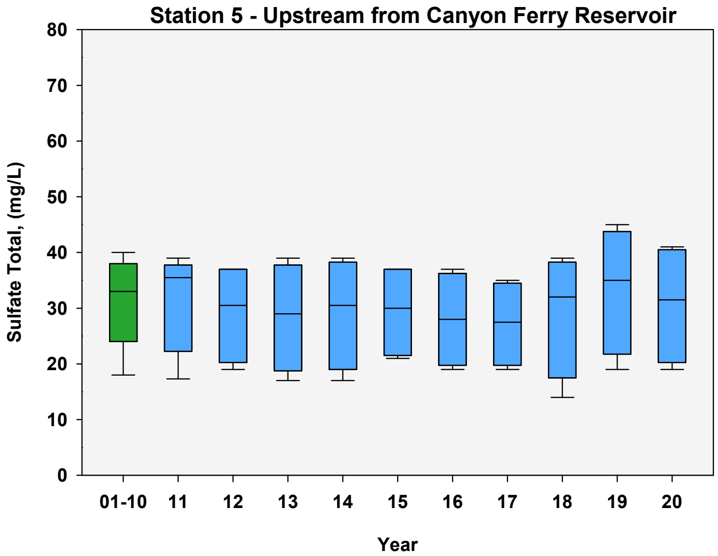
Figure B-11: Sulfate, Total (mg/L) for Stations 1 to 10.

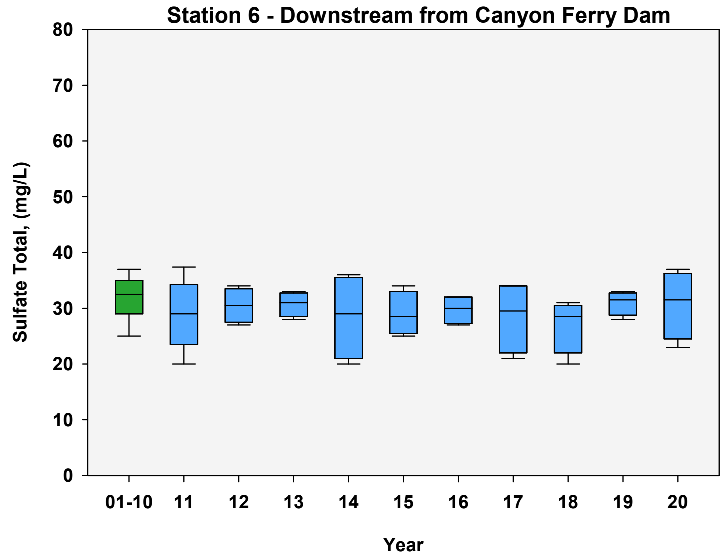


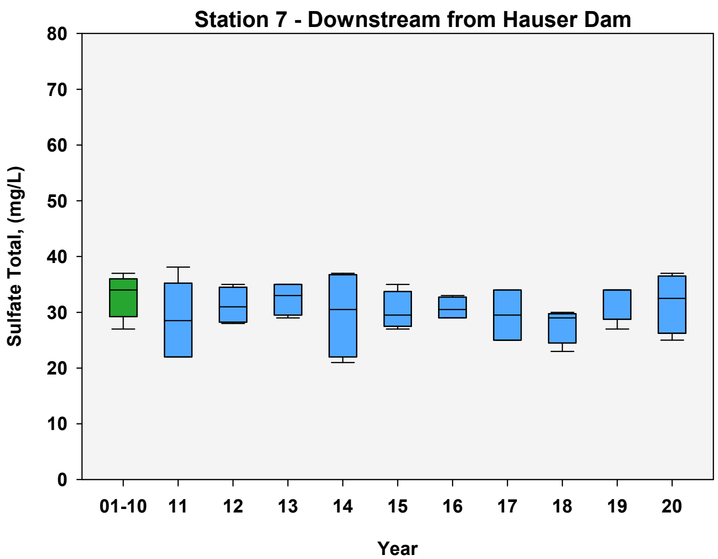


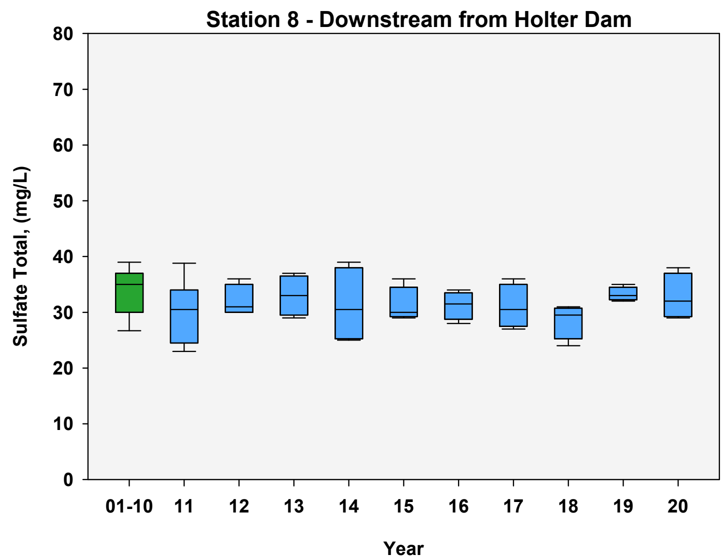


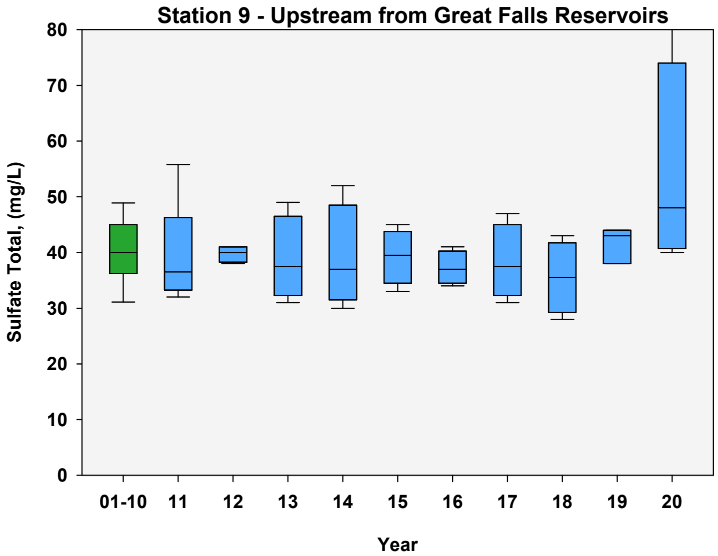



Station 5 - Upstream from Canyon Ferry Reservoir
Sulfate Total, (mg/L)
0
10
20
30
40
50
60
70
80
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Sulfate Total, (mg/L)
0
10
20
30
40
50
60
70
80
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Sulfate Total, (mg/L)
0
10
20
30
40
50
60
70
80
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Sulfate Total, (mg/L)
0
10
20
30
40
50
60
70
80
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Sulfate Total, (mg/L)
0
10
20
30
40
50
60
70
80
01-10
11
12
13
14
15
16
17
18
19
20
Year

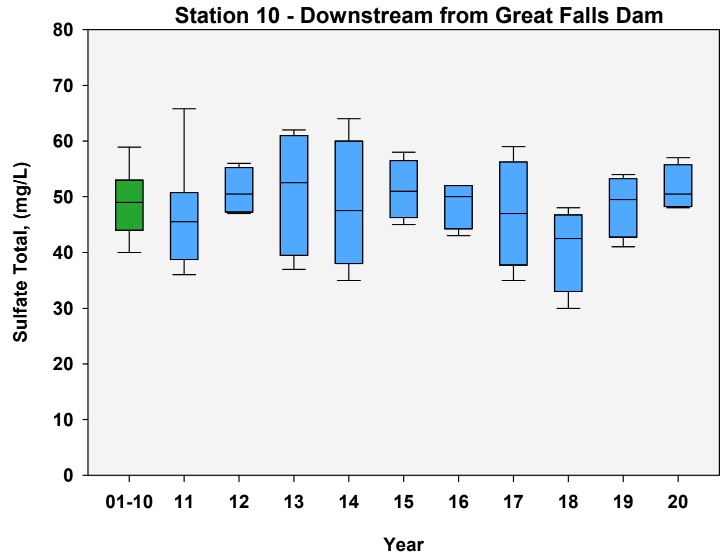
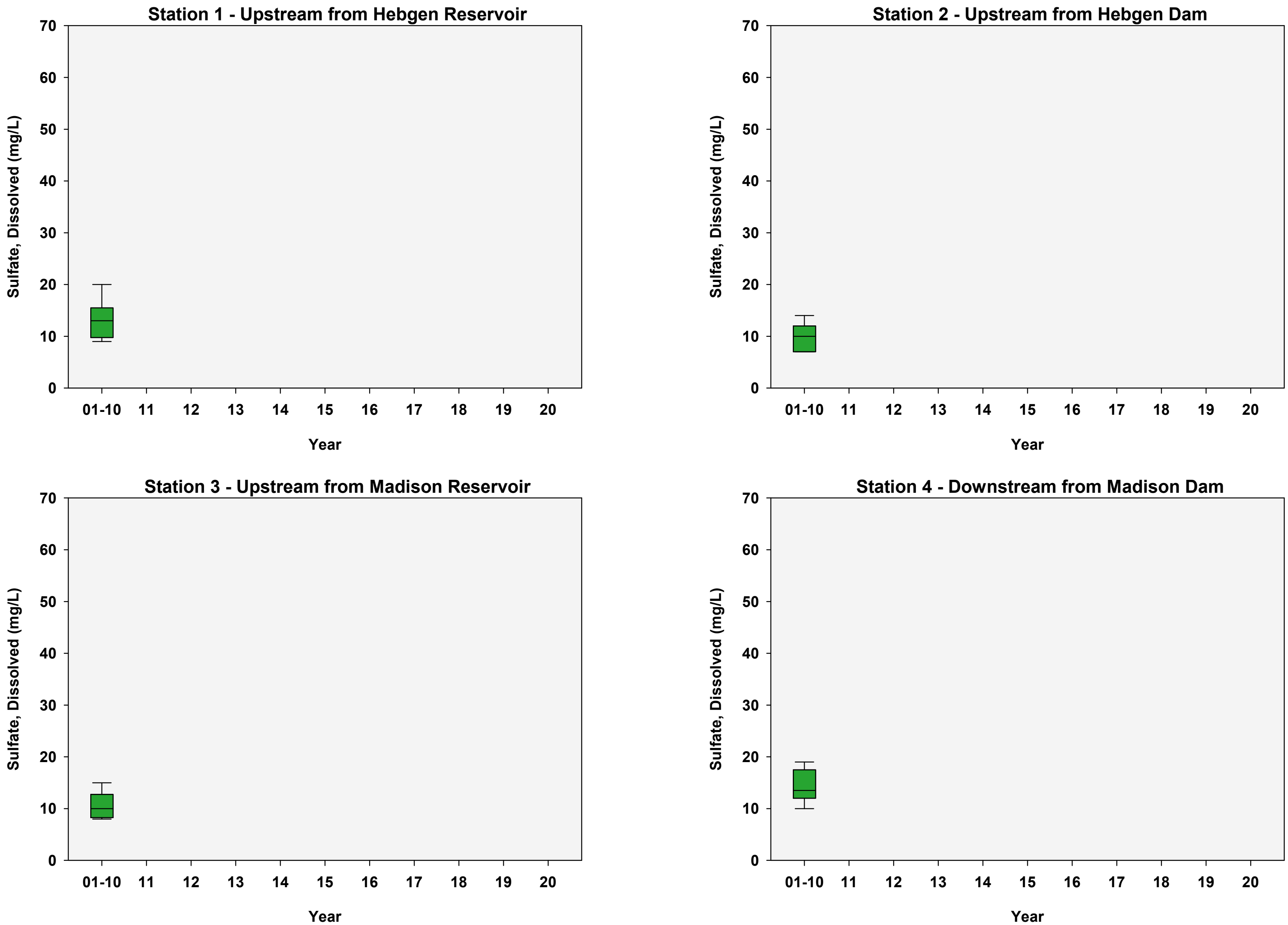
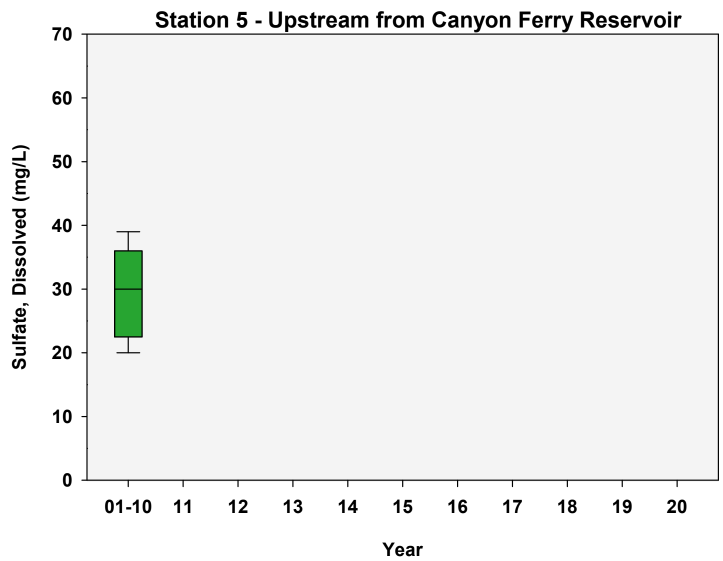
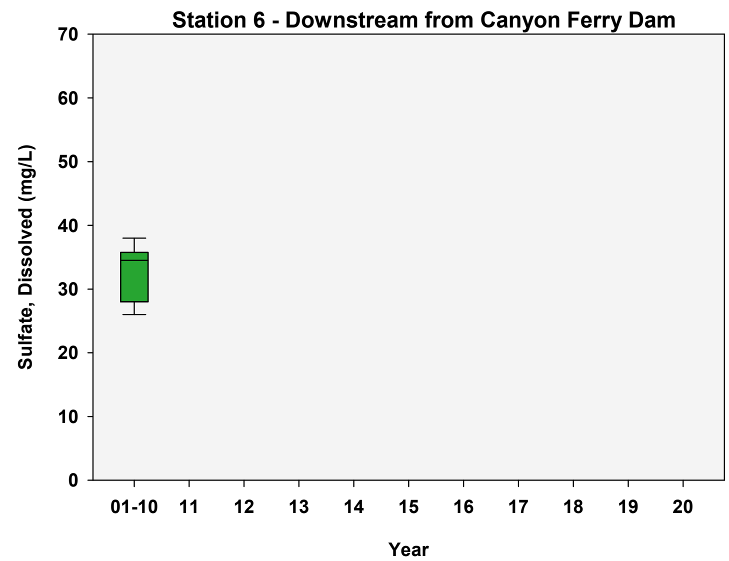
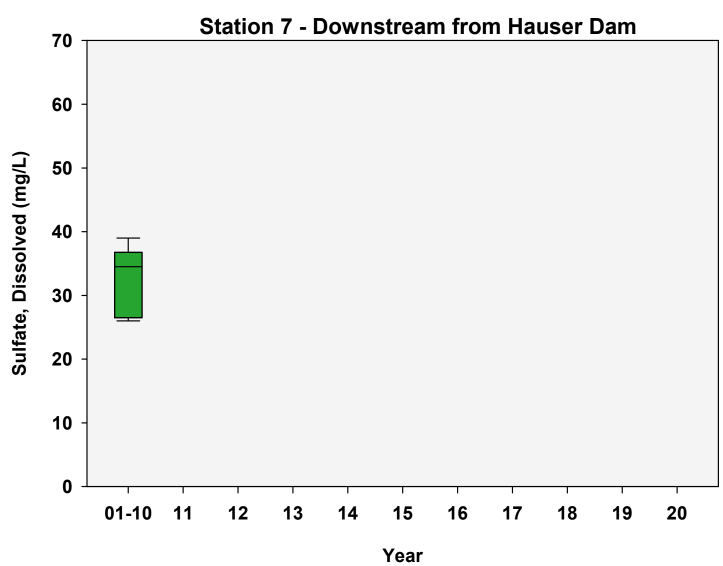

Station 10 - Downstream from Great Falls Dam
Sulfate Total, (mg/L)
0
10
20
30
40
50
60
70
80
01-10
11
12
13
14
15
16
17
18
19
20
Year

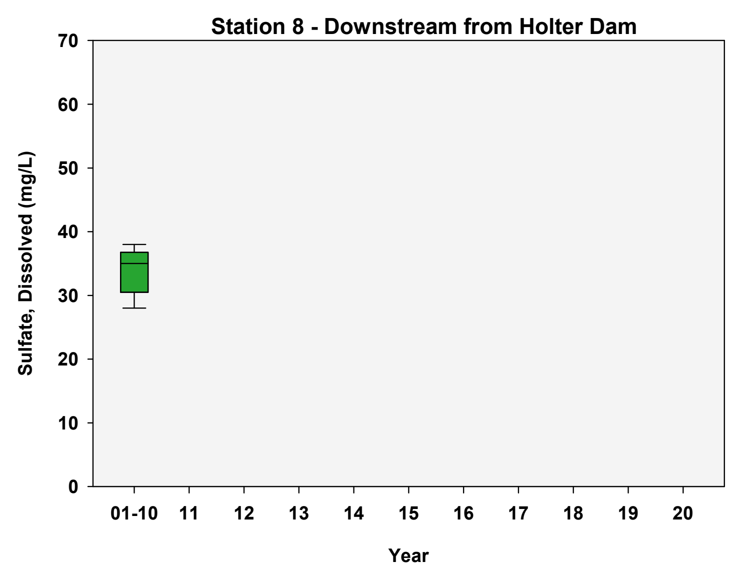
Figure B-12: Sulfate, Dissolved (mg/L) for Stations 1 to 10.

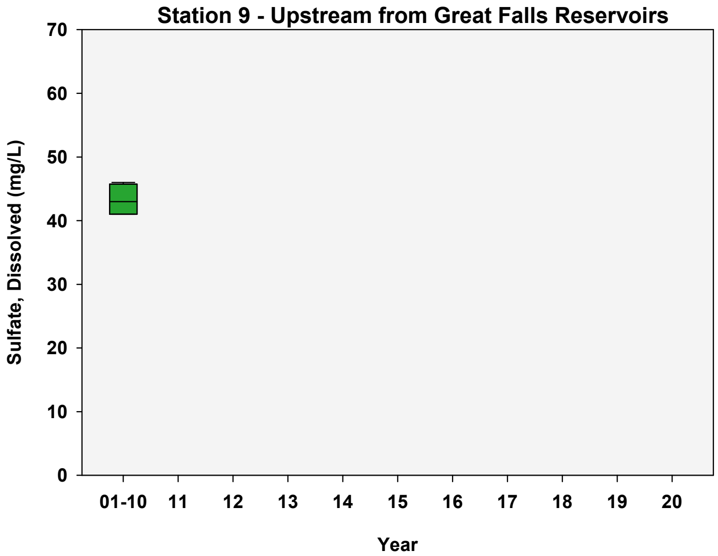



Station 5 - Upstream from Canyon Ferry Reservoir
Sulfate, Dissolved (mg/L)
0
10
20
30
40
50
60
70
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Sulfate, Dissolved (mg/L)
0
10
20
30
40
50
60
70
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Sulfate, Dissolved (mg/L)
0
10
20
30
40
50
60
70
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Sulfate, Dissolved (mg/L)
0
10
20
30
40
50
60
70
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Sulfate, Dissolved (mg/L)
70
60
50
40
30
20
10
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

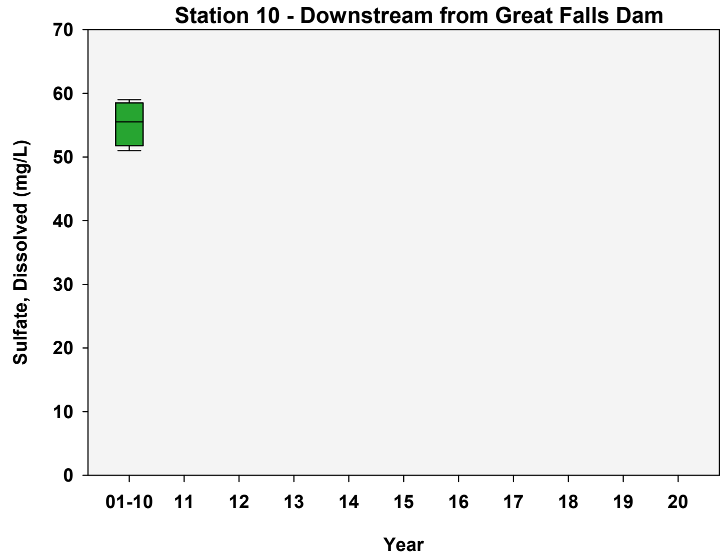
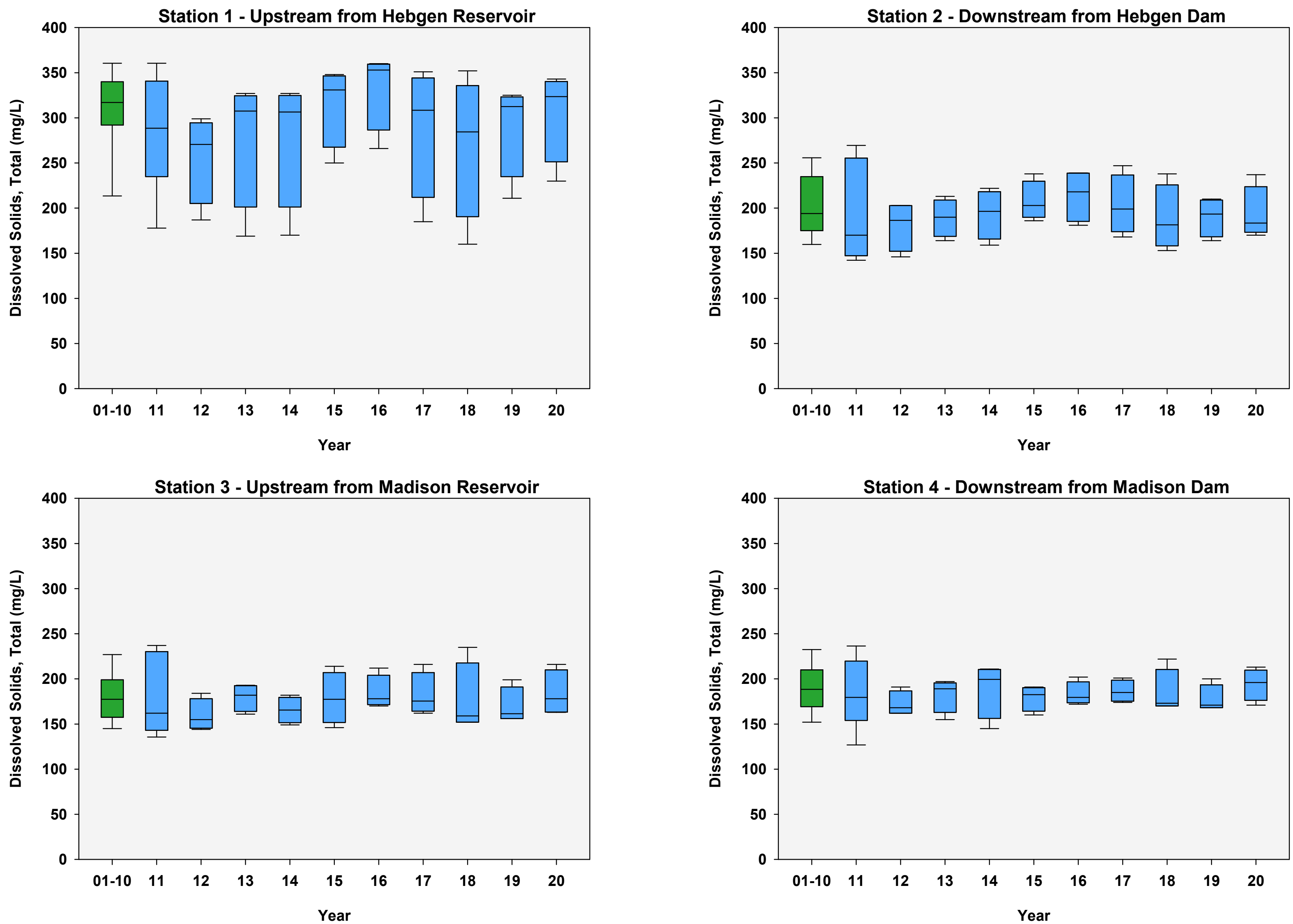
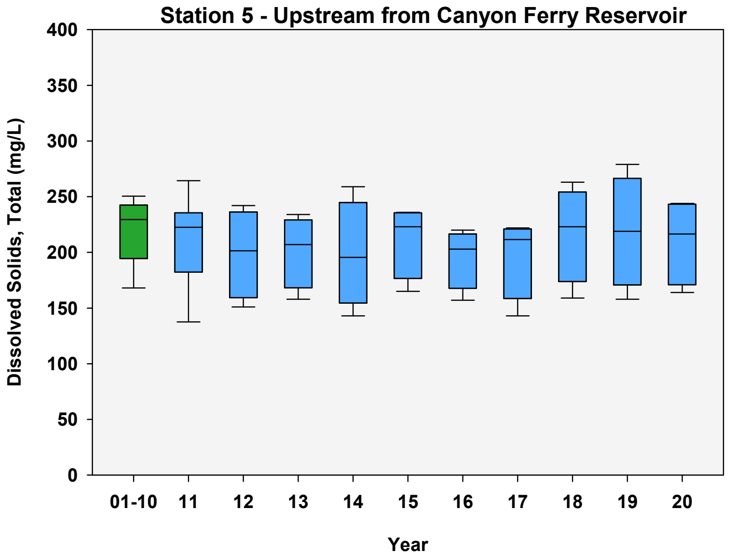
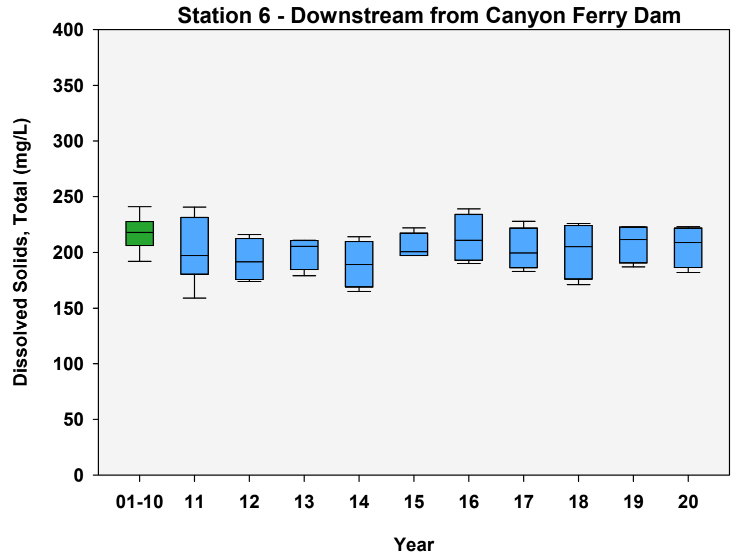
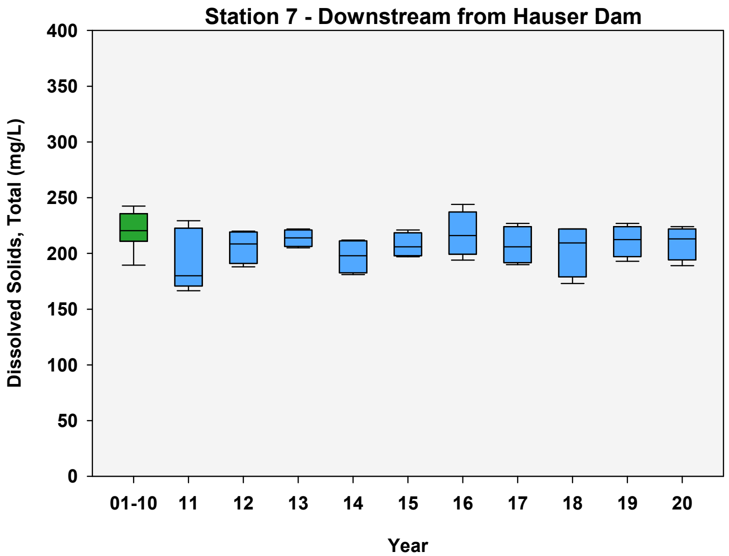

Station 10 - Downstream from Great Falls Dam
Sulfate, Dissolved (mg/L)
70
60
50
40
30
20
10
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

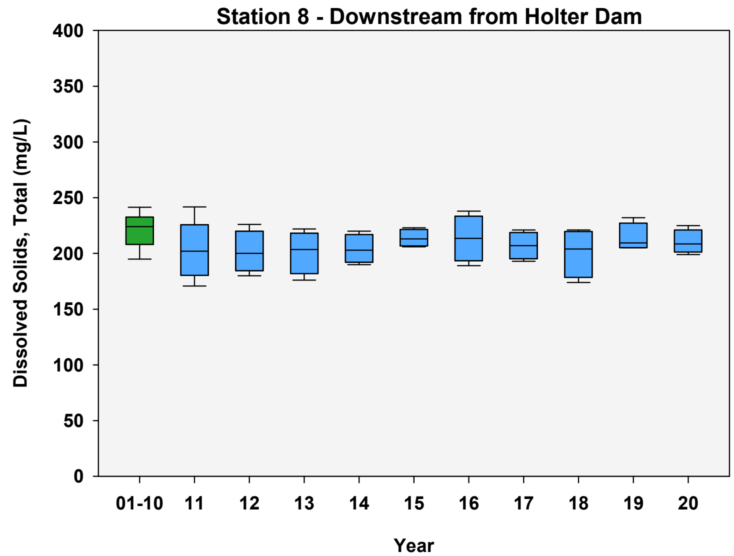
Figure B-13: Dissolved Solids, Total (mg/L) for Stations 1 to 10.

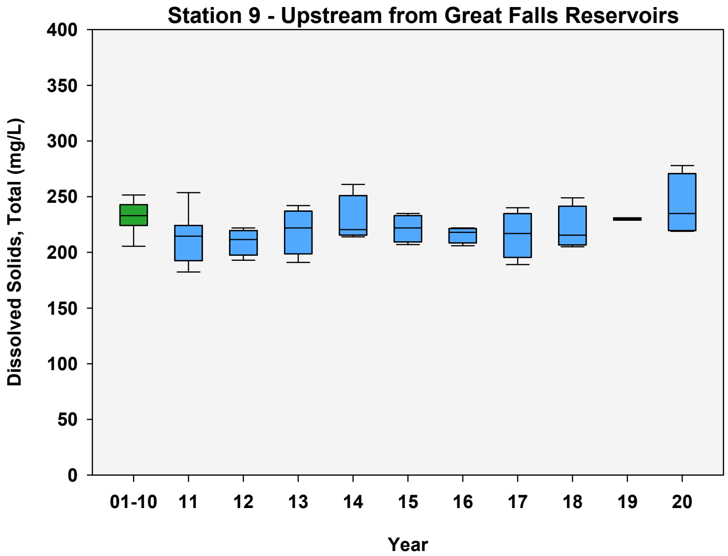



Station 5 - Upstream from Canyon Ferry Reservoir
Dissolved Solids, Total (mg/L)
0
50
100
150
200
250
300
350
400
01-10
11
12
13
14
15
16
17
18
19
20
Year

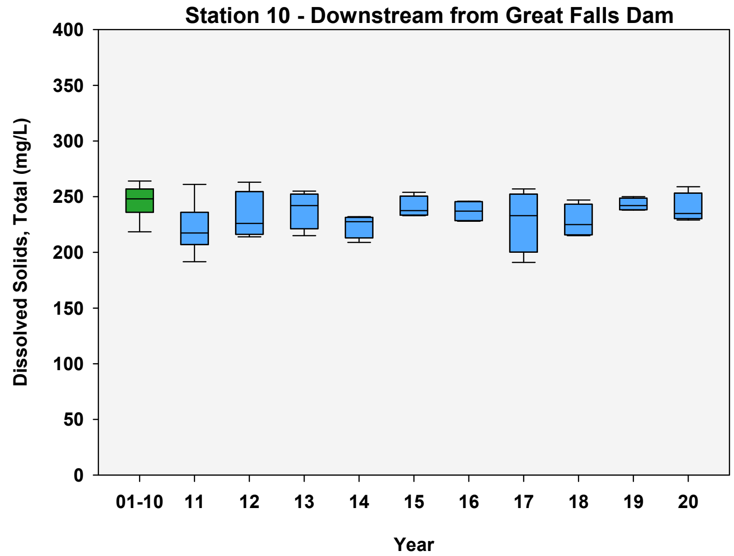

Station 6 - Downstream from Canyon Ferry Dam
Dissolved Solids, Total (mg/L)
0
50
100
150
200
250
300
350
400
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Dissolved Solids, Total (mg/L)
0
50
100
150
200
250
300
350
400
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Dissolved Solids, Total (mg/L)
0
50
100
150
200
250
300
350
400
01-10
11
12
13
14
15
16
17
18
19
20
Year

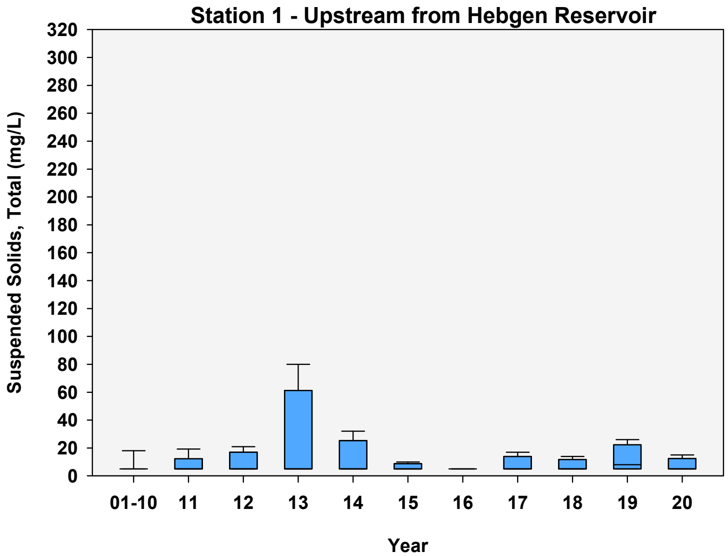


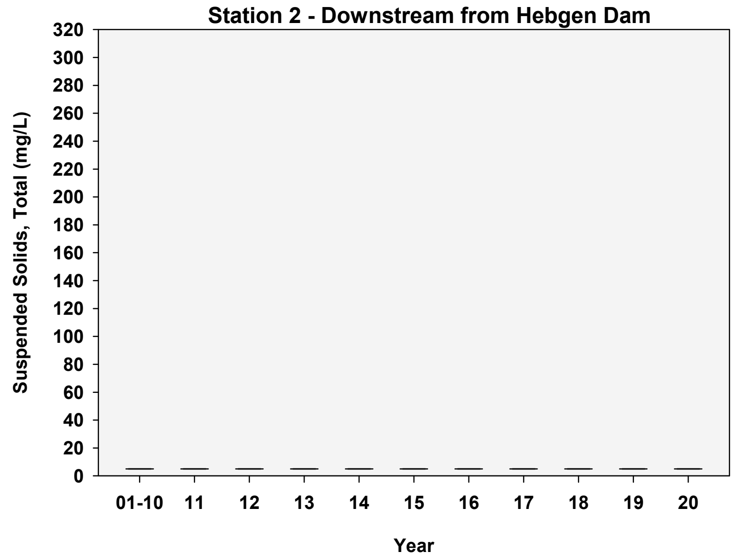
Station 9 - Upstream from Great Falls Reservoirs
Dissolved Solids, Total (mg/L)
0
50
100
150
200
250
300
350
400
01-10
11
12
13
14
15
16
17
18
19
20
Year

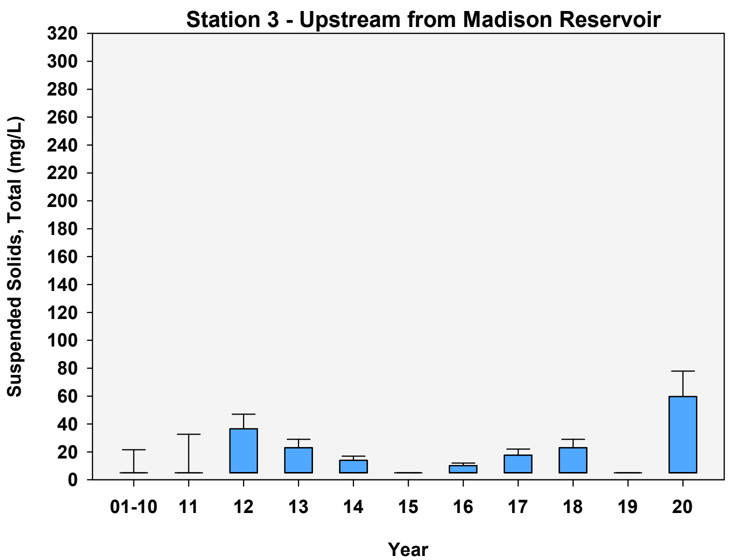


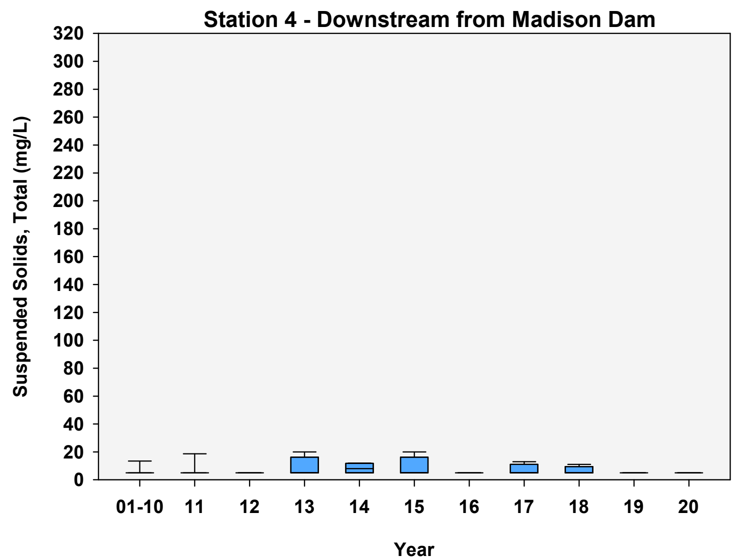
Station 10 - Downstream from Great Falls Dam
Dissolved Solids, Total (mg/L)
0
50
100
150
200
250
300
350
400
01-10
11
12
13
14
15
16
17
18
19
20
Year

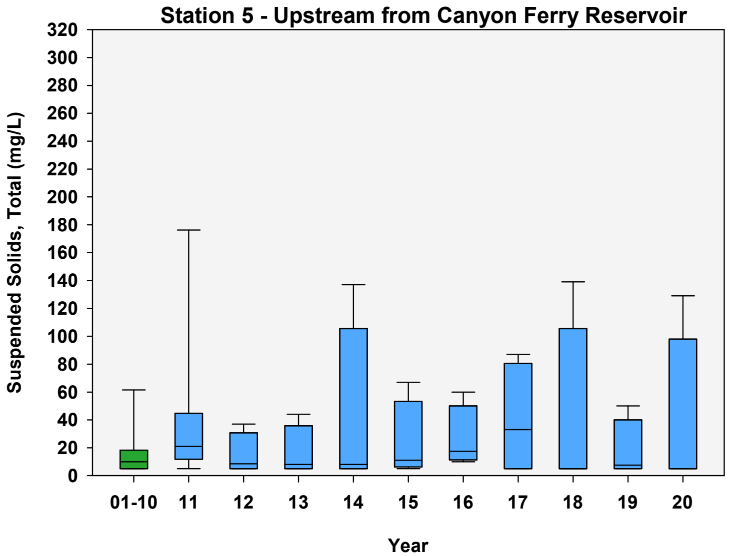
Figure B-14: Suspended Solids Total (mg/L) for Stations 1 to 10.

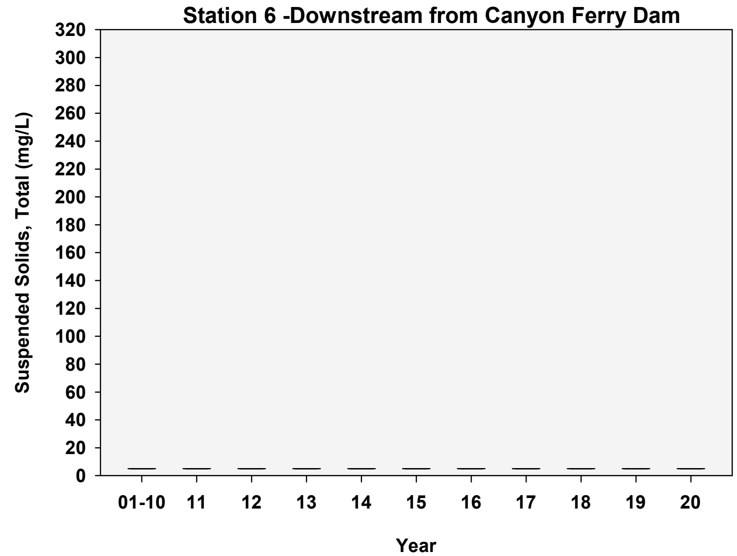


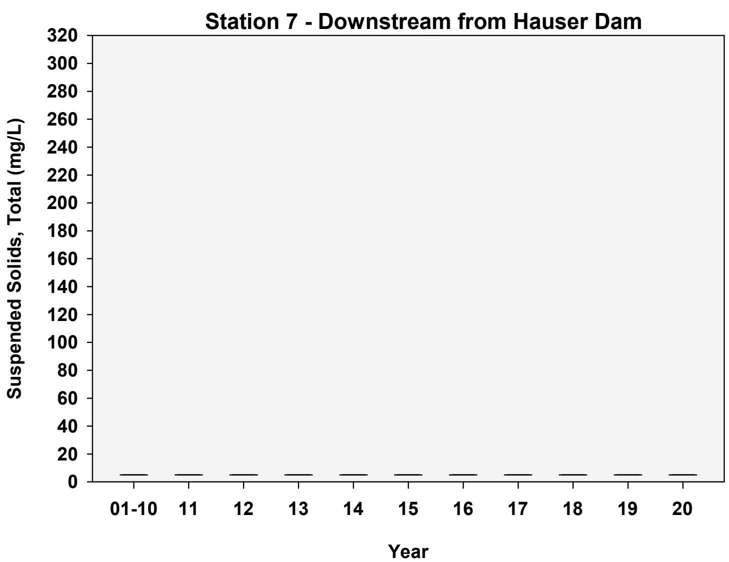


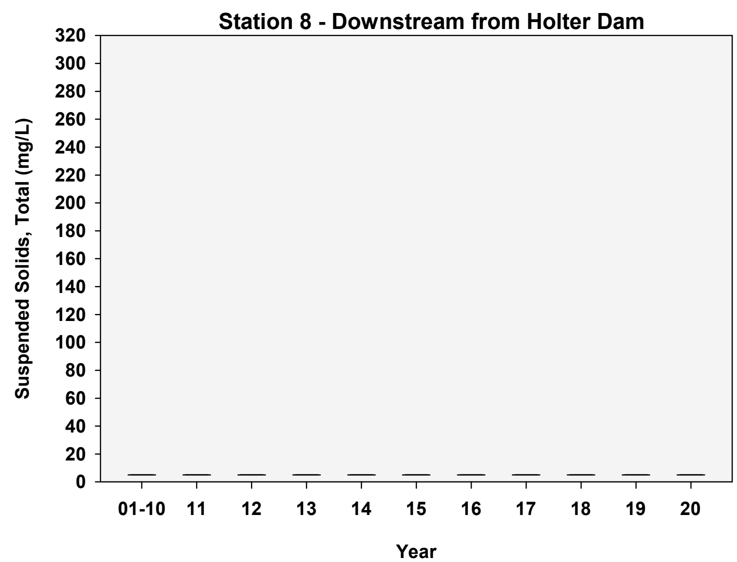


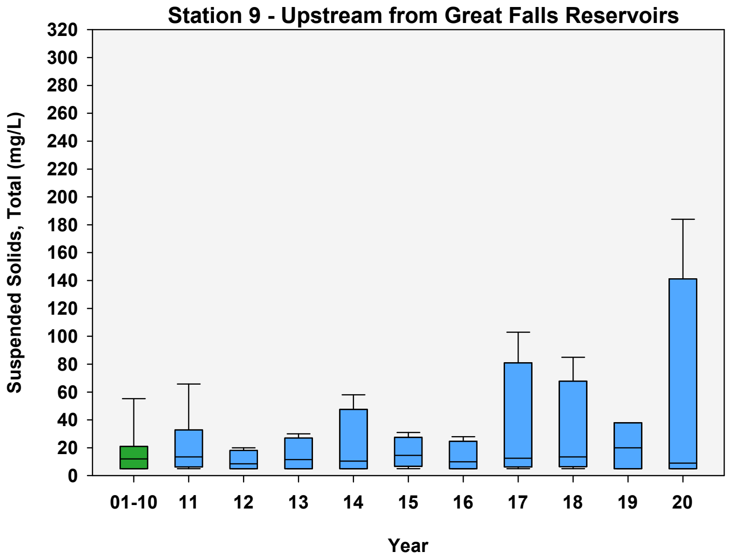



Station 5 - Upstream from Canyon Ferry Reservoir
Suspended Solids, Total (mg/L)
Year
01-10
11
12
13
14
15
16
17
18
19
20


Station 6 -Downstream from Canyon Ferry Dam
Suspended Solids, Total (mg/L)
Year


Station 7 - Downstream from Hauser Dam
Suspended Solids, Total (mg/L)
Year


Station 8 - Downstream from Holter Dam
Suspended Solids, Total (mg/L)
Year


Station 9 - Upstream from Great Falls Reservoirs
Suspended Solids, Total (mg/L)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
01-10
11
12
13
14
15
16
17
18
19
20
Year

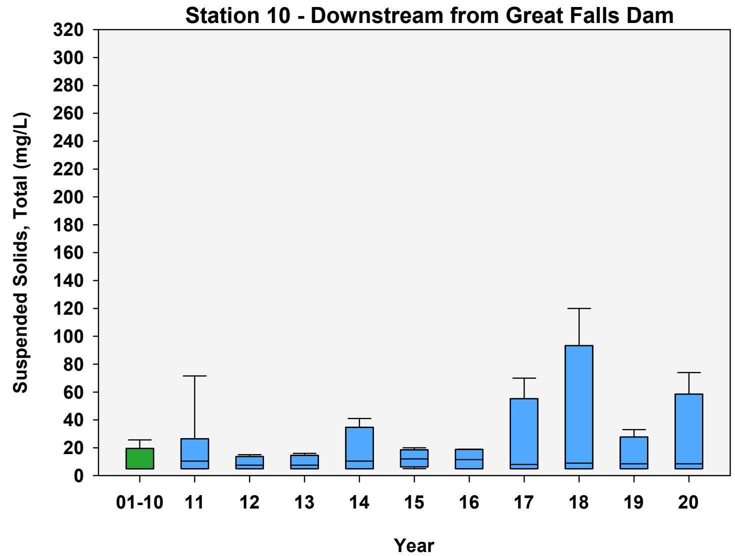
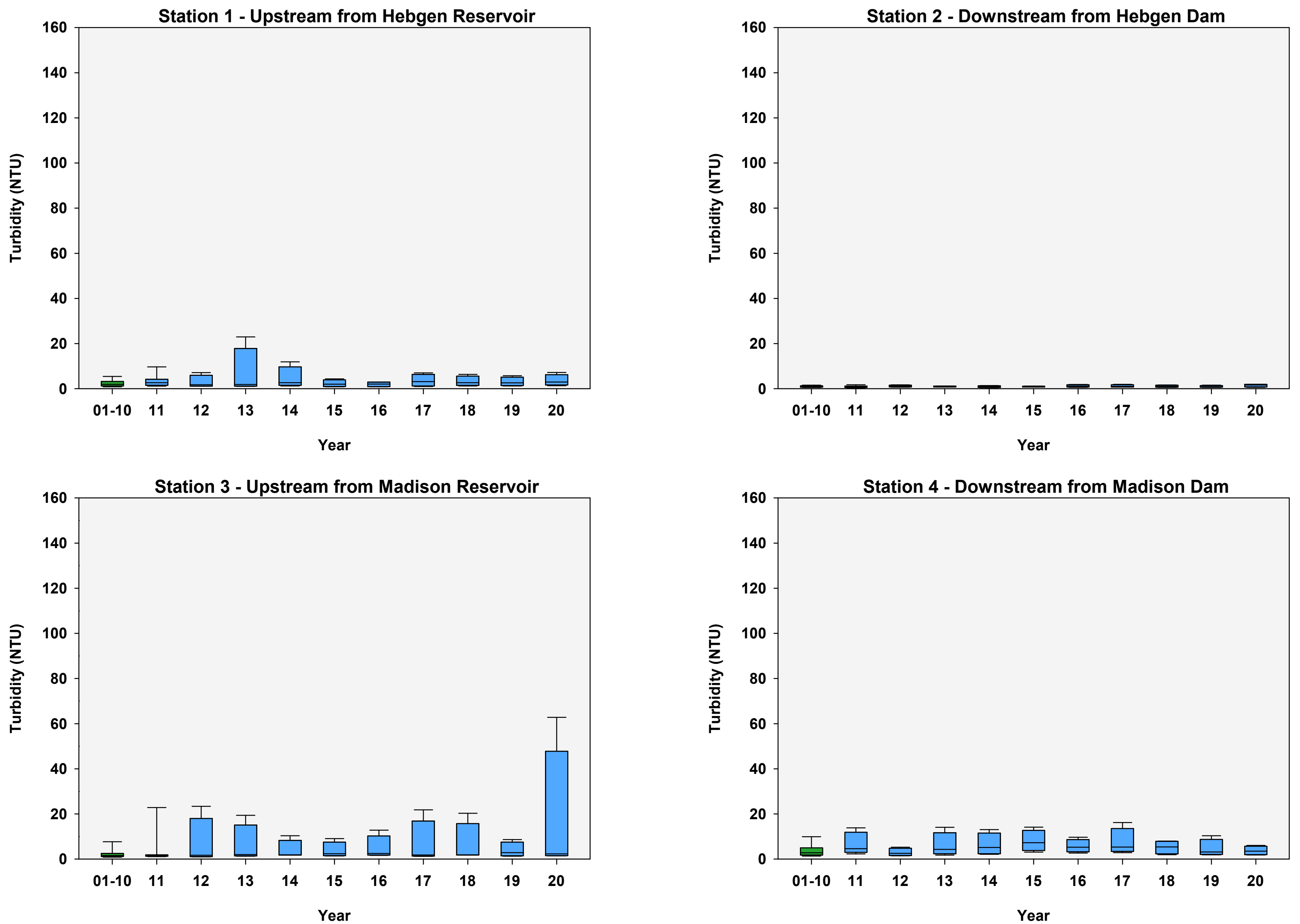
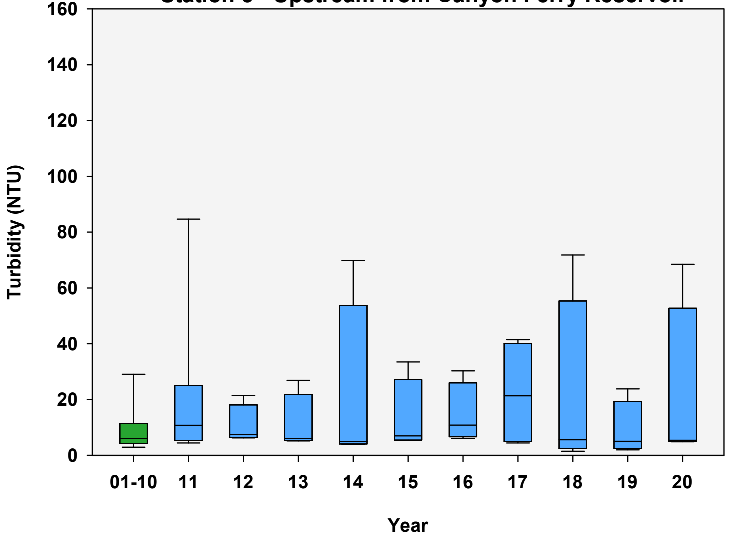

Station 10 - Downstream from Great Falls Dam
Suspended Solids, Total (mg/L)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
01-10
11
12
13
14
15
16
17
18
19
20
Year

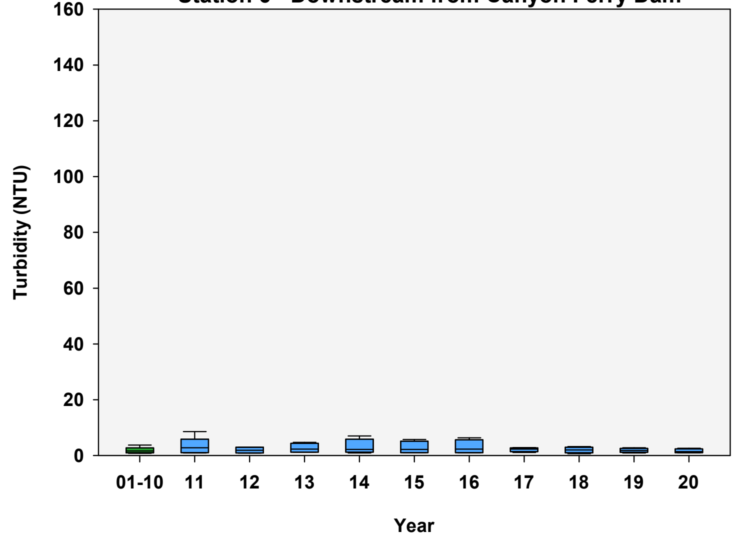
Figure B-15: Turbidity (NTU) for Stations 1 to 10.



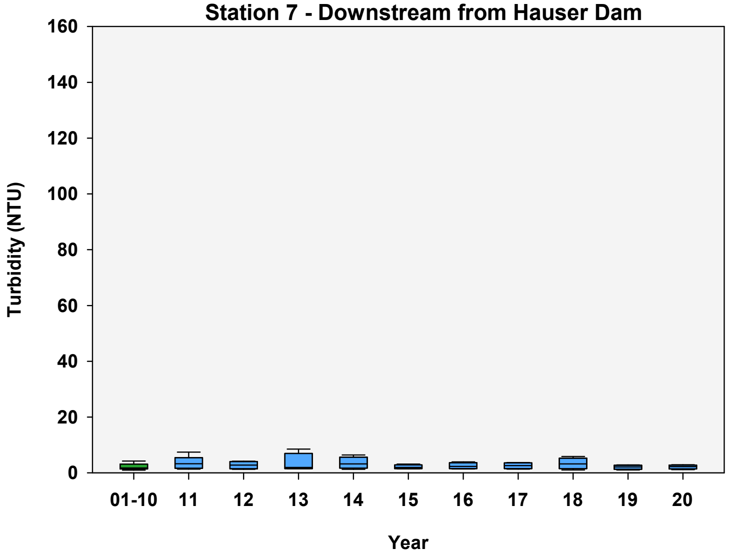
Station 5 - Upstream from Canyon Ferry Reservoir



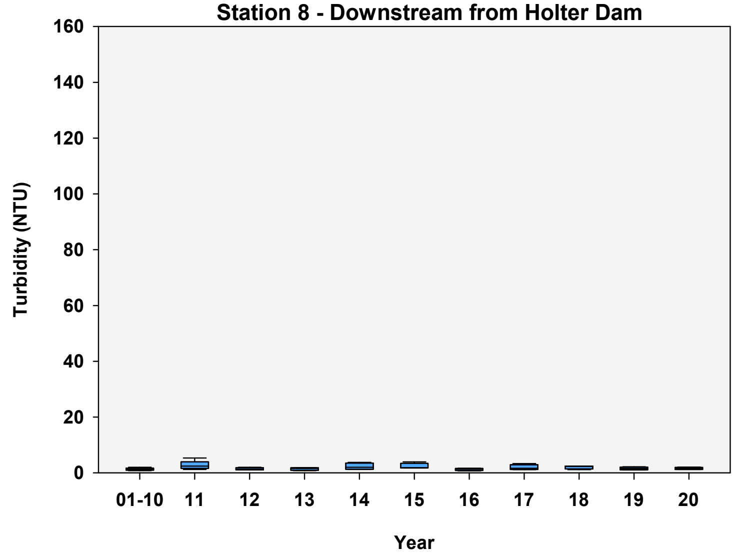
Station 6 - Downstream from Canyon Ferry Dam

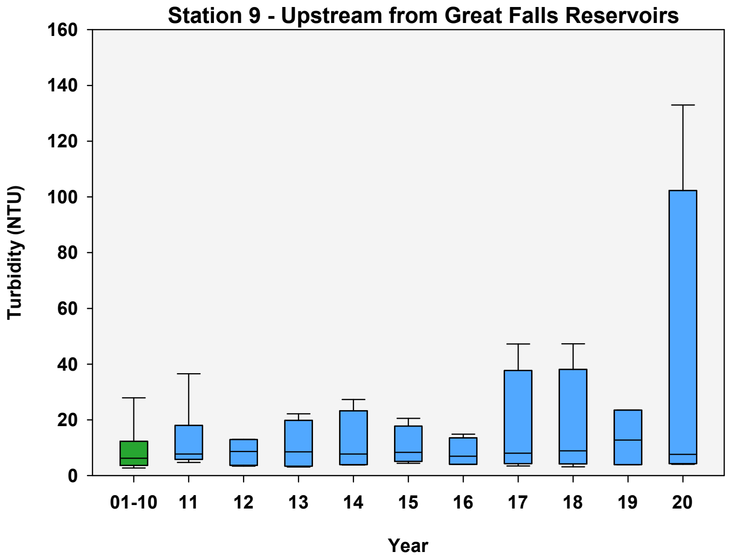


Station 7 - Downstream from Hauser Dam



Station 8 - Downstream from Holter Dam




Station 9 - Upstream from Great Falls Reservoirs
Turbidity (NTU)
0
20
40
60
80
100
120
140
160
01-10
11
12
13
14
15
16
17
18
19
20
Year

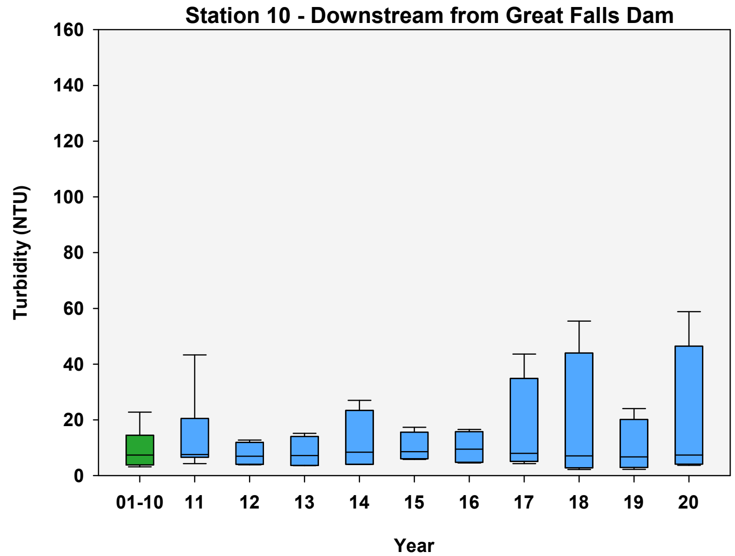
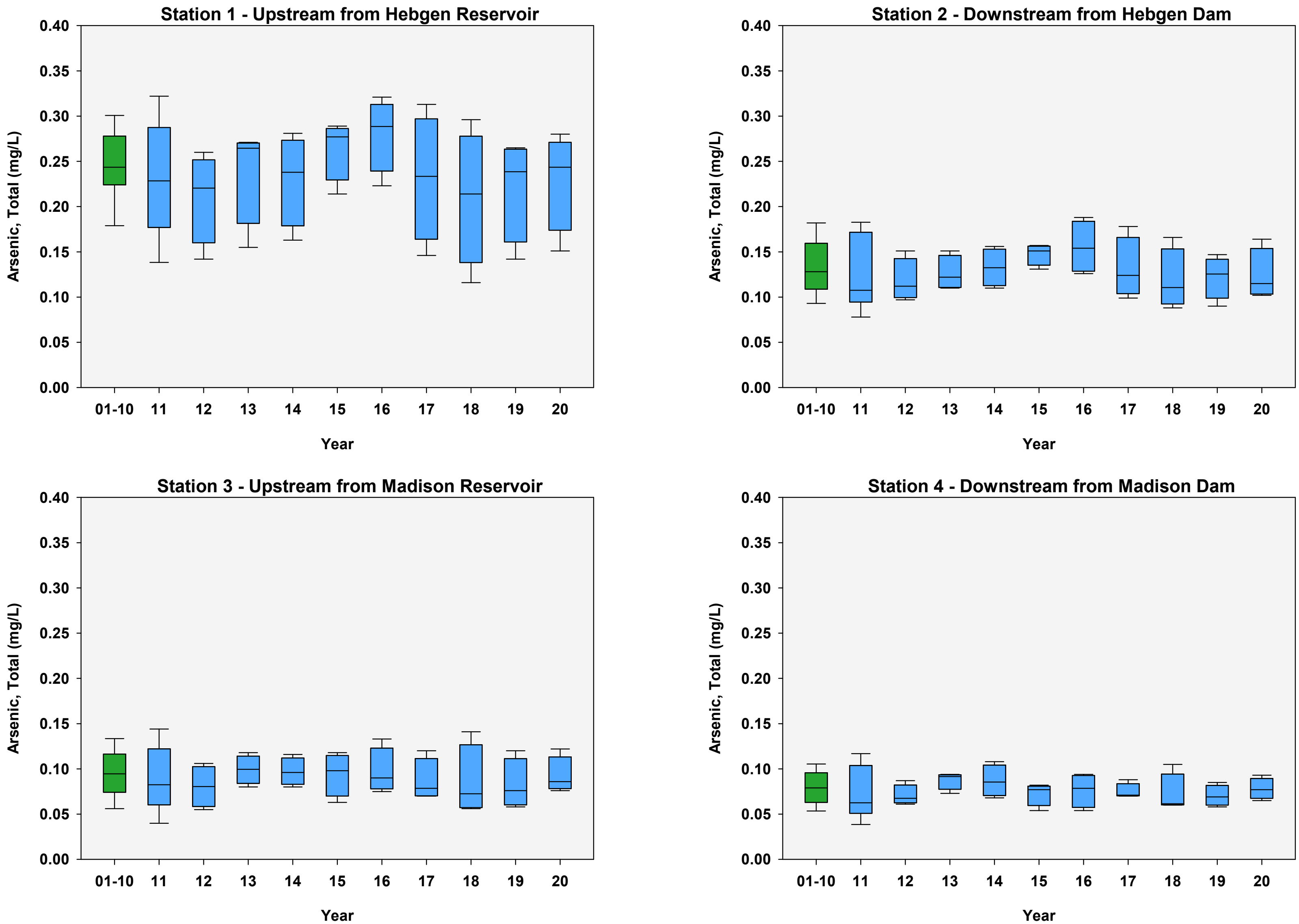
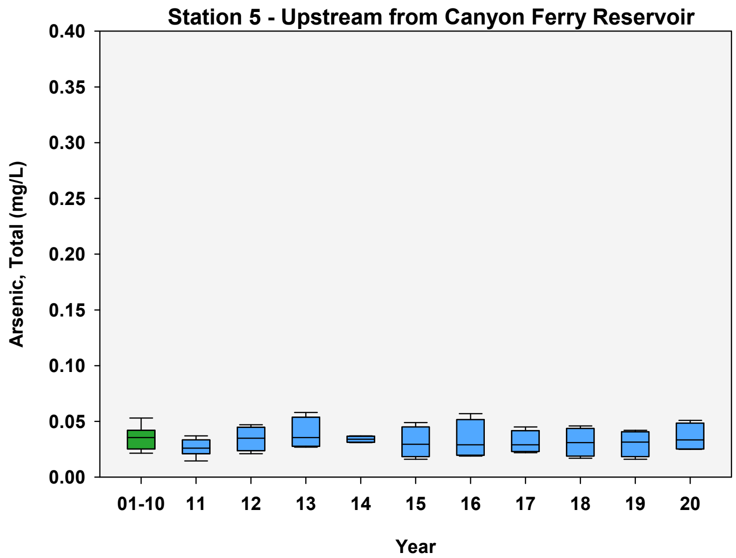
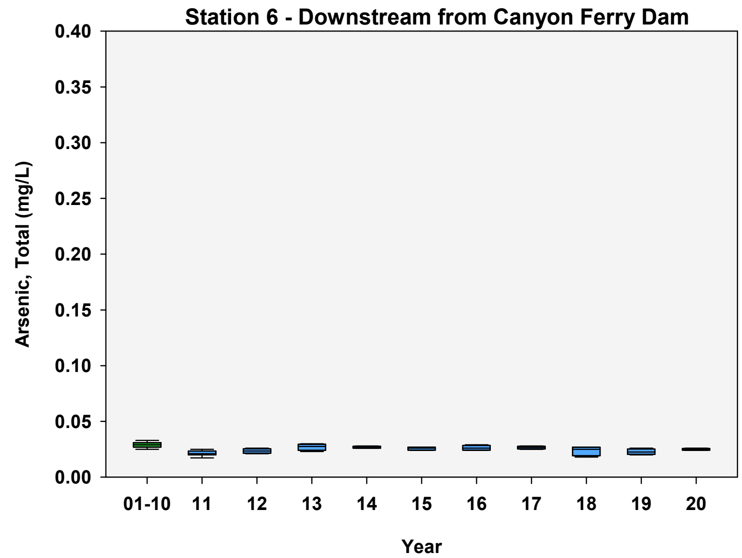
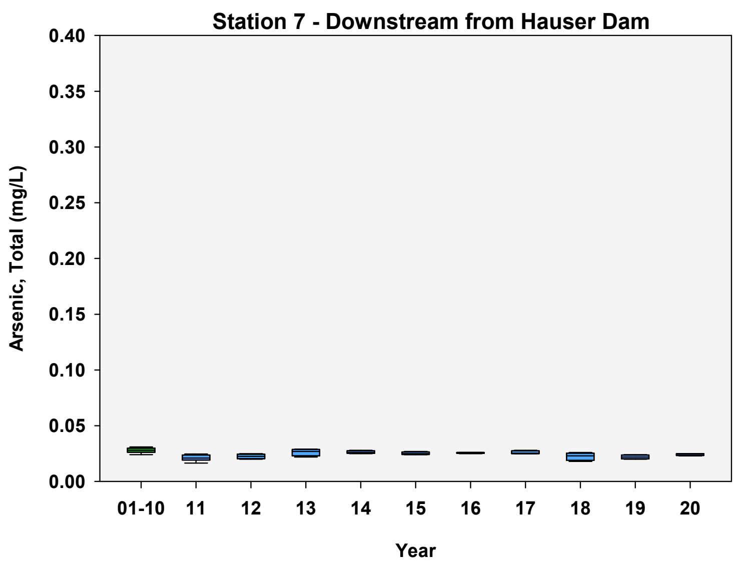

Station 10 - Downstream from Great Falls Dam
Turbidity (NTU)
0
20
40
60
80
100
120
140
160
01-10
11
12
13
14
15
16
17
18
19
20
Year

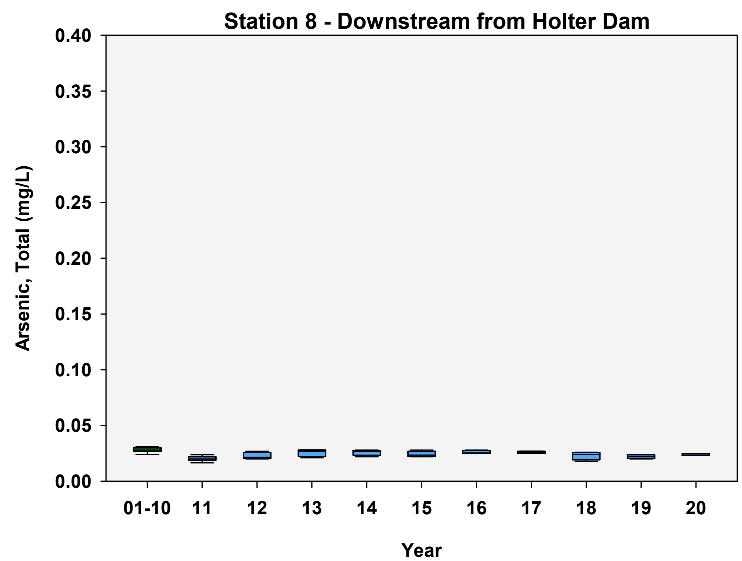
Figure B-16: Arsenic, Total (mg/L) for Stations 1 to 10.

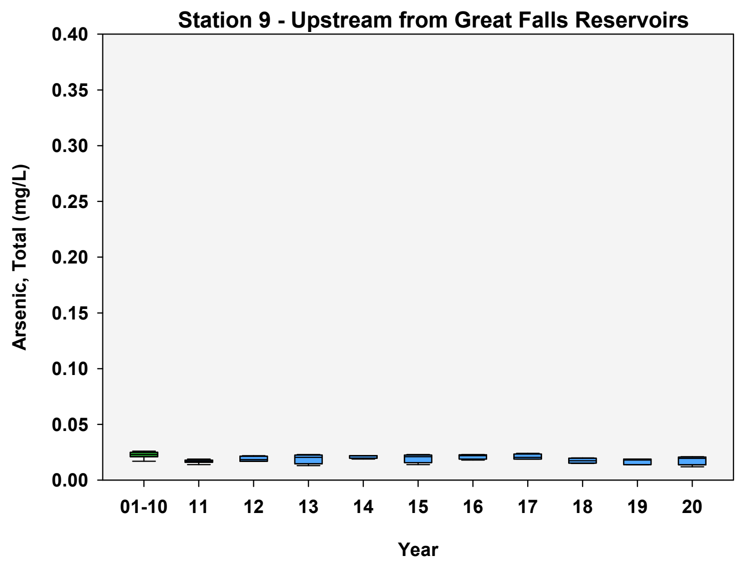



Station 5 - Upstream from Canyon Ferry Reservoir
Arsenic, Total (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Arsenic, Total (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Arsenic, Total (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Arsenic, Total (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Arsenic, Total (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

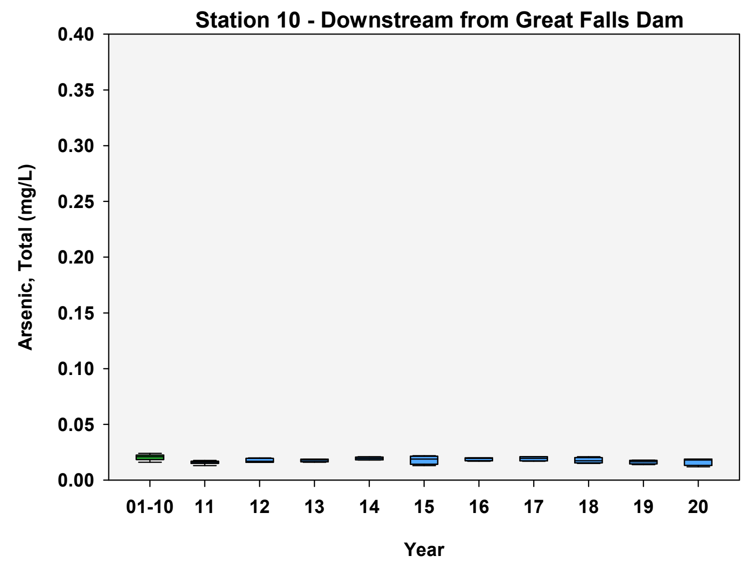
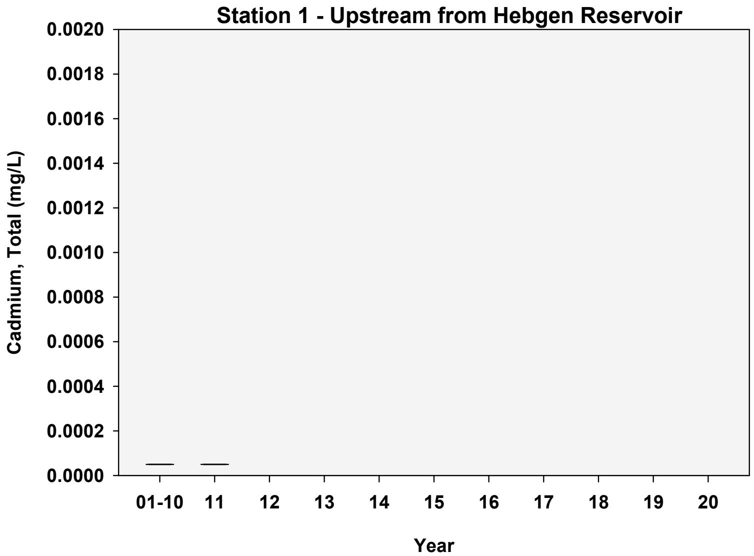
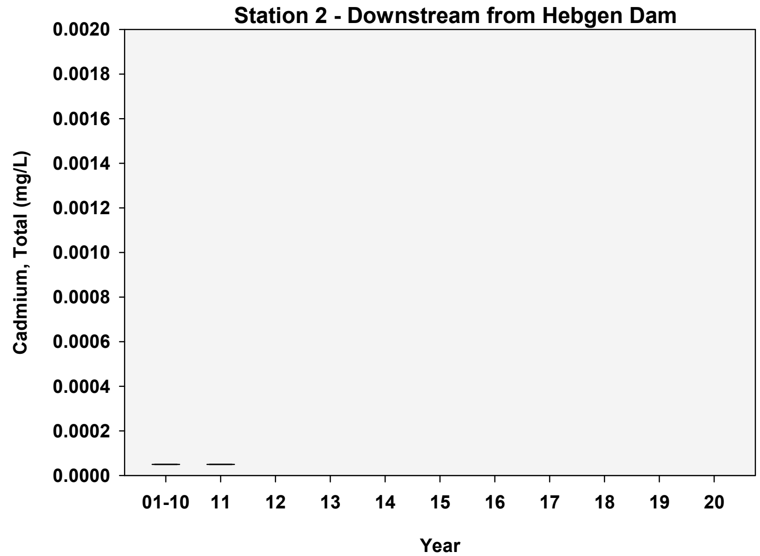
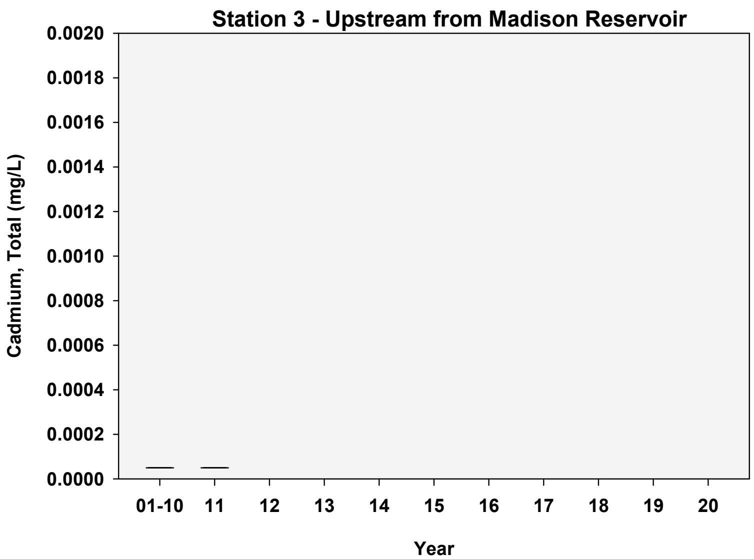
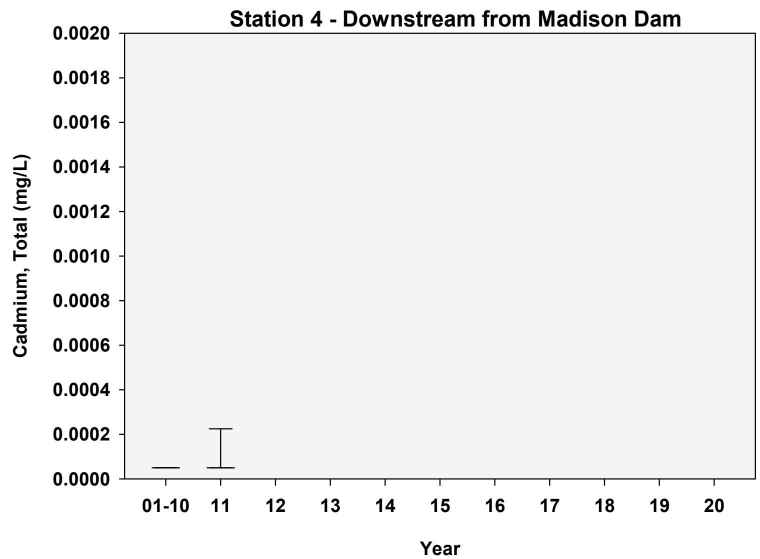

Station 10 - Downstream from Great Falls Dam
Arsenic, Total (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

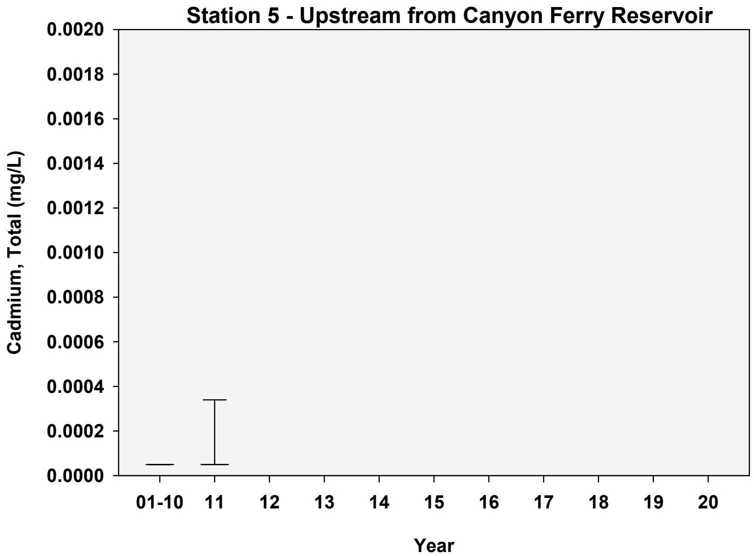
Figure B-17: Cadmium, Total (mg/L) for Stations 1 to 10.

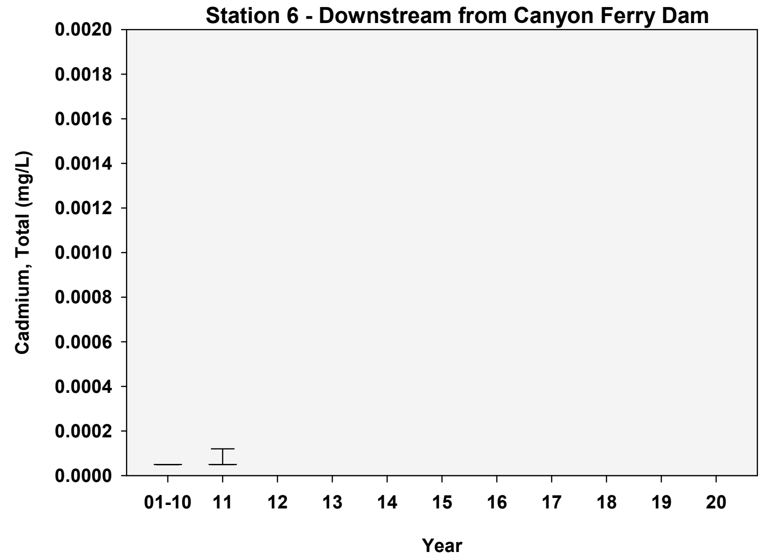


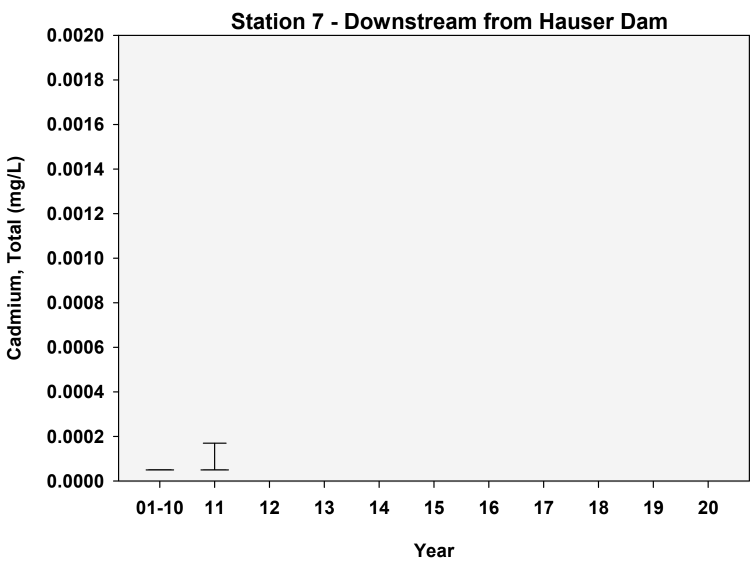


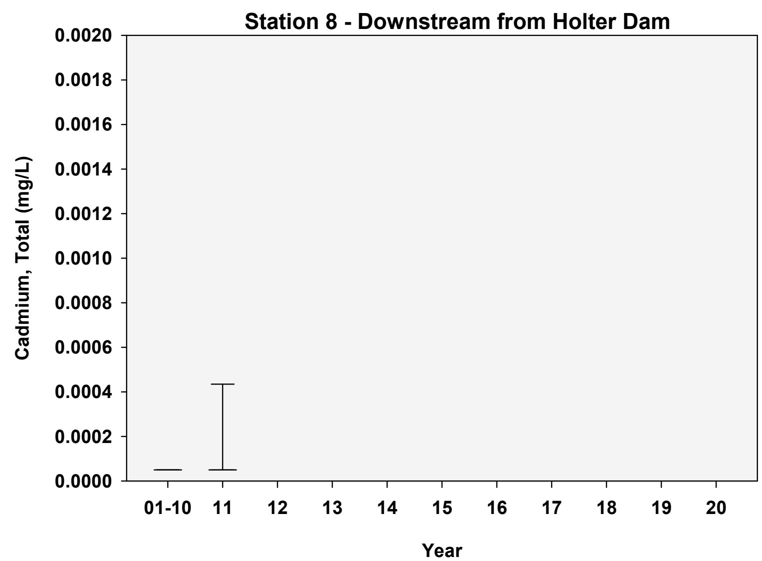


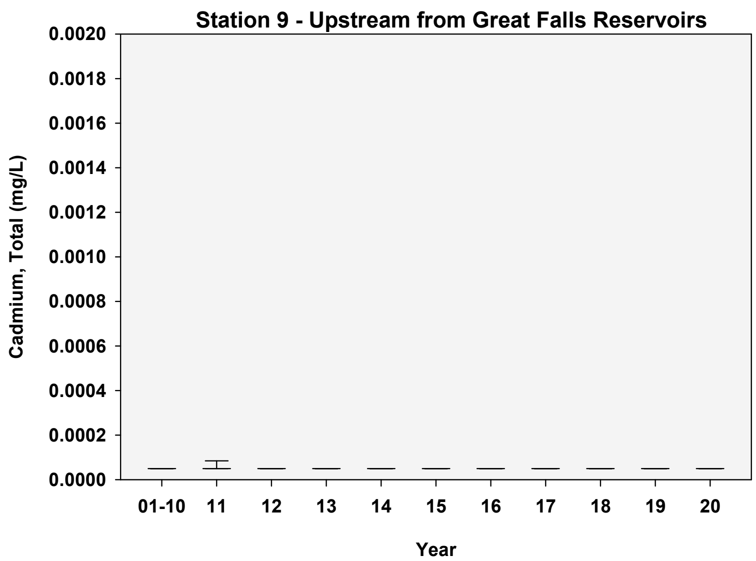



Station 5 - Upstream from Canyon Ferry Reservoir
Cadmium, Total (mg/L)
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Cadmium, Total (mg/L)
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Cadmium, Total (mg/L)
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Cadmium, Total (mg/L)
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Cadmium, Total (mg/L)
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
01-10
11
12
13
14
15
16
17
18
19
20
Year

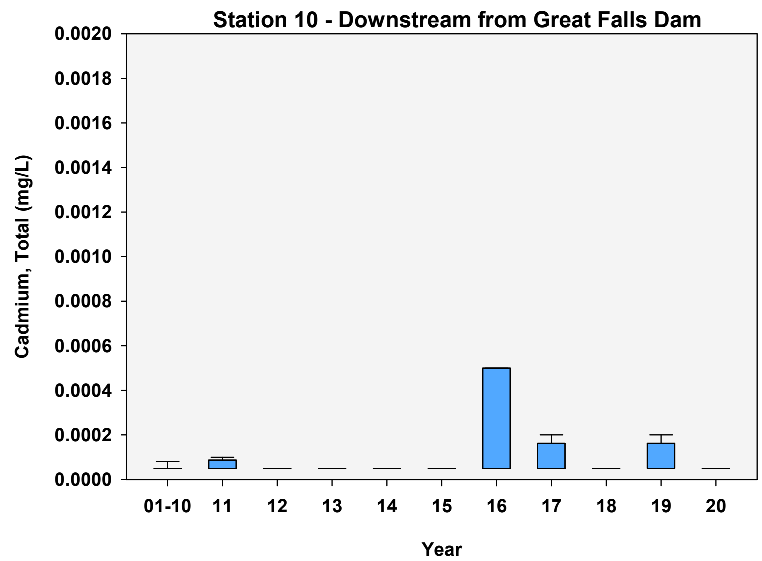
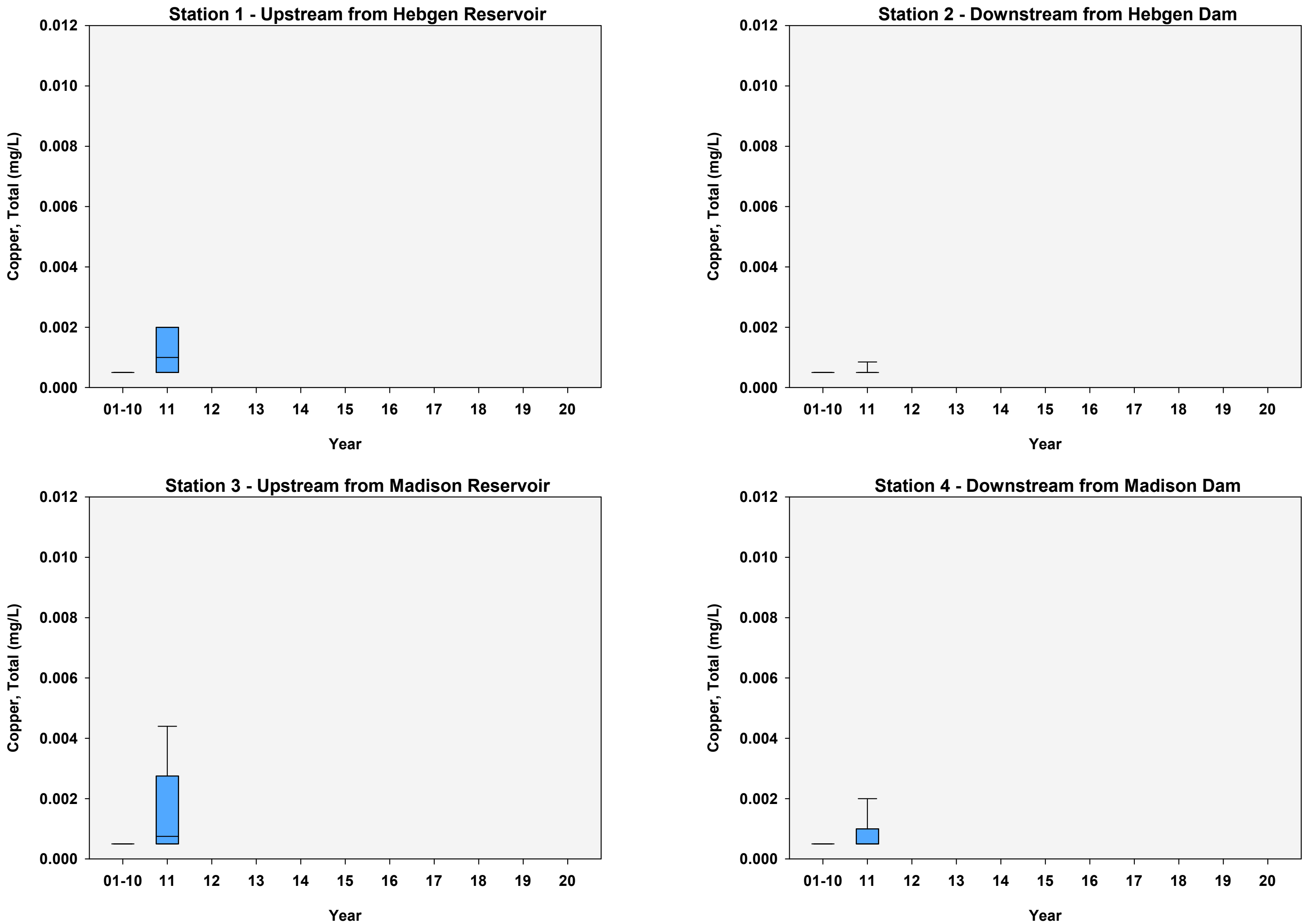
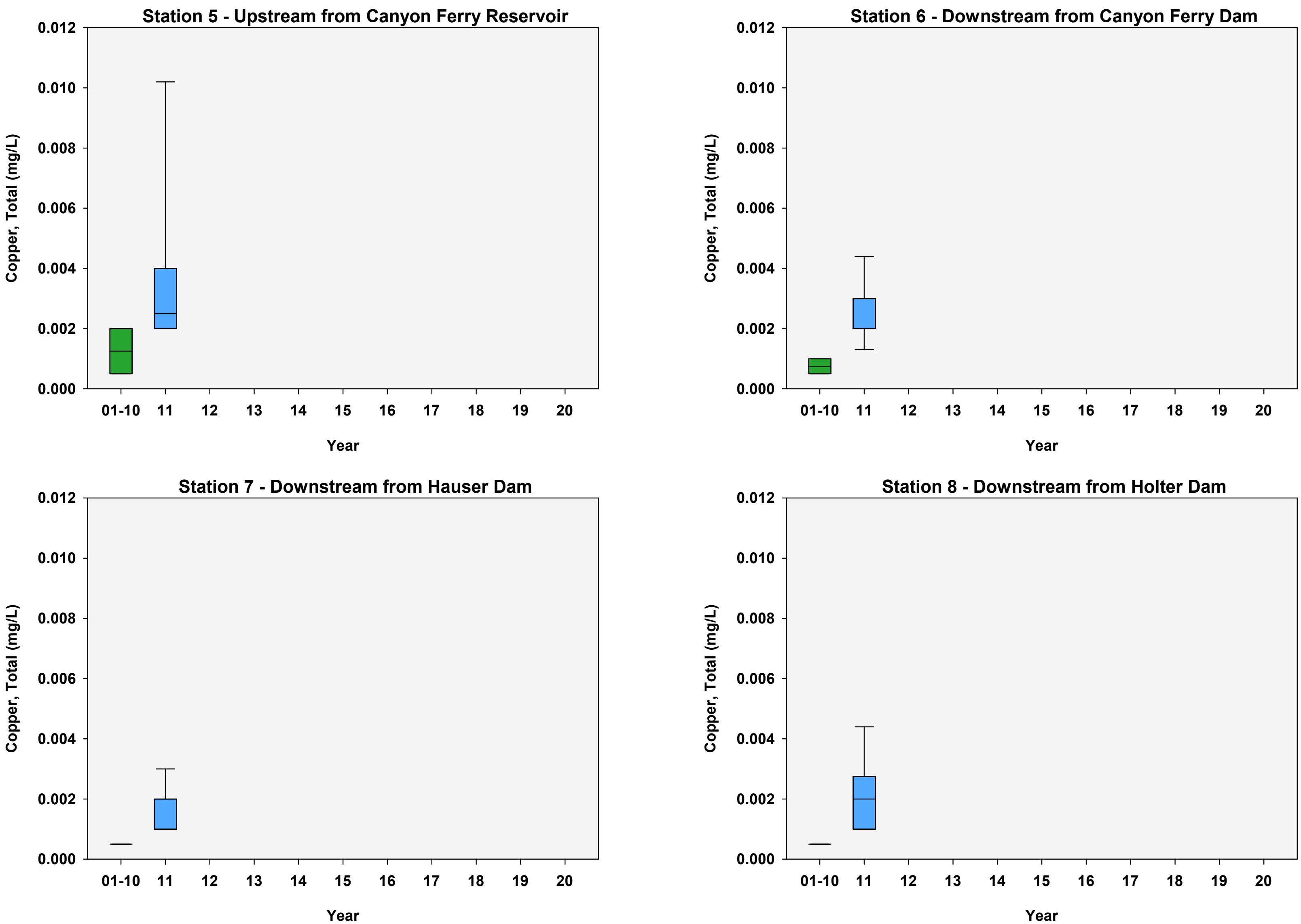
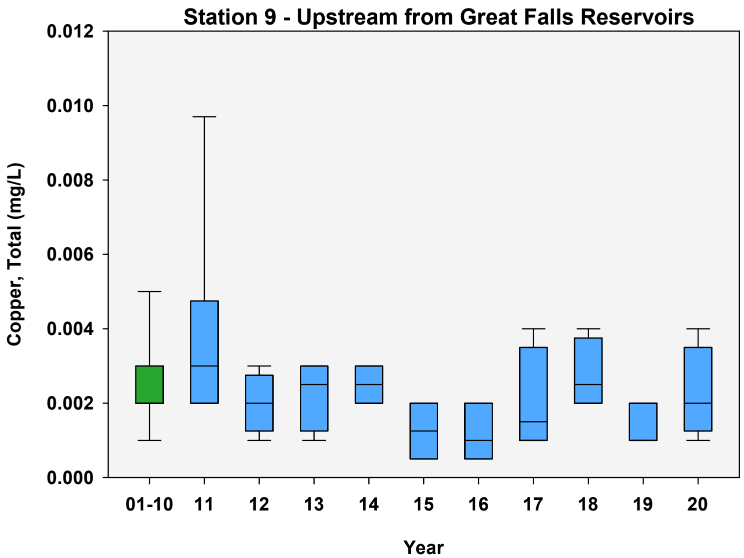

Station 10 - Downstream from Great Falls Dam
Cadmium, Total (mg/L)
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
01-10
11
12
13
14
15
16
17
18
19
20
Year

Figure B-18: Copper, Total (mg/L) for Stations 1 to 10.




Station 5 - Upstream from Canyon Ferry Reservoir
Station 6 - Downstream from Canyon Ferry Dam
Station 7 - Downstream from Hauser Dam
Station 8 - Downstream from Holter Dam
Copper, Total (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
Year
01-10
11
12
13
14
15
16
17
18
19
20


Station 9 - Upstream from Great Falls Reservoirs
Copper, Total (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
01-10
11
12
13
14
15
16
17
18
19
20
Year

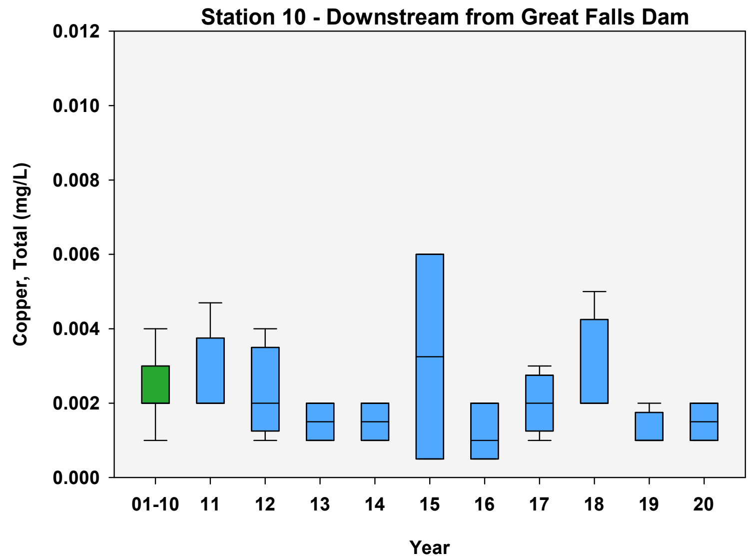
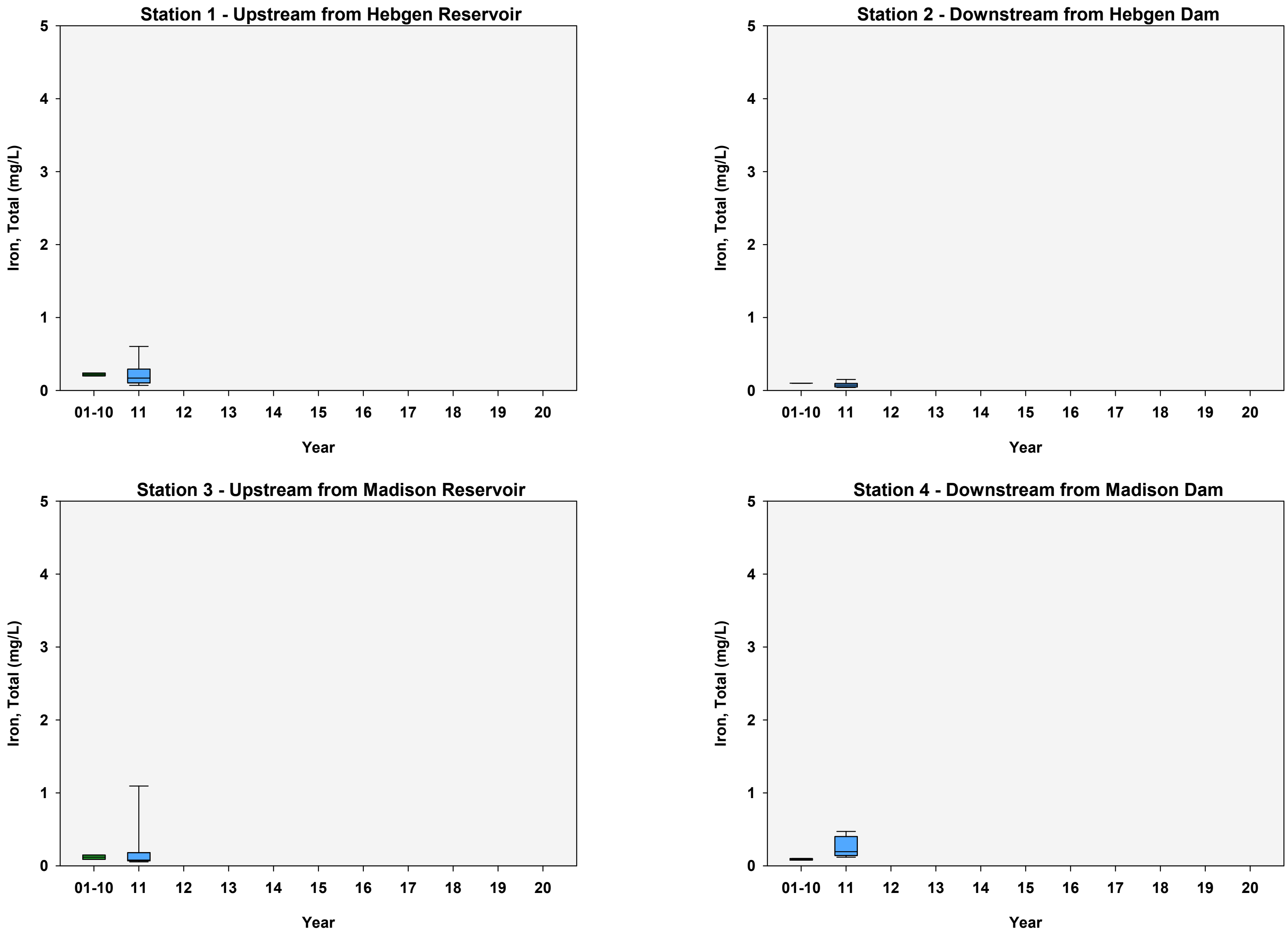
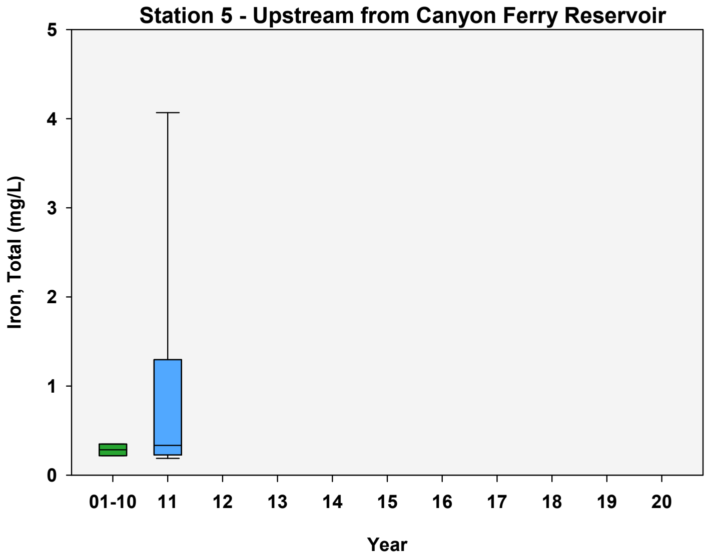
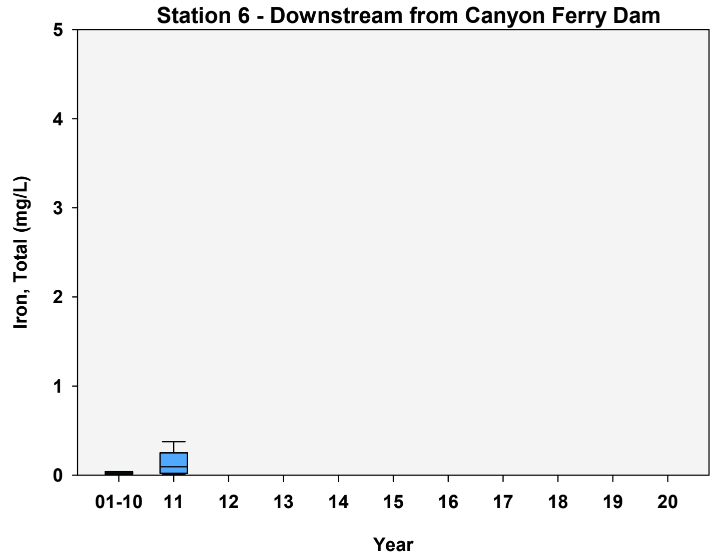
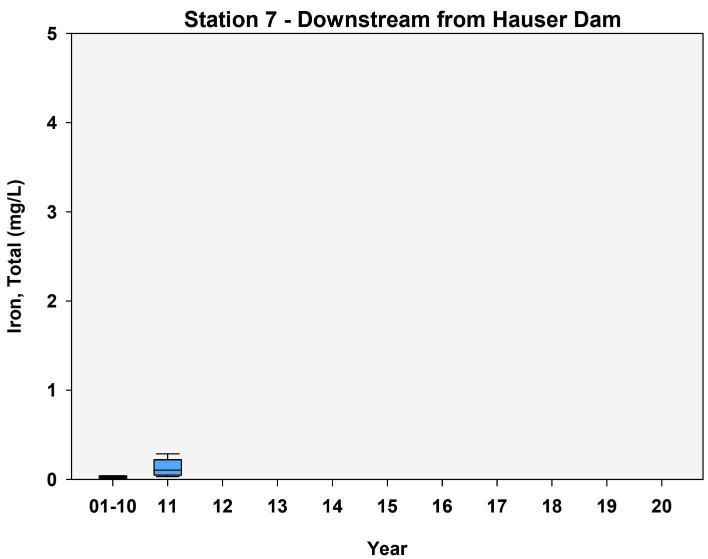

Station 10 - Downstream from Great Falls Dam
Copper, Total (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
01-10
11
12
13
14
15
16
17
18
19
20
Year

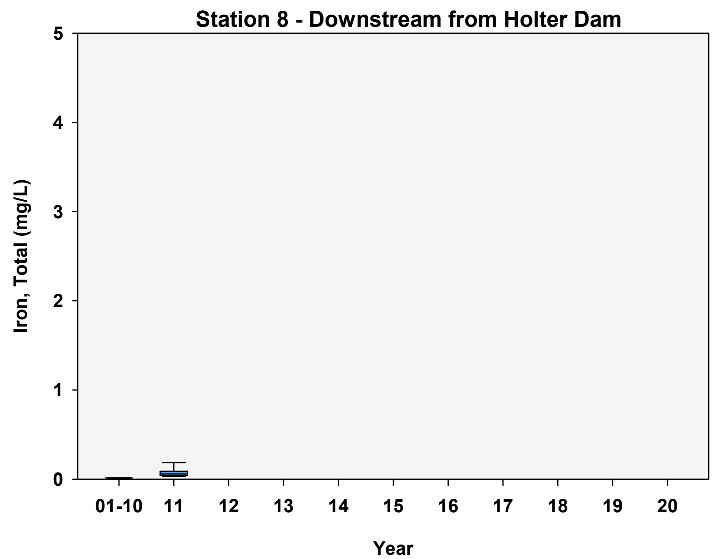
Figure B-19: Iron, Total (mg/L) for Stations 1 to 10.

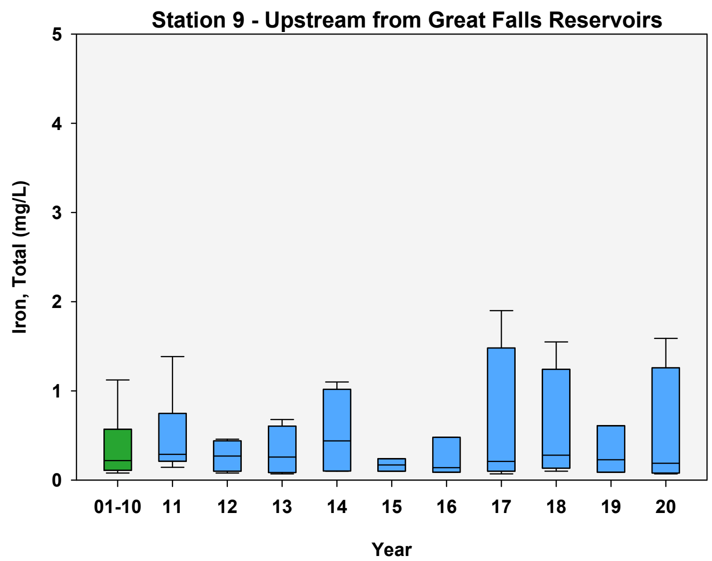



Station 5 - Upstream from Canyon Ferry Reservoir
Iron, Total (mg/L)
0
1
2
3
4
5
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Iron, Total (mg/L)
0
1
2
3
4
5
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Iron, Total (mg/L)
0
1
2
3
4
5
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Iron, Total (mg/L)
0
1
2
3
4
5
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Iron, Total (mg/L)
0
1
2
3
4
5
01-10
11
12
13
14
15
16
17
18
19
20
Year

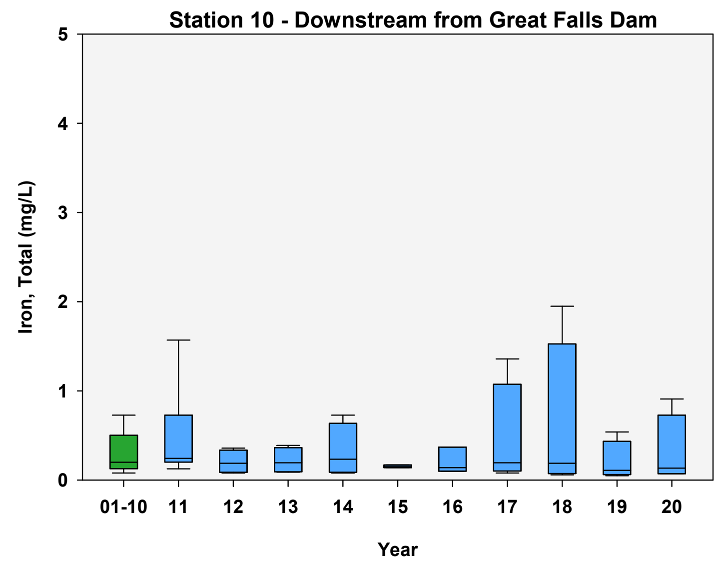
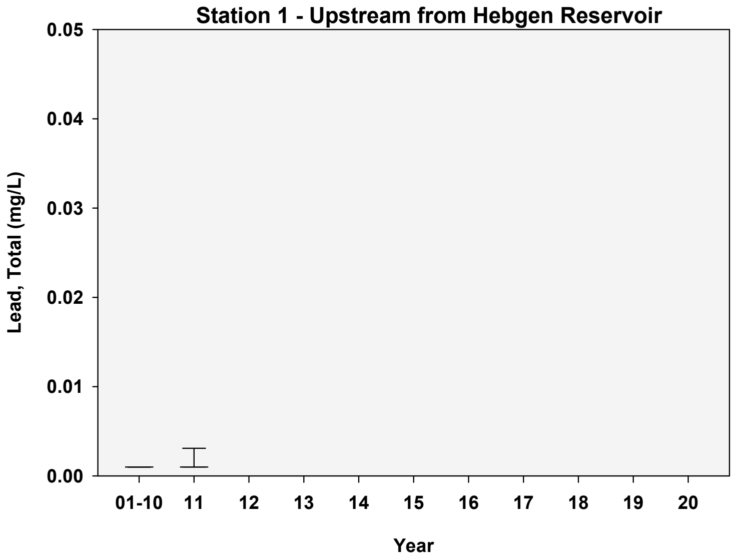
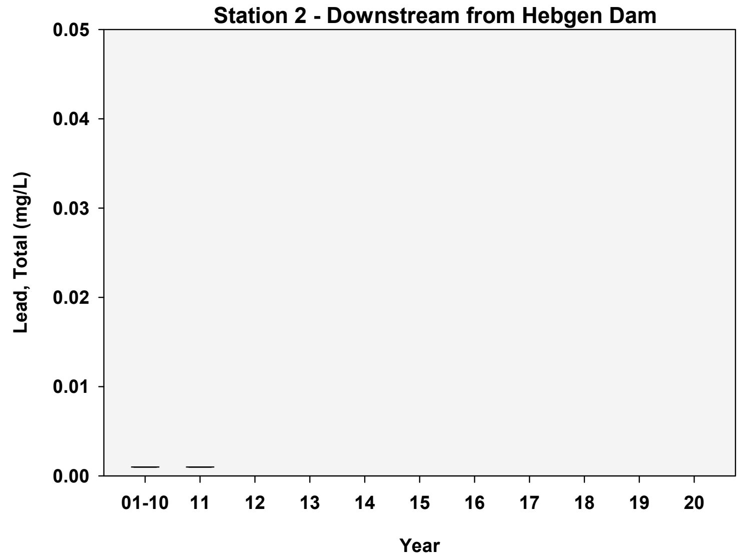
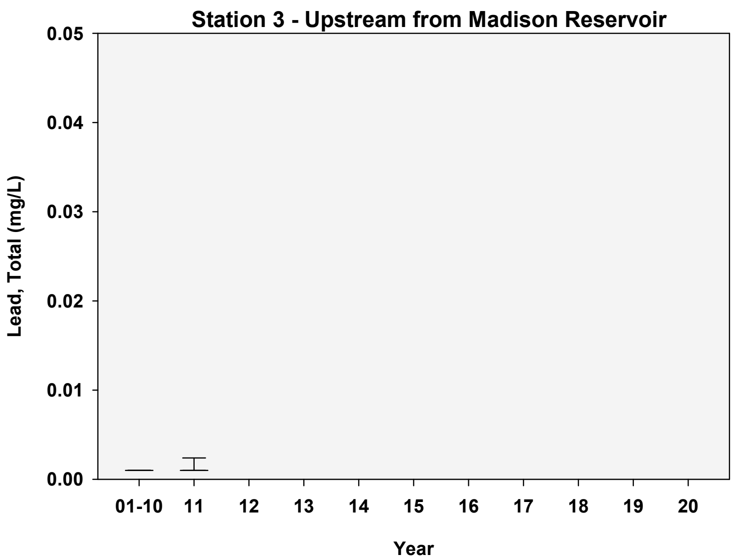
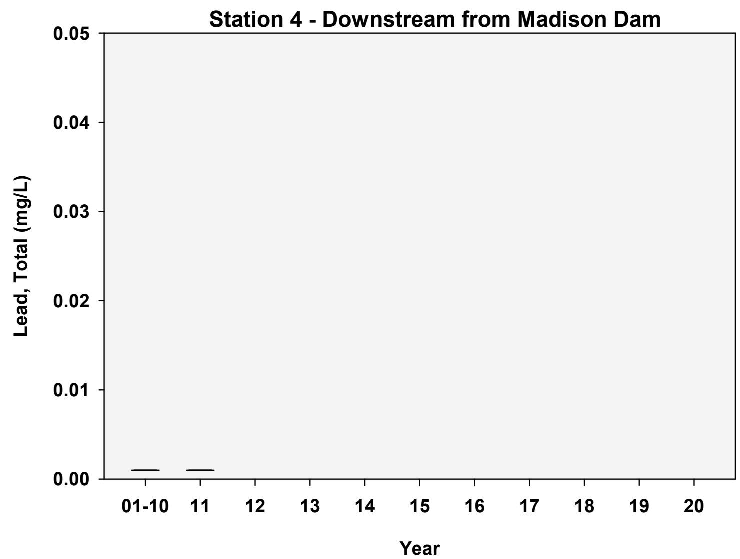

Station 10 - Downstream from Great Falls Dam
Iron, Total (mg/L)
0
1
2
3
4
5
01-10
11
12
13
14
15
16
17
18
19
20
Year

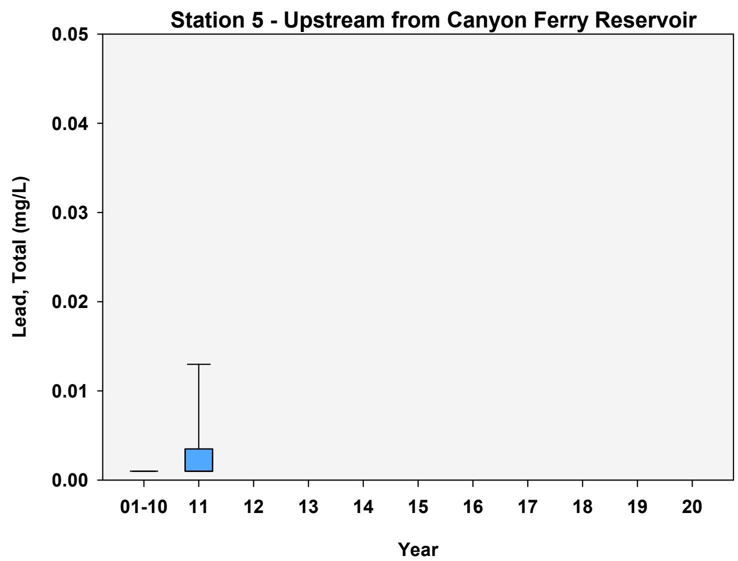
Figure B-20: Lead, Total (mg/L) for Stations 1 to 10.

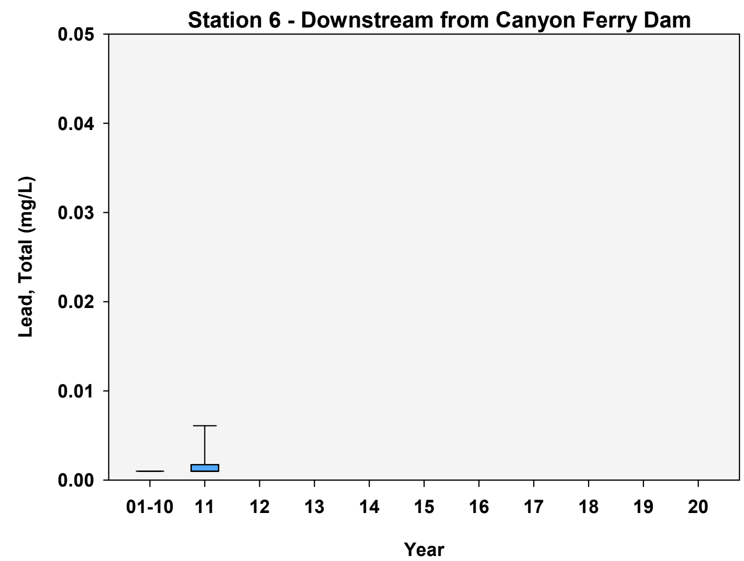


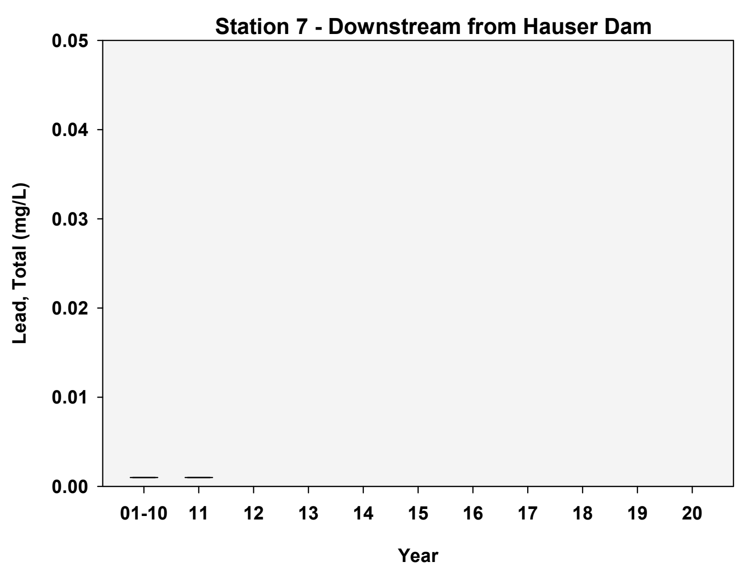


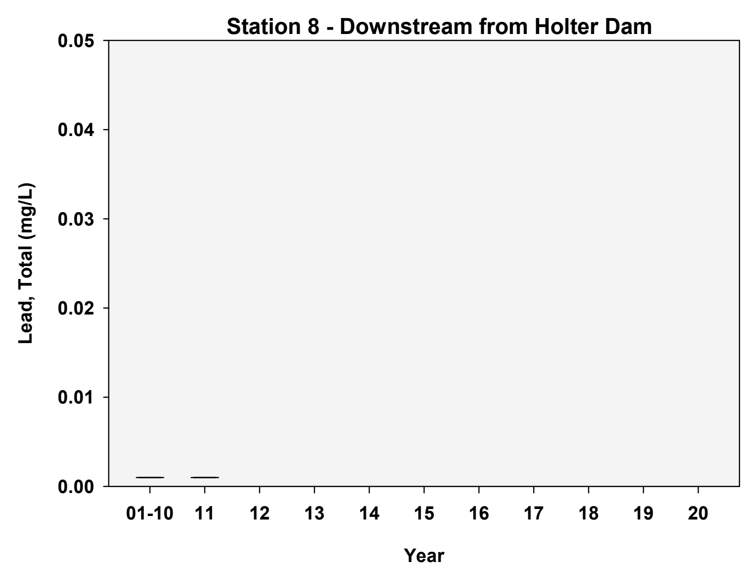


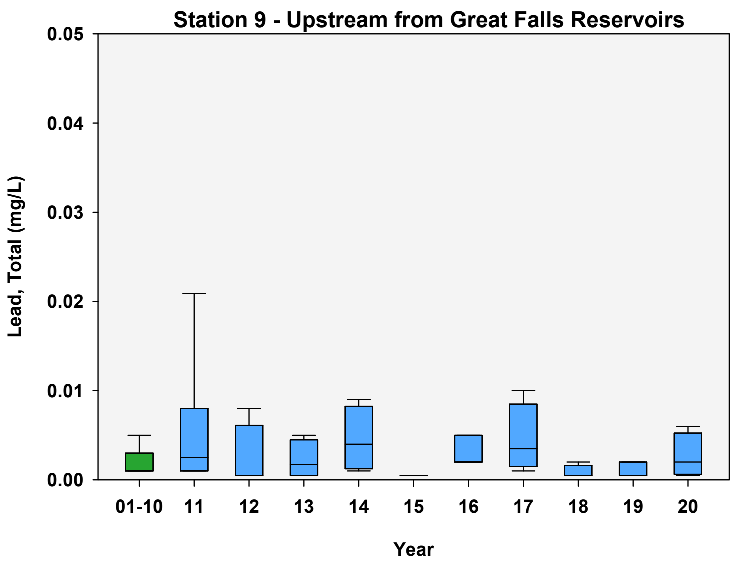



Station 5 - Upstream from Canyon Ferry Reservoir
0.05
0.04
0.03
0.02
0.01
0.00
Lead, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year

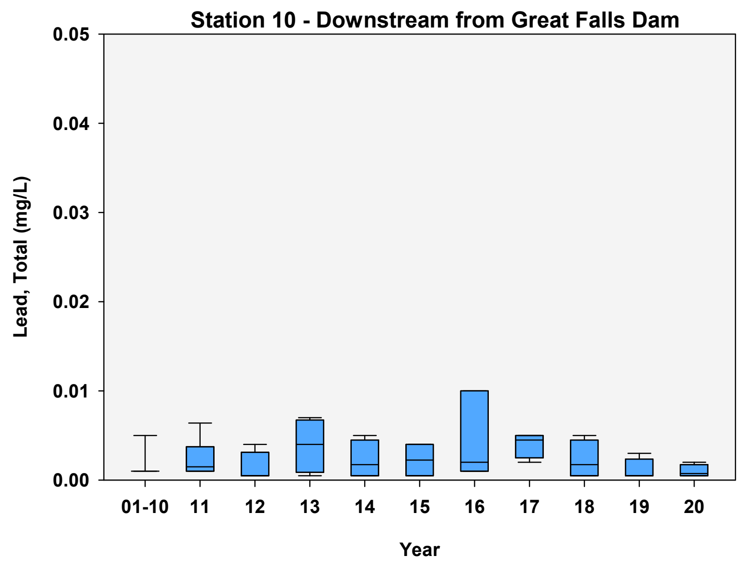

Station 6 - Downstream from Canyon Ferry Dam
0.05
0.04
0.03
0.02
0.01
0.00
Lead, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
0.05
0.04
0.03
0.02
0.01
0.00
Lead, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
0.05
0.04
0.03
0.02
0.01
0.00
Lead, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year

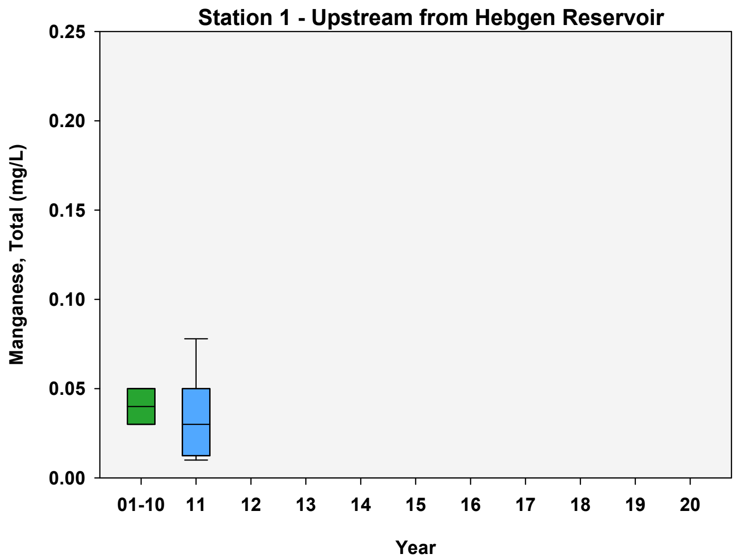


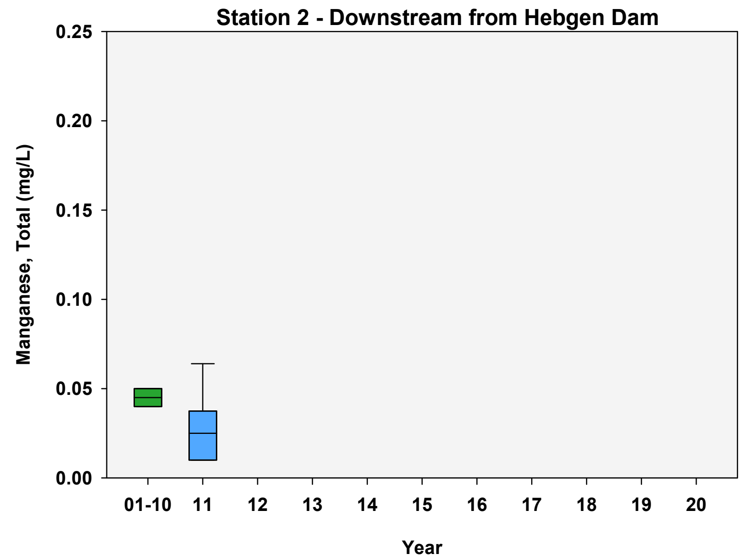
Station 9 - Upstream from Great Falls Reservoirs
Lead, Total (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

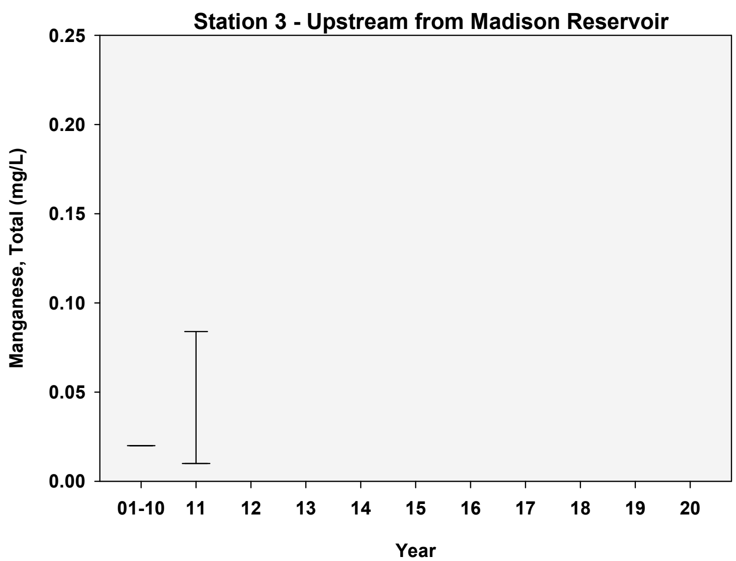


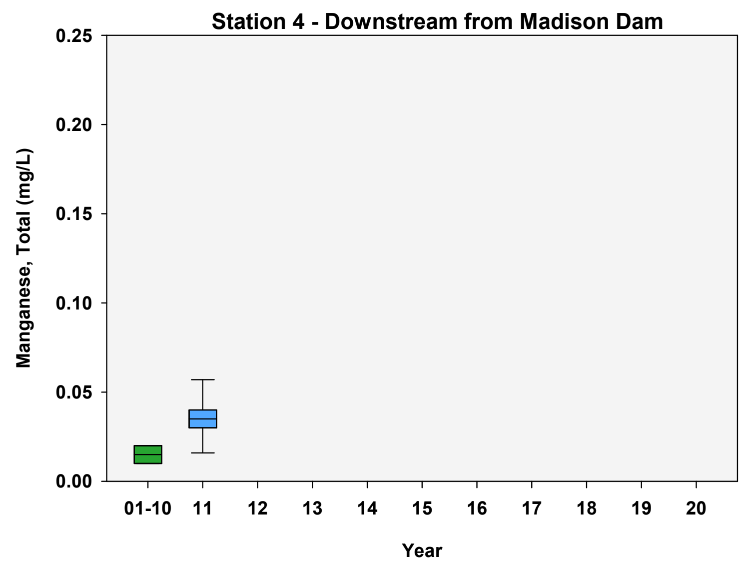
Station 10 - Downstream from Great Falls Dam
Lead, Total (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

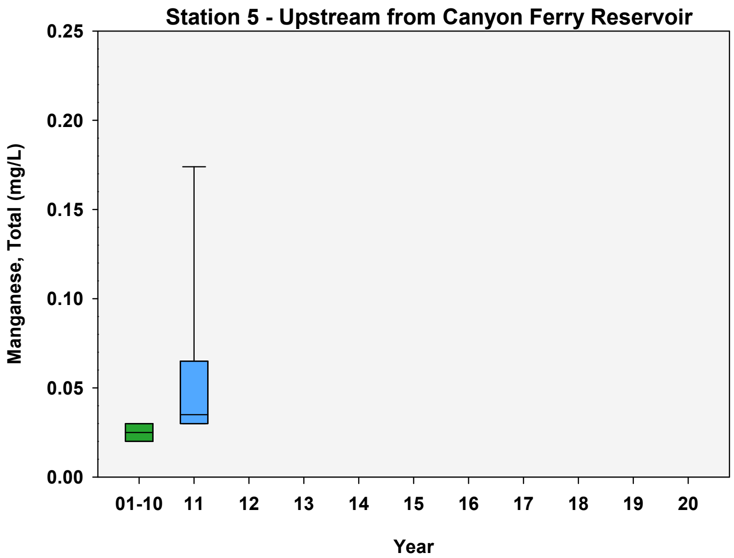
Figure B-21: Manganese, Total (mg/L) for Stations 1 to 10.

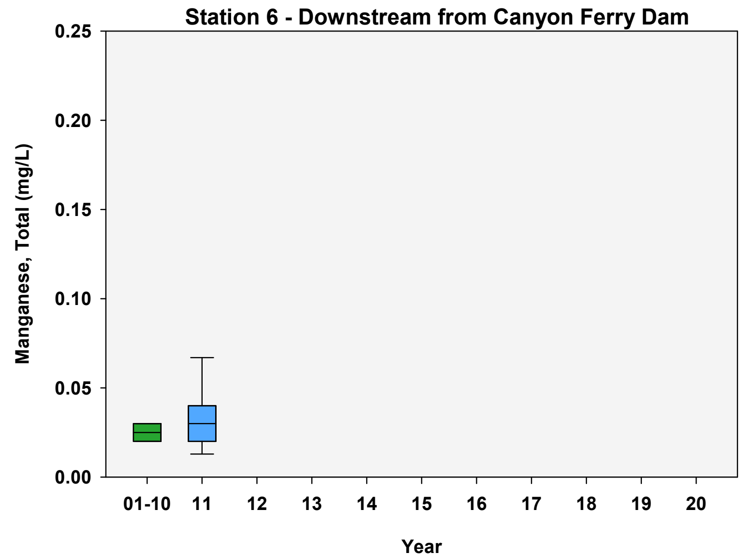


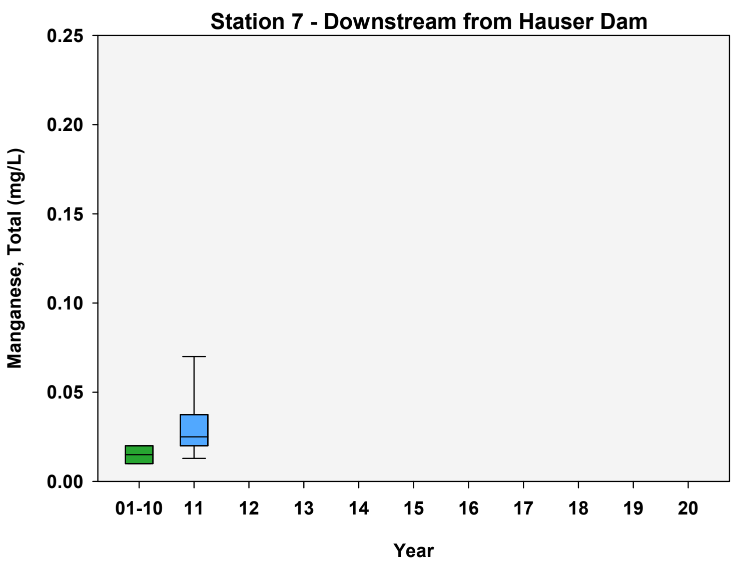


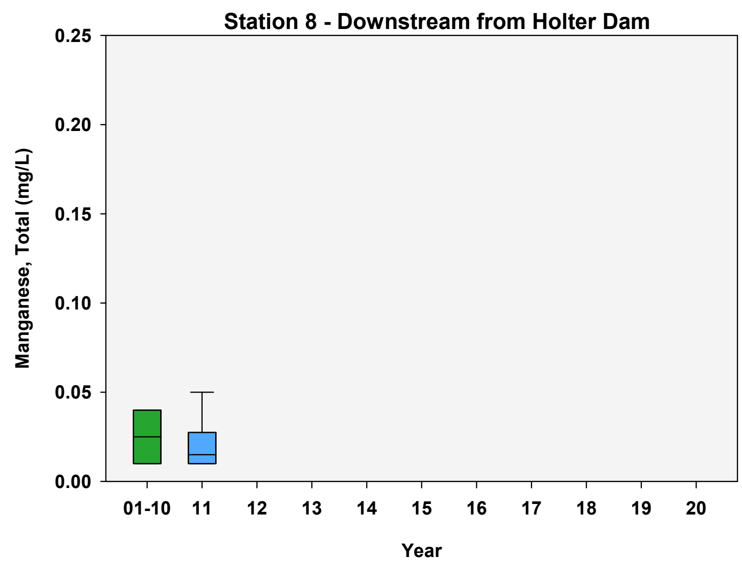


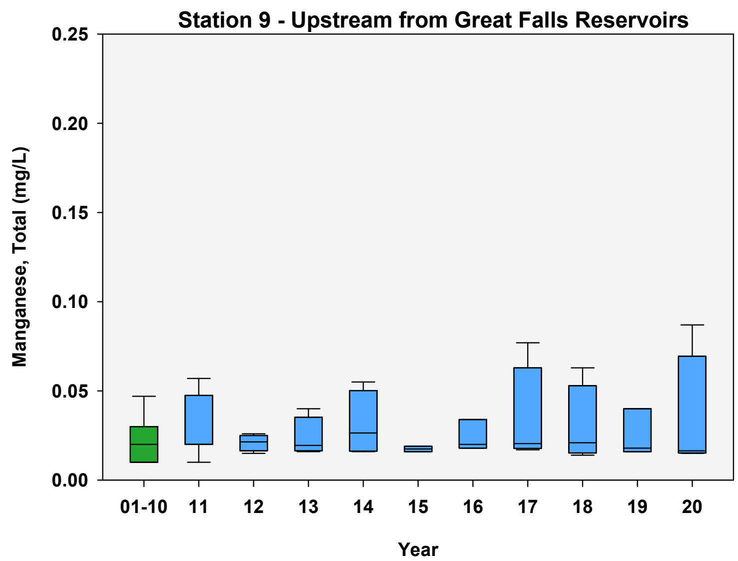



Station 5 - Upstream from Canyon Ferry Reservoir
Manganese, Total (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Manganese, Total (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Manganese, Total (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Manganese, Total (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Manganese, Total (mg/L)
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

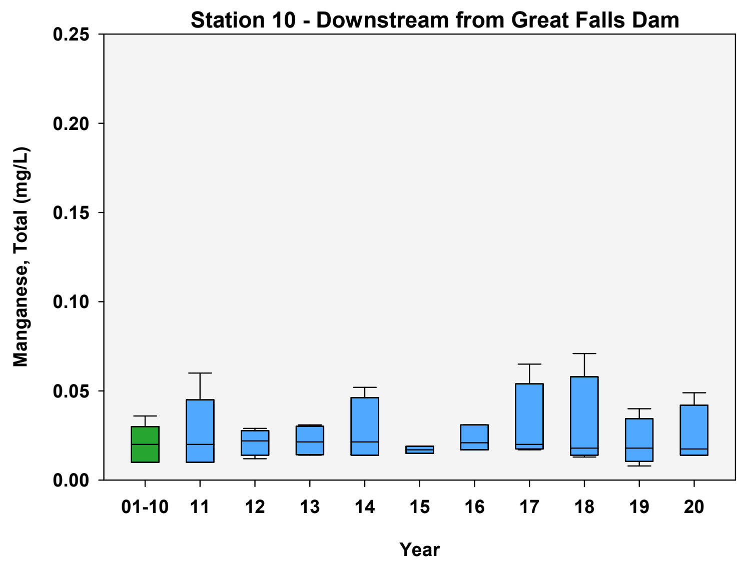
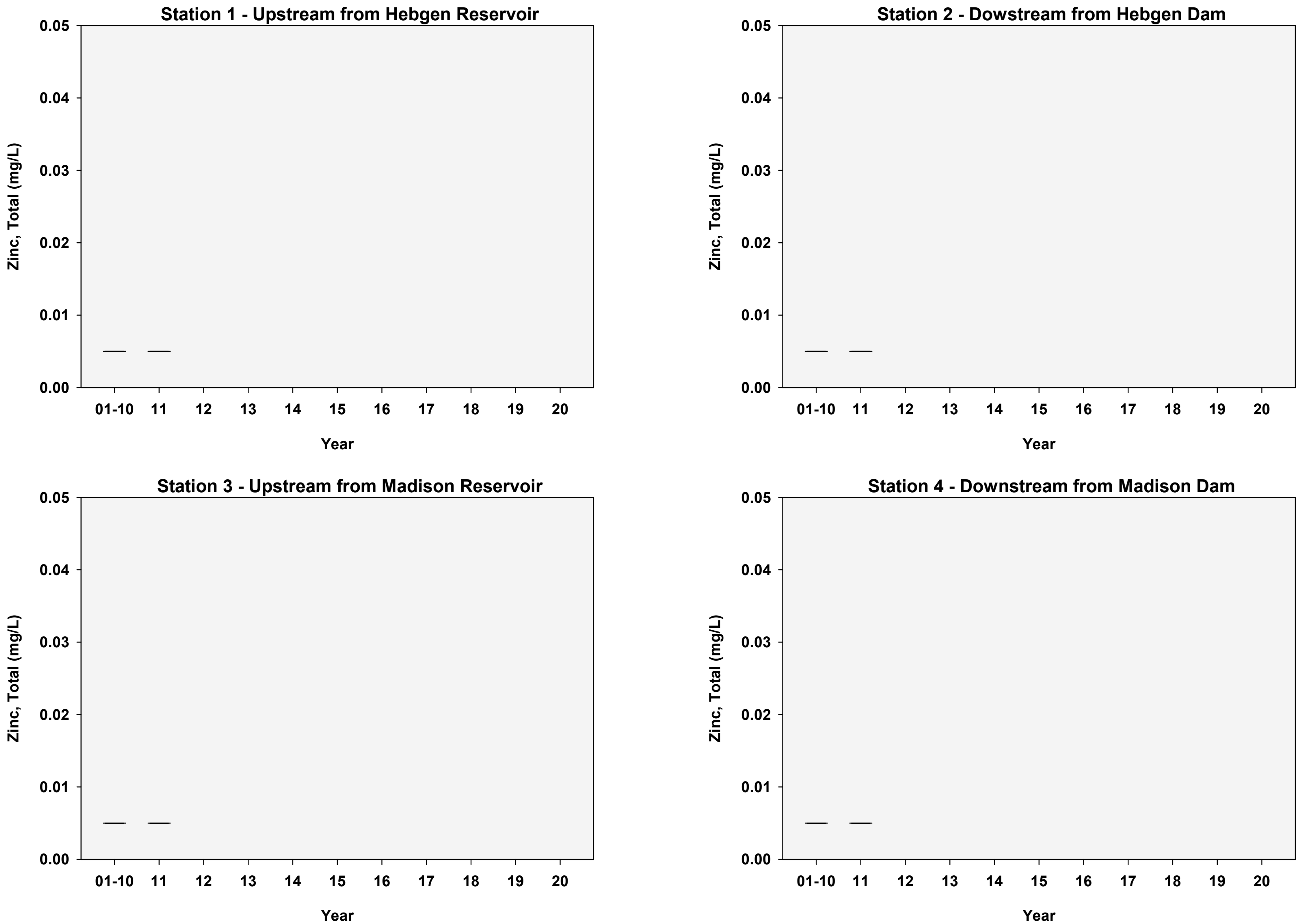
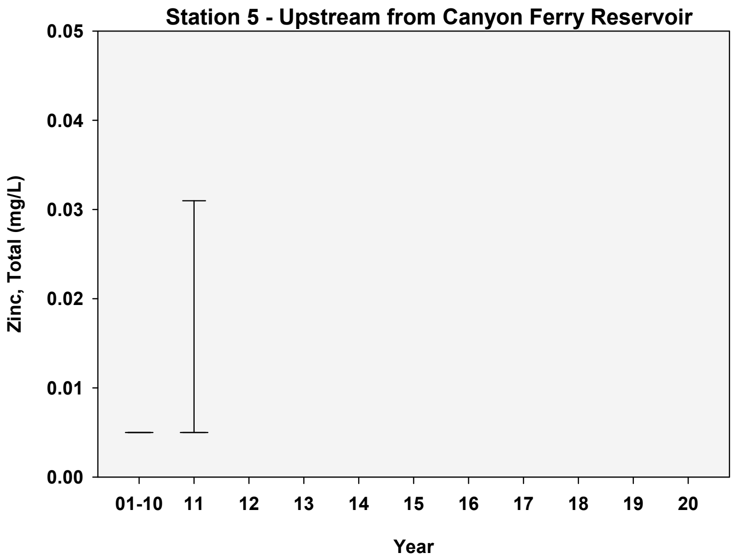
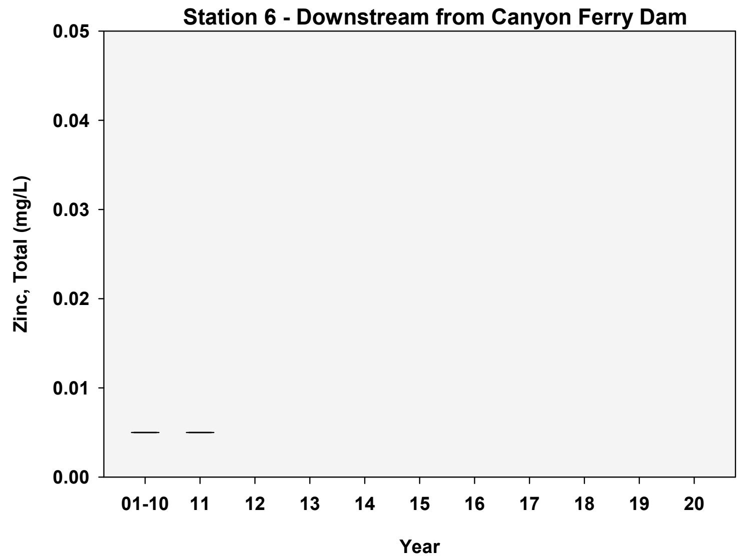

Station 10 - Downstream from Great Falls Dam
Manganese, Total (mg/L)
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

Figure B-22: Zinc, Total (mg/L) for Stations 1 to 10.

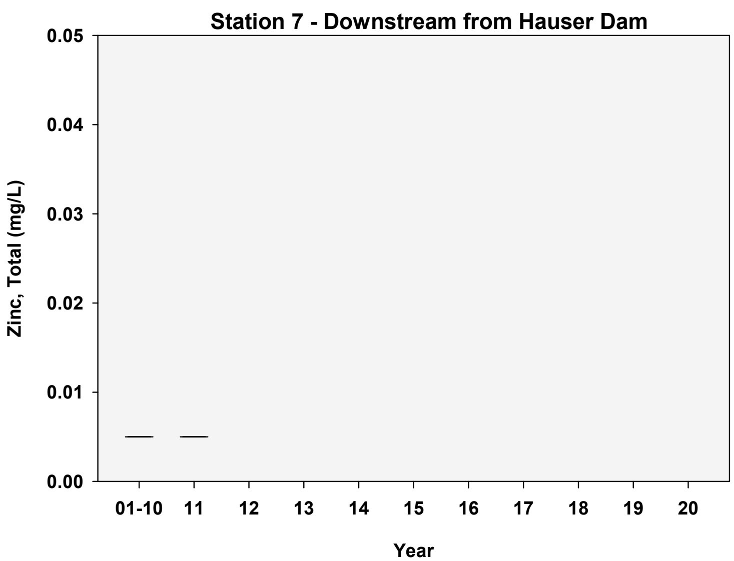




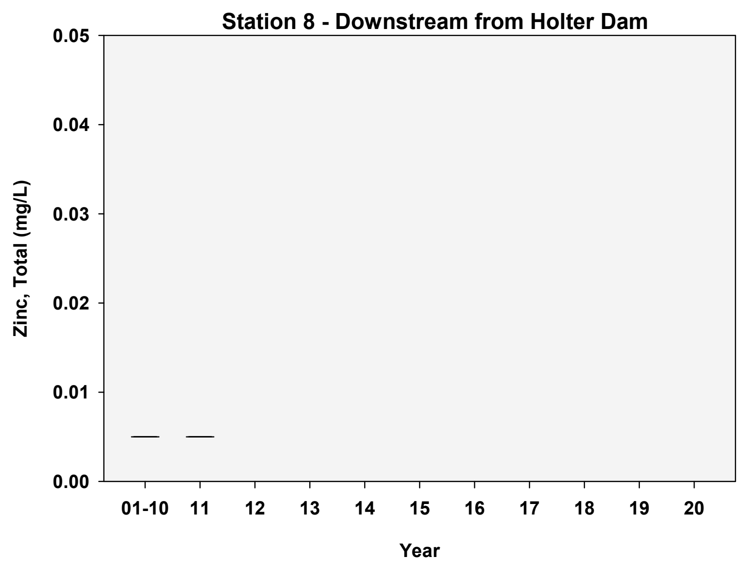
Station 5 - Upstream from Canyon Ferry Reservoir
Zinc, Total (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year



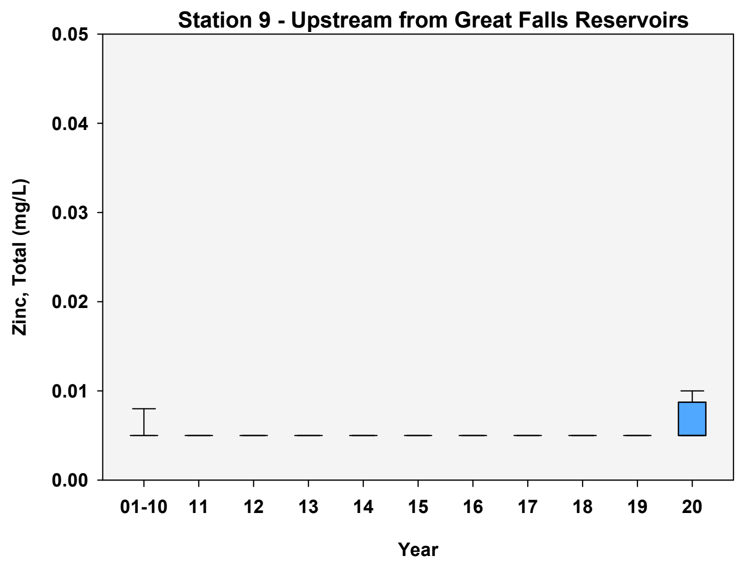
Station 6 - Downstream from Canyon Ferry Dam
Zinc, Total (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year



Station 7 - Downstream from Hauser Dam
Zinc, Total (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year



Station 8 - Downstream from Holter Dam
Zinc, Total (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
0.05
0.04
0.03
0.02
0.01
0.00
Zinc, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year

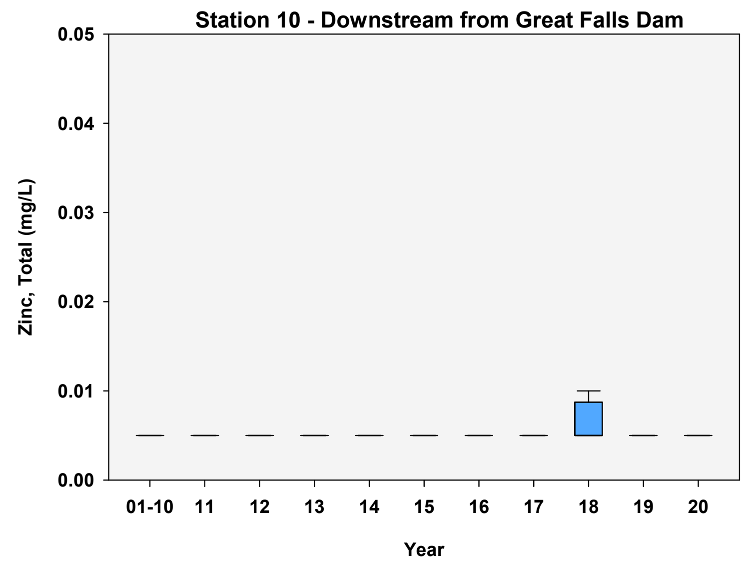
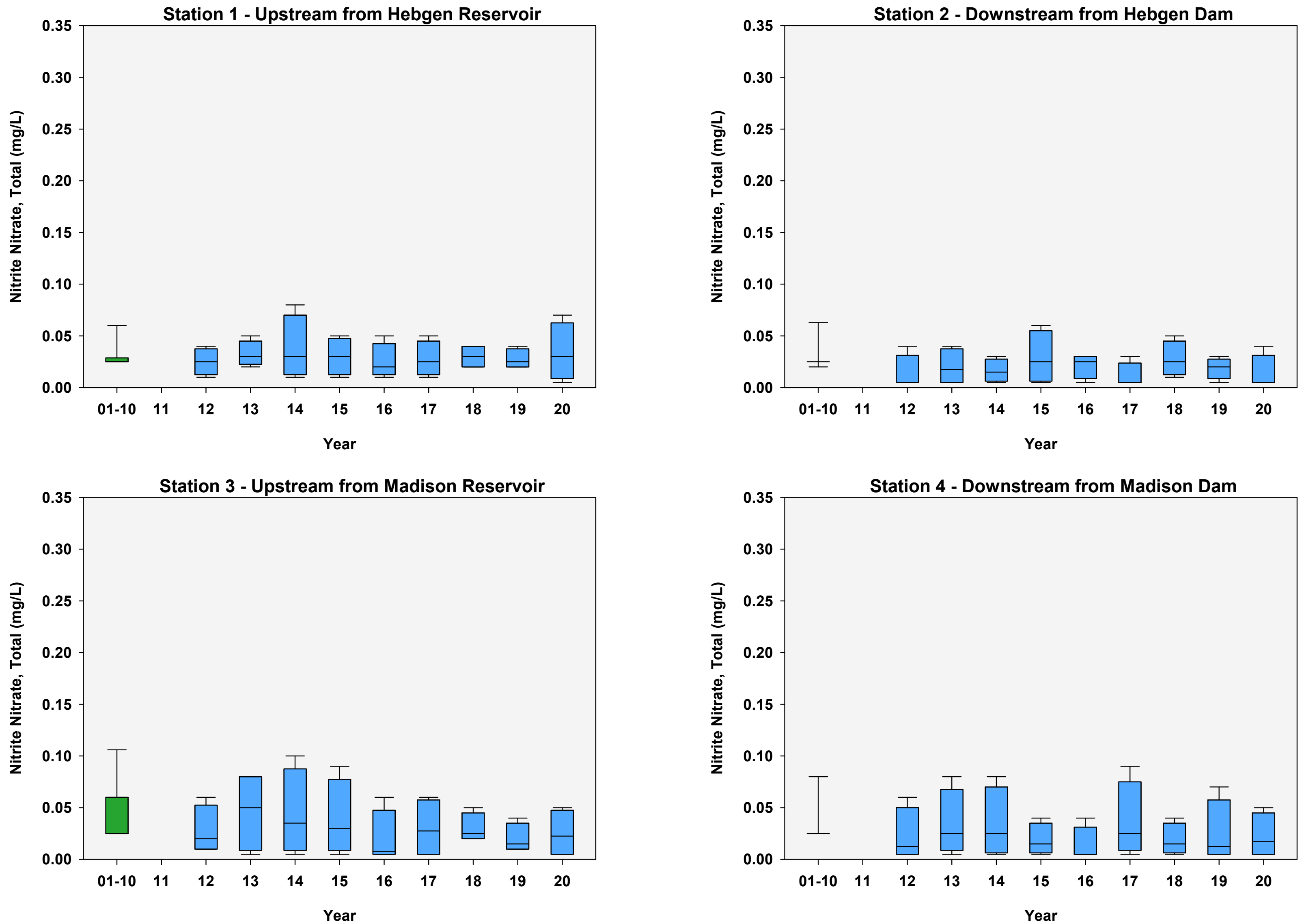
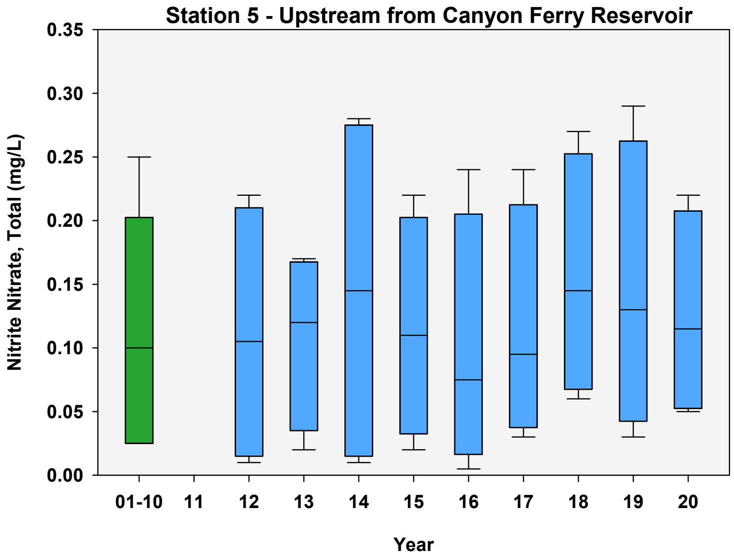
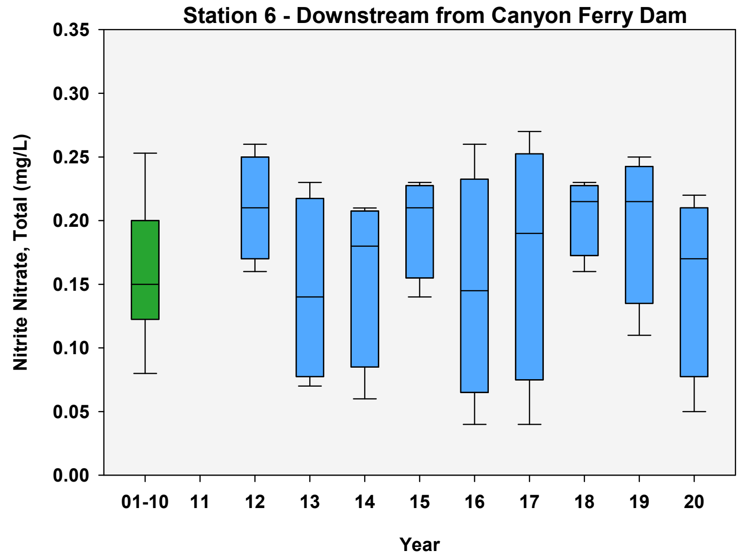
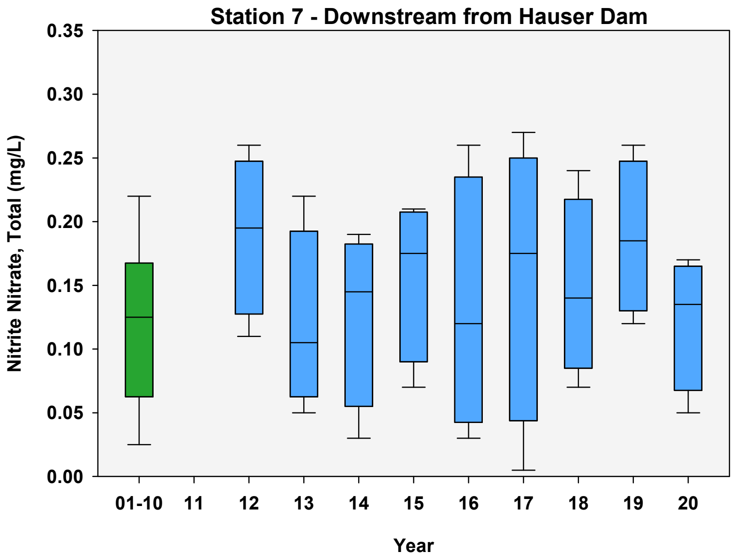

Station 10 - Downstream from Great Falls Dam
0.05
0.04
0.03
0.02
0.01
0.00
Zinc, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year

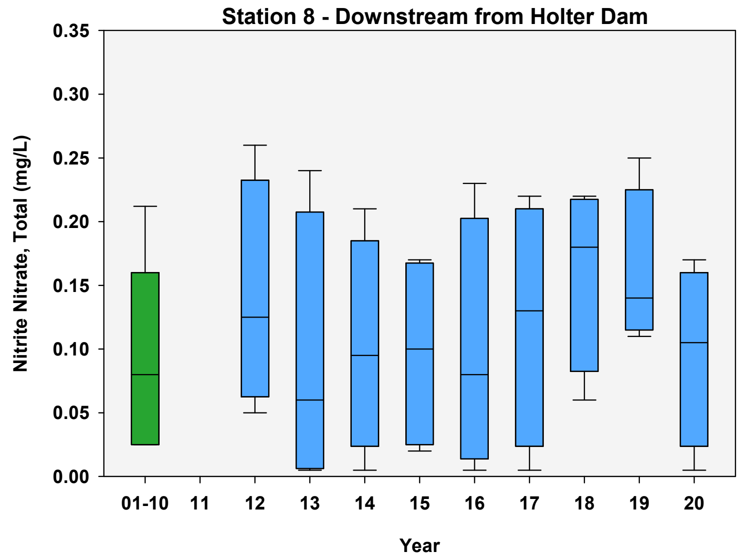
Figure B-23: Nitrite-Nitrate, Total (mg/L) for Stations 1 to 10.

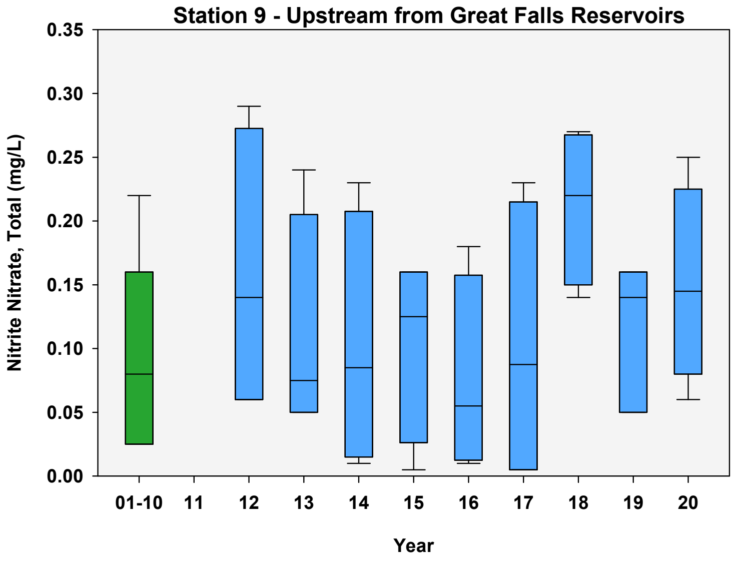



Station 5 - Upstream from Canyon Ferry Reservoir
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Nitrite Nitrate, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Nitrite Nitrate, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Nitrite Nitrate, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Nitrite Nitrate, Total (mg/L)
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Nitrite Nitrate, Total (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

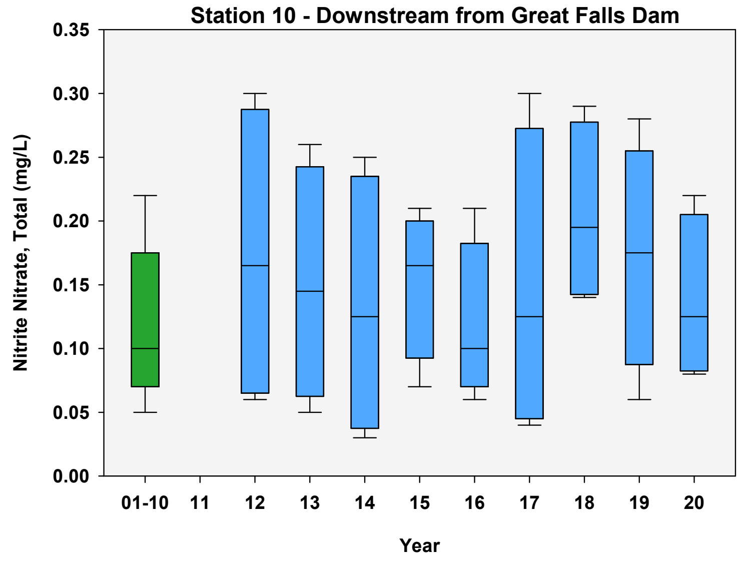
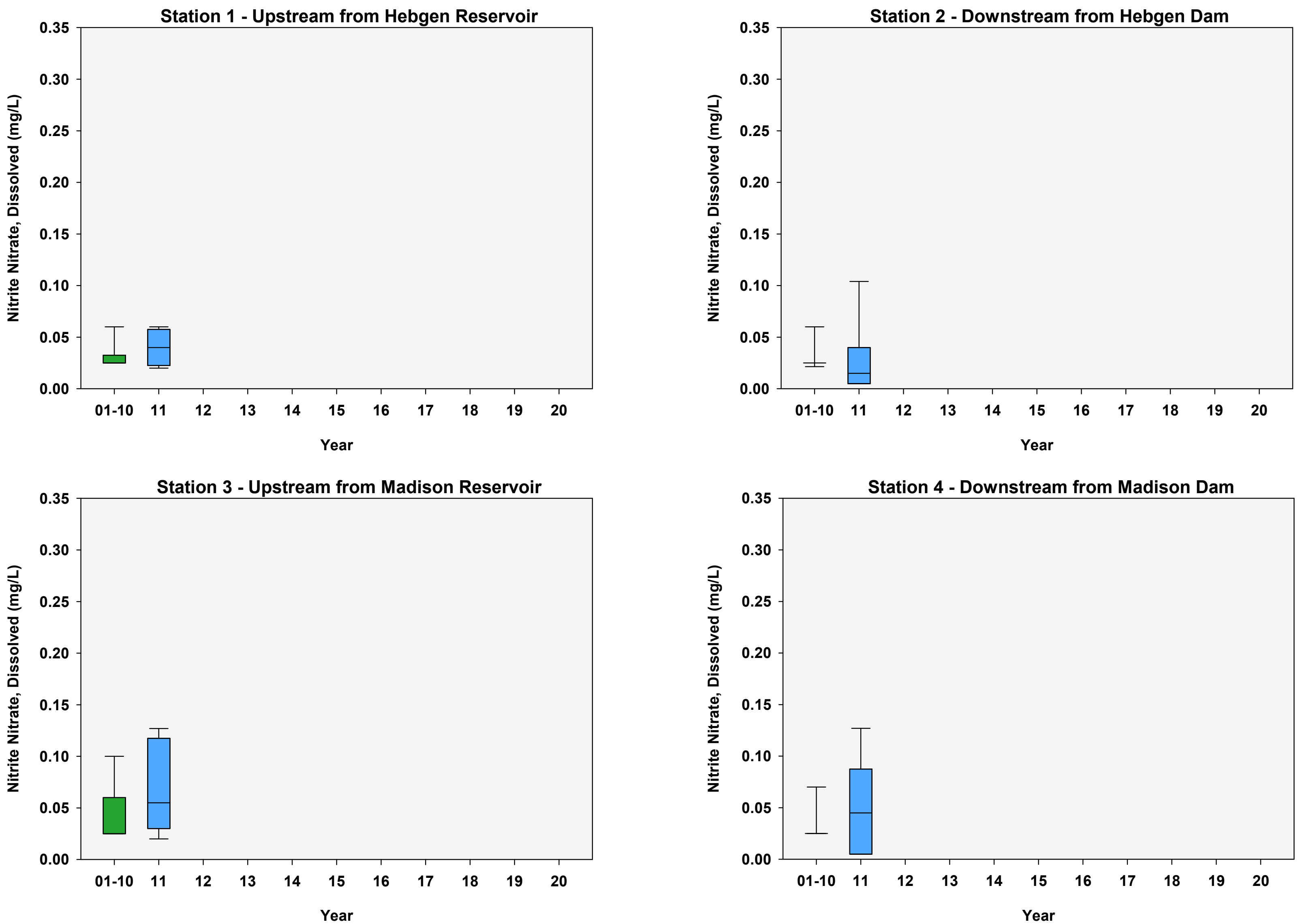
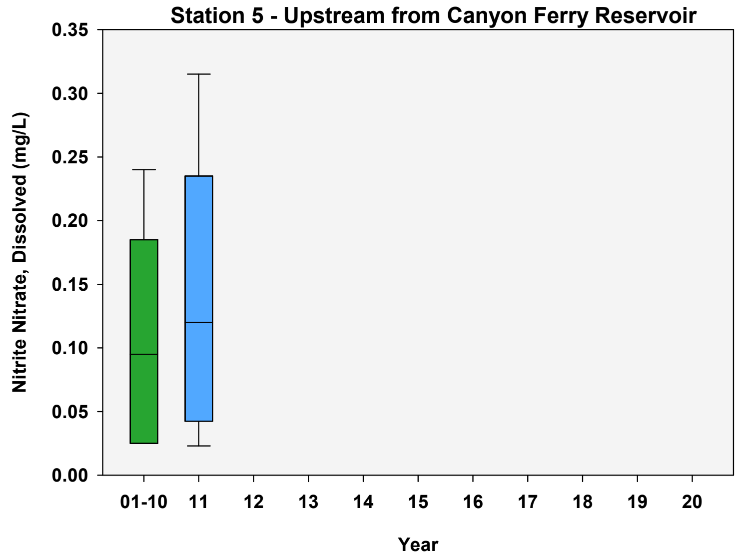
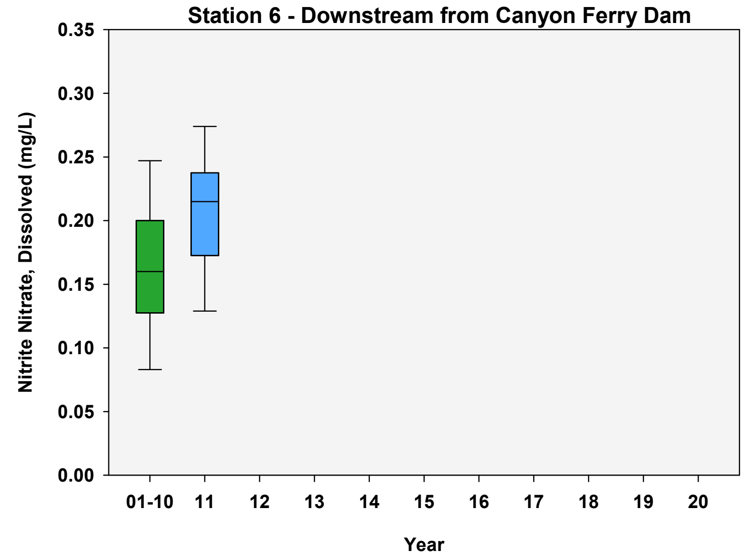
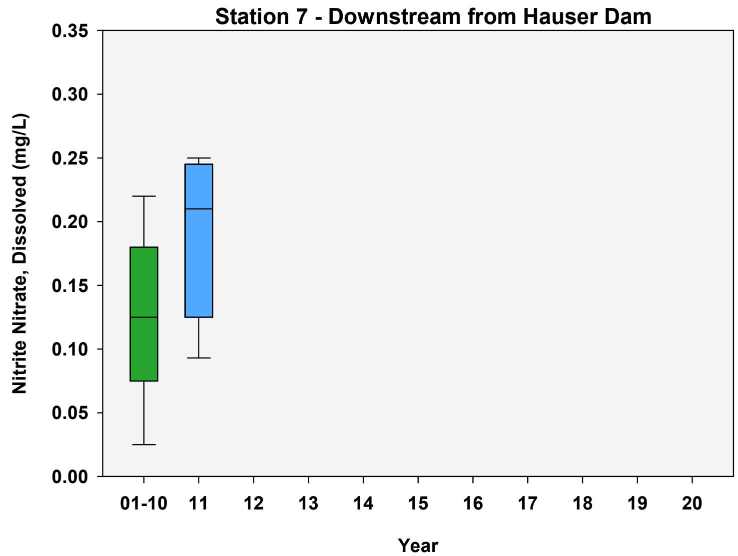

Station 10 - Downstream from Great Falls Dam
Nitrite Nitrate, Total (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

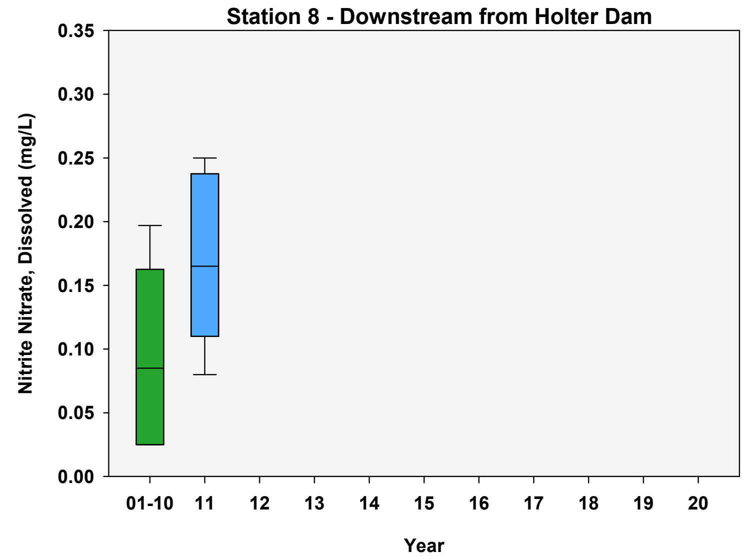
Figure B-24: Nitrite-Nitrate, Dissolved (mg/L) for Stations 1 to 10.

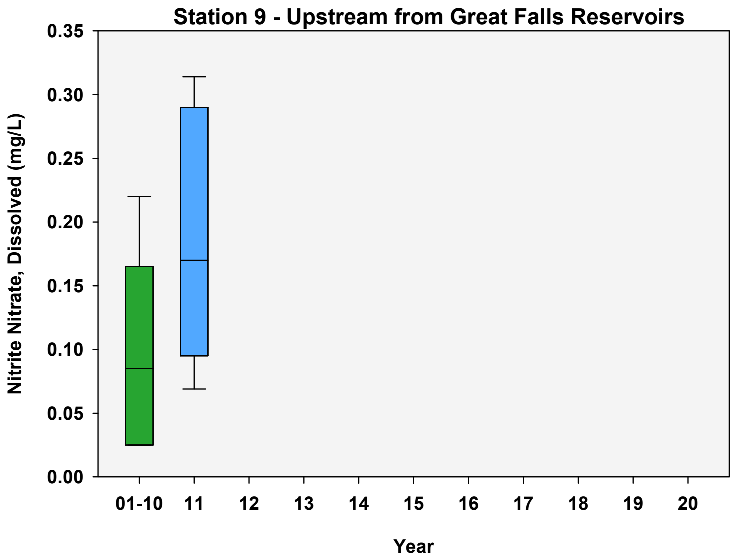



Station 5 - Upstream from Canyon Ferry Reservoir
Nitrite Nitrate, Dissolved (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Nitrite Nitrate, Dissolved (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Nitrite Nitrate, Dissolved (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Nitrite Nitrate, Dissolved (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Nitrite Nitrate, Dissolved (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

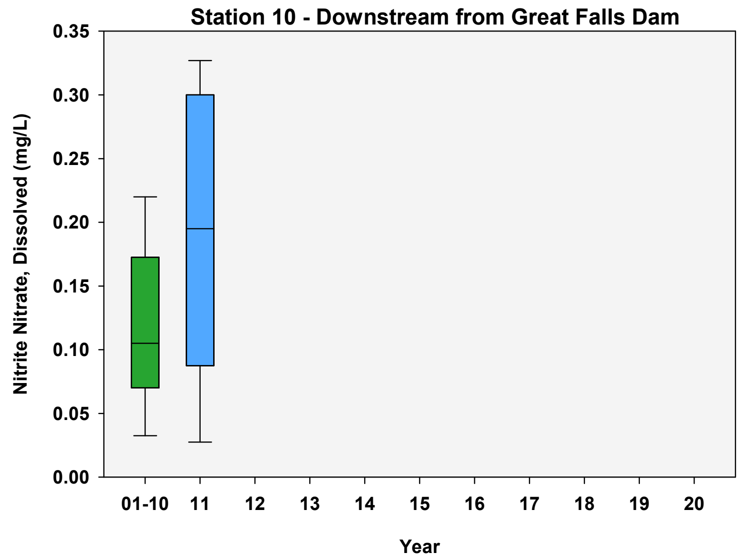
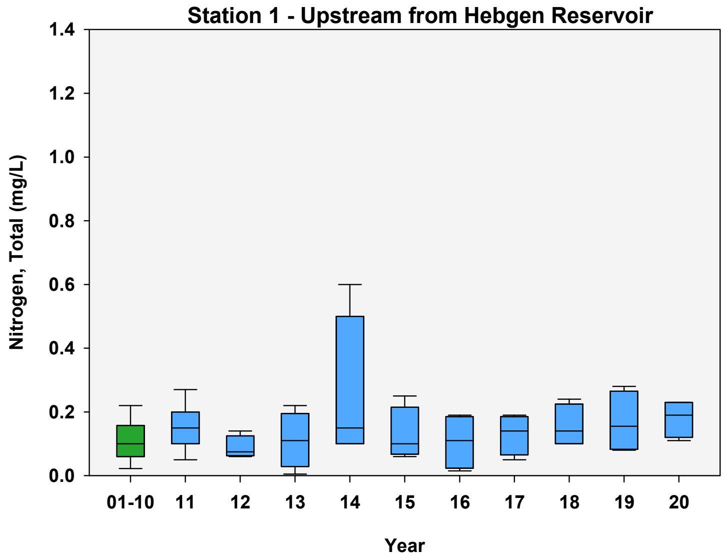
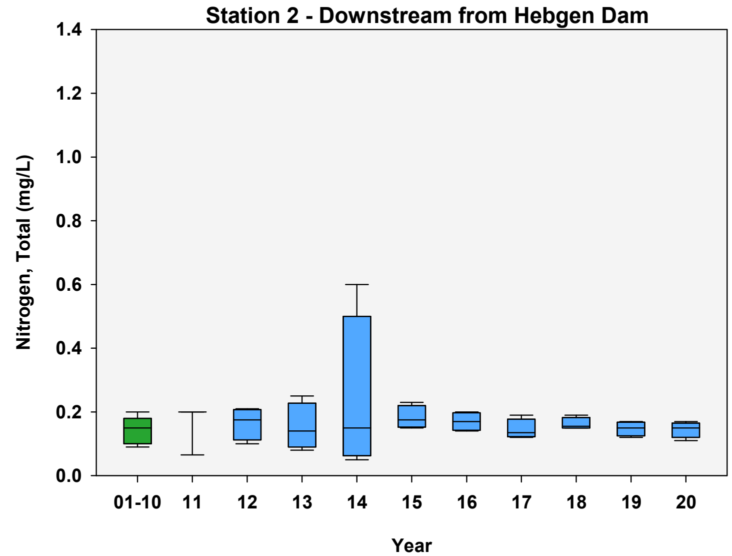
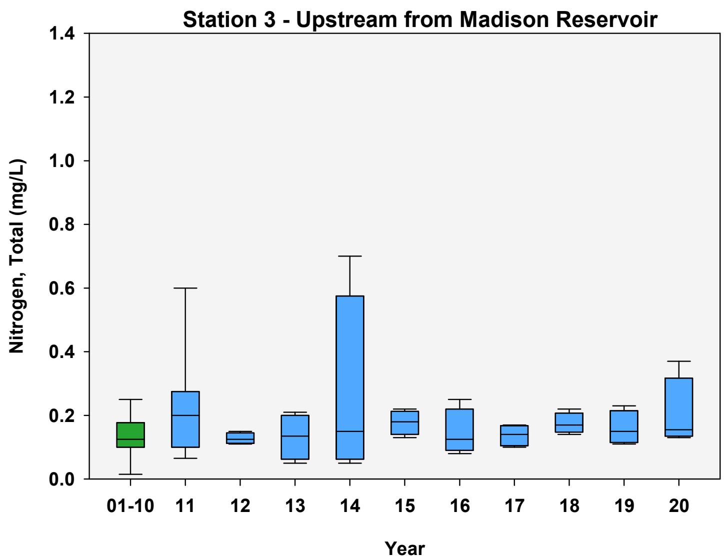
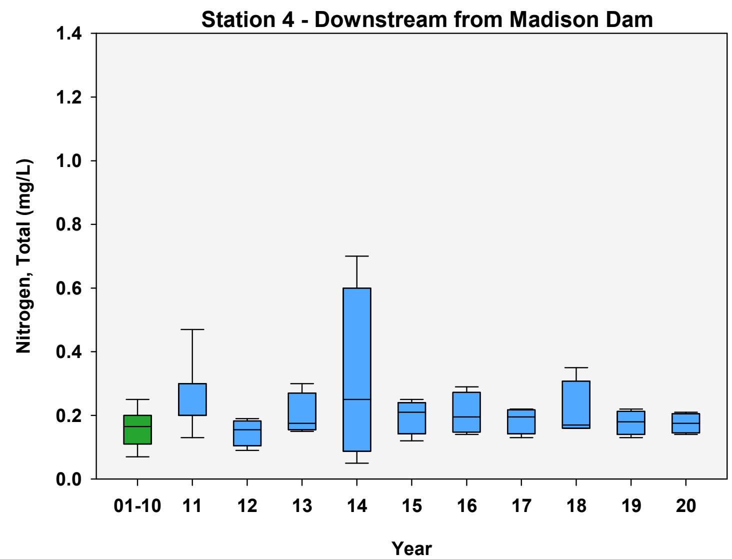

Station 10 - Downstream from Great Falls Dam
Nitrite Nitrate, Dissolved (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

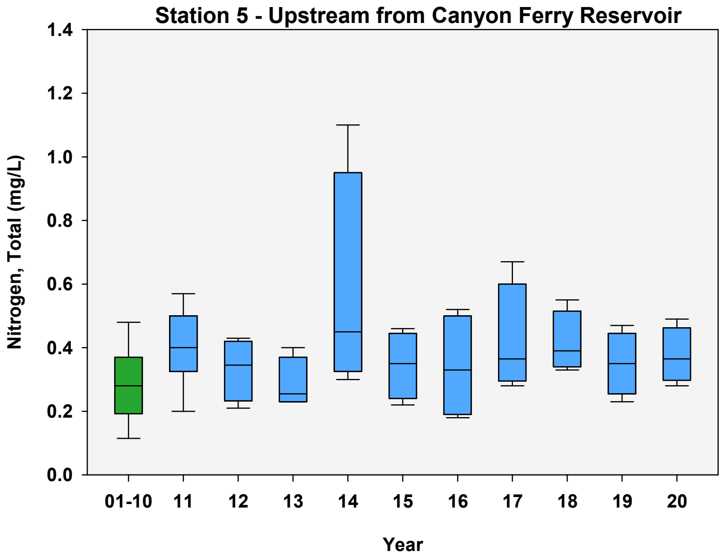
Figure B-25: Nitrogen, Total (mg/L) for Stations 1 to 10.

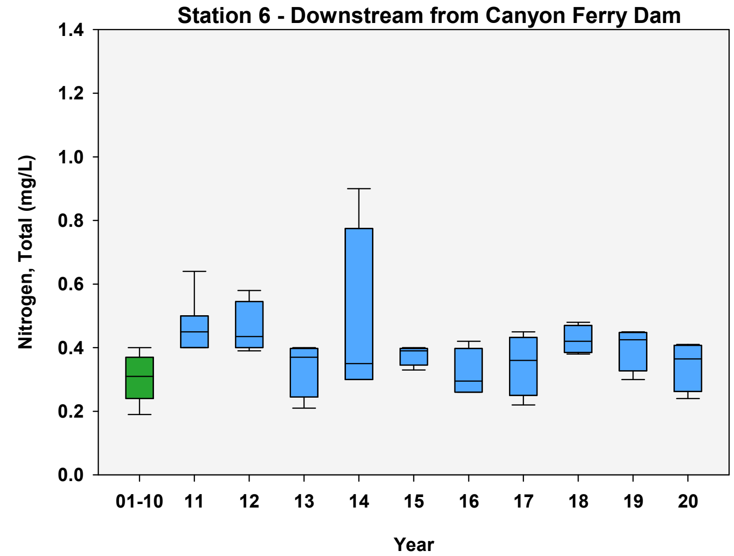


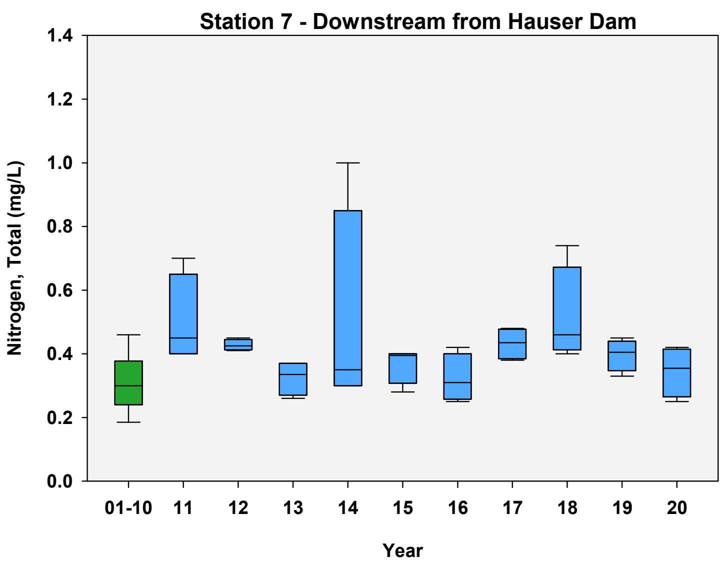


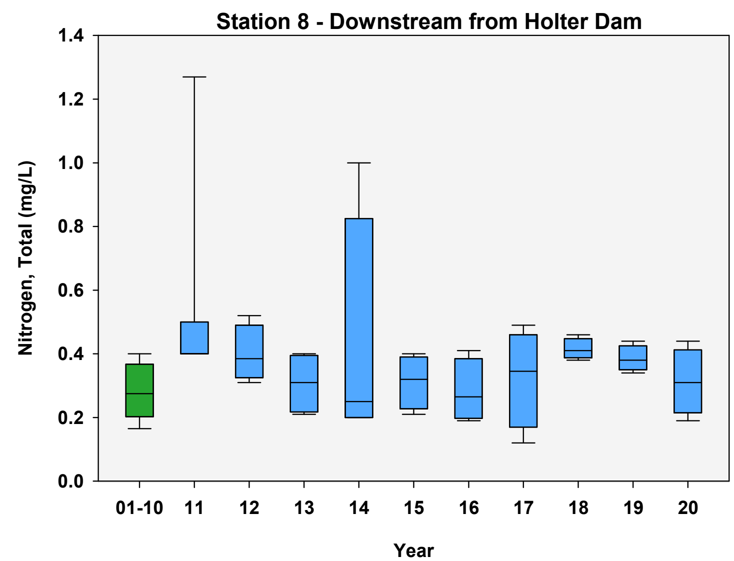


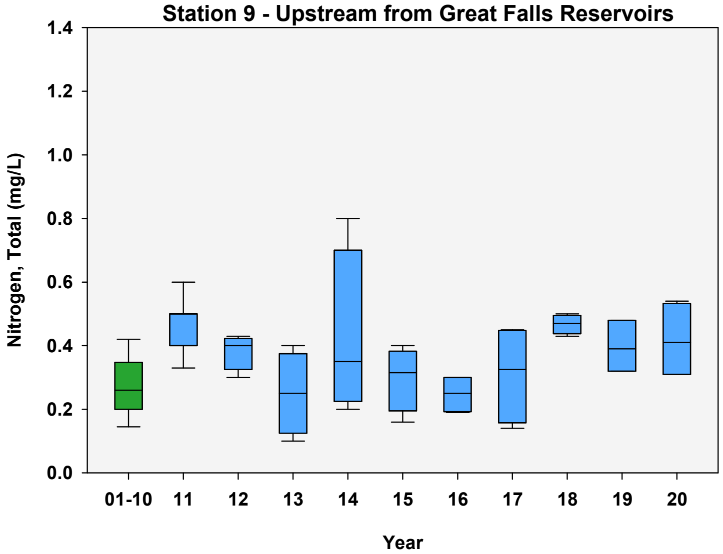



Station 5 - Upstream from Canyon Ferry Reservoir
Nitrogen, Total (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Nitrogen, Total (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Nitrogen, Total (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Nitrogen, Total (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Nitrogen, Total (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
01-10
11
12
13
14
15
16
17
18
19
20
Year

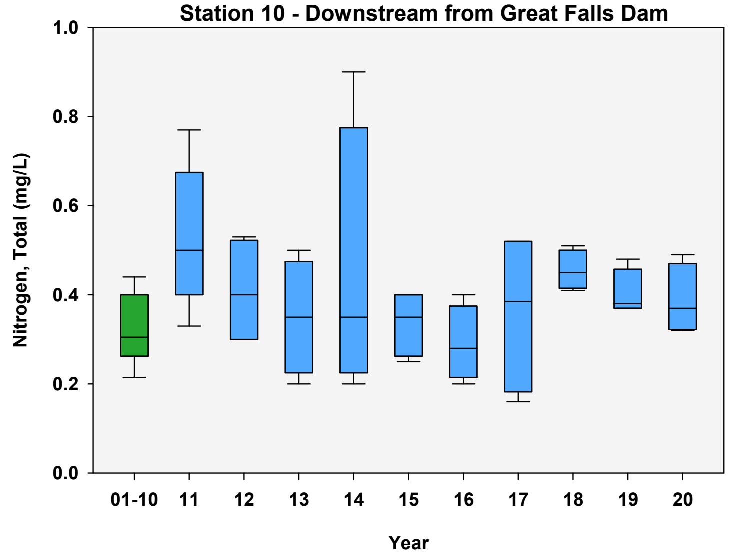
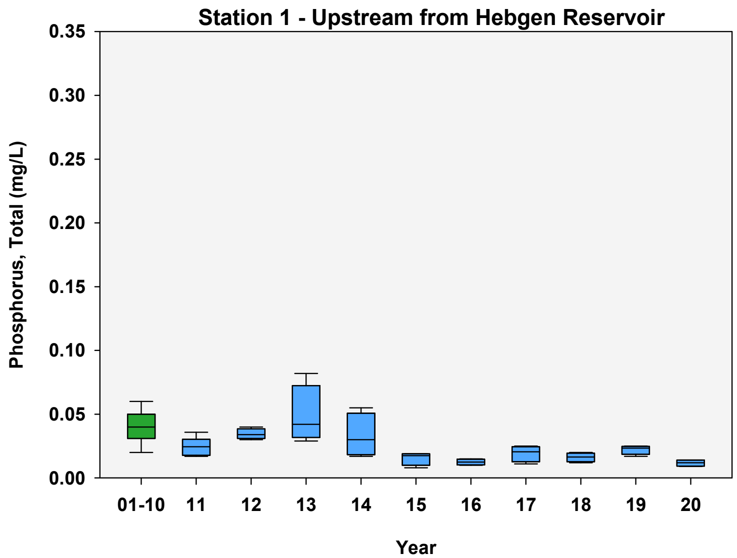
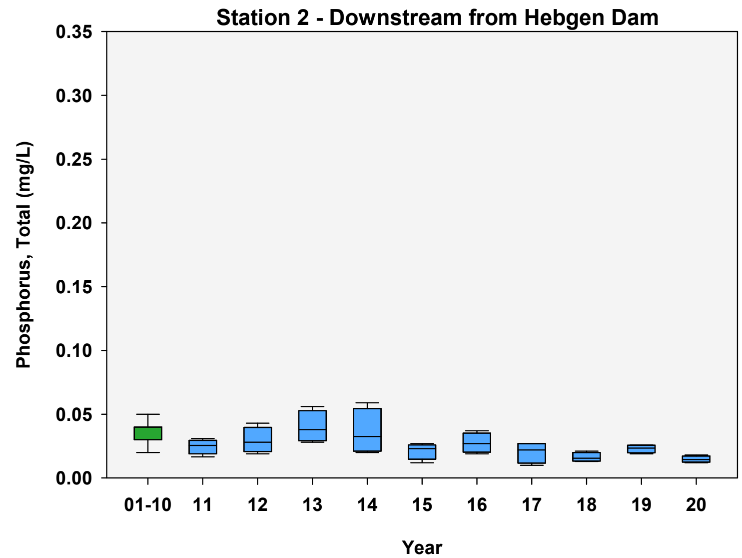
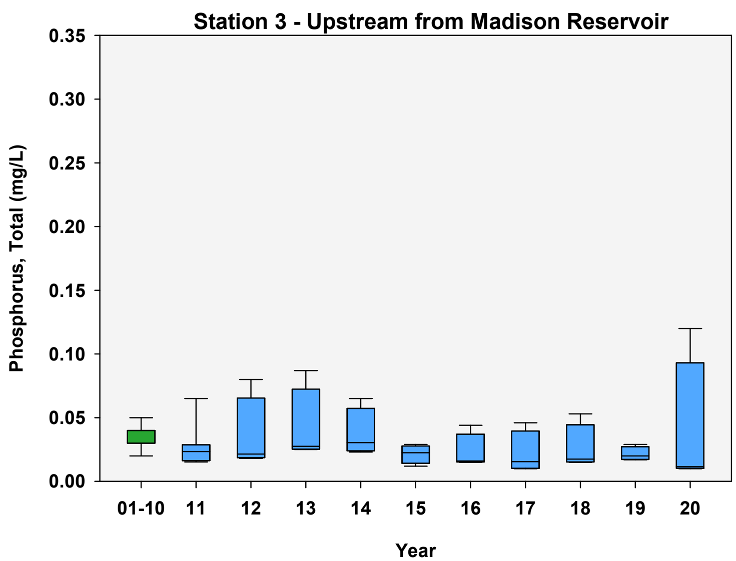
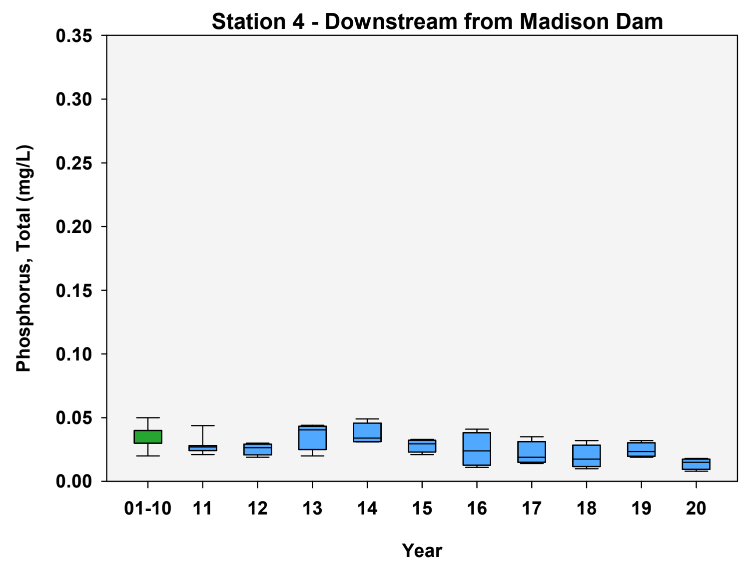

Station 10 - Downstream from Great Falls Dam
Nitrogen, Total (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
01-10
11
12
13
14
15
16
17
18
19
20
Year

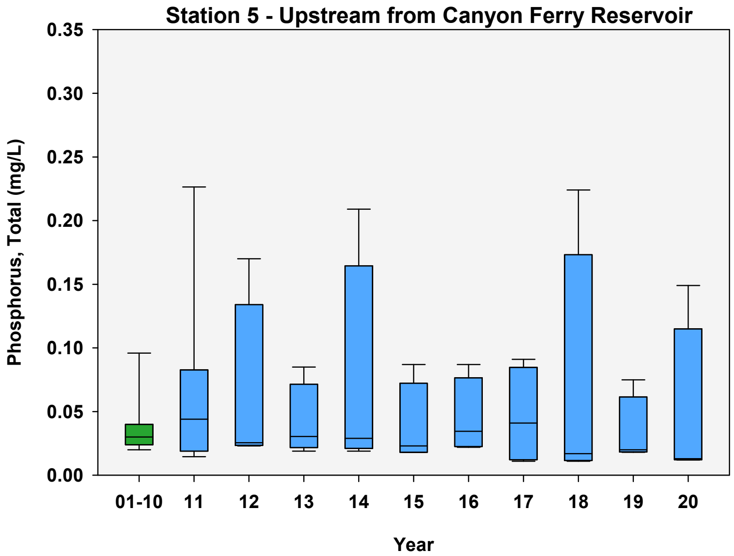
Figure B-26: Phosphorus, Total (mg/L) for Stations 1 to 10.

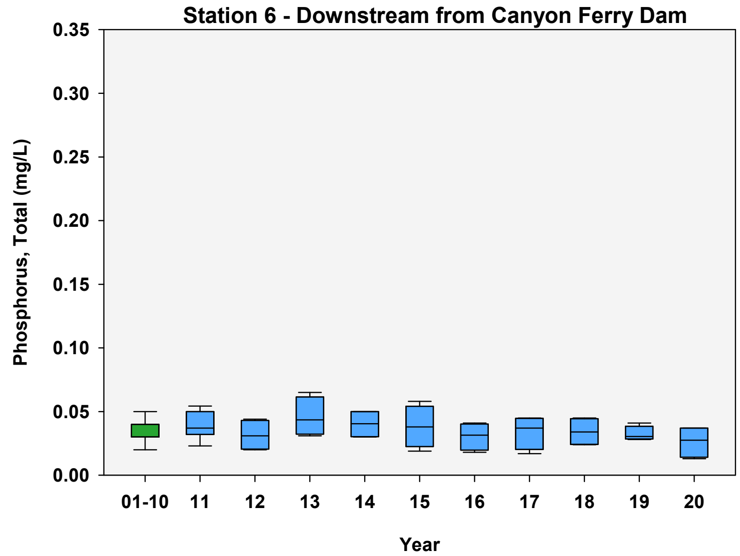


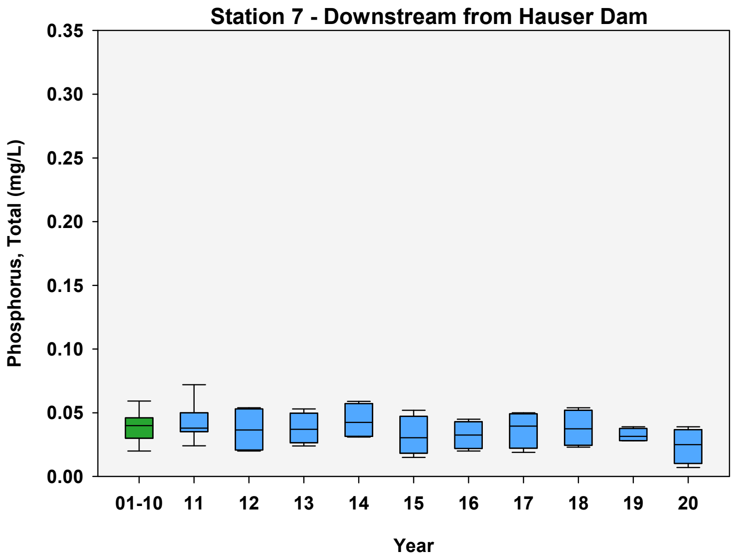


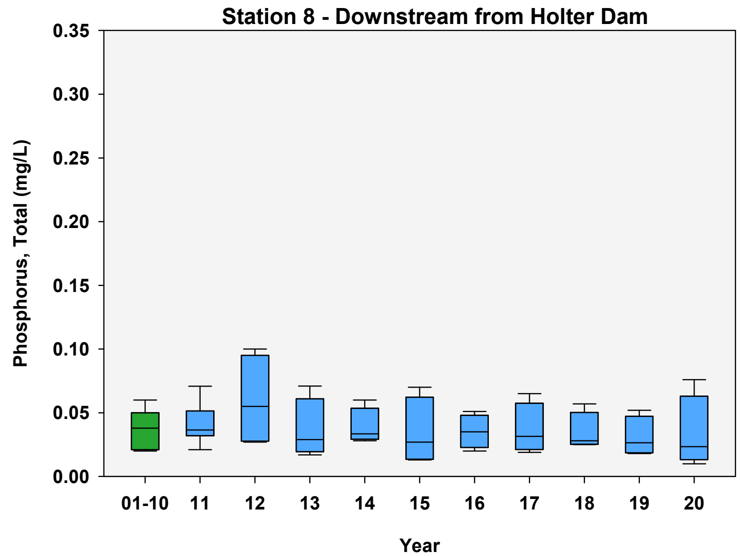


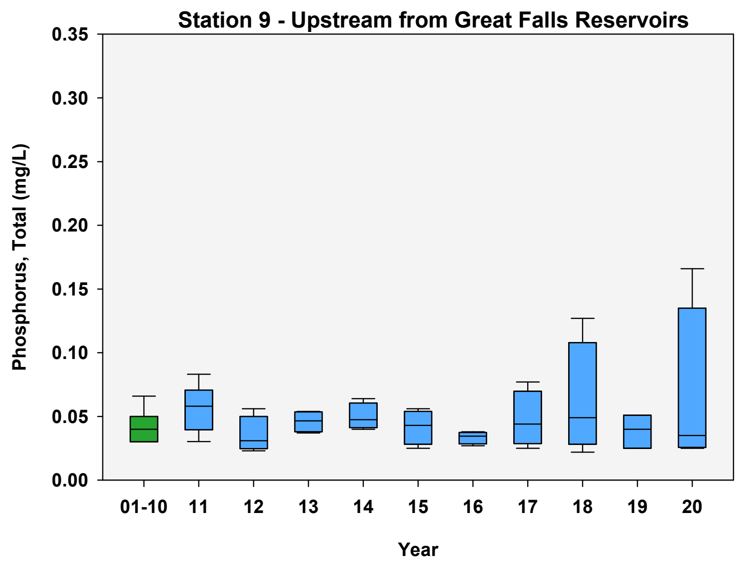



Station 5 - Upstream from Canyon Ferry Reservoir
Phosphorus, Total (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Phosphorus, Total (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Phosphorus, Total (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Phosphorus, Total (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Phosphorus, Total (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

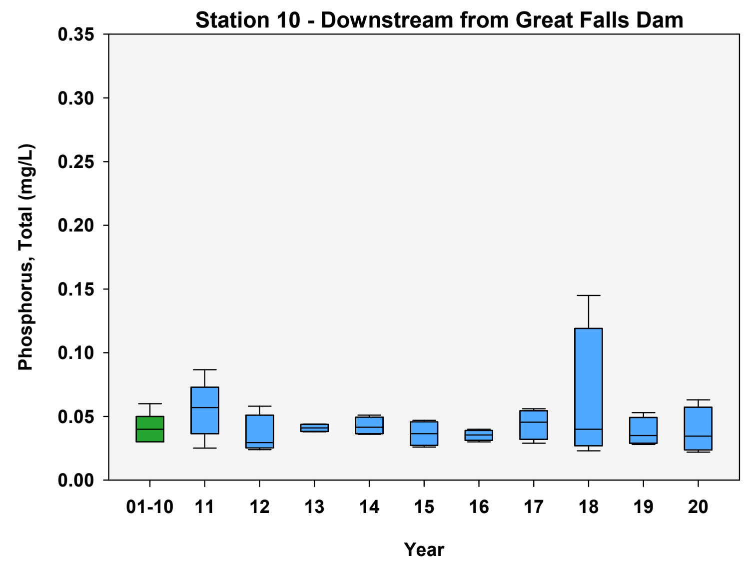
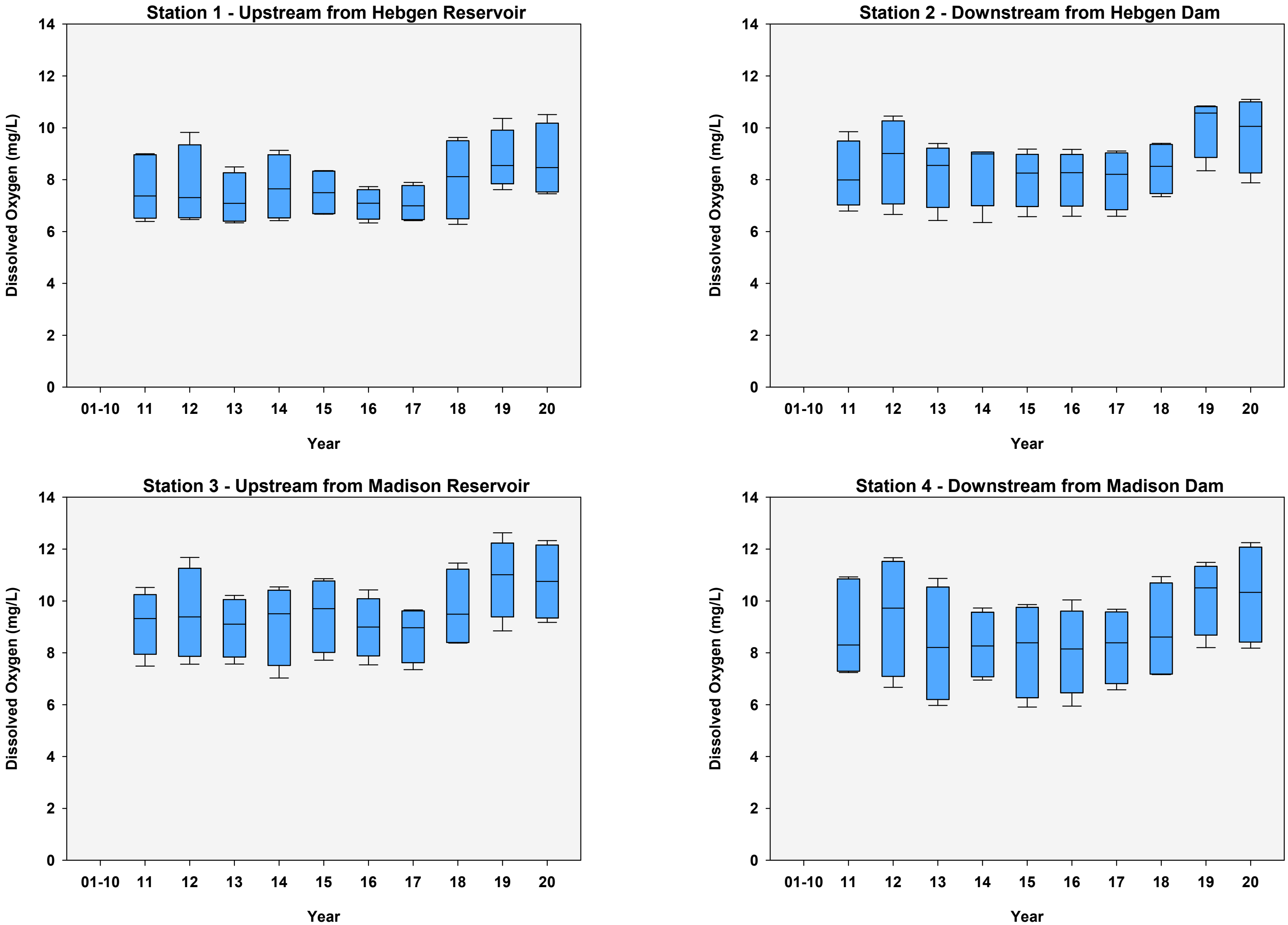
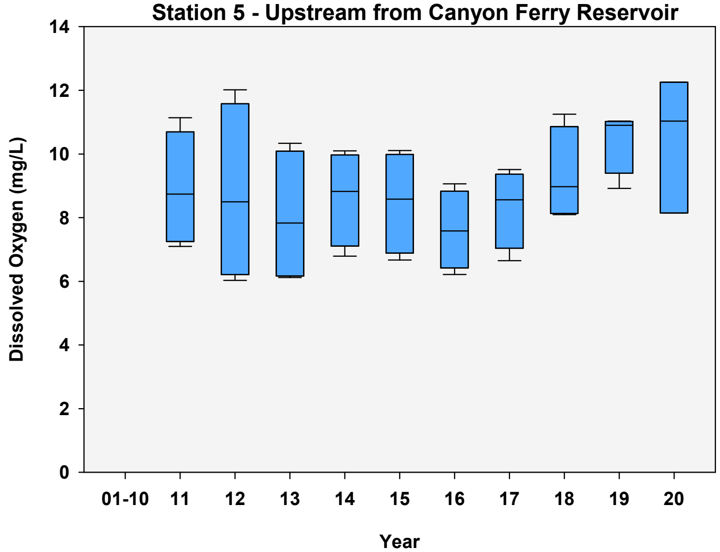

Station 10 - Downstream from Great Falls Dam
Phosphorus, Total (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
01-10
11
12
13
14
15
16
17
18
19
20
Year

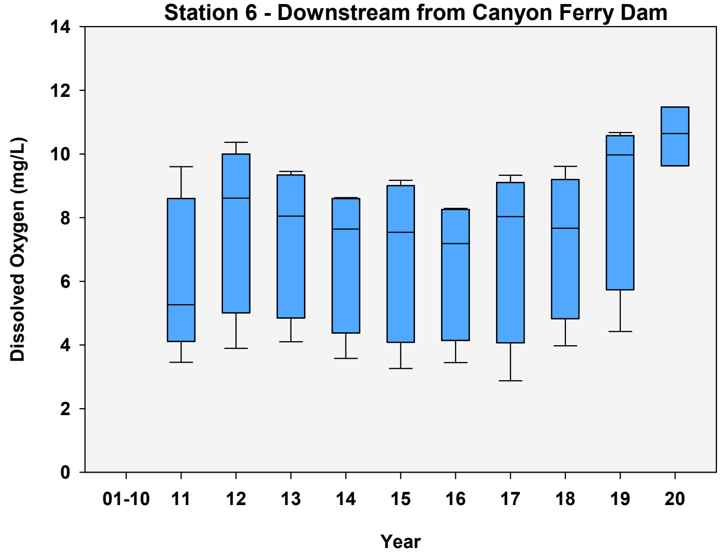
Figure B-27: Dissolved Oxygen (mg/L) for Stations 1 to 10.



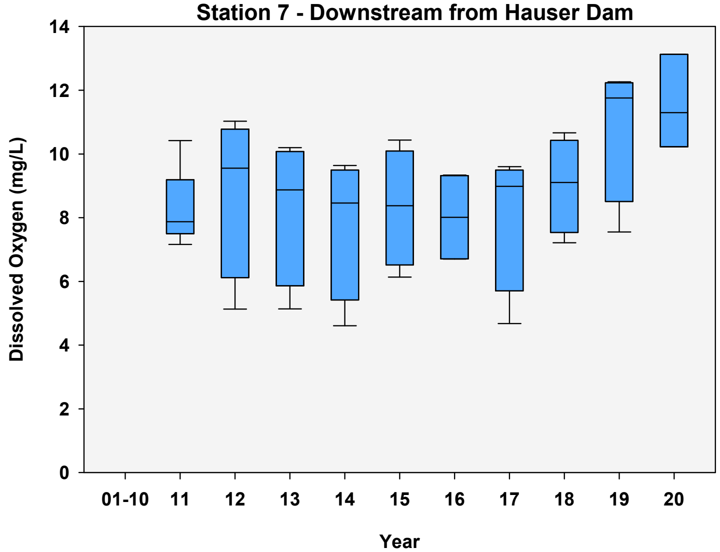
Station 5 - Upstream from Canyon Ferry Reservoir



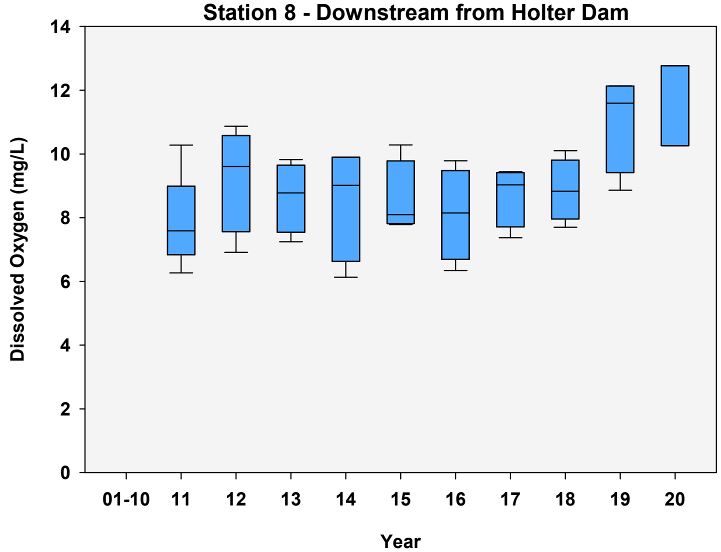
Station 6 - Downstream from Canyon Ferry Dam

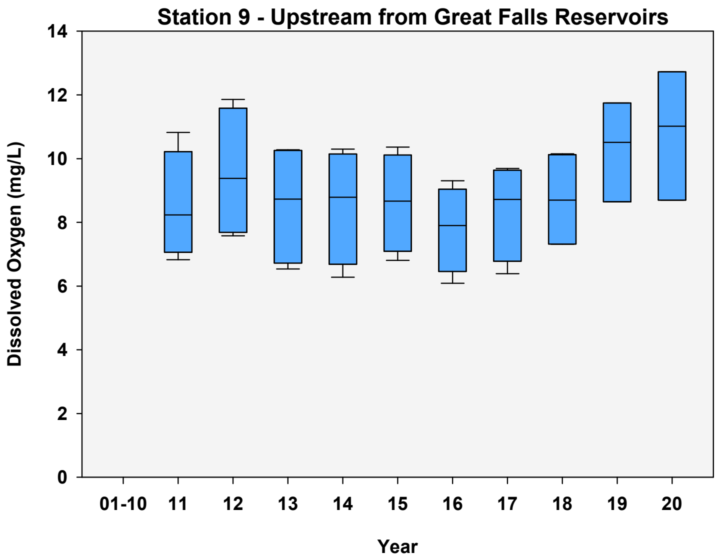


Station 7 - Downstream from Hauser Dam



Station 8 - Downstream from Holter Dam




Station 9 - Upstream from Great Falls Reservoirs
Dissolved Oxygen (mg/L)
14
12
10
8
6
4
2
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

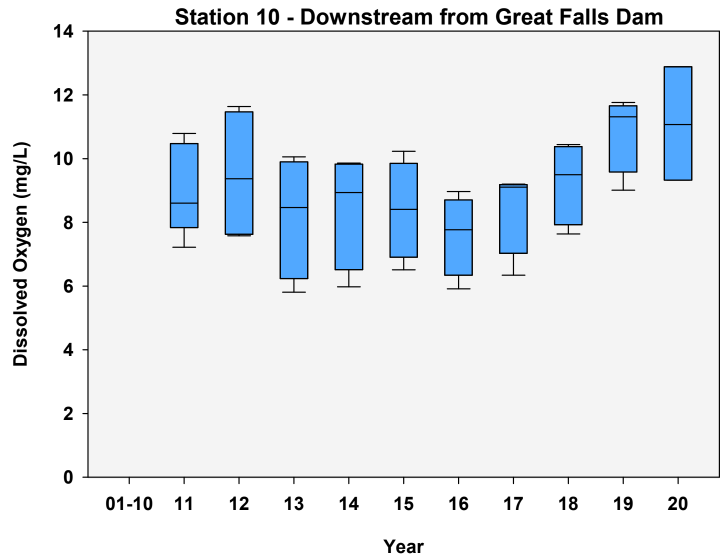
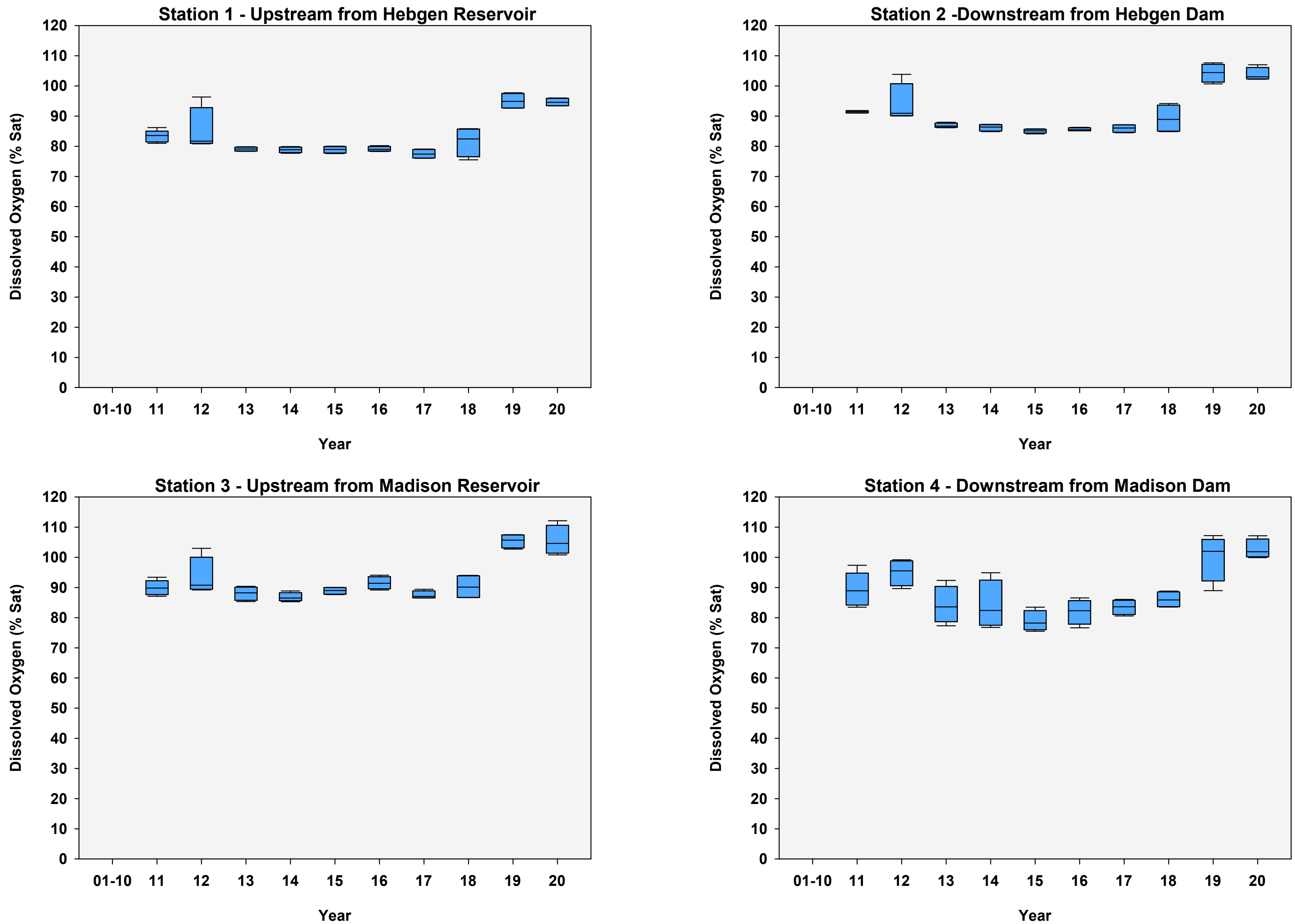
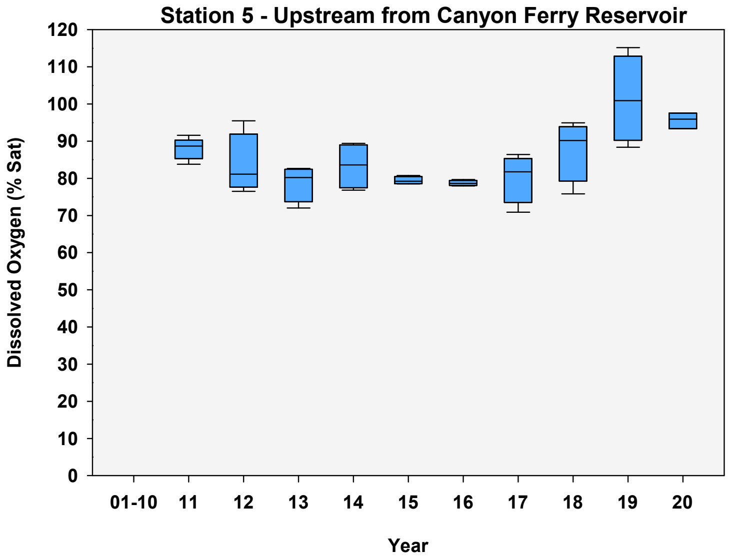
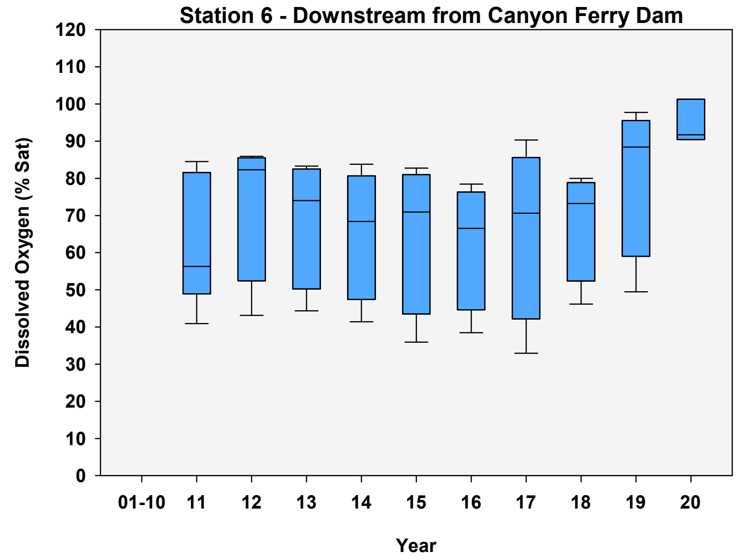
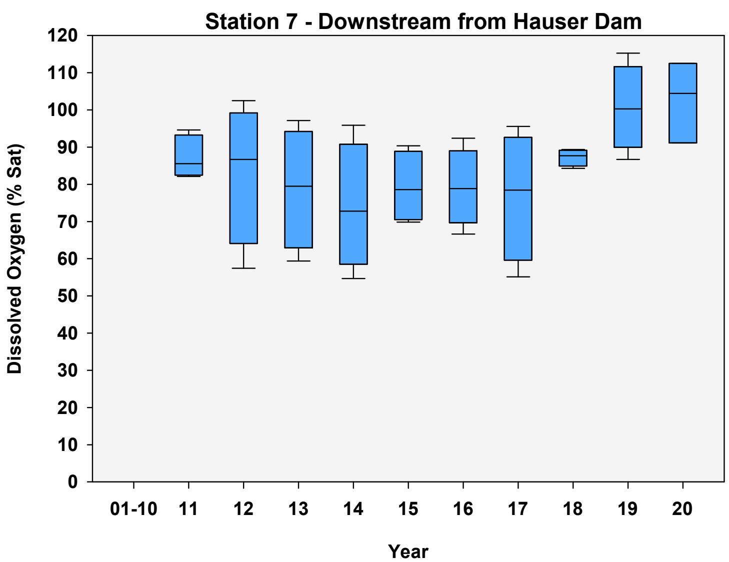

Station 10 - Downstream from Great Falls Dam
Dissolved Oxygen (mg/L)
14
12
10
8
6
4
2
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

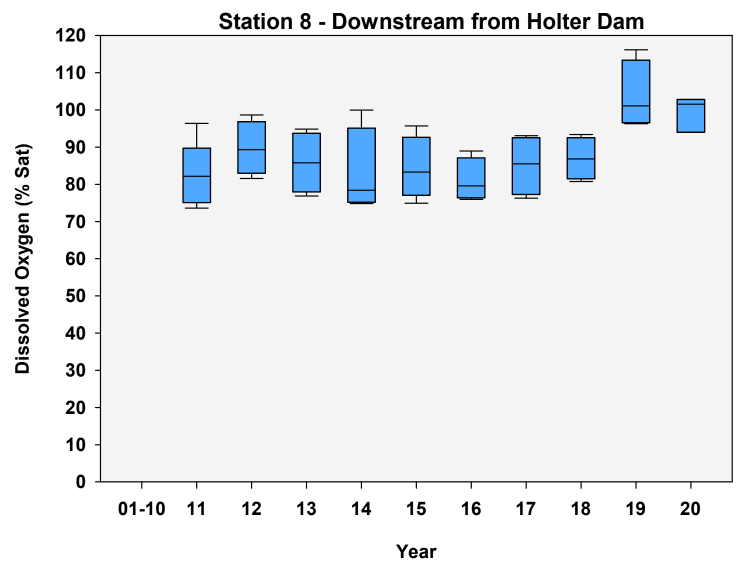
Figure B-28: Dissolved Oxygen (% Sat) for Stations 1 to 10.

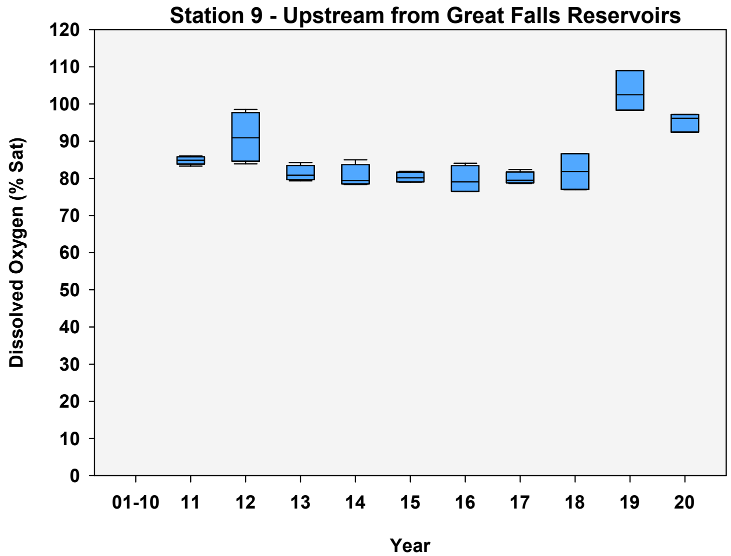



Station 5 - Upstream from Canyon Ferry Reservoir
Dissolved Oxygen (% Sat)
0
10
20
30
40
50
60
70
80
90
100
110
120
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Dissolved Oxygen (% Sat)
0
10
20
30
40
50
60
70
80
90
100
110
120
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Dissolved Oxygen (% Sat)
0
10
20
30
40
50
60
70
80
90
100
110
120
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Dissolved Oxygen (% Sat)
0
10
20
30
40
50
60
70
80
90
100
110
120
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Dissolved Oxygen (% Sat)
0
10
20
30
40
50
60
70
80
90
100
110
120
01-10
11
12
13
14
15
16
17
18
19
20
Year

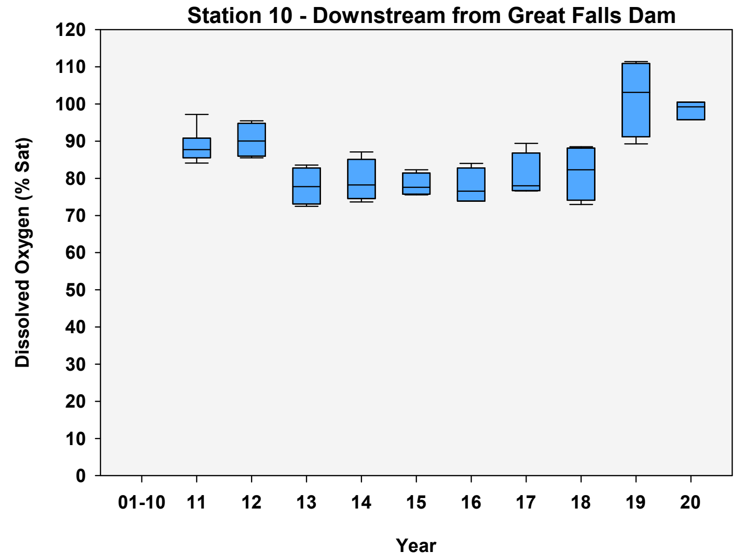
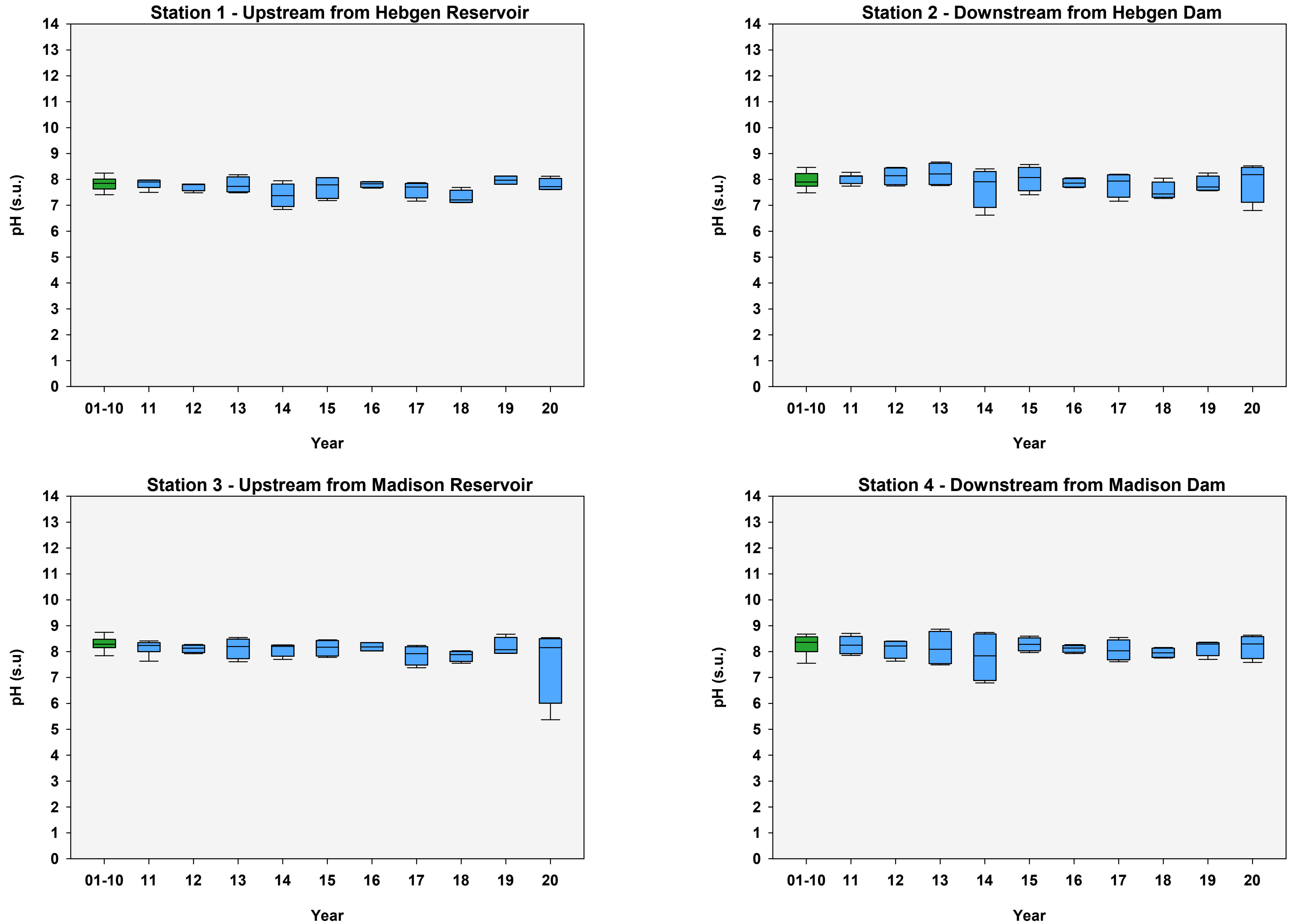
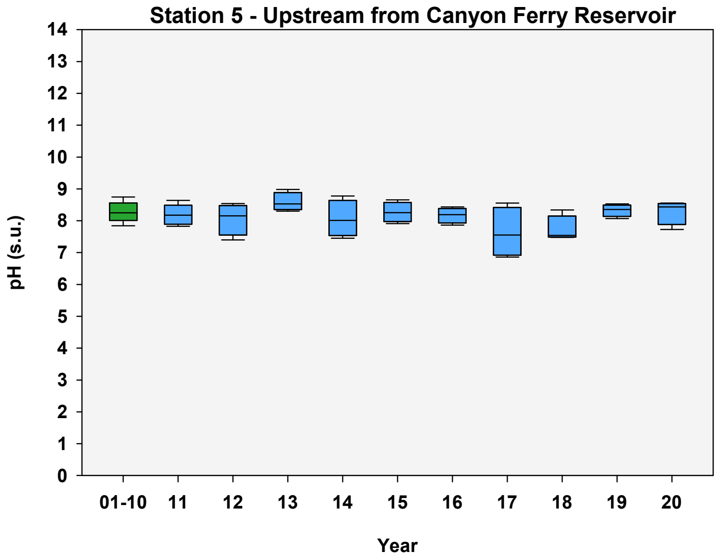
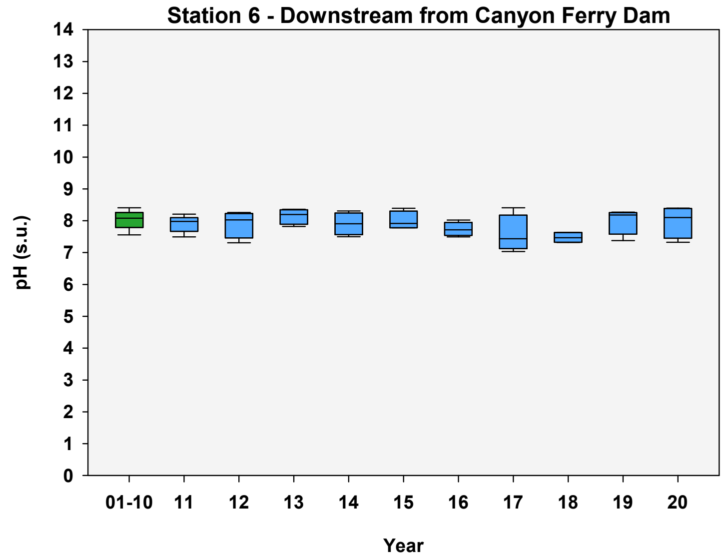
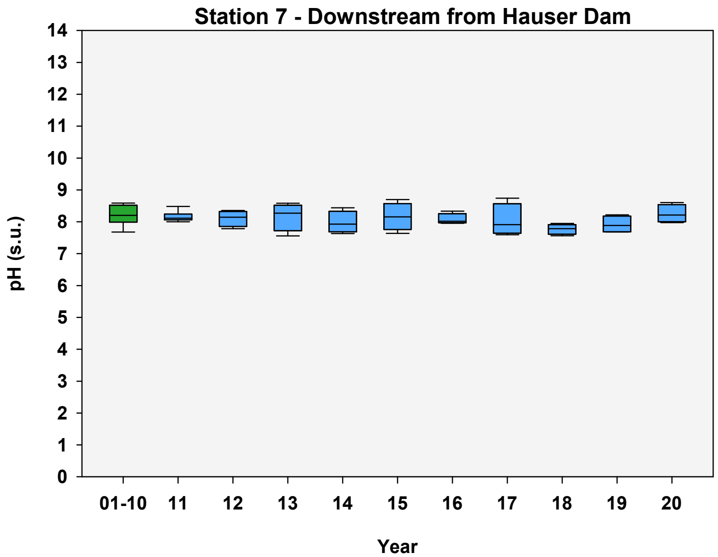

Station 10 - Downstream from Great Falls Dam
Dissolved Oxygen (% Sat)
0
10
20
30
40
50
60
70
80
90
100
110
120
01-10
11
12
13
14
15
16
17
18
19
20
Year

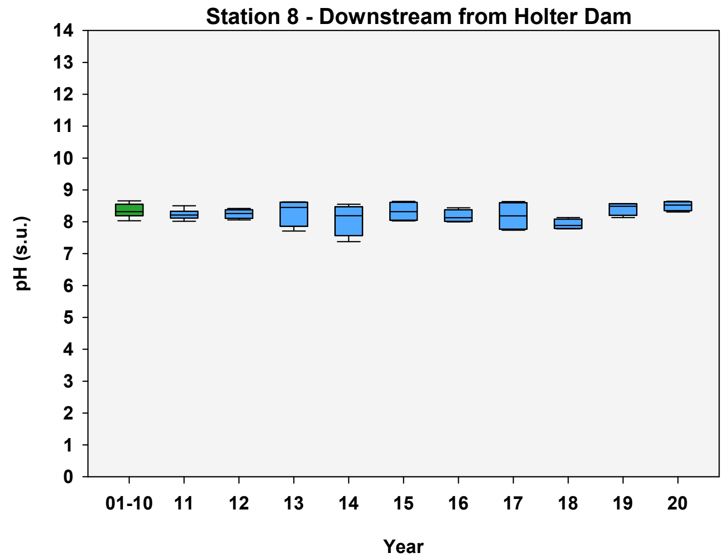
Figure B-29: pH (s.u.) for Stations 1 to 10.

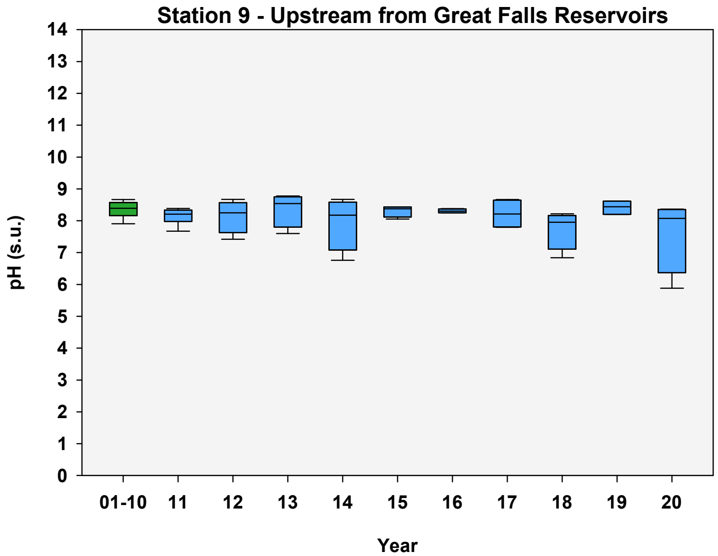



Station 5 - Upstream from Canyon Ferry Reservoir
pH (s.u.)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
pH (s.u.)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
pH (s.u.)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
pH (s.u.)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
pH (s.u.)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
01-10
11
12
13
14
15
16
17
18
19
20
Year

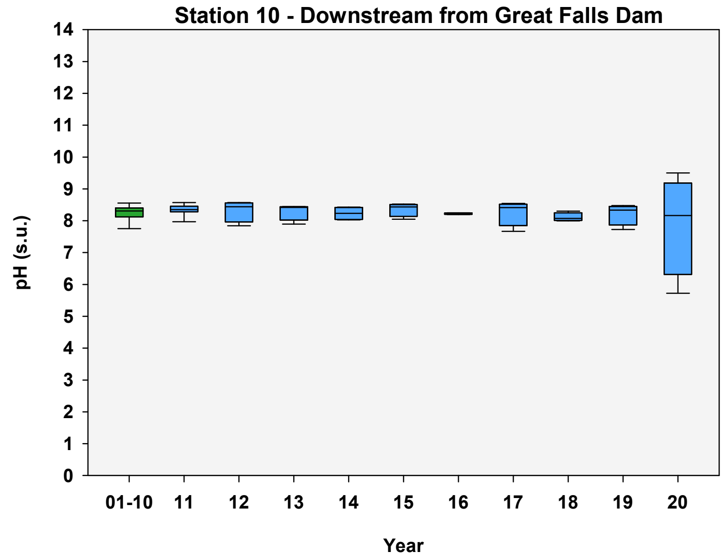
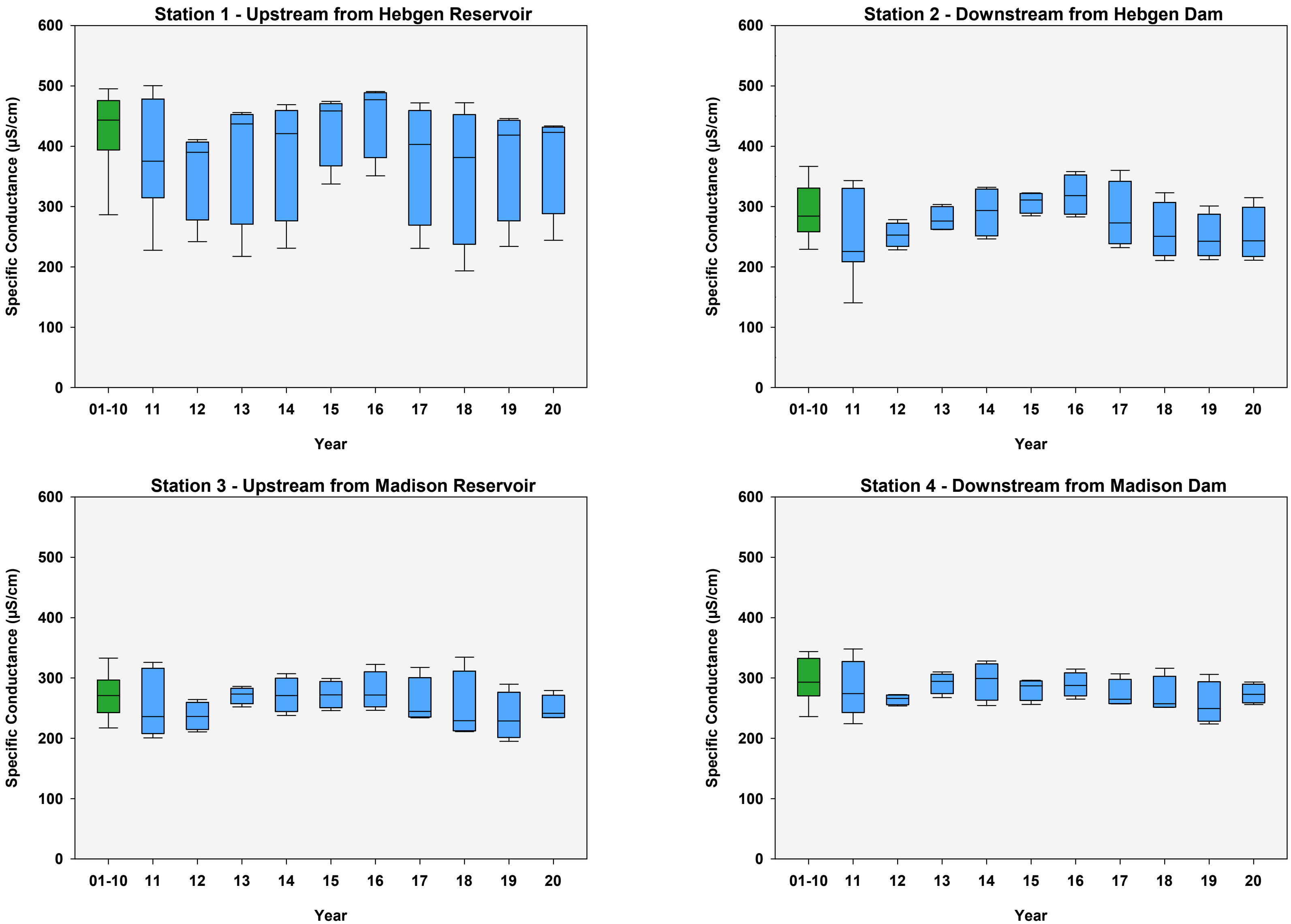
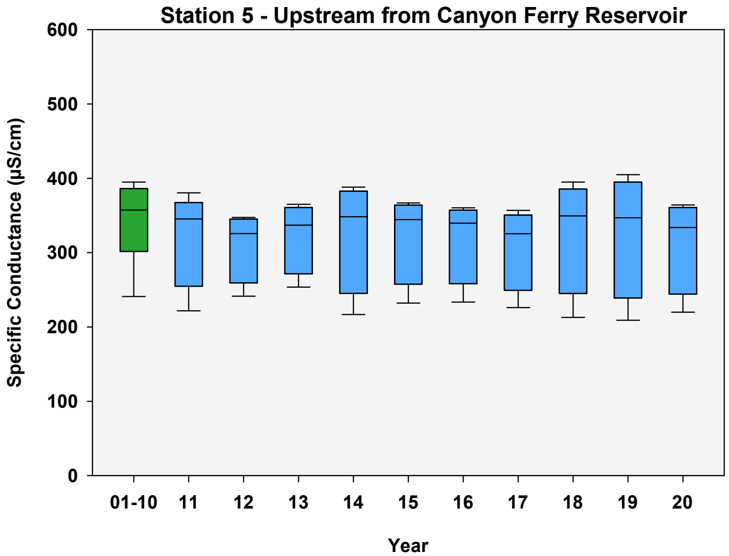
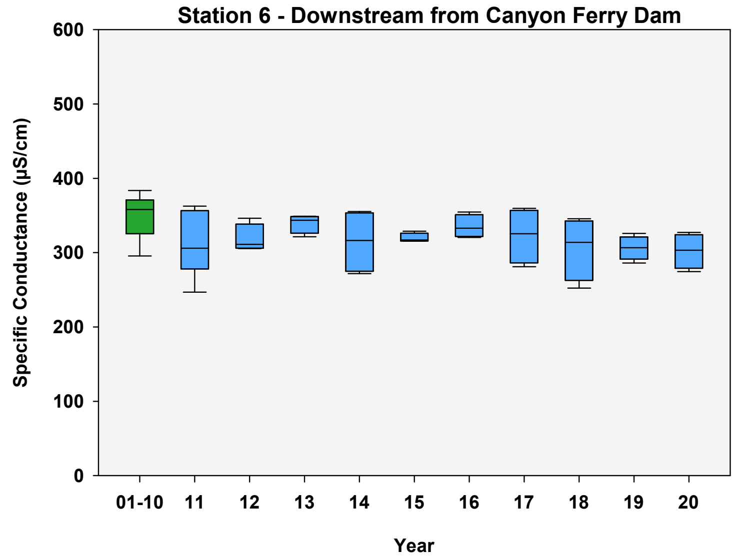
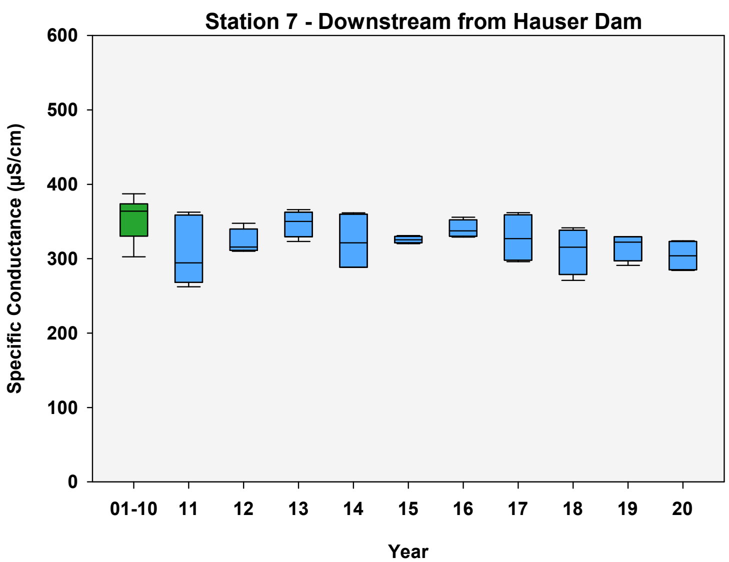

Station 10 - Downstream from Great Falls Dam
pH (s.u.)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
01-10
11
12
13
14
15
16
17
18
19
20
Year

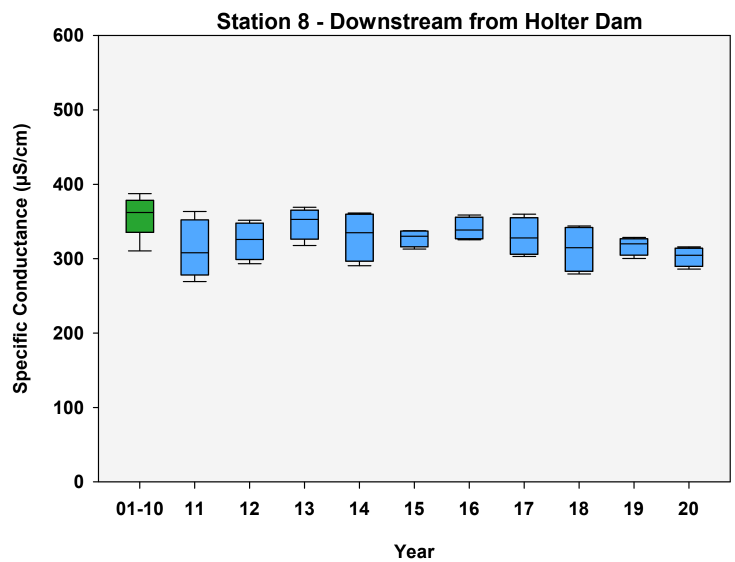
Figure B-30: Specific Conductance (µS/cm) for Stations 1 to 10.

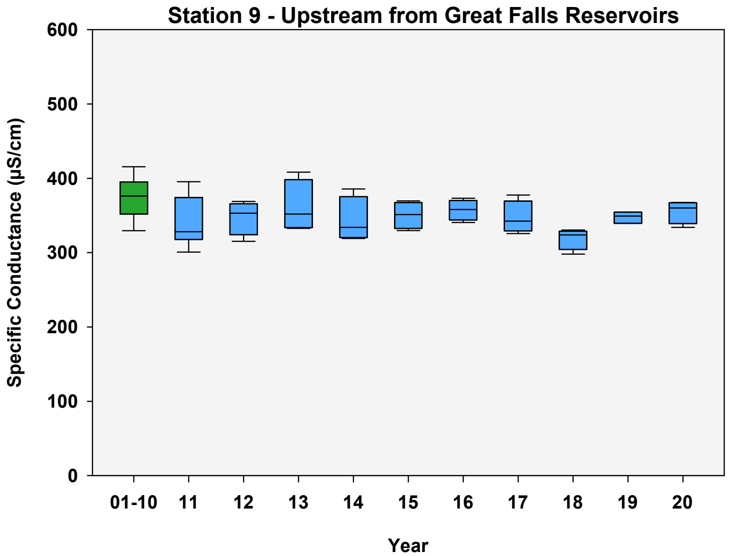



Station 5 - Upstream from Canyon Ferry Reservoir
Specific Conductance (µS/cm)
0
100
200
300
400
500
600
01-10
11
12
13
14
15
16
17
18
19
20
Year

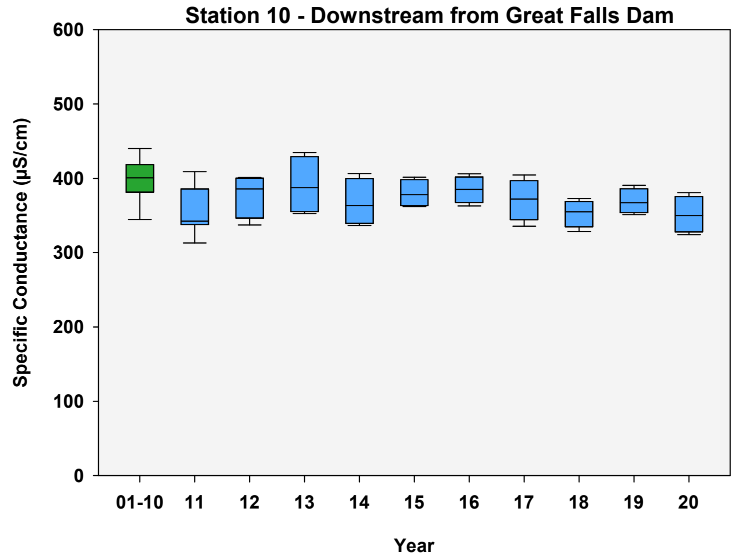

Station 6 - Downstream from Canyon Ferry Dam
Specific Conductance (µS/cm)
0
100
200
300
400
500
600
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Specific Conductance (µS/cm)
0
100
200
300
400
500
600
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Specific Conductance (µS/cm)
0
100
200
300
400
500
600
01-10
11
12
13
14
15
16
17
18
19
20
Year

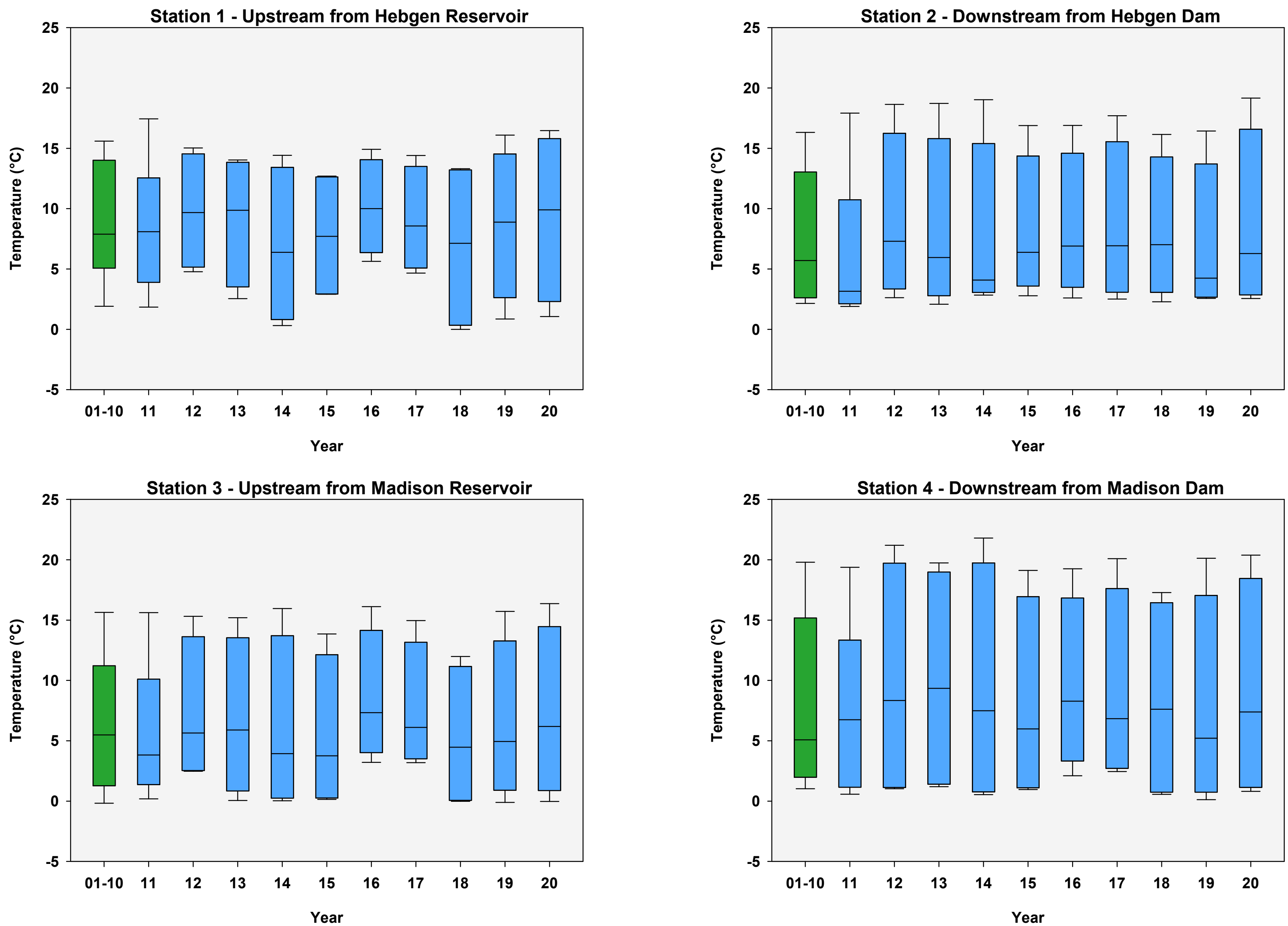


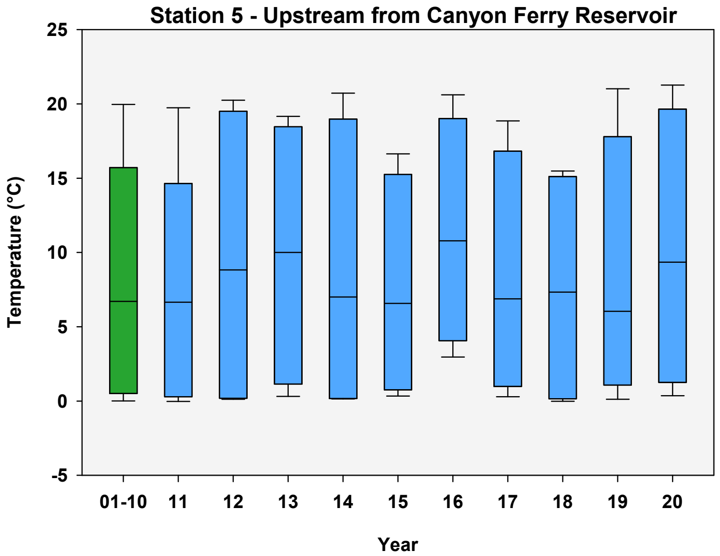
Station 9 - Upstream from Great Falls Reservoirs
Specific Conductance (µS/cm)
600
500
400
300
200
100
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

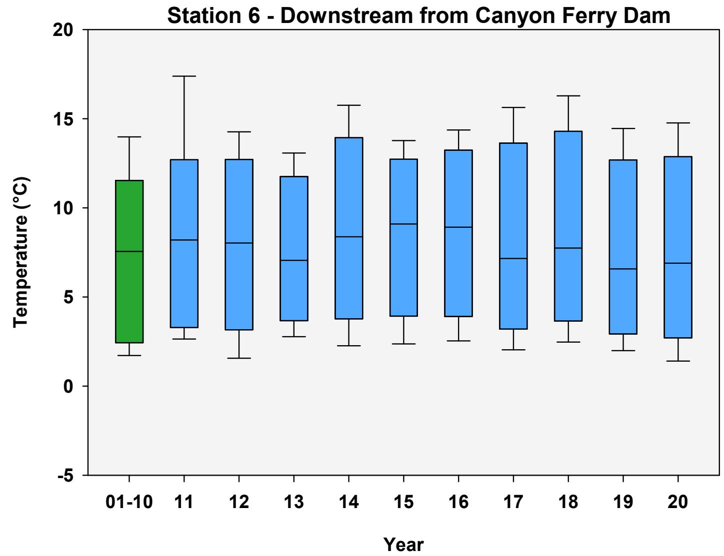


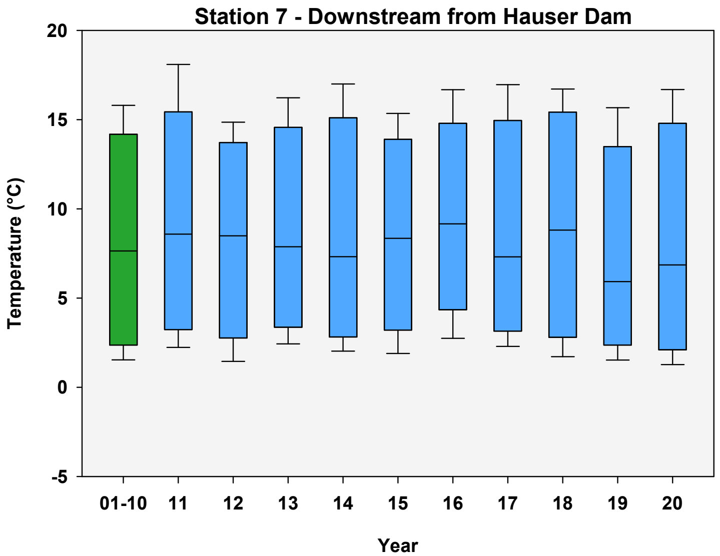
Station 10 - Downstream from Great Falls Dam
Specific Conductance (µS/cm)
600
500
400
300
200
100
0
01-10
11
12
13
14
15
16
17
18
19
20
Year

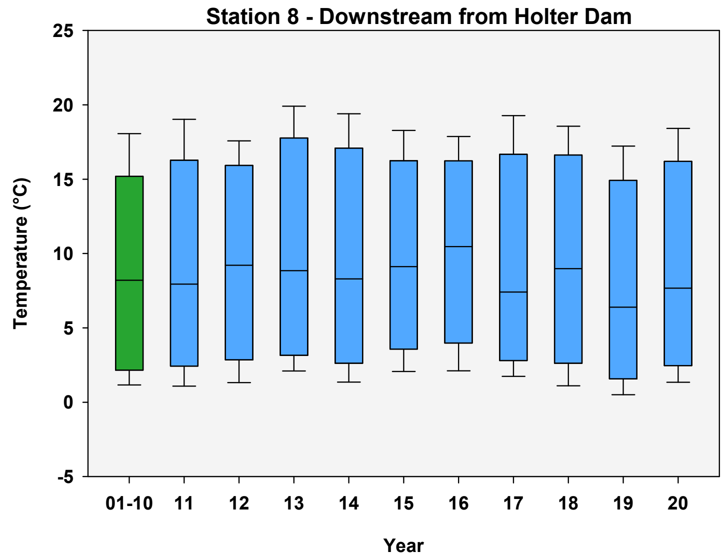
Figure B-31: Temperature, Water (°C) for Stations 1 to 10.

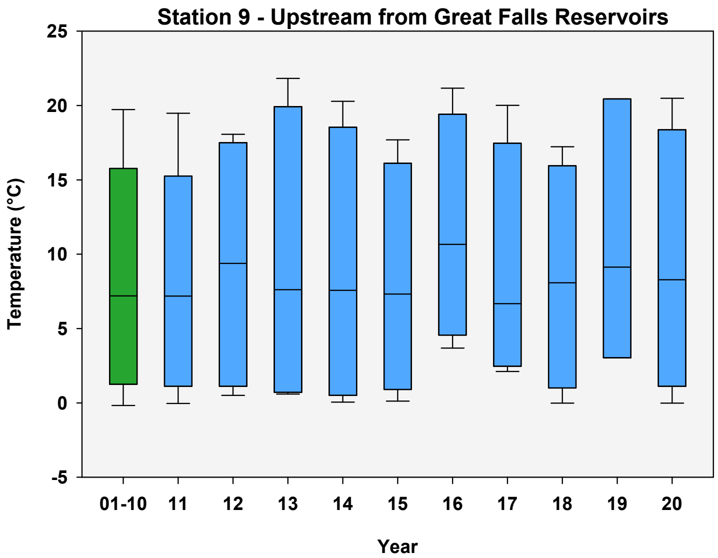


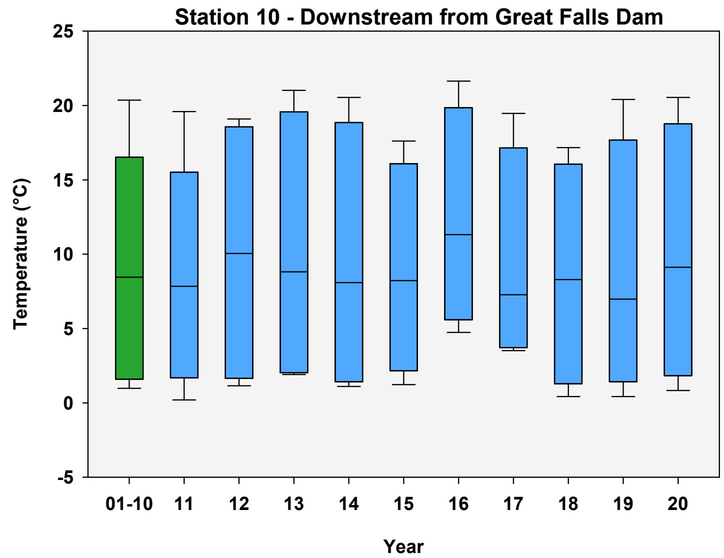

Station 5 - Upstream from Canyon Ferry Reservoir
Temperature (°C)
25
20
15
10
5
0
-5
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Temperature (°C)
20
15
10
5
0
-5
01-10
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Temperature (°C)
20
15
10
5
0
-5
01-10
11
12
13
14
15
16
17
18
19
20
Year

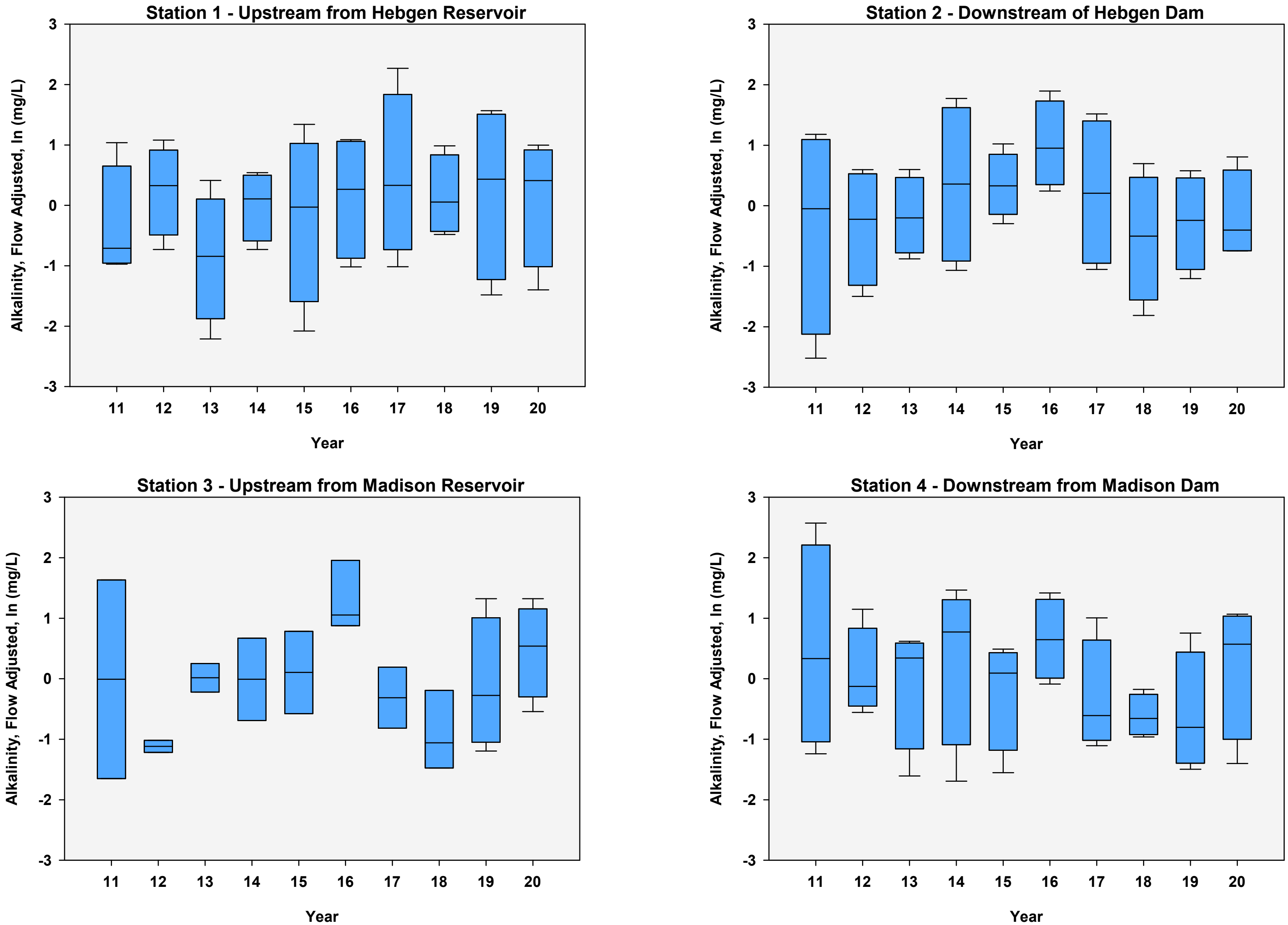

Station 8 - Downstream from Holter Dam
Temperature (°C)
25
20
15
10
5
0
-5
01-10
11
12
13
14
15
16
17
18
19
20
Year

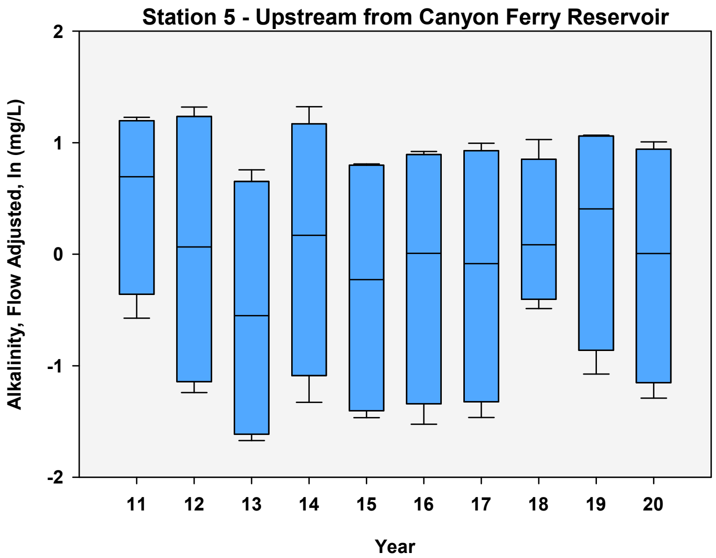

Station 9 - Upstream from Great Falls Reservoirs
Temperature (°C)
25
20
15
10
5
0
-5
01-10
11
12
13
14
15
16
17
18
19
20
Year

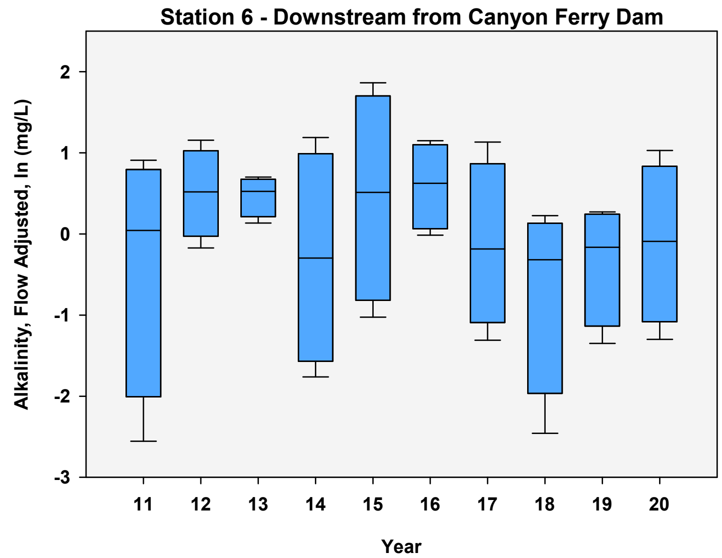

Station 10 - Downstream from Great Falls Dam
Temperature (°C)
25
20
15
10
5
0
-5
01-10
11
12
13
14
15
16
17
18
19
20
Year

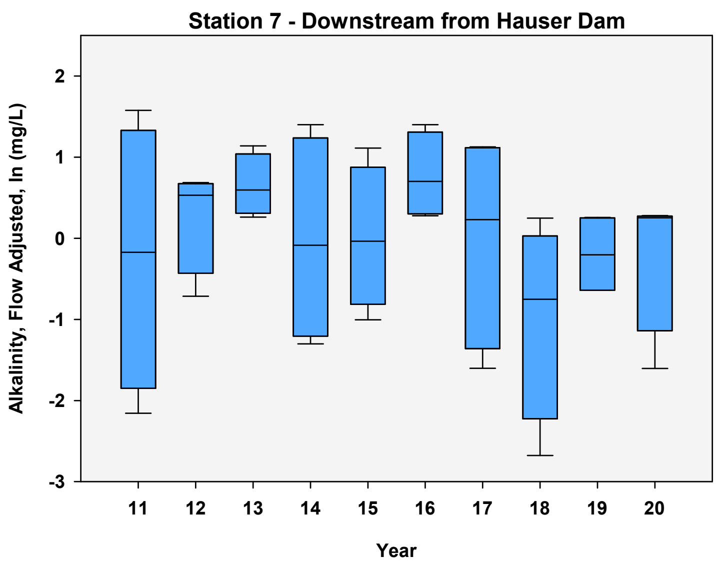
Appendix B.5 Flow-adjusted Temporal Graphs

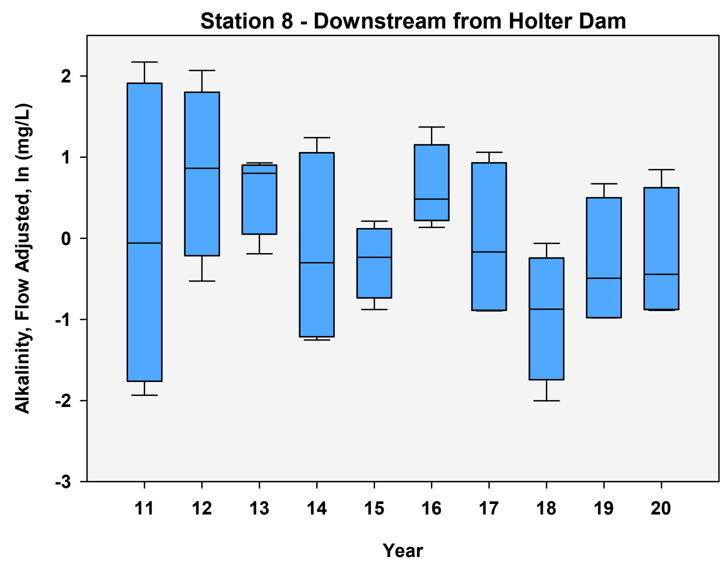
Figure B-32: Alkalinity, Flow Adjusted, ln (mg/L) for Stations 1 to 10.

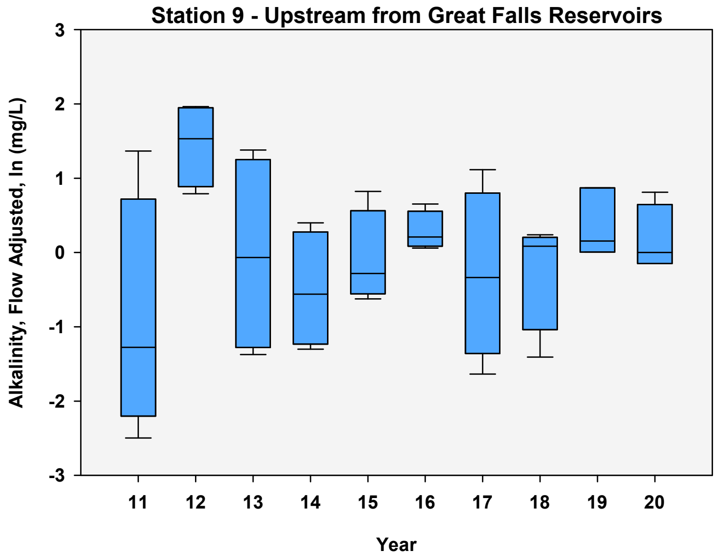



Station 5 - Upstream from Canyon Ferry Reservoir
Alkalinity, Flow Adjusted, ln (mg/L)
Year
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20


Station 6 - Downstream from Canyon Ferry Dam
Alkalinity, Flow Adjusted, ln (mg/L)
Year
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20


Station 7 - Downstream from Hauser Dam
Alkalinity, Flow Adjusted, ln (mg/L)
Year
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20


Station 8 - Downstream from Holter Dam
Alkalinity, Flow Adjusted, ln (mg/L)
Year
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20


Station 9 - Upstream from Great Falls Reservoirs
Alkalinity, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
-3
11 12 13 14 15 16 17 18 19 20
Year

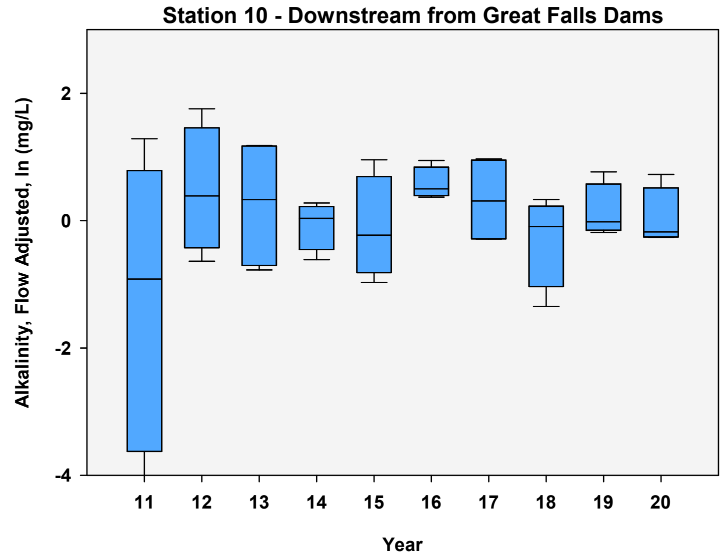
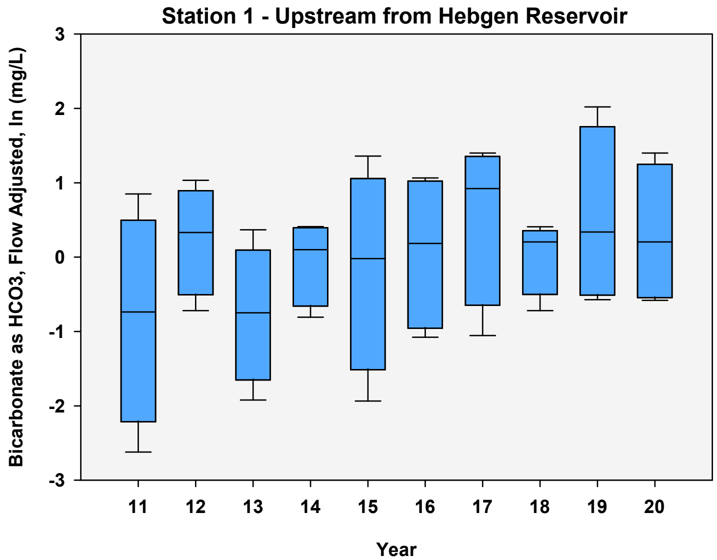
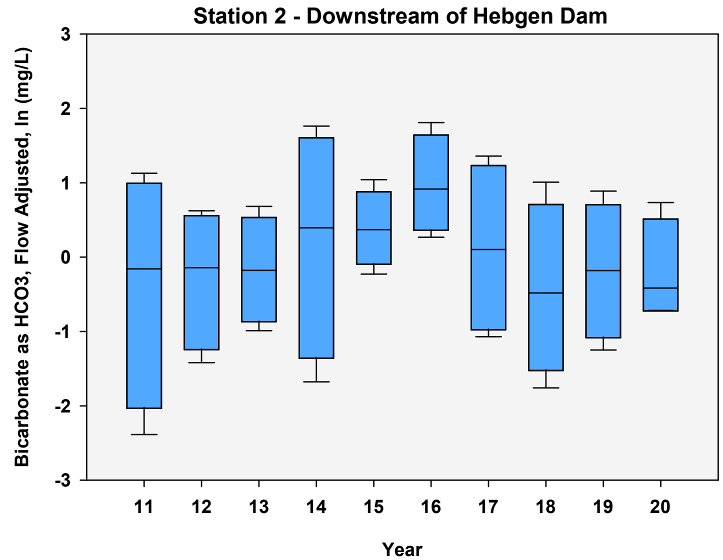
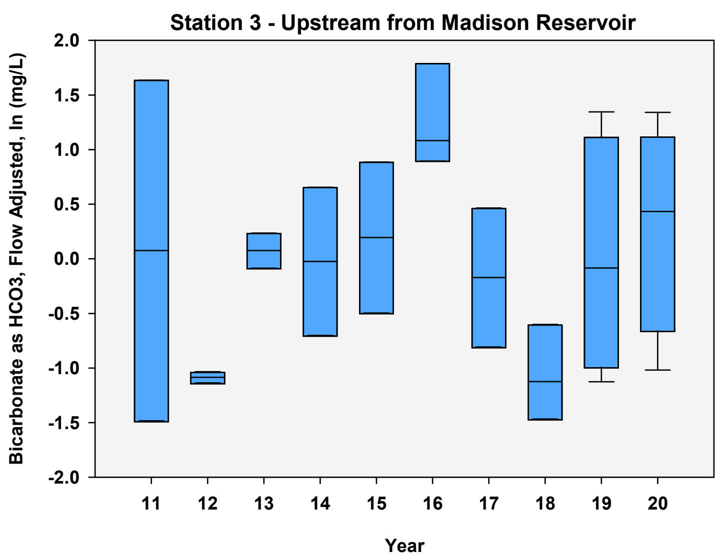
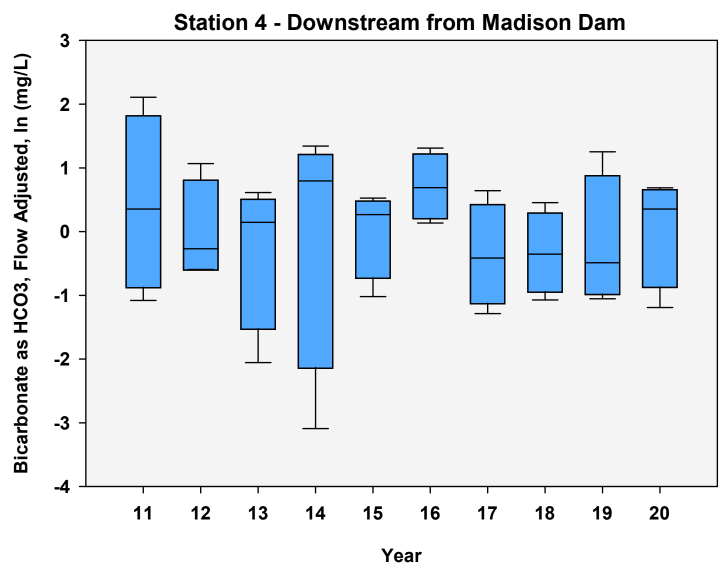

Station 10 - Downstream from Great Falls Dams
Alkalinity, Flow Adjusted, ln (mg/L)
2
0
-2
-4
11 12 13 14 15 16 17 18 19 20
Year

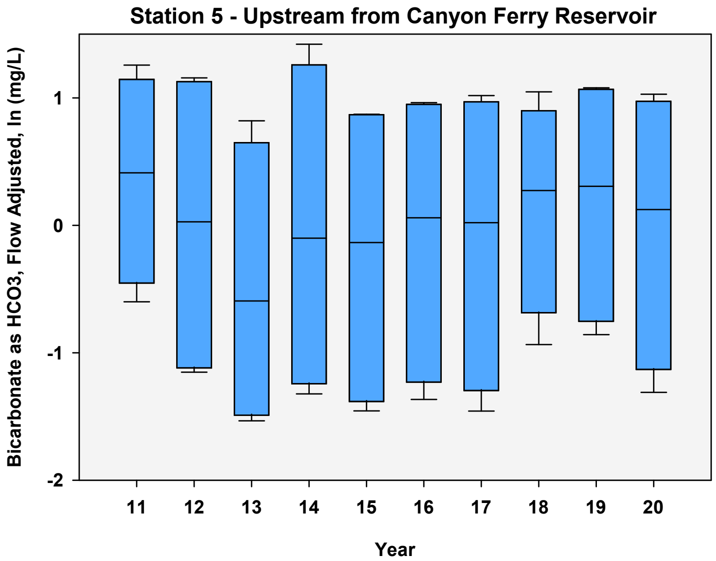
Figure B-33: Bicarbonate as HCO_3, Flow Adjusted, ln (mg/L) for Stations 1 to 10.

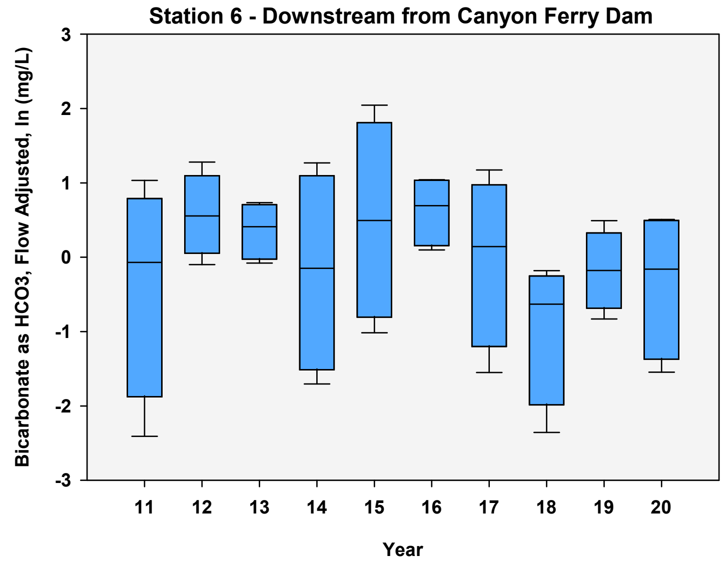


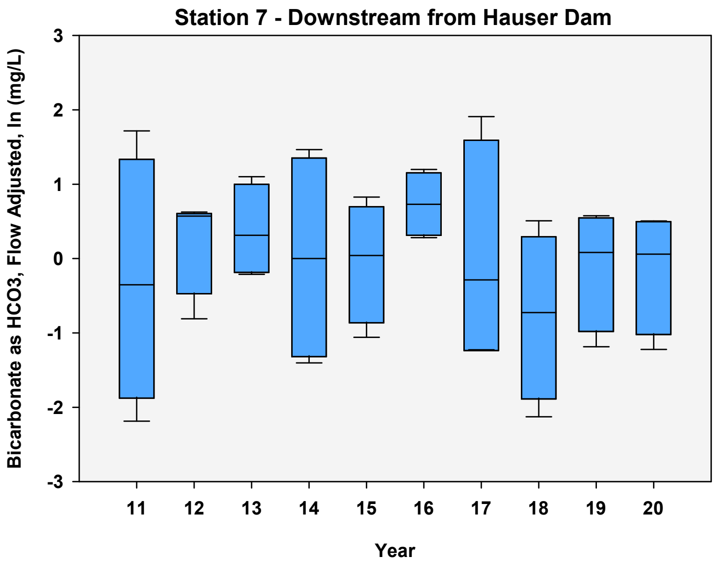


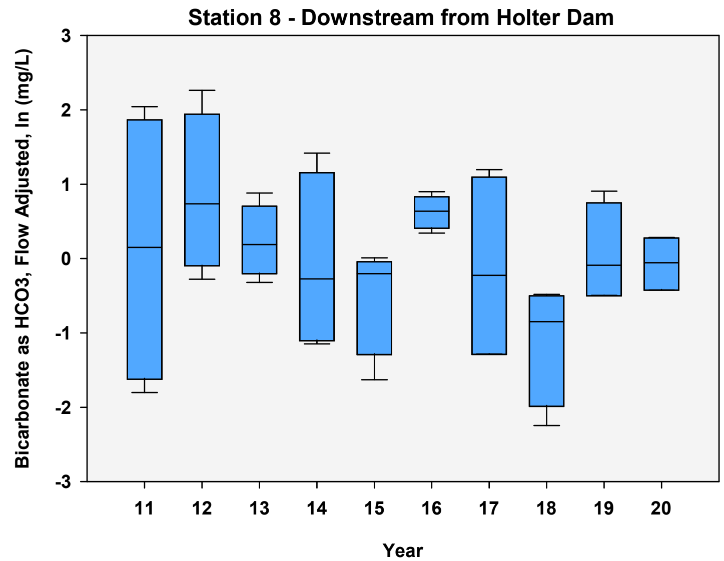


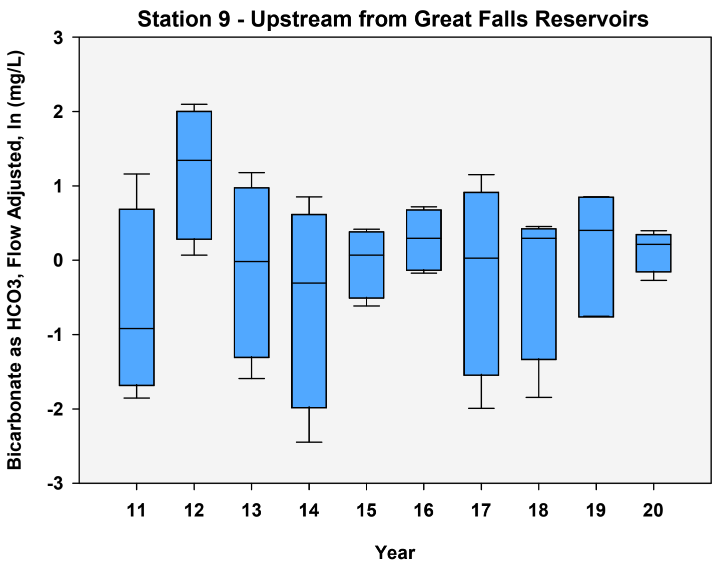



Station 5 - Upstream from Canyon Ferry Reservoir
Bicarbonate as HCO3, Flow Adjusted, ln (mg/L)
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Bicarbonate as HCO3, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Bicarbonate as HCO3, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Bicarbonate as HCO3, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Bicarbonate as HCO3, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year

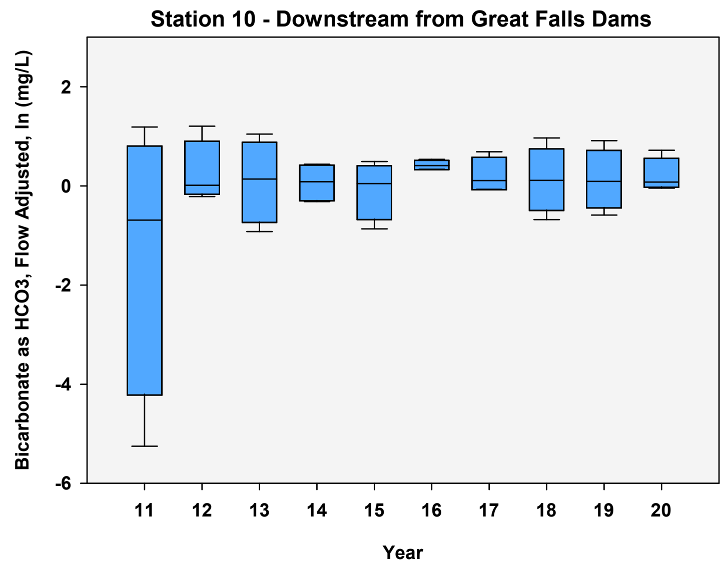
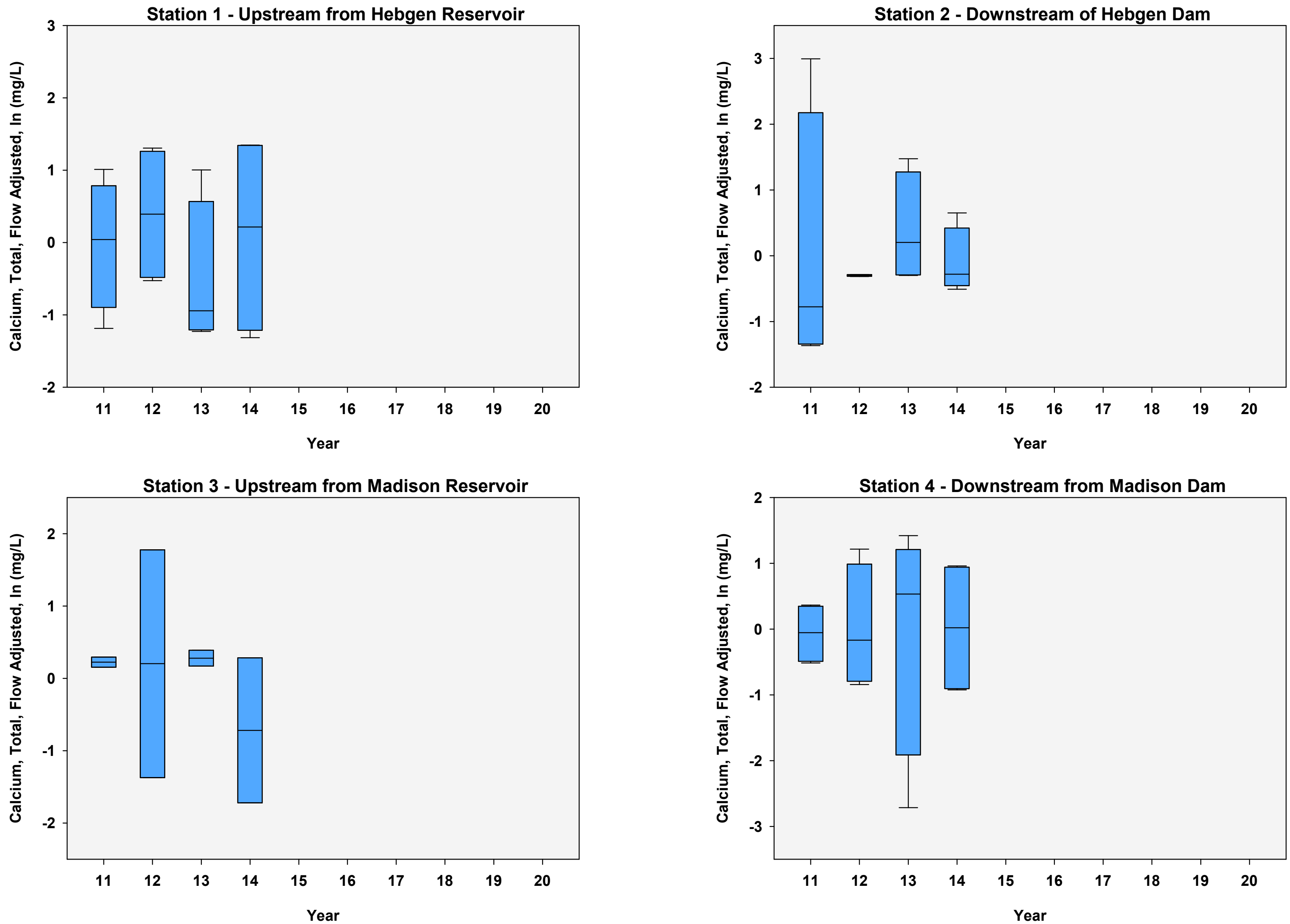
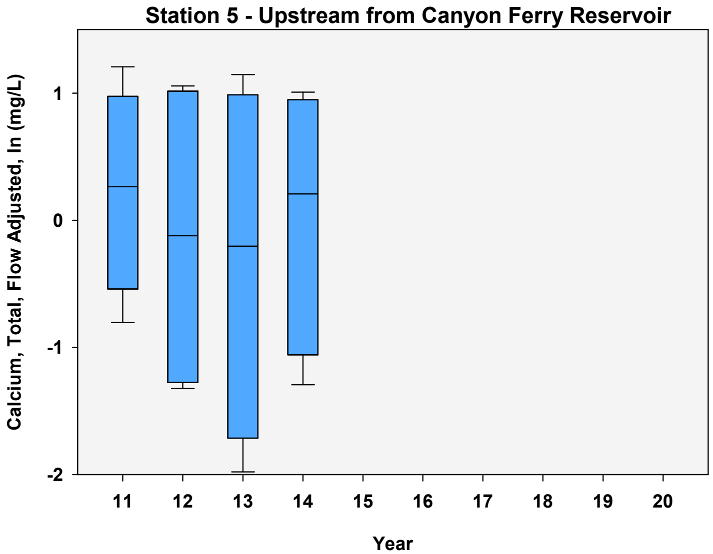
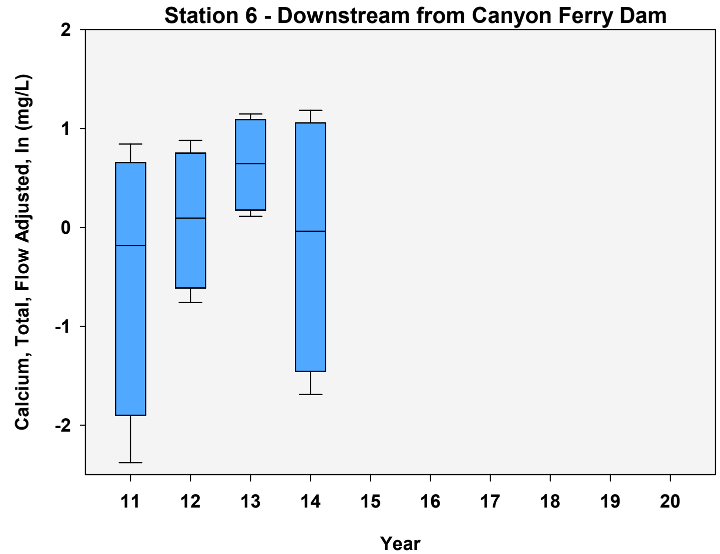
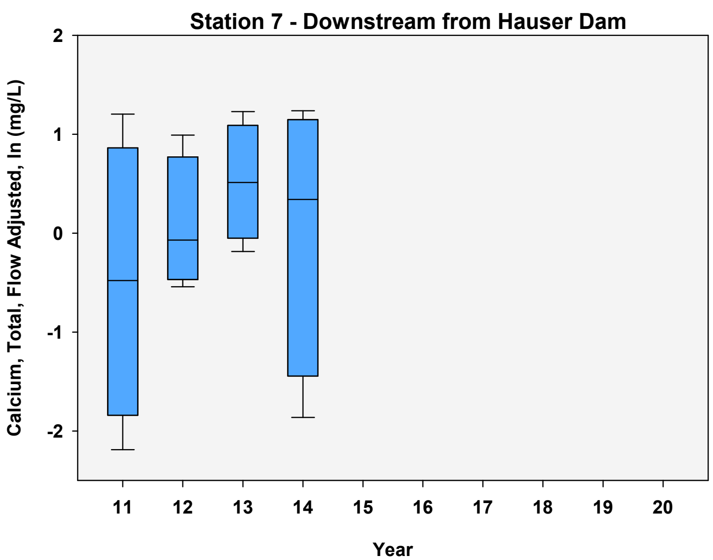

Station 10 - Downstream from Great Falls Dams
Bicarbonate as HCO3, Flow Adjusted, ln (mg/L)
2
0
-2
-4
-6
11
12
13
14
15
16
17
18
19
20
Year

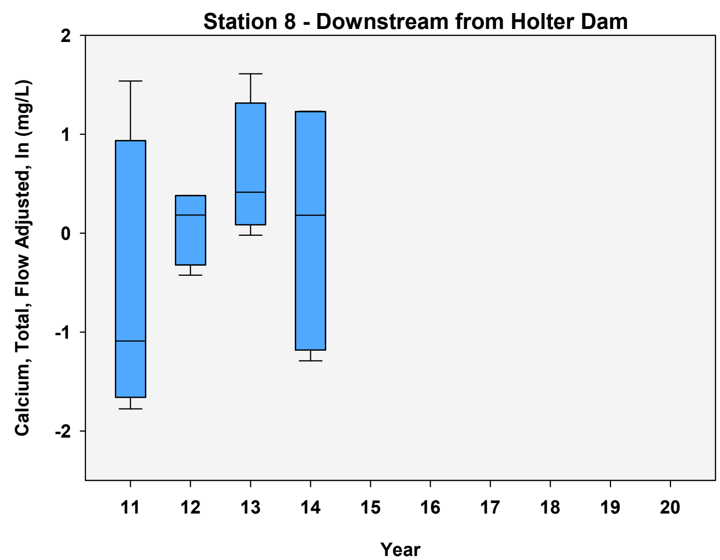
Figure B-34: **Calcium, Total, Flow Adjusted, ln (mg/L) for Stations 1 to 10.**

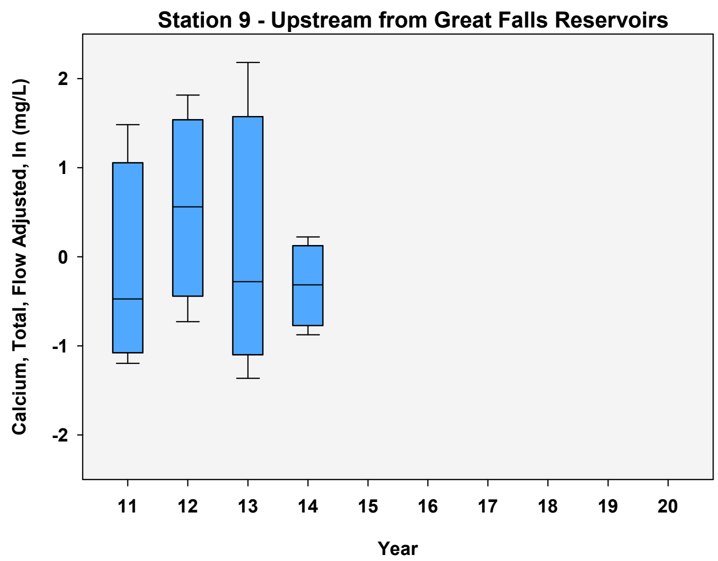



Station 5 - Upstream from Canyon Ferry Reservoir
Calcium, Total, Flow Adjusted, ln (mg/L)
1
0
-1
-2
11 12 13 14 15 16 17 18 19 20
Year


Station 6 - Downstream from Canyon Ferry Dam
Calcium, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11 12 13 14 15 16 17 18 19 20
Year


Station 7 - Downstream from Hauser Dam
Calcium, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11 12 13 14 15 16 17 18 19 20
Year


Station 8 - Downstream from Holter Dam
Calcium, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11 12 13 14 15 16 17 18 19 20
Year


Station 9 - Upstream from Great Falls Reservoirs
Calcium, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

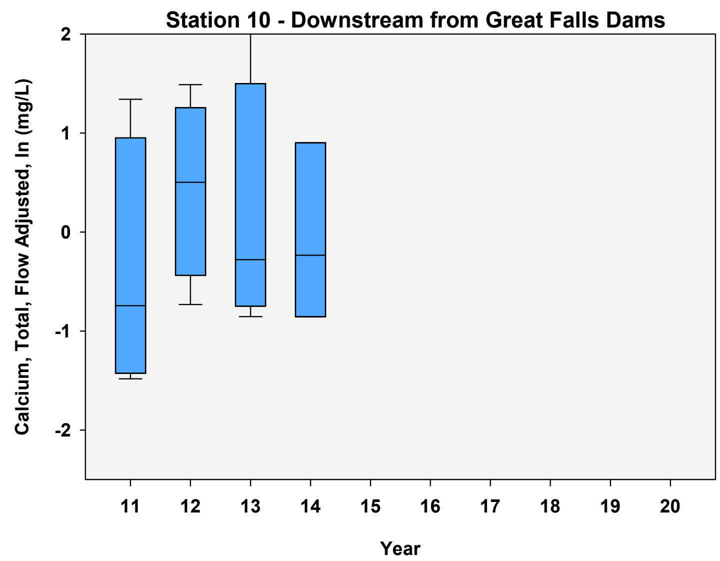
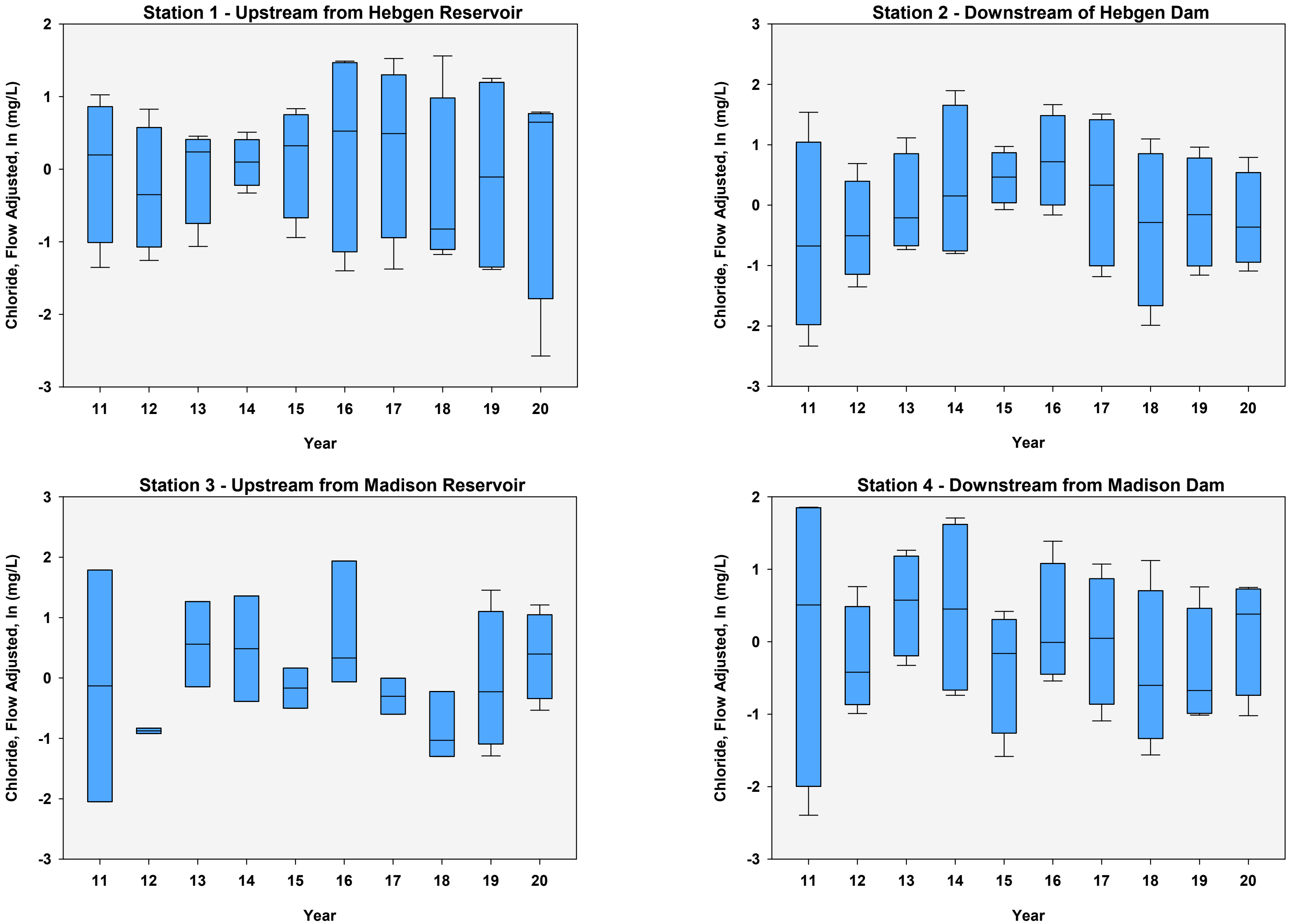
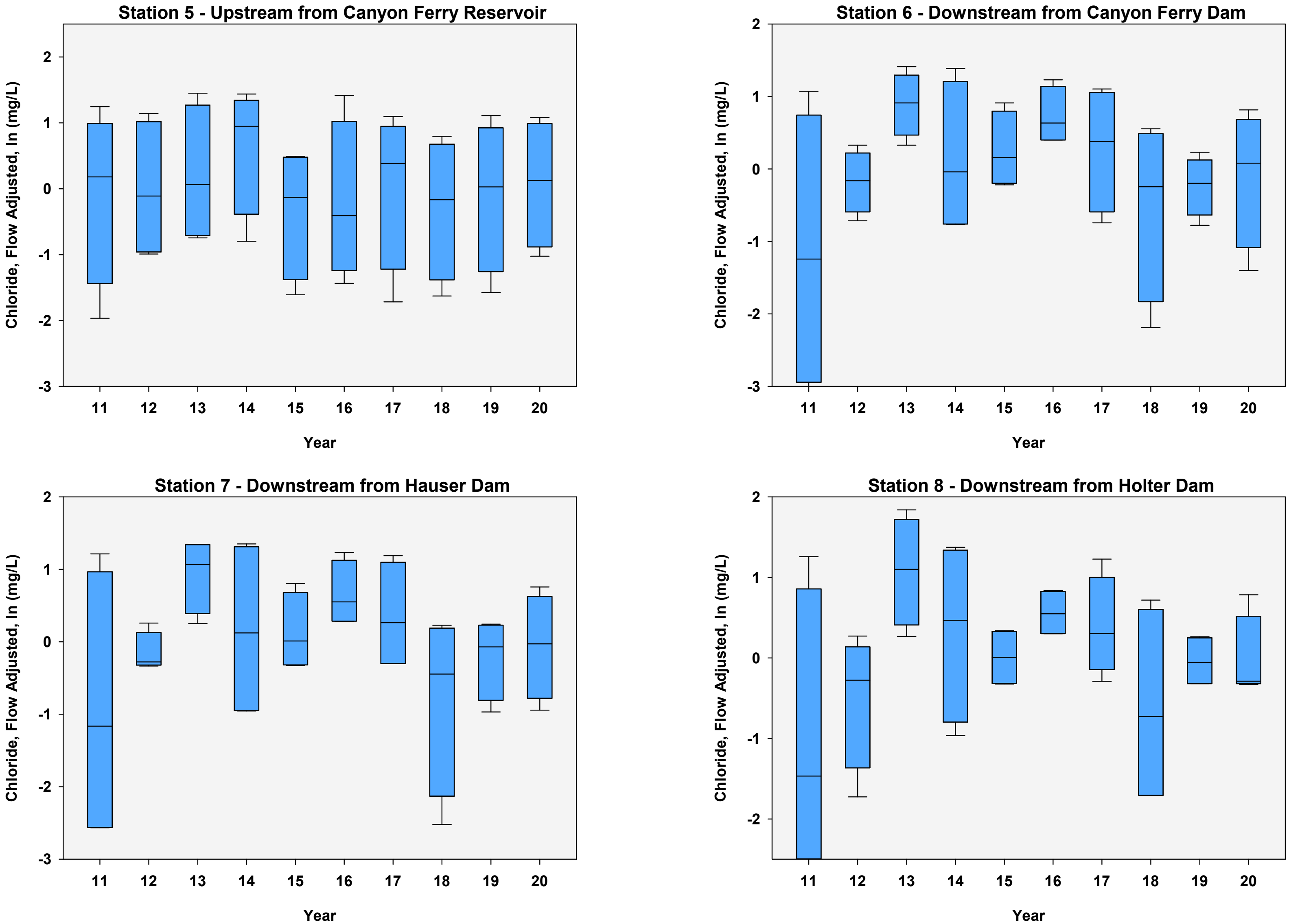
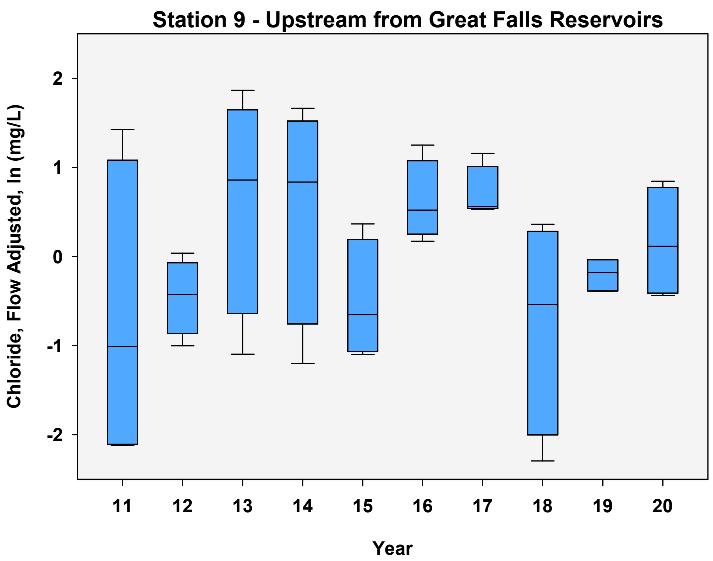

Station 10 - Downstream from Great Falls Dams
Calcium, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

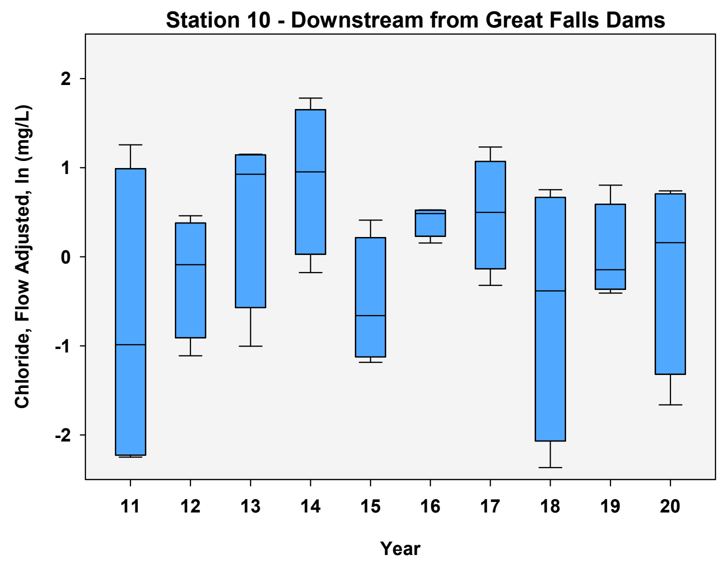
Figure B-35: Chloride, Flow Adjusted, ln (mg/L) for Stations 1 to 10.




Station 5 - Upstream from Canyon Ferry Reservoir
Station 6 - Downstream from Canyon Ferry Dam
Station 7 - Downstream from Hauser Dam
Station 8 - Downstream from Holter Dam
Chloride, Flow Adjusted, ln (mg/L)
Year
11 12 13 14 15 16 17 18 19 20
2 1 0 -1 -2 -3

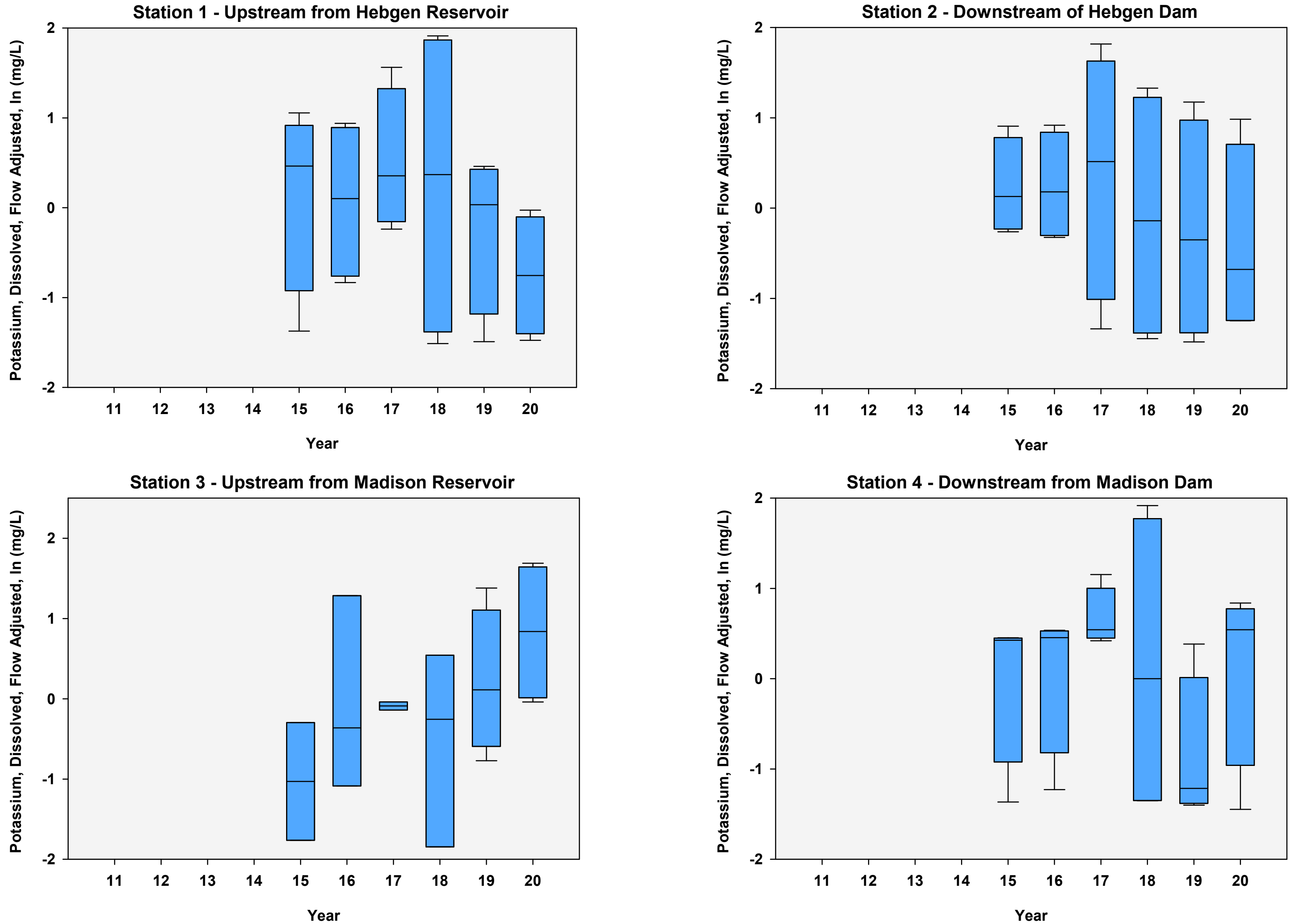


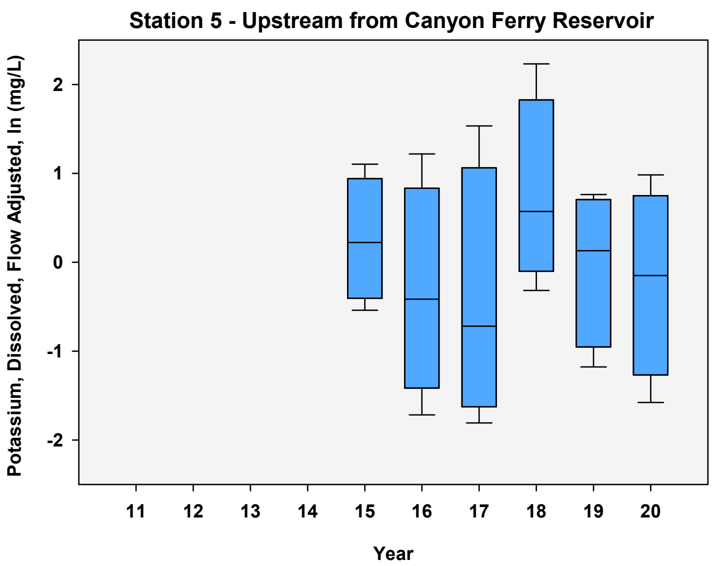
Station 9 - Upstream from Great Falls Reservoirs
Chloride, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

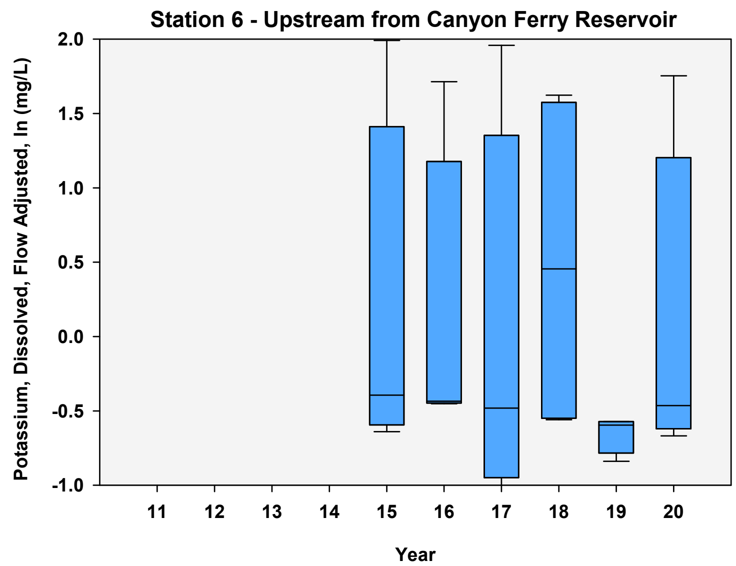


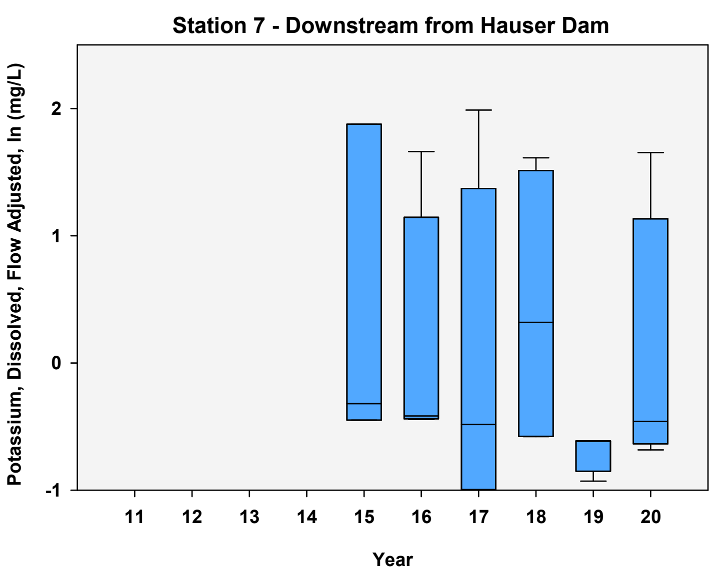
Station 10 - Downstream from Great Falls Dams
Chloride, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

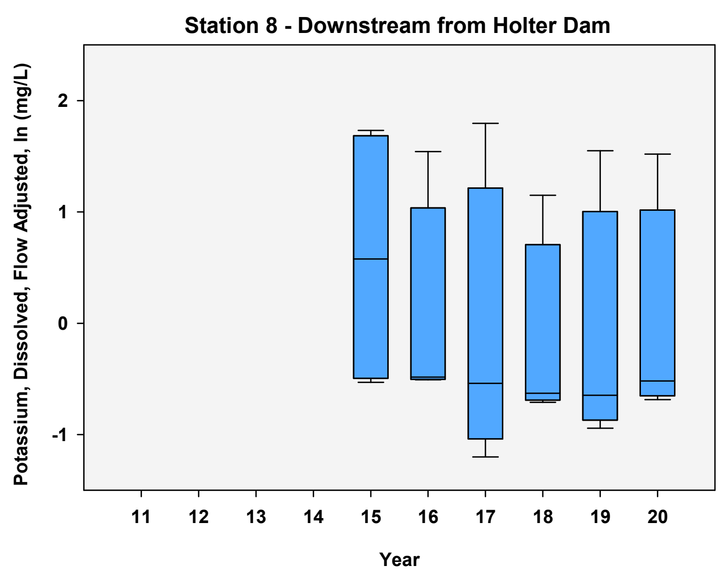
Figure B-36: Potassium, Dissolved, Flow Adjusted, ln (mg/L) for Stations 1 to 10.

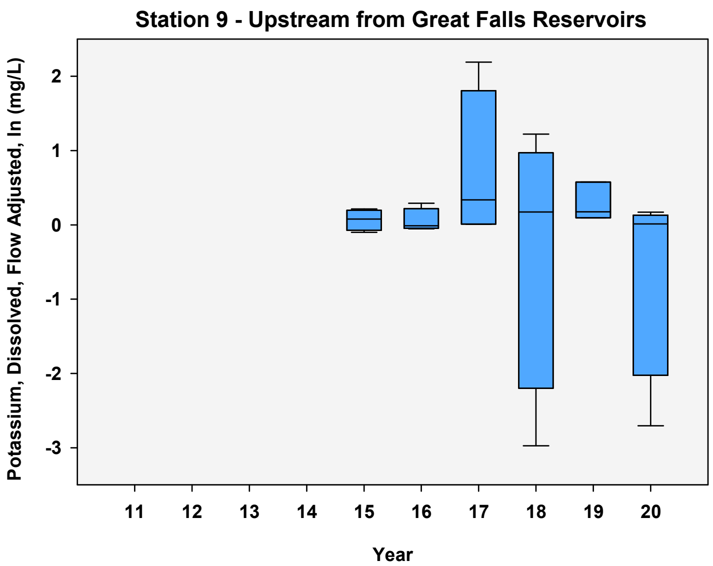



Station 5 - Upstream from Canyon Ferry Reservoir
Potassium, Dissolved, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Upstream from Canyon Ferry Reservoir
Potassium, Dissolved, Flow Adjusted, ln (mg/L)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Potassium, Dissolved, Flow Adjusted, ln (mg/L)
2
1
0
-1
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Potassium, Dissolved, Flow Adjusted, ln (mg/L)
2
1
0
-1
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Potassium, Dissolved, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year

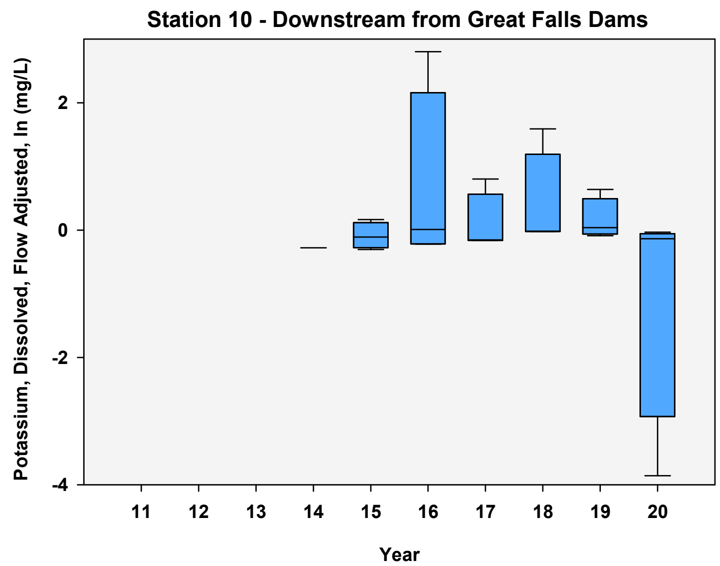
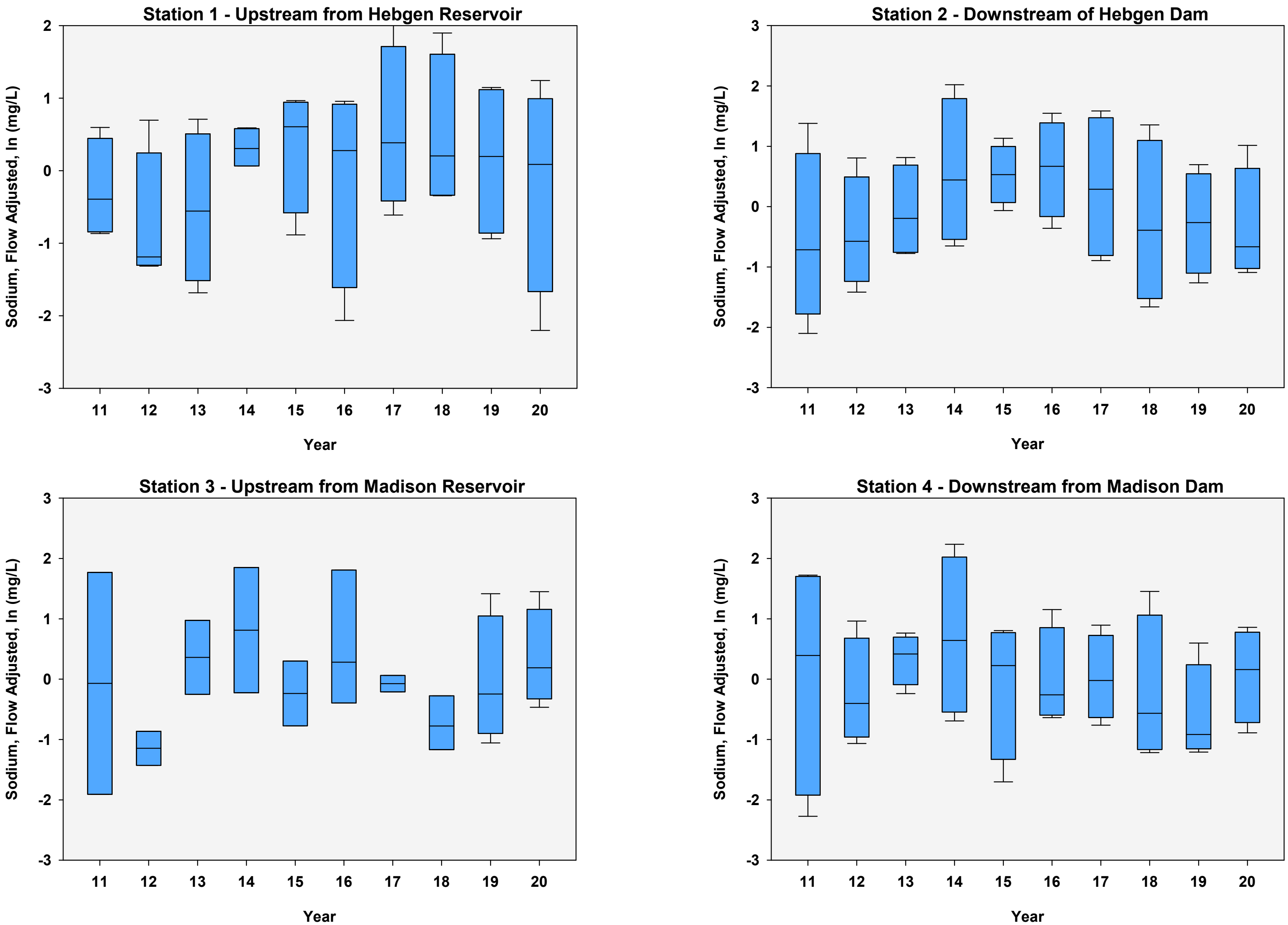
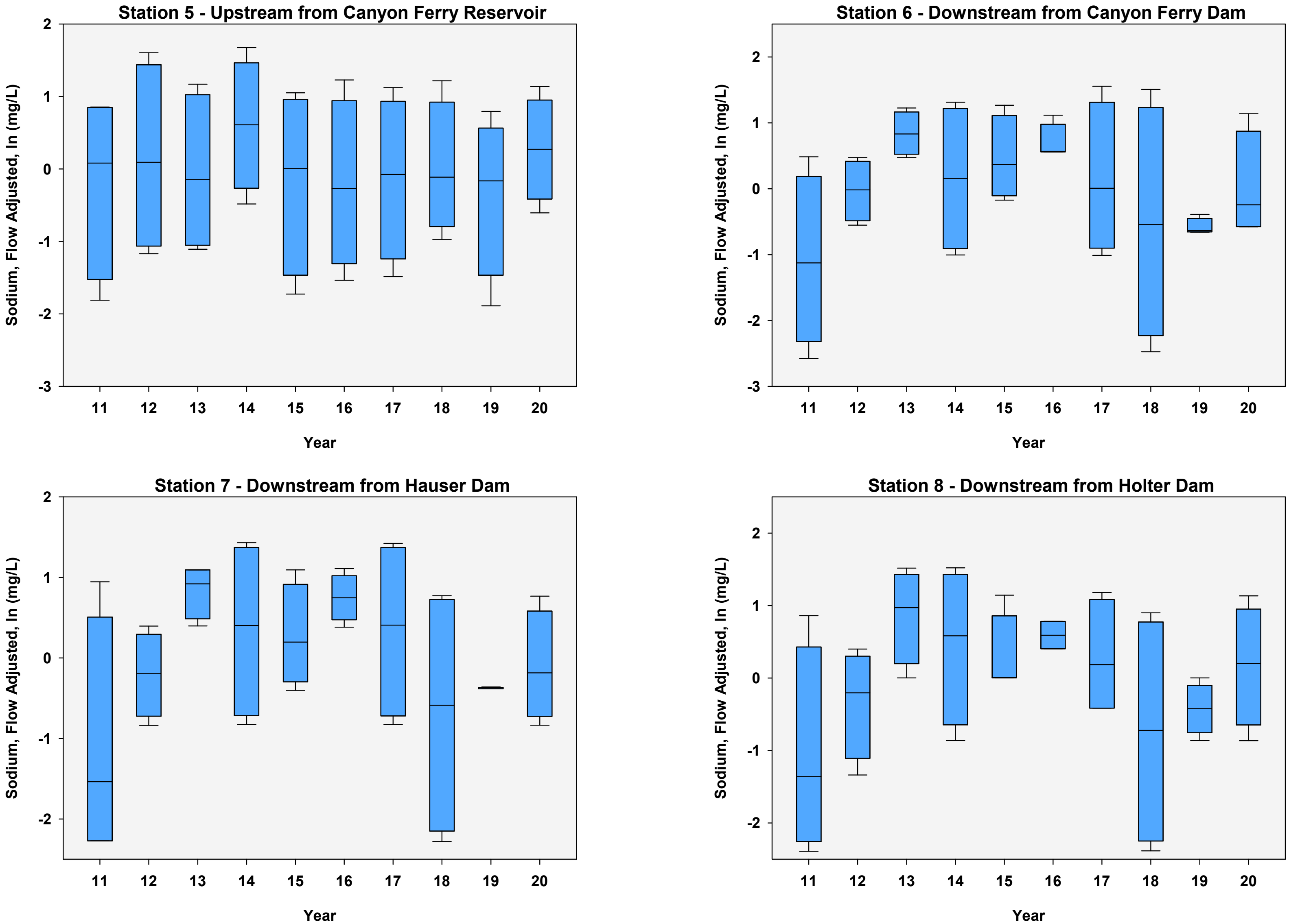
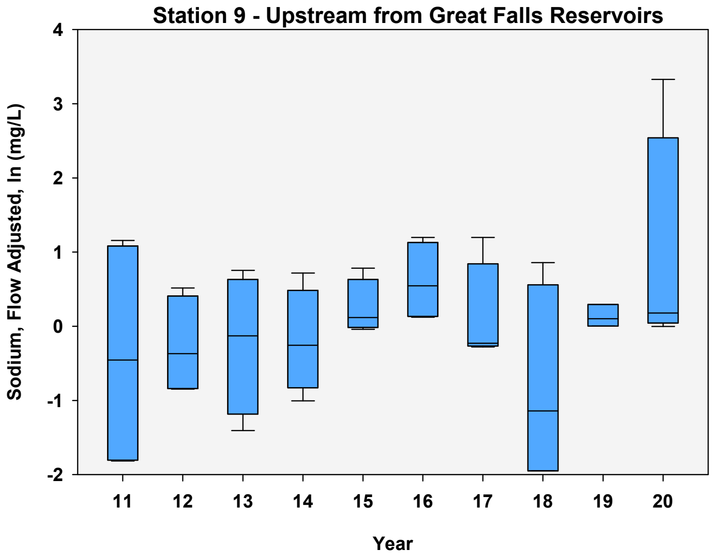

Station 10 - Downstream from Great Falls Dams
Potassium, Dissolved, Flow Adjusted, ln (mg/L)
2
0
-2
-4
11
12
13
14
15
16
17
18
19
20
Year

Figure B-37: Sodium, Flow Adjusted, ln (mg/L) for Stations 1 to 10.





Station 5 - Upstream from Canyon Ferry Reservoir
Station 6 - Downstream from Canyon Ferry Dam
Station 7 - Downstream from Hauser Dam
Station 8 - Downstream from Holter Dam
Sodium, Flow Adjusted, ln (mg/L)
Year
11
12
13
14
15
16
17
18
19
20


Station 9 - Upstream from Great Falls Reservoirs
Sodium, Flow Adjusted, ln (mg/L)
4
3
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

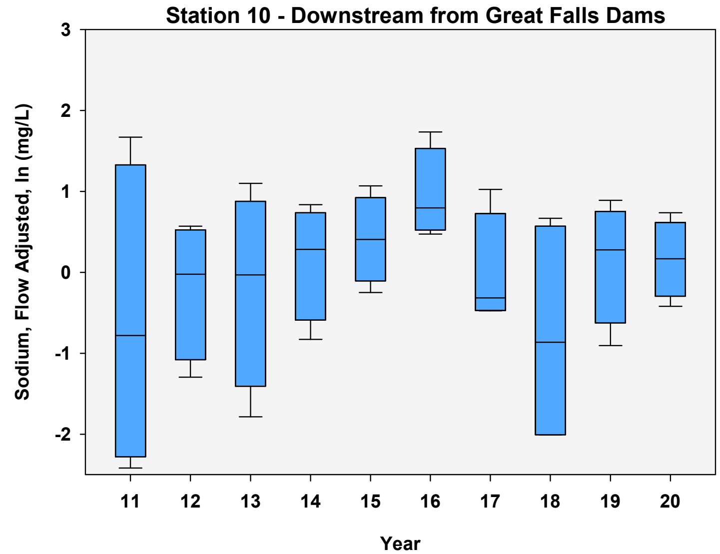
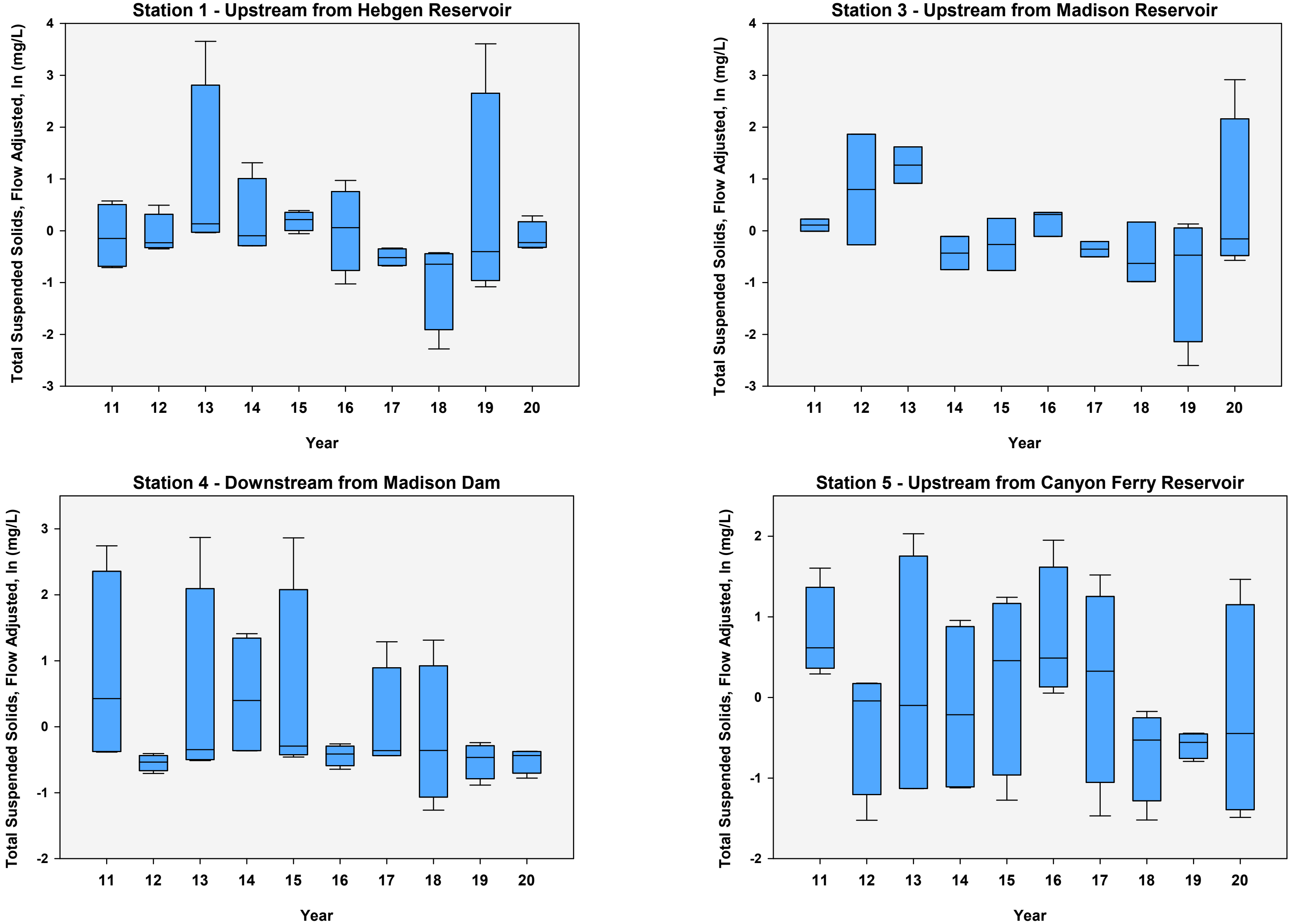
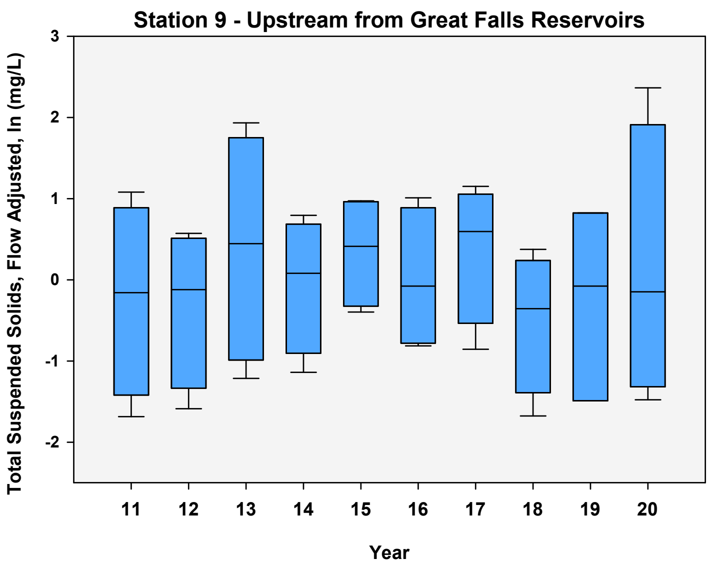

Station 10 - Downstream from Great Falls Dams
Sodium, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

Figure B-38: Total Suspended Solids, Flow Adjusted, ln (mg/L) for Stations 1, 3 to 5, 9 and 10. Total suspended solids concentrations at Stations 2, 6, 7, or 8 were generally below detection limit and figures are not presented here.




Station 9 - Upstream from Great Falls Reservoirs
Total Suspended Solids, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

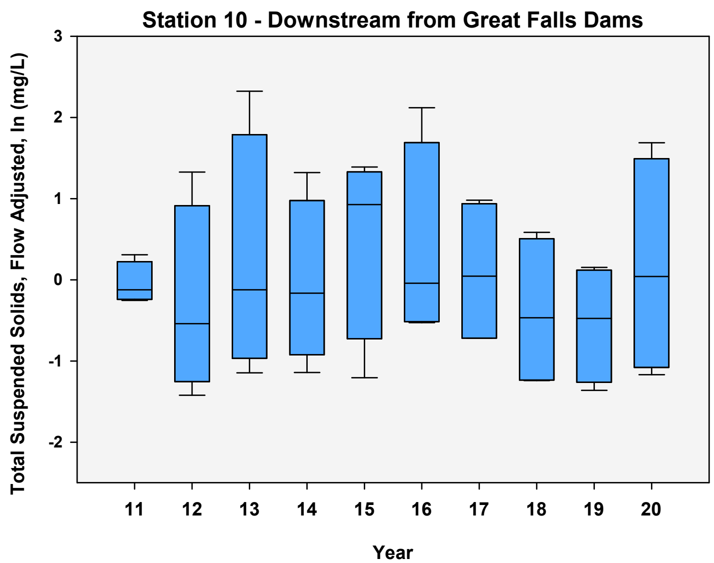
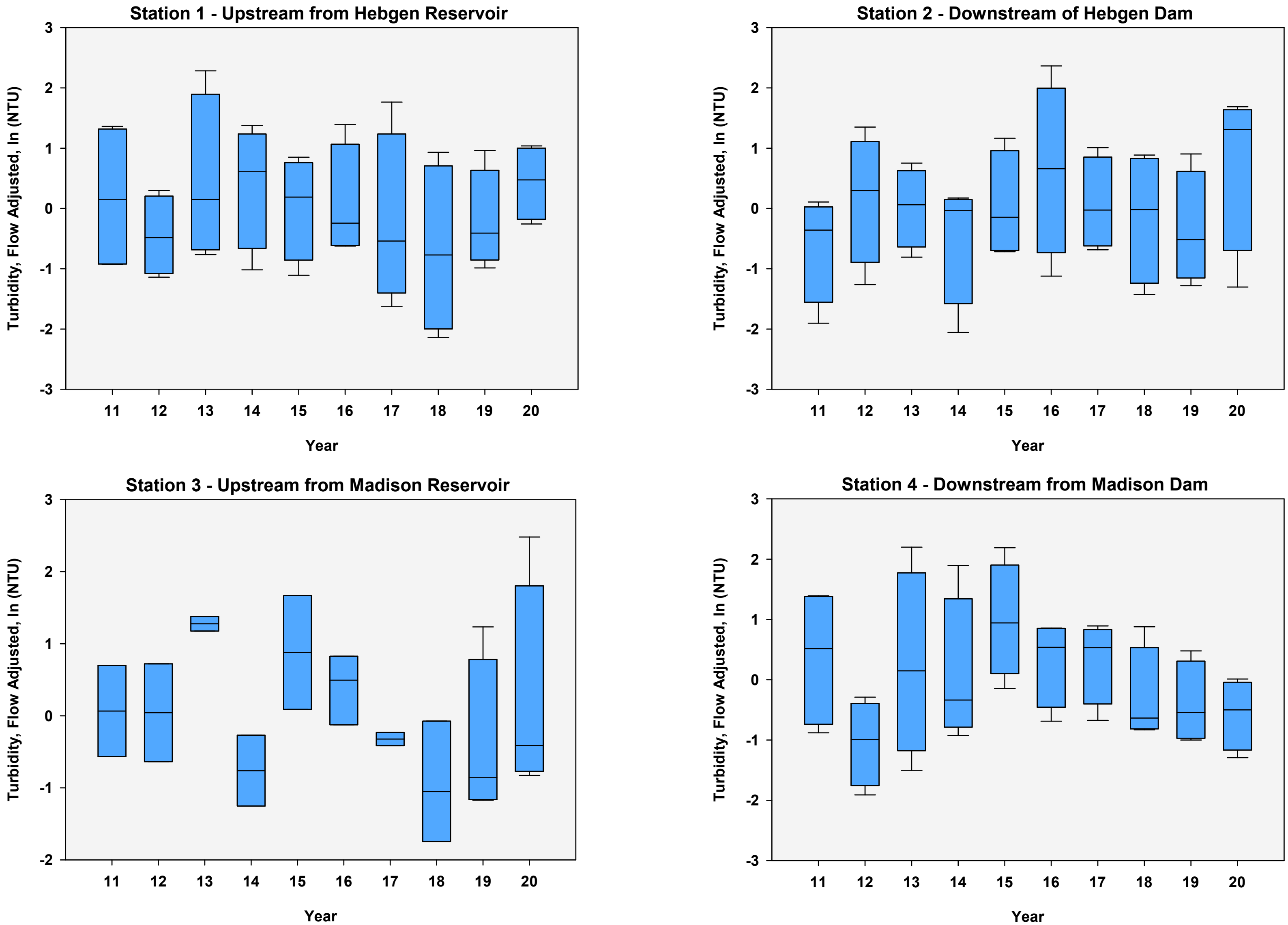
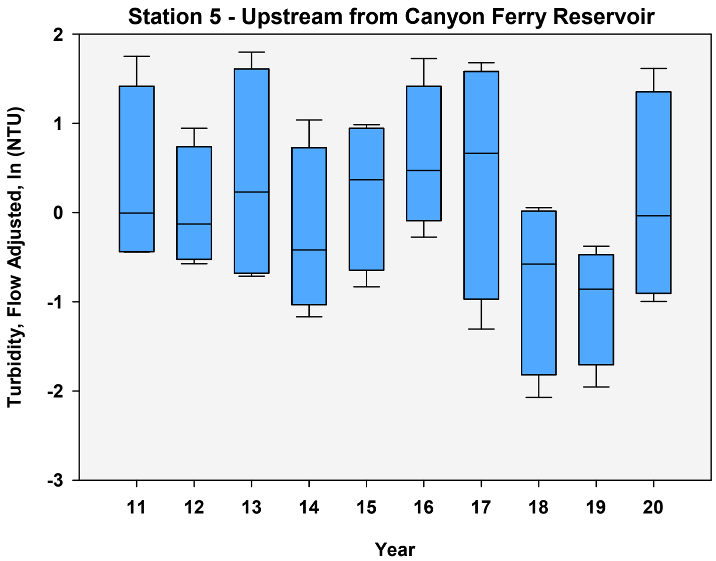
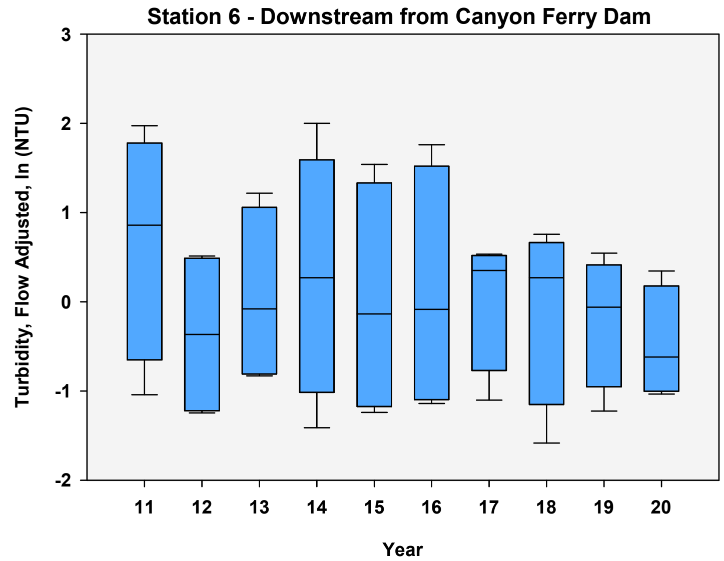
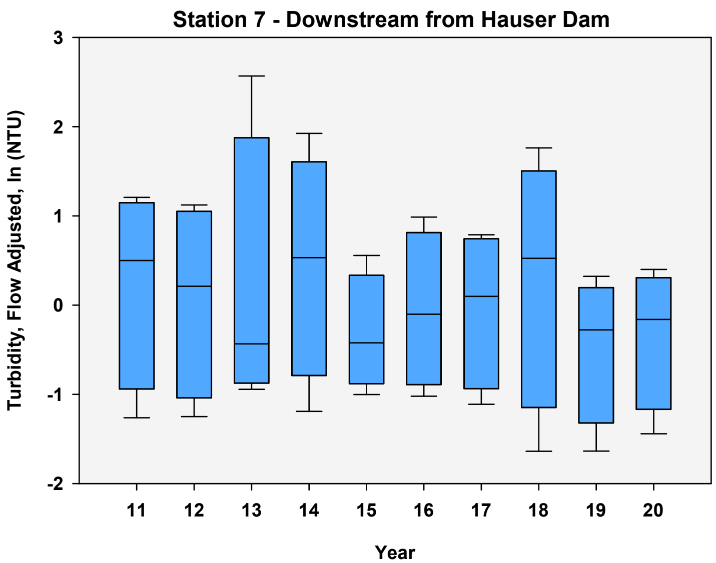

Station 10 - Downstream from Great Falls Dams
Total Suspended Solids, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

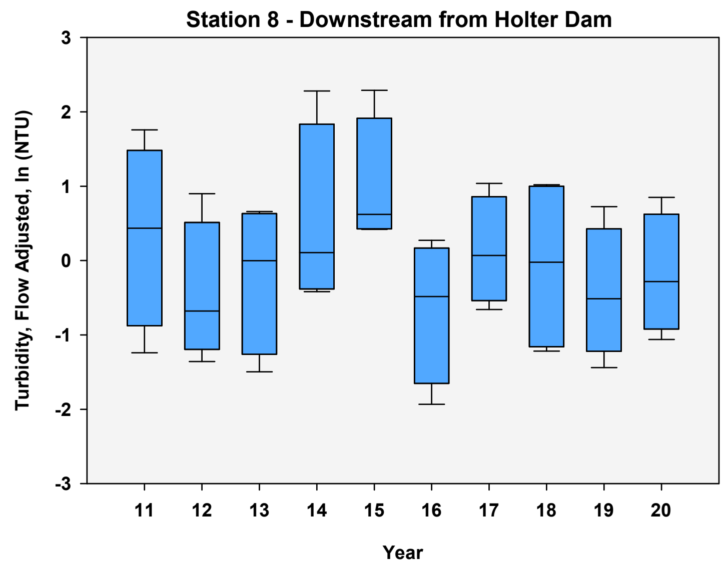
Figure B-39: Turbidity, Flow Adjusted, ln (NTU) for Stations 1 to 10.

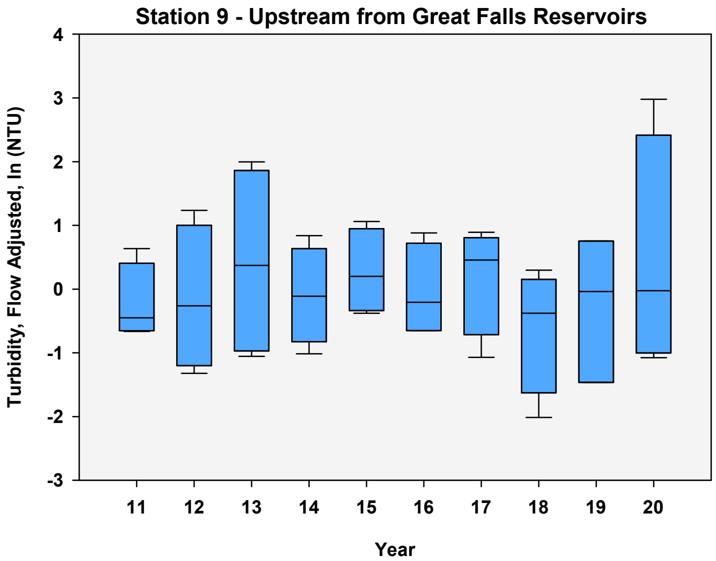



Station 5 - Upstream from Canyon Ferry Reservoir
Turbidity, Flow Adjusted, ln (NTU)
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year

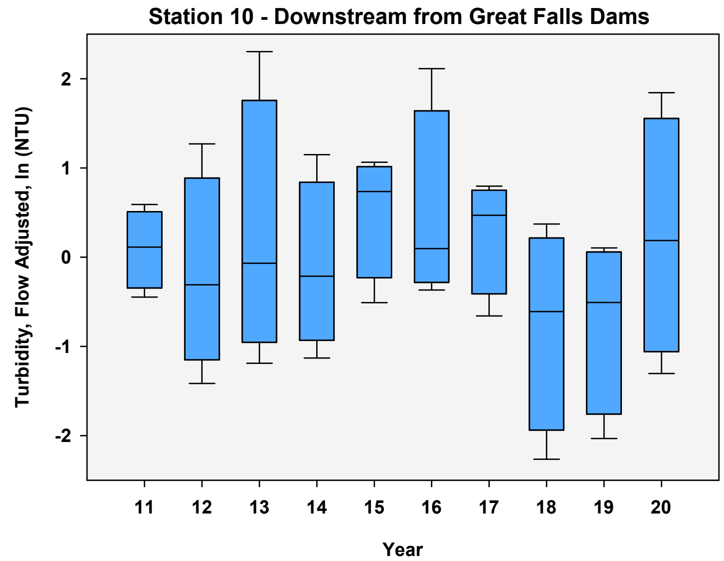

Station 6 - Downstream from Canyon Ferry Dam
Turbidity, Flow Adjusted, ln (NTU)
3
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Turbidity, Flow Adjusted, ln (NTU)
3
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Turbidity, Flow Adjusted, ln (NTU)
3
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year

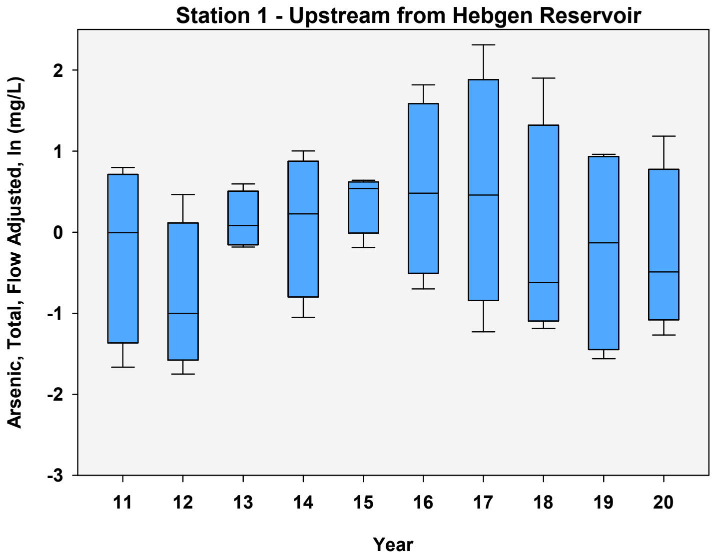


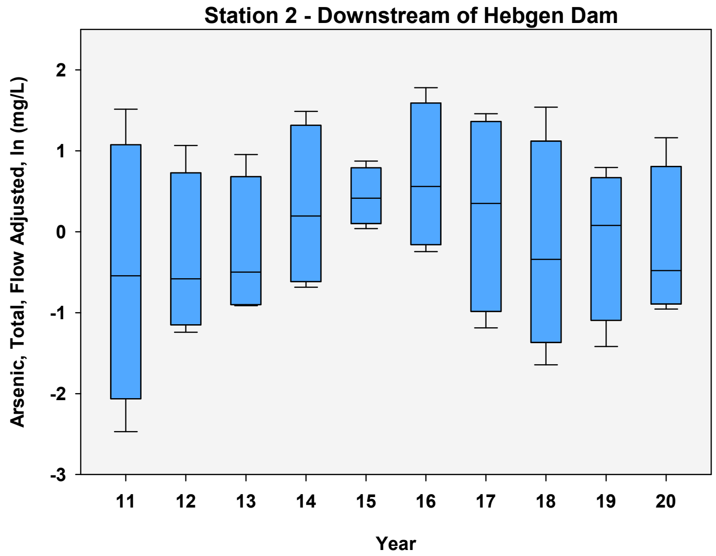
Station 9 - Upstream from Great Falls Reservoirs
Turbidity, Flow Adjusted, ln (NTU)
4
3
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year

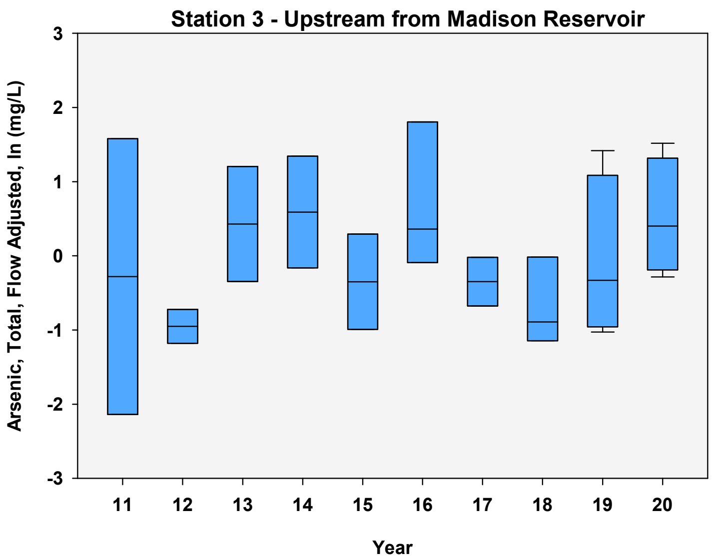


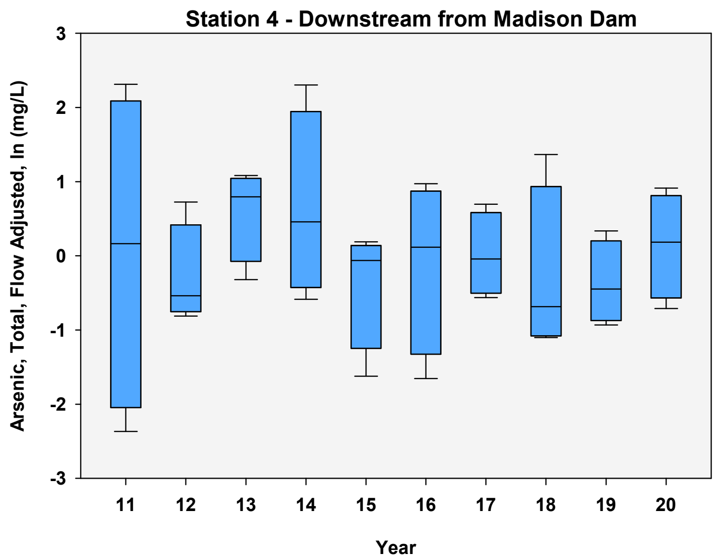
Station 10 - Downstream from Great Falls Dams
Turbidity, Flow Adjusted, ln (NTU)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

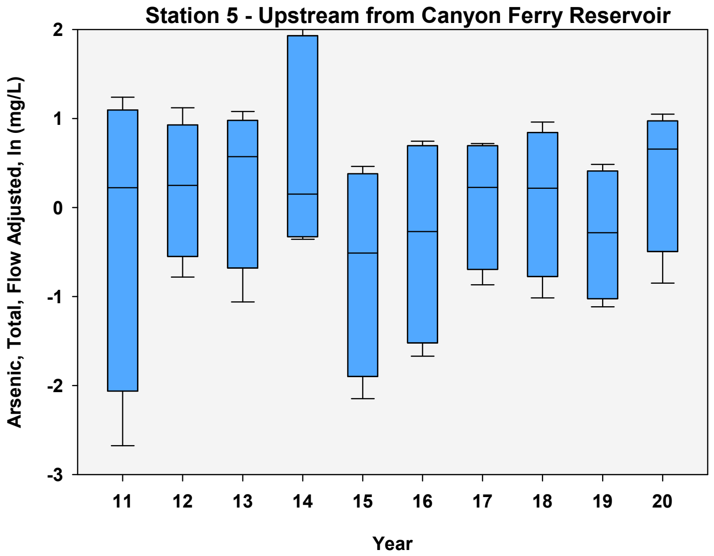
Figure B-40: Arsenic, Total, Flow Adjusted, ln (mg/L) for Stations 1 to 10.



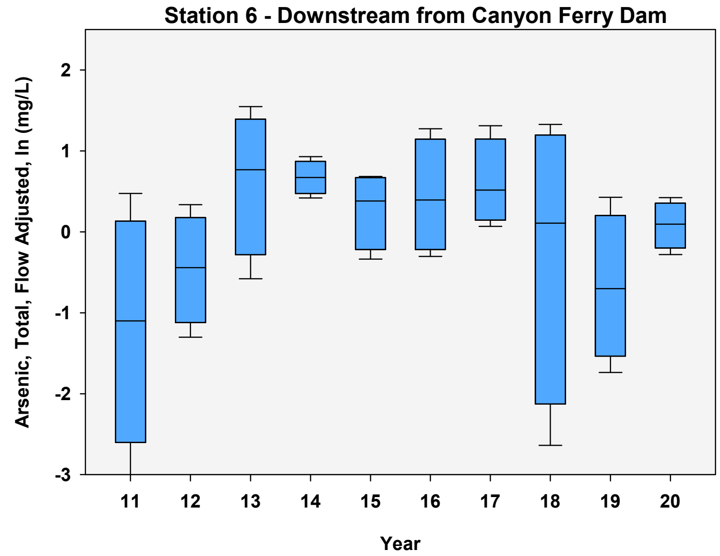




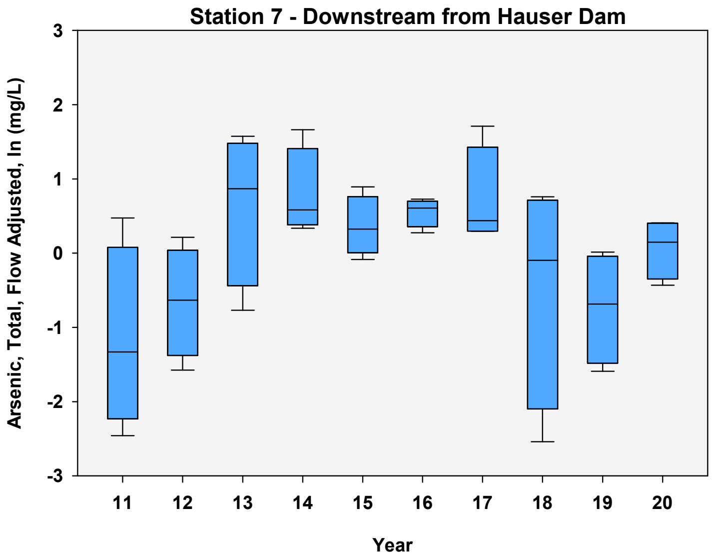




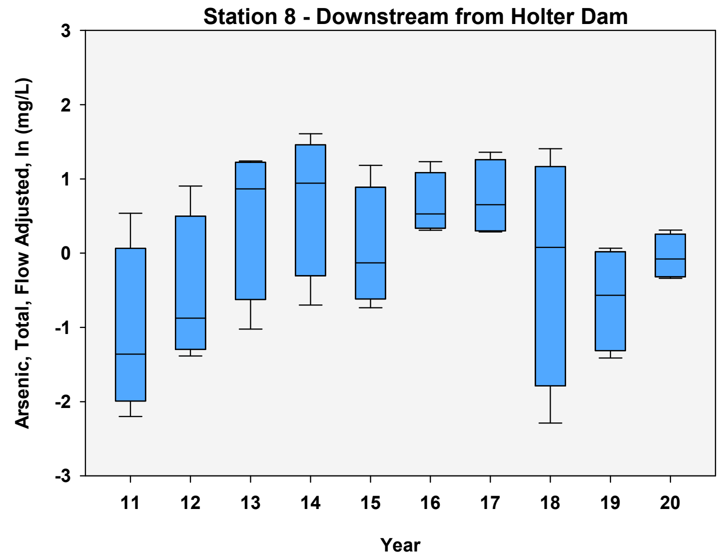
Station 5 - Upstream from Canyon Ferry Reservoir
Arsenic, Total, Flow Adjusted, ln (mg/L)
Year



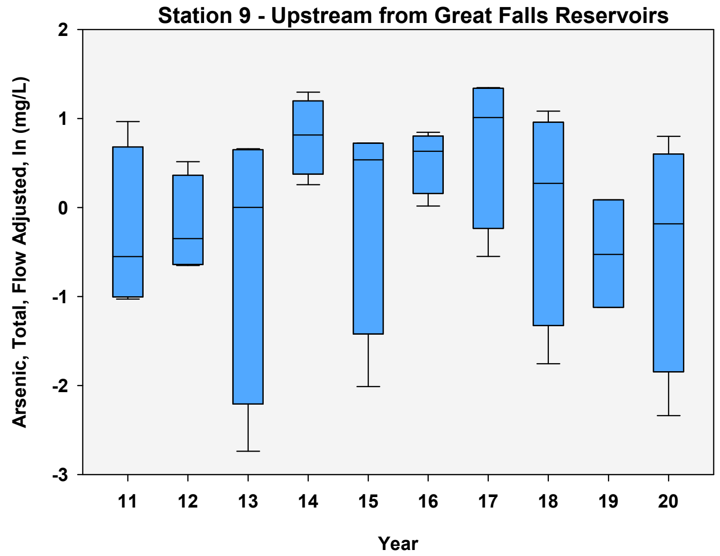
Station 6 - Downstream from Canyon Ferry Dam
Arsenic, Total, Flow Adjusted, ln (mg/L)
Year



Station 7 - Downstream from Hauser Dam
Arsenic, Total, Flow Adjusted, ln (mg/L)
Year



Station 8 - Downstream from Holter Dam
Arsenic, Total, Flow Adjusted, ln (mg/L)
Year


Station 9 - Upstream from Great Falls Reservoirs
Arsenic, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year

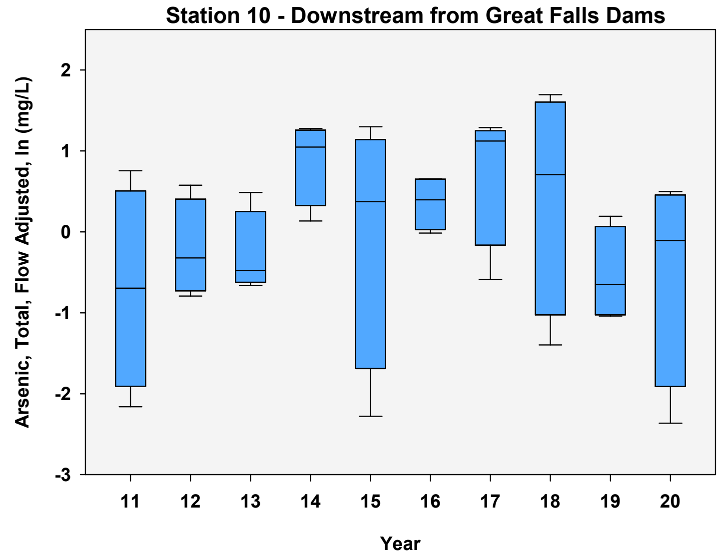
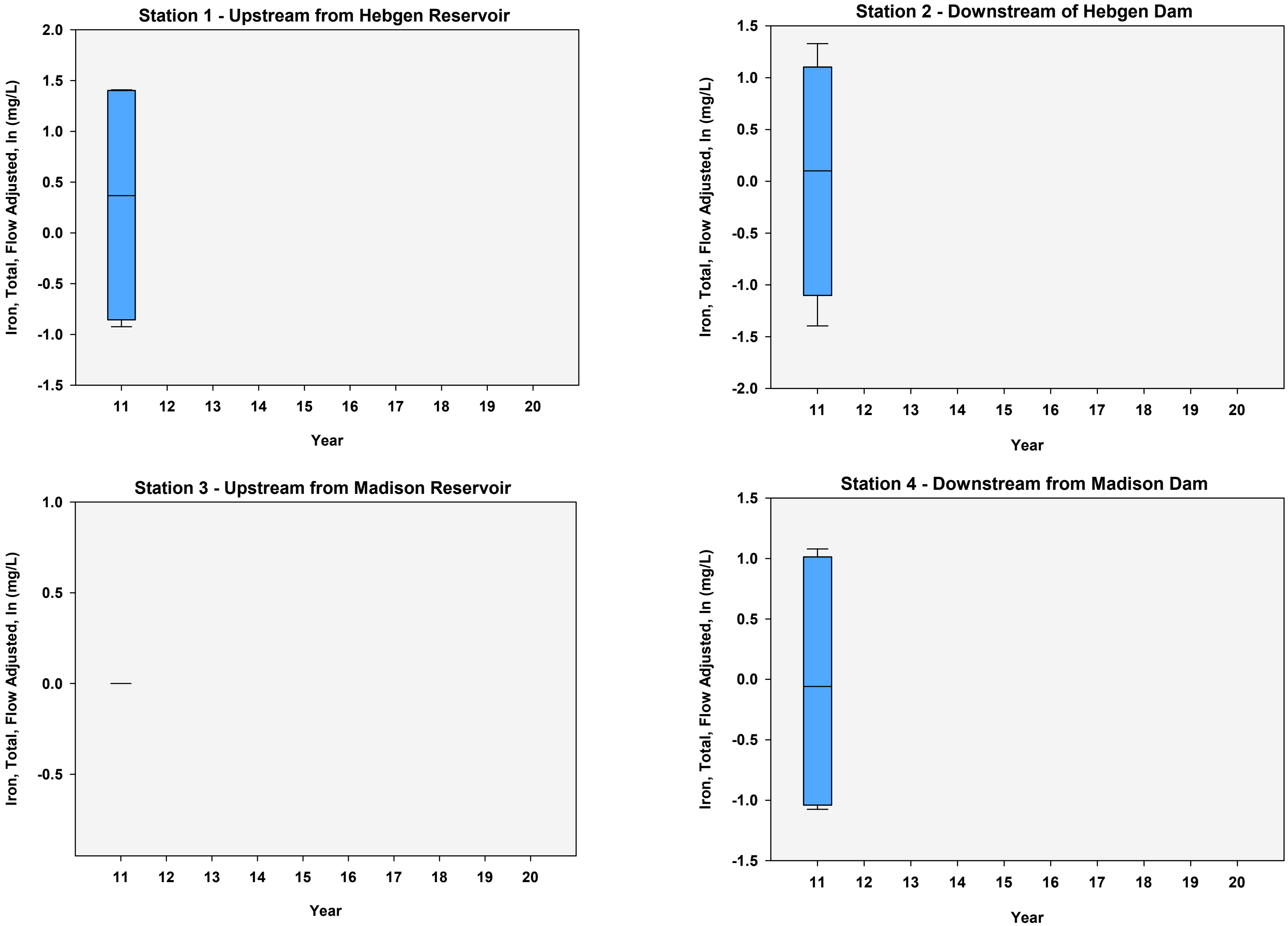
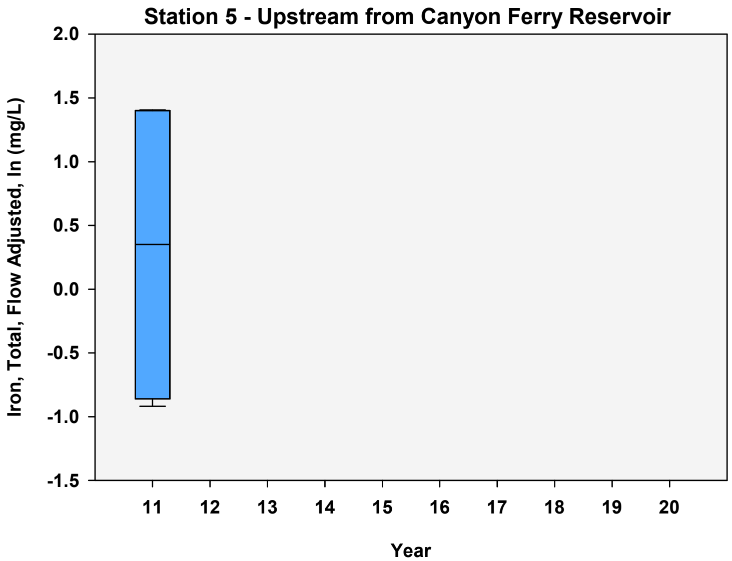
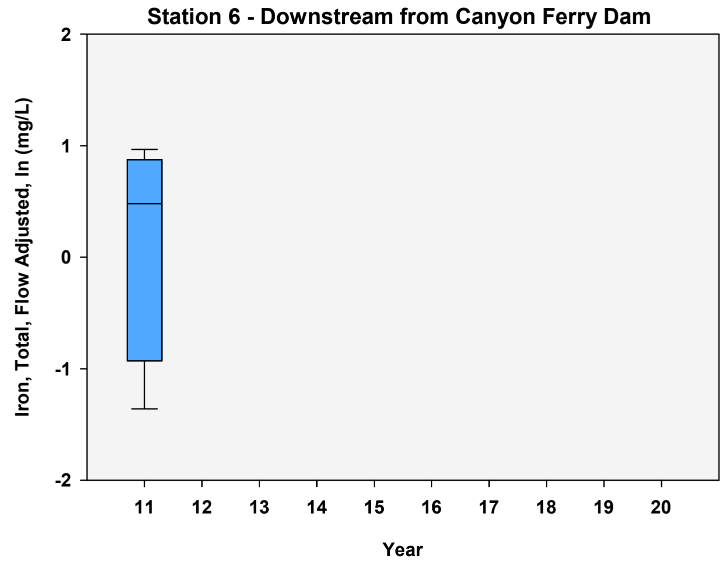
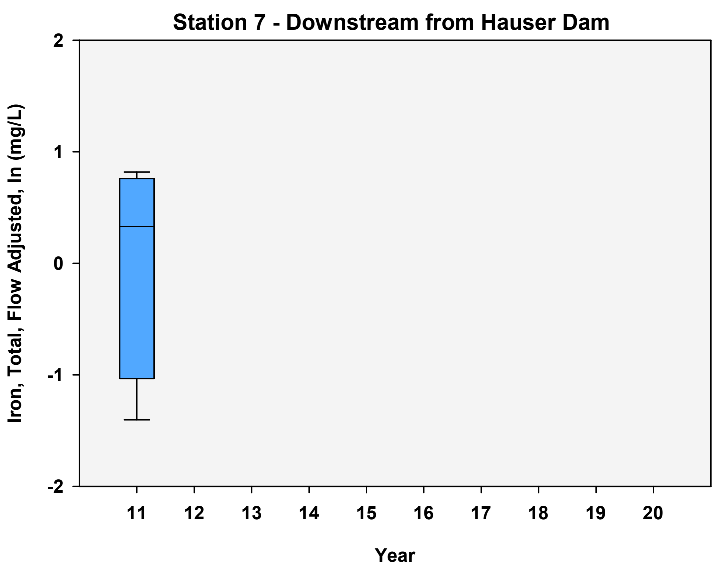

Station 10 - Downstream from Great Falls Dams
Arsenic, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year

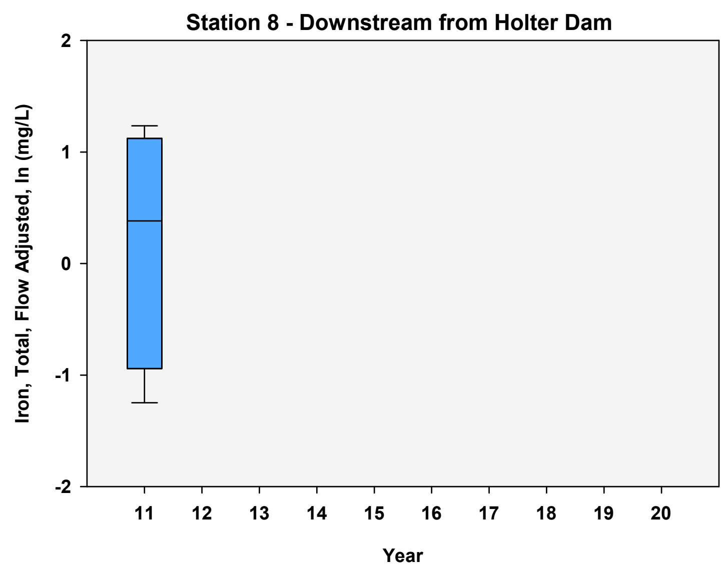
Figure B-41: **Iron, Total, Flow Adjusted, ln (mg/L) for Stations 1 to 10. Iron was sampled only in 2011 for all Stations except Station 9 and 10 which was samples from 2011 to 2020.**

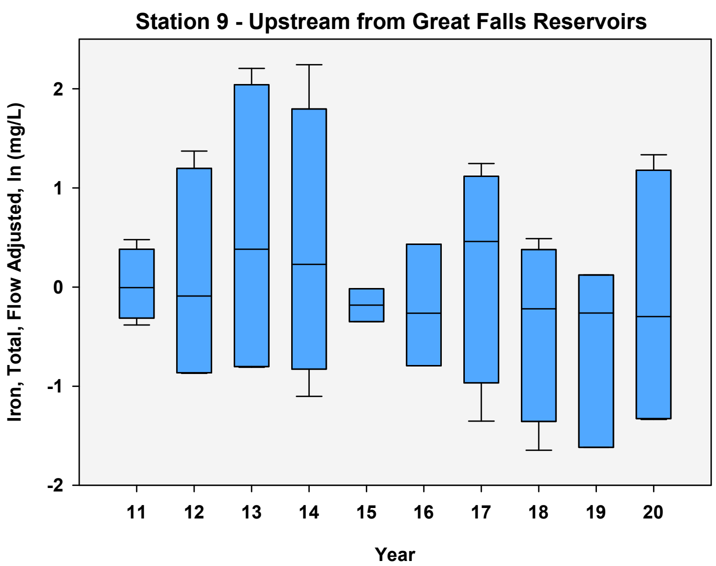



Station 5 - Upstream from Canyon Ferry Reservoir
Iron, Total, Flow Adjusted, ln (mg/L)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
11
12
13
14
15
16
17
18
19
20
Year


Station 6 - Downstream from Canyon Ferry Dam
Iron, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Iron, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Iron, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year


Station 9 - Upstream from Great Falls Reservoirs
Iron, Total, Flow Adjusted, ln (mg/L)
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

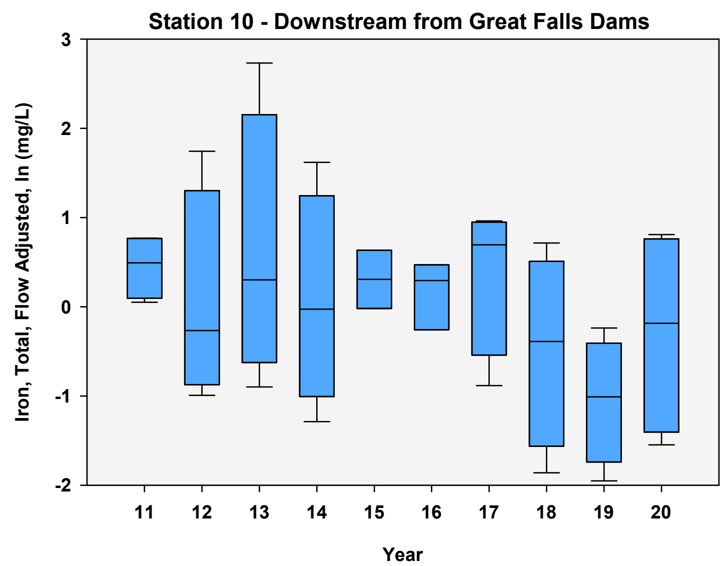
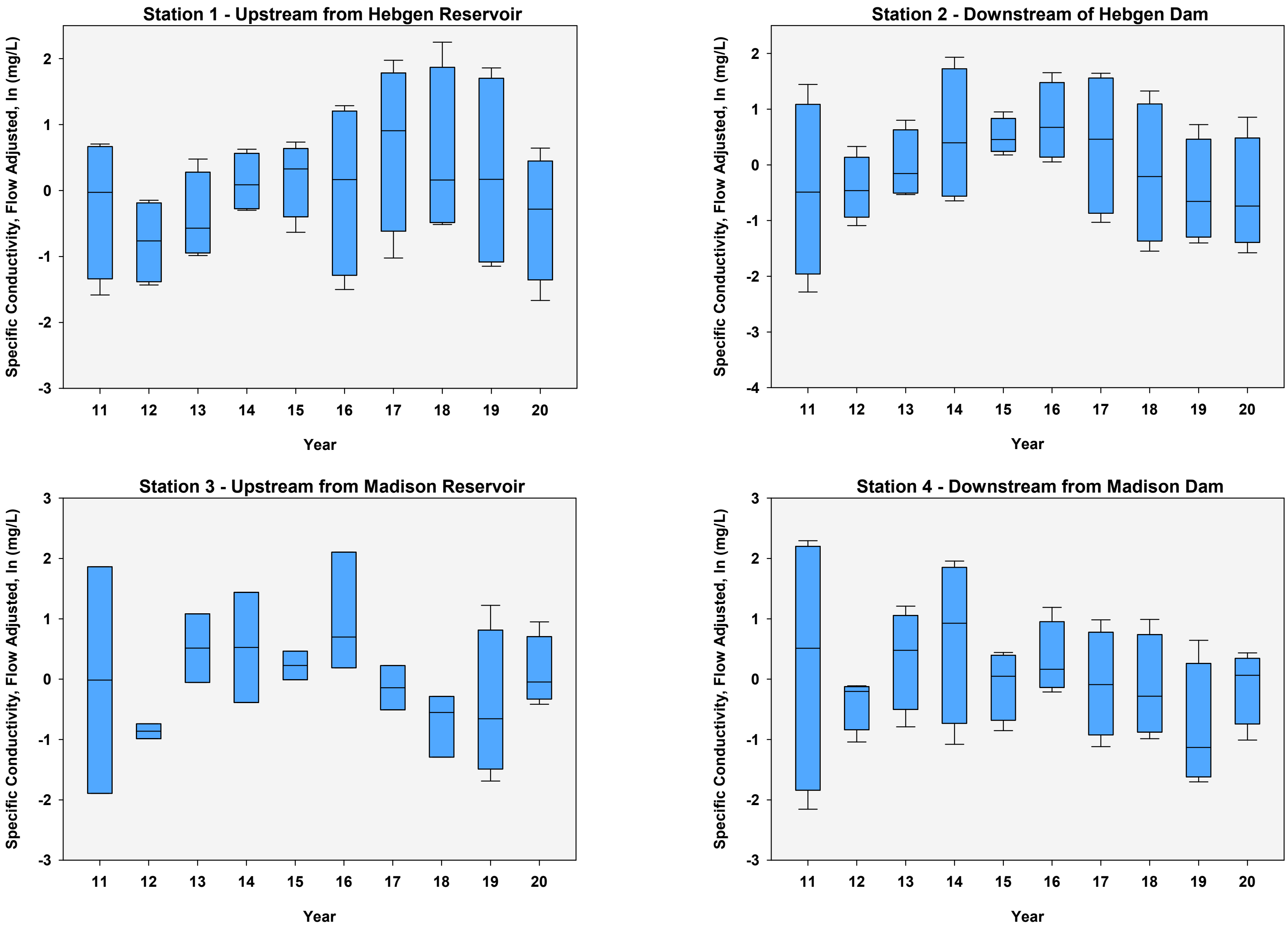
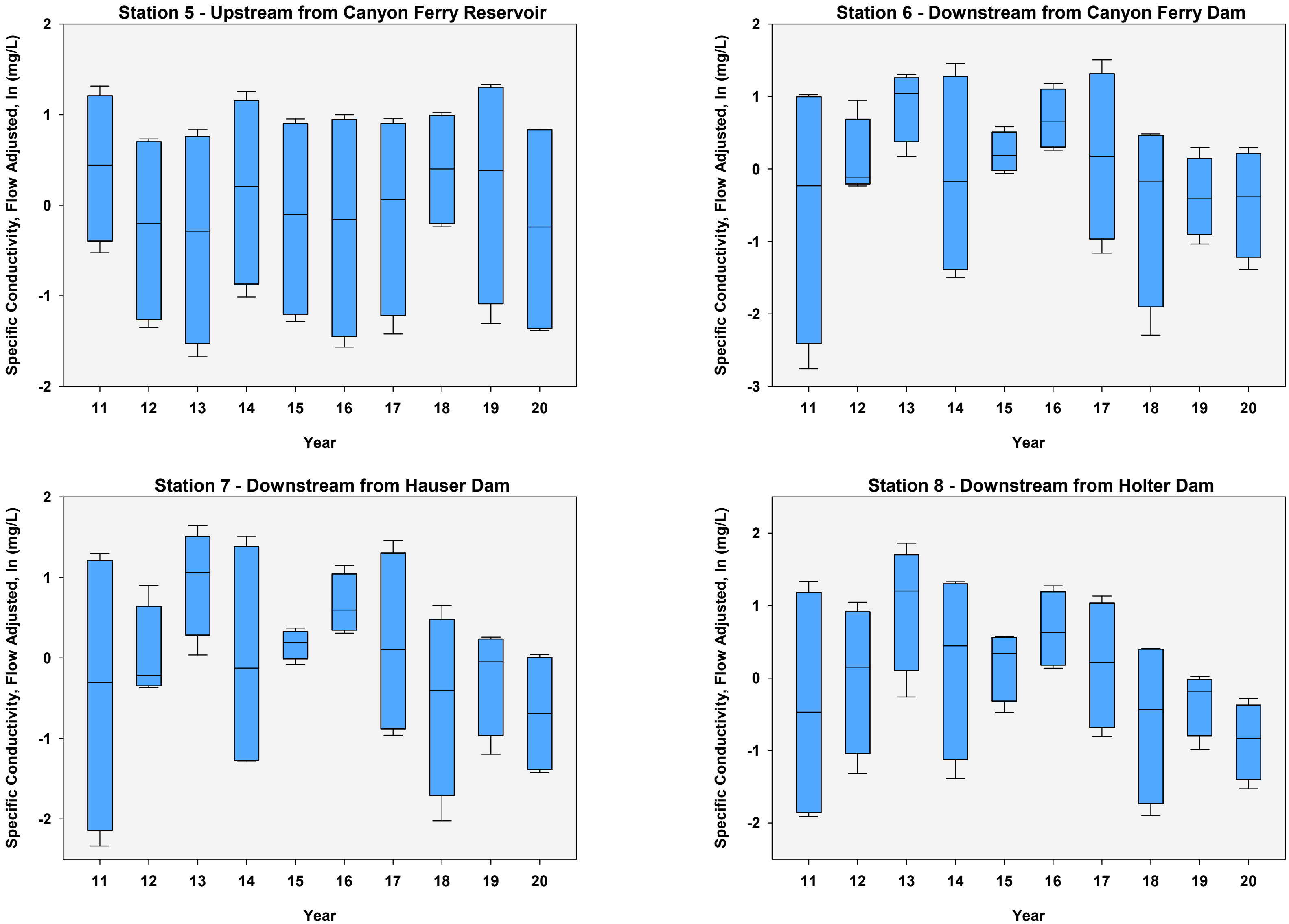
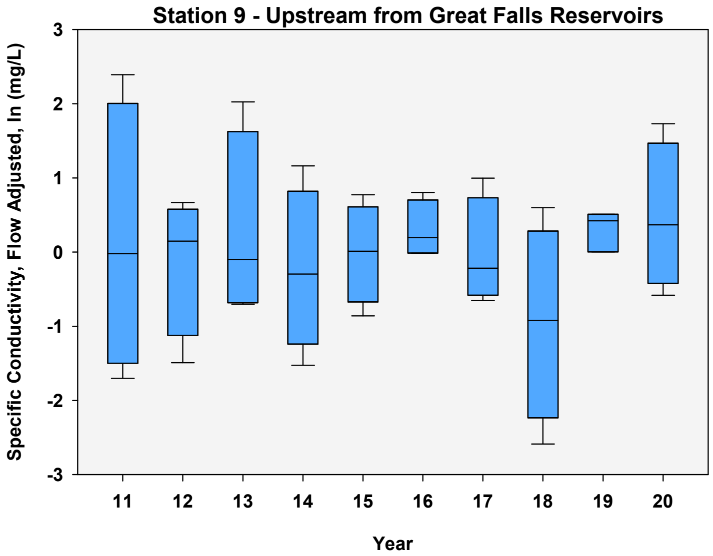

Station 10 - Downstream from Great Falls Dams
Iron, Total, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

Figure B-42: Specific Conductivity, Flow Adjusted, ln (mg/L) for Stations 1 to 10.




Station 5 - Upstream from Canyon Ferry Reservoir
Station 6 - Downstream from Canyon Ferry Dam
Station 7 - Downstream from Hauser Dam
Station 8 - Downstream from Holter Dam
Specific Conductivity, Flow Adjusted, ln (mg/L)
Year
11
12
13
14
15
16
17
18
19
20


Station 9 - Upstream from Great Falls Reservoirs
Specific Conductivity, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
-3
11
12
13
14
15
16
17
18
19
20
Year

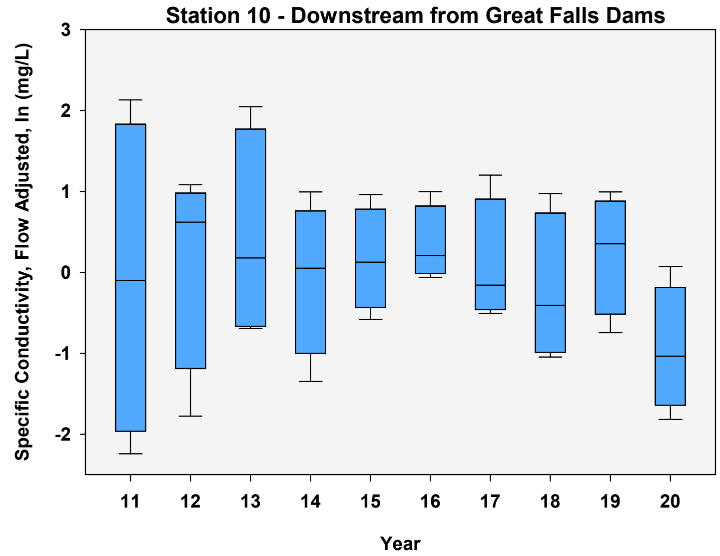
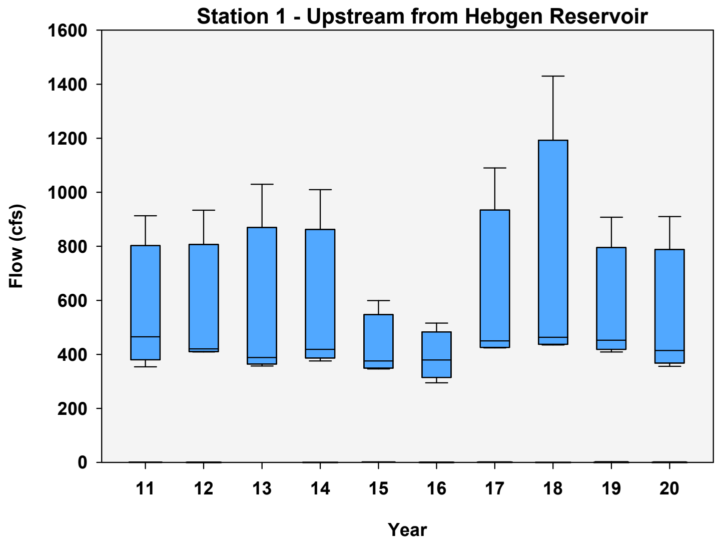
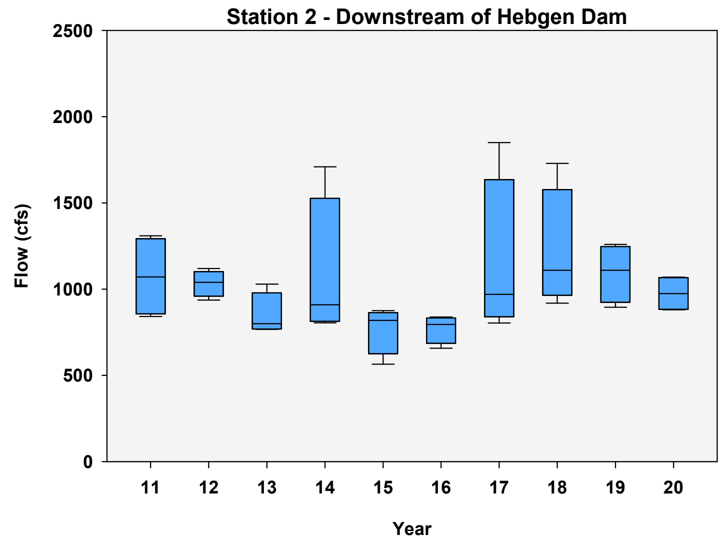
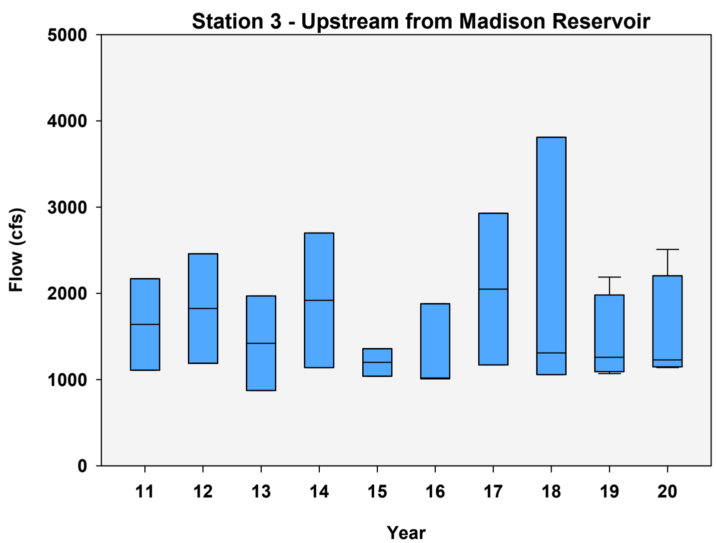
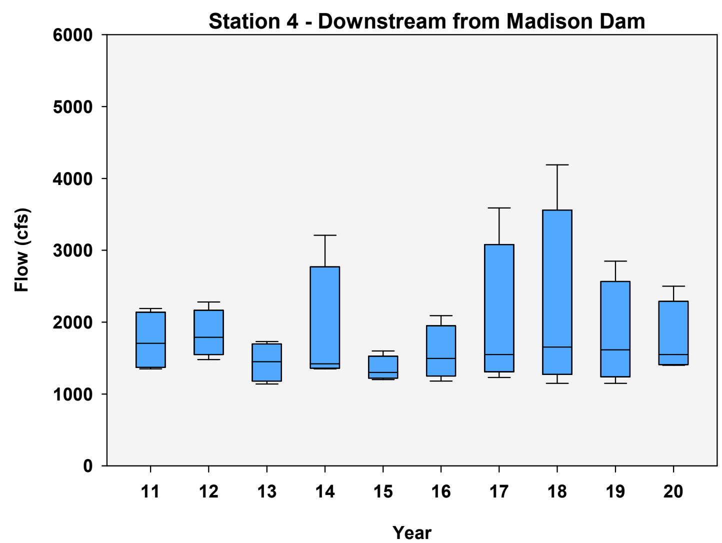

Station 10 - Downstream from Great Falls Dams
Specific Conductivity, Flow Adjusted, ln (mg/L)
3
2
1
0
-1
-2
11
12
13
14
15
16
17
18
19
20
Year

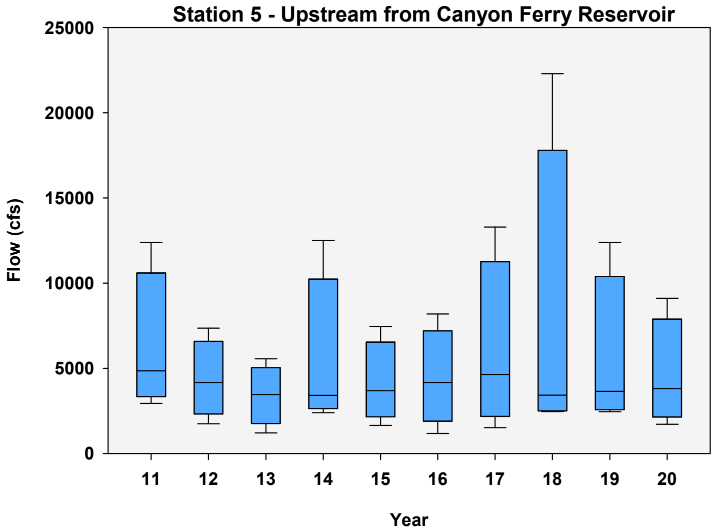
Figure B-43: Flow (CFS) for Stations 1 to 10.

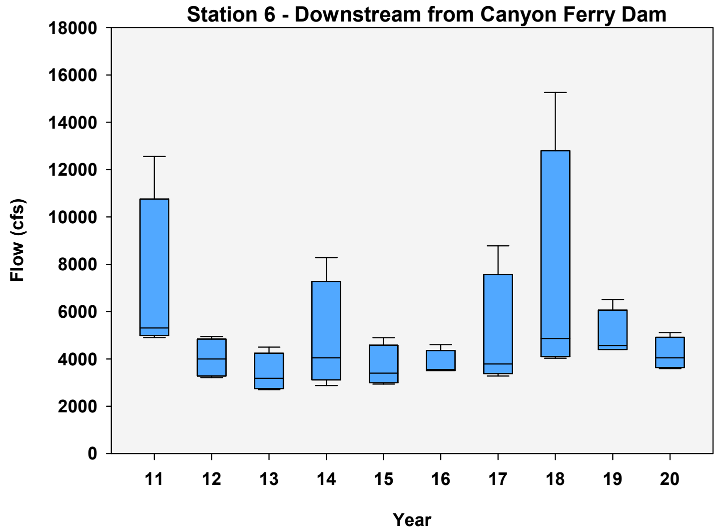


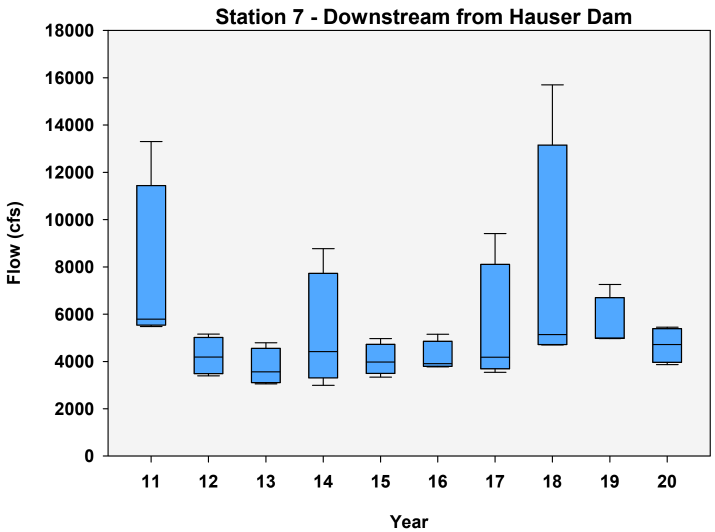


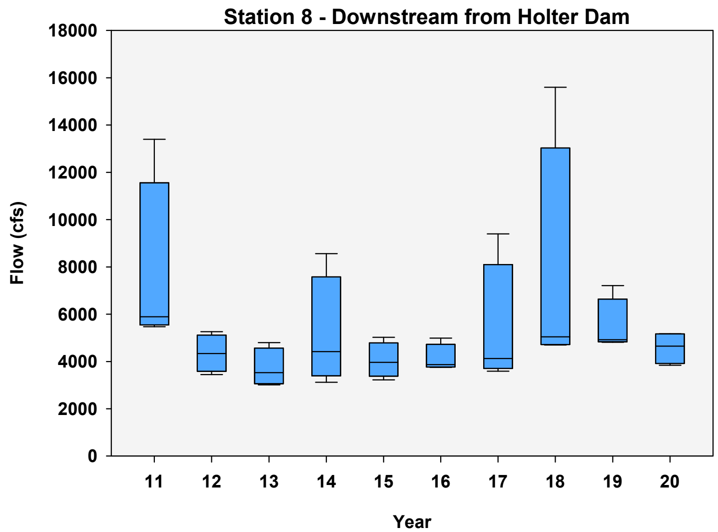


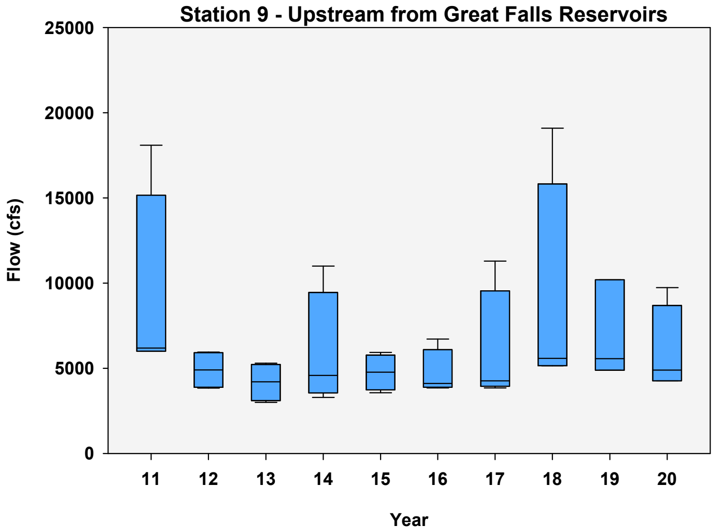



Station 5 - Upstream from Canyon Ferry Reservoir
Flow (cfs)
0
5000
10000
15000
20000
25000
11
12
13
14
15
16
17
18
19
20
Year

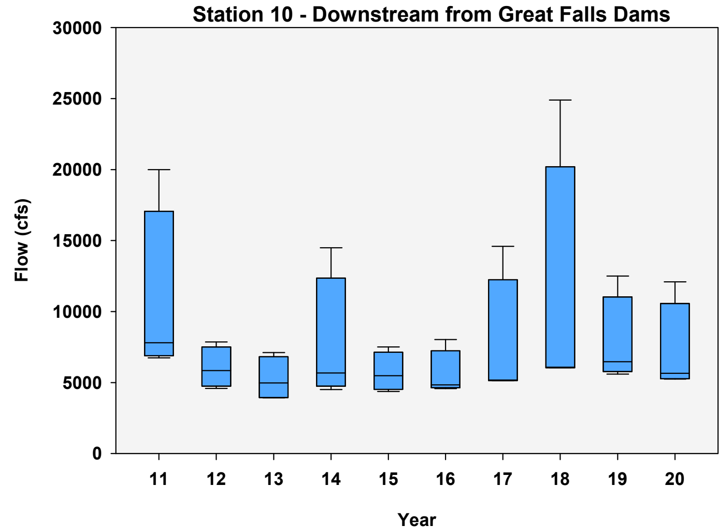

Station 6 - Downstream from Canyon Ferry Dam
Flow (cfs)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
11
12
13
14
15
16
17
18
19
20
Year


Station 7 - Downstream from Hauser Dam
Flow (cfs)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
11
12
13
14
15
16
17
18
19
20
Year


Station 8 - Downstream from Holter Dam
Flow (cfs)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
11
12
13
14
15
16
17
18
19
20
Year

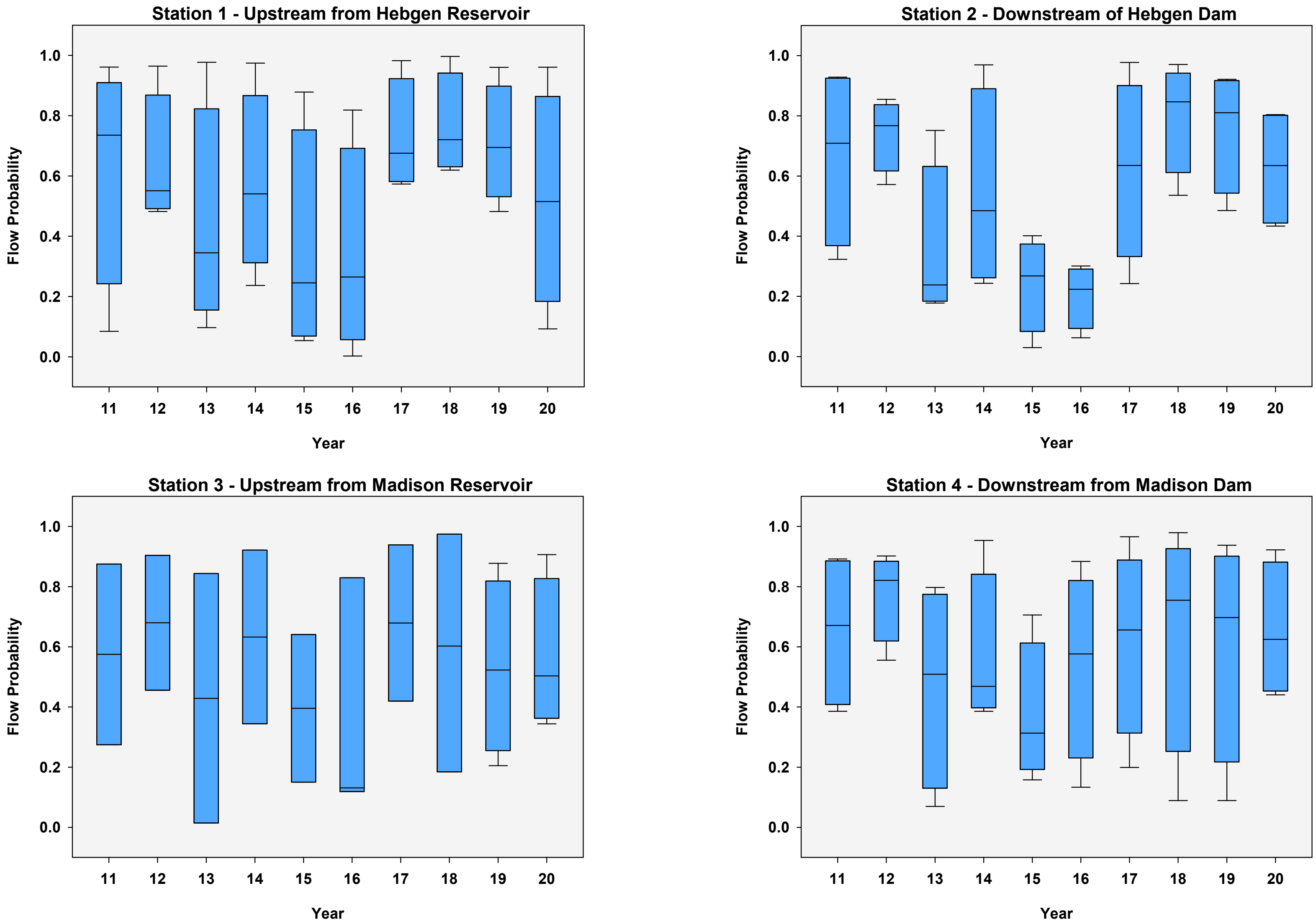


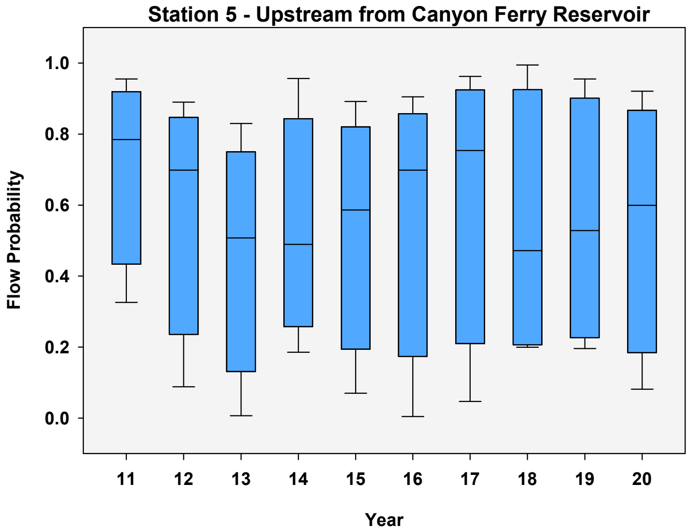
Station 9 - Upstream from Great Falls Reservoirs
Flow (cfs)
25000
20000
15000
10000
5000
0
11
12
13
14
15
16
17
18
19
20
Year

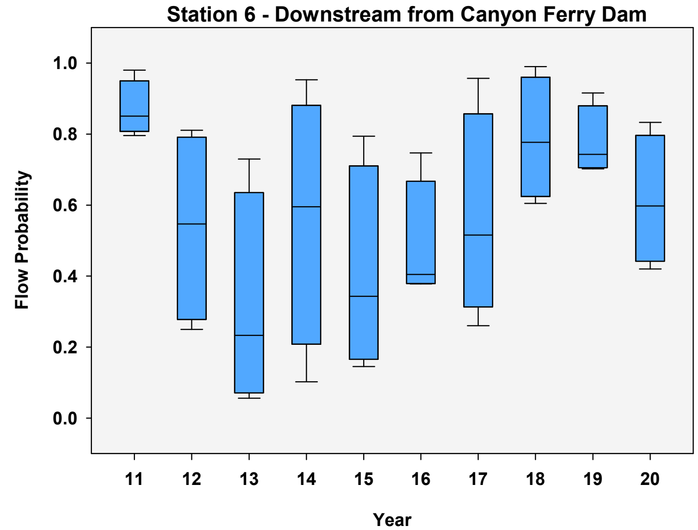


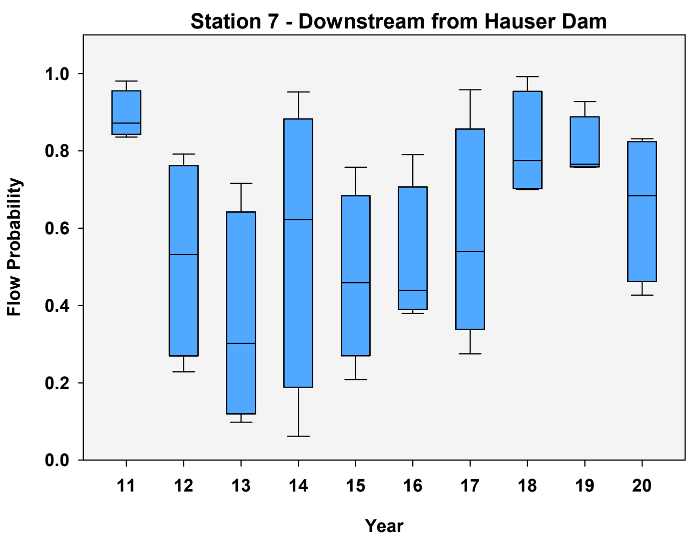
Station 10 - Downstream from Great Falls Dams
Flow (cfs)
30000
25000
20000
15000
10000
5000
0
11
12
13
14
15
16
17
18
19
20
Year

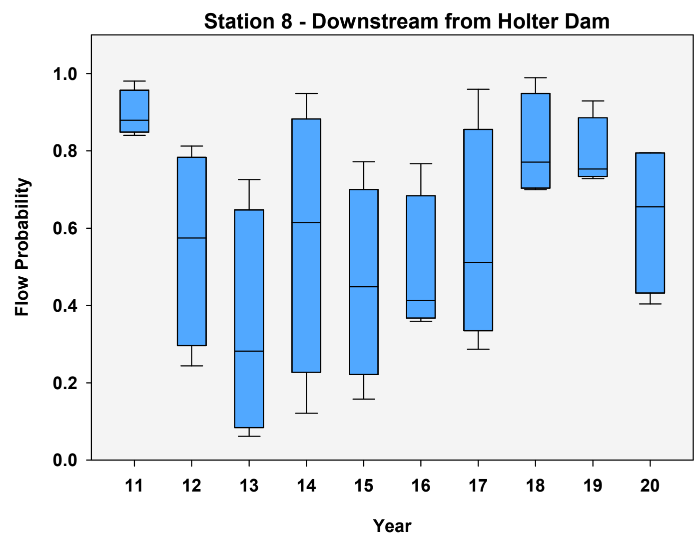
Figure B-44: Flow Probability for Stations 1 to 10.

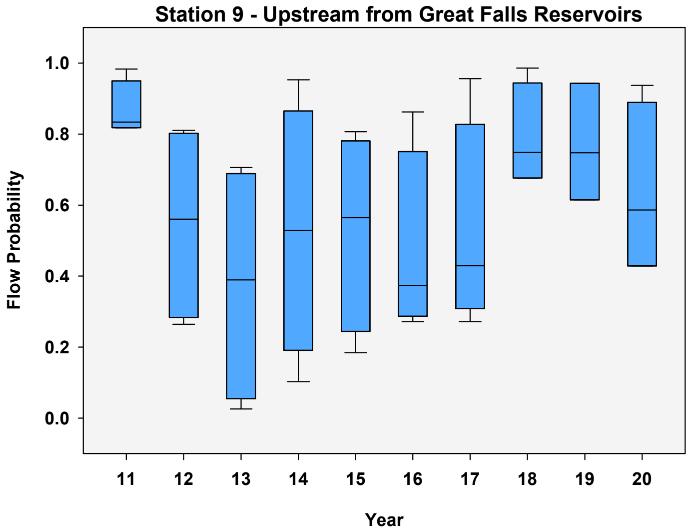



Station 5 - Upstream from Canyon Ferry Reservoir
Flow Probability
Year
0.0
0.2
0.4
0.6
0.8
1.0
11
12
13
14
15
16
17
18
19
20

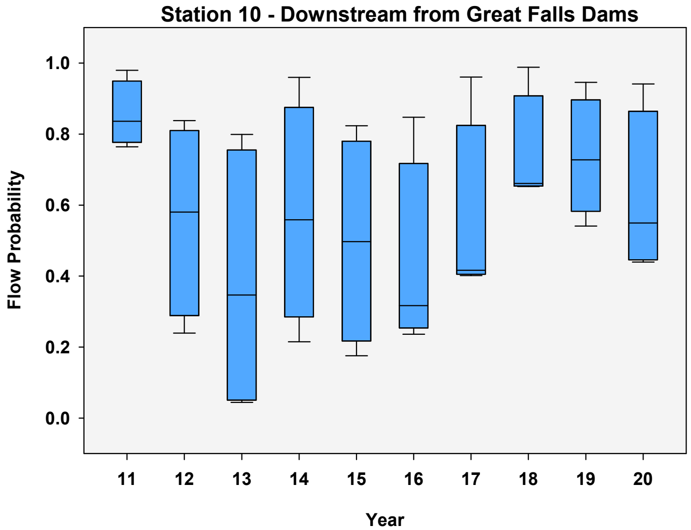

Station 6 - Downstream from Canyon Ferry Dam
Flow Probability
Year
0.0
0.2
0.4
0.6
0.8
1.0
11
12
13
14
15
16
17
18
19
20


Station 7 - Downstream from Hauser Dam
Flow Probability
Year
0.0
0.2
0.4
0.6
0.8
1.0
11
12
13
14
15
16
17
18
19
20


Station 8 - Downstream from Holter Dam
Flow Probability
Year
0.0
0.2
0.4
0.6
0.8
1.0
11
12
13
14
15
16
17
18
19
20



Station 9 - Upstream from Great Falls Reservoirs
Flow Probability
1.0
0.8
0.6
0.4
0.2
0.0
11
12
13
14
15
16
17
18
19
20
Year



Station 10 - Downstream from Great Falls Dams
Flow Probability
1.0
0.8
0.6
0.4
0.2
0.0
11
12
13
14
15
16
17
18
19
20
Year

Appendix C Chlorophyll-a

Appendix C.1 Descriptive Statistics

Table C-1: Chlorophyll-a (mg/m^2) descriptive statistics of replicate samples in August at Station B2, 2011-2020.

Year	Sample Type	N	Minimum	Maximum	Mean	Standard Deviation
2011	Scrape	10	0.1	31.4	13.3	11.8
	Whole Rock	6	9.1	39.6	23.4	10.7
2012	Whole Rock	6	27.0	74.6	41.7	17.3
2013	Whole Rock	6	15.6	45.0	27.5	10.3
2014	Whole Rock	6	38.2	100.5	63.9	25.2
2015	Whole Rock	6	0.2	31.3	18.2	10.6
2016	Whole Rock	6	31.0	60.1	47.0	12.7
2017	Whole Rock	6	9.2	58.1	30.1	19.7
2018	Whole Rock	6	38.7	129.0	80.5	37.1
2019	Whole Rock	6	24.9	101.8	67.8	26.6
2020	Whole Rock	6	69.4	197.7	118.7	57.5

Table C-2: Chlorophyll-a (mg/m^2) descriptive statistics of replicate samples in August at Station B3, 2011-2020.

Year	Sample Type	N	Minimum	Maximum	Mean	Standard Deviation
2011	Scrape	10	0.1	14.9	3.0	4.5
	Whole Rock	6	3.3	9.4	5.3	2.3
2012	Whole Rock	6	5.3	21.1	9.1	6.1
2013	Whole Rock	6	9.6	33.7	14.6	9.4
2014	Whole Rock	6	9.6	30.0	18.7	6.7
2015	Whole Rock	6	7.8	14.0	11.0	2.4
2016	Whole Rock	6	15.6	34.1	24.7	7.7
2017	Whole Rock	6	6.3	9.1	7.4	1.1
2018	Whole Rock	6	9.7	29.1	17.2	6.6
2019	Whole Rock	6	10.0	16.0	13.2	2.3
2020	Whole Rock	6	10.9	41.9	20.5	11.7

Table C-3: Chlorophyll-a (mg/m²) descriptive statistics of replicate samples in August at Station 4, 2011-2020.

Year	Sample Type	N	Minimum	Maximum	Mean	Standard Deviation
2011	Scrape	10	0.1	483.3	93.7	149.2
	Whole Rock	6	36.5	146.8	90.2	47.8
2012	Whole Rock	6	68.5	160.4	115.8	29.7
2013	Whole Rock	6	86.9	152.8	120.5	24.8
2014	Whole Rock	6	140.4	414.0	243.7	92.8
2015	Whole Rock	6	76.4	221.1	160.5	49.1
2016	Whole Rock	6	73.7	130.6	108.9	23.0
2017	Whole Rock	6	102.1	158.1	135.4	24.1
2018	Whole Rock	6	53.6	109.4	79.9	19.2
2019	Whole Rock	6	70.9	143.4	110.8	28.1
2020	Whole Rock	6	66.3	129.4	95.8	22.9

Table C-4: Chlorophyll-a (mg/m²) descriptive statistics of replicate samples in August at Station B5, 2011-2020.

Year	Sample Type	N	Minimum	Maximum	Mean	Standard Deviation
2011	Scrape	10	3.1	147.8	38.3	45.3
	Whole Rock	6	20.0	48.9	29.4	11.4
2012	Whole Rock	6	69.7	135.6	103.2	22.6
2013	Whole Rock	6	54.6	111.2	84.7	22.6
2014	Whole Rock	6	70.9	102.3	84.2	10.3
2015	Whole Rock	6	35.2	115.0	88.3	27.5
2016	Whole Rock	6	0.1	122.4	64.6	40.3
2017	Whole Rock	6	29.0	46.3	38.4	6.4
2018	Whole Rock	6	31.6	52.0	39.5	8.1
2019	Whole Rock	6	44.1	125.8	66.7	31.0
2020	Whole Rock	6	49.9	95.5	72.9	15.7

Table C-5: Chlorophyll-a (mg/m^2) descriptive statistics of replicate samples in August at Station B7, 2011-2020.

Year	Sample Type	N	Minimum	Maximum	Mean	Standard Deviation
2011	Scrape	10	0.1	690.0	165.1	235.6
	Whole Rock	6	28.1	228.6	149.7	74.1
2012	Whole Rock	6	75.9	293.7	191.2	86.9
2013	Whole Rock	6	38.8	220.9	123.1	68.5
2014	Whole Rock	6	133.0	232.7	187.5	39.3
2015	Whole Rock	6	119.8	336.1	192.3	77.5
2016	Whole Rock	6	109.7	279.6	181.7	59.6
2017	Whole Rock	6	64.6	233.2	147.9	67.1
2018	Whole Rock	6	71.7	186.5	113.8	40.0
2019	Whole Rock	6	36.1	115.7	84.3	26.9
2020	Whole Rock	6	236.1	947.1	476.8	263.5

Table C-6: Chlorophyll-a (mg/m^2) descriptive statistics of replicate samples in August at Station B8, 2011-2020.

Year	Sample Type	N	Minimum	Maximum	Mean	Standard Deviation
2011	Scrape	10	9.4	331.0	97.9	98.9
	Whole Rock	6	31.5	184.5	120.2	69.0
2012	Whole Rock	6	52.2	227.4	118.8	61.6
2013	Whole Rock	6	47.6	79.6	57.8	12.5
2014	Whole Rock	6	38.8	87.5	67.7	20.2
2015	Whole Rock	6	64.6	101.7	79.4	12.8
2016	Whole Rock	6	39.8	101.5	70.2	19.7
2017	Whole Rock	6	42.9	76.5	62.0	15.3
2018	Whole Rock	6	54.5	96.5	67.3	15.9
2019	Whole Rock	6	15.8	34.0	26.5	6.3
2020	Whole Rock	6	29.6	61.1	47.7	12.5

Table C-7: Chlorophyll-a (mg/m^2) descriptive statistics of replicate samples in August at Station B10, 2011-2020.

Year	Sample Type	N	Minimum	Maximum	Mean	Standard Deviation
2011	Scrape	10	5.2	117.1	39.2	39.7
	Whole Rock	6	18.5	47.7	34.0	11.8
2012	Whole Rock	6	85.2	163.5	118.7	34.4
2013	Whole Rock	6	44.8	123.7	85.9	34.8
2014	Whole Rock	6	98.3	162.4	117.4	24.4
2015	Whole Rock	6	73.4	173.5	104.8	41.3
2016	Whole Rock	6	91.5	138.8	110.6	20.2
2017	Whole Rock	6	68.1	143.9	98.7	28.6
2018	Whole Rock	6	31.5	65.7	49.5	11.0
2019	Whole Rock	6	44.2	98.7	75.3	18.8
2020	Whole Rock	6	98.4	149.2	123.7	20.1

Appendix C.2 Upstream-Downstream Comparisons

Table C-8: Rank comparisons of scrape method chlorophyll-a concentrations between Stations B2 and B3 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
B2	10	12.70	127.00
B3	10	8.30	83.00
Total	20		

Table C-9: Mann–Whitney U test results for scrape method chlorophyll-a concentrations at Stations B2 and B3 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	28.000
Wilcoxon W	83.000
Z	-1.670
Asymp. Sig. (2-tailed)	.095

Table C-10: Rank comparisons of whole rock method chlorophyll-a concentrations between Stations B2 and B3 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
B2	60	84.15	5049.00
B3	60	36.85	2211.00
Total	120		

Table C-11: Mann–Whitney U test results for whole rock method chlorophyll-a concentrations at Stations B2 and B3 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	381.000
Wilcoxon W	2211.000
Z	-7.448
Asymp. Sig. (2-tailed)	.000

Table C-12: Rank comparisons of scrape method chlorophyll-a concentrations between Stations B3 and 4 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
B3	10	6.65	66.50
4	10	14.35	143.50
Total	20		

Table C-13: Mann–Whitney U test results for scrape method chlorophyll-a concentrations at Stations B3 and 4 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	11.500
Wilcoxon W	66.500
Z	-2.917
Asymp. Sig. (2-tailed)	.004

Table C-14: Rank comparisons of whole rock method chlorophyll-a concentrations between Stations B3 and 4 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
B3	60	30.52	1831.00
4	60	90.48	5429.00
Total	120		

Table C-15: Mann–Whitney U test results for whole rock method chlorophyll-a concentrations at Stations B3 and 4 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	1.000
Wilcoxon W	1831.000
Z	-9.443
Asymp. Sig. (2-tailed)	.000

Table C-16: Rank comparisons of scrape method chlorophyll-a concentrations between Stations 4 and B5 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
4	10	11.45	114.50
B5	10	9.55	95.50
Total	20		

Table C-17: Mann–Whitney U test results for scrape method chlorophyll-a concentrations at Stations 4 and B5 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	40.500
Wilcoxon W	95.500
Z	-.718
Asymp. Sig. (2-tailed)	.473

Table C-18: Rank comparisons of whole rock method chlorophyll-a concentrations between Stations 4 and B5 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
4	60	81.05	4863.00
B5	60	39.95	2397.00
Total	120		

Table C-19: Mann–Whitney U test results for whole rock method chlorophyll-a concentrations at Stations 4 and B5 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	567.000
Wilcoxon W	2397.000
Z	-6.472
Asymp. Sig. (2-tailed)	.000

Table C-20: Rank comparisons of scrape method chlorophyll-a concentrations between Stations B5 and B7 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
B5	10	8.60	86.00
B7	10	12.40	124.00
Total	20		

Table C-21: Mann–Whitney U test results for scrape method chlorophyll-a concentrations at Stations B5 and B7 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	31.000
Wilcoxon W	86.000
Z	-1.436
Asymp. Sig. (2-tailed)	.151

Table C-22: Rank comparisons of whole rock method chlorophyll-a concentrations between Stations B5 and B7 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
B5	60	37.44	2246.50
B7	60	83.56	5013.50
Total	120		

Table C-23: Mann–Whitney U test results for whole rock method chlorophyll-a concentrations at Stations B5 and B7 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	416.500
Wilcoxon W	2246.500
Z	-7.262
Asymp. Sig. (2-tailed)	.000

Table C-24: Rank comparisons of scrape method chlorophyll-a concentrations between Stations B7 and B8 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
B7	10	10.50	105.00
B8	10	10.50	105.00
Total	20		

Table C-25: Mann–Whitney U test results for scrape method chlorophyll-a concentrations at Stations B7 and B8 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	50.000
Wilcoxon W	105.000
Z	.000
Asymp. Sig. (2-tailed)	1.000

Table C-26: Rank comparisons of whole rock method chlorophyll-a concentrations between Stations B7 and B8 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
B7	60	82.77	4966.00
B8	60	38.23	2294.00
Total	120		

Table C-27: Mann–Whitney U test results for whole rock method chlorophyll-a concentrations at Stations B7 and B8 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	464.000
Wilcoxon W	2294.000
Z	-7.012
Asymp. Sig. (2-tailed)	.000

Table C-28: Rank comparisons of scrape method chlorophyll-a concentrations between Stations B8 and B10 from 2011 to 2020.

Station	N	Mean Rank	Sum of Ranks
B8	10	12.90	129.00
B10	10	8.10	81.00
Total	20		

Table C-29: Mann–Whitney U test results for scrape method chlorophyll-a concentrations at Stations B8 and B10 from 2011 to 2020.

Statistic	Result
Mann-Whitney U	26.000
Wilcoxon W	81.000
Z	-1.814
Asymp. Sig. (2-tailed)	.070

Table C-30: Rank comparisons of whole rock method chlorophyll-a concentrations between Stations B8 and B10 from 2011 to 2020.

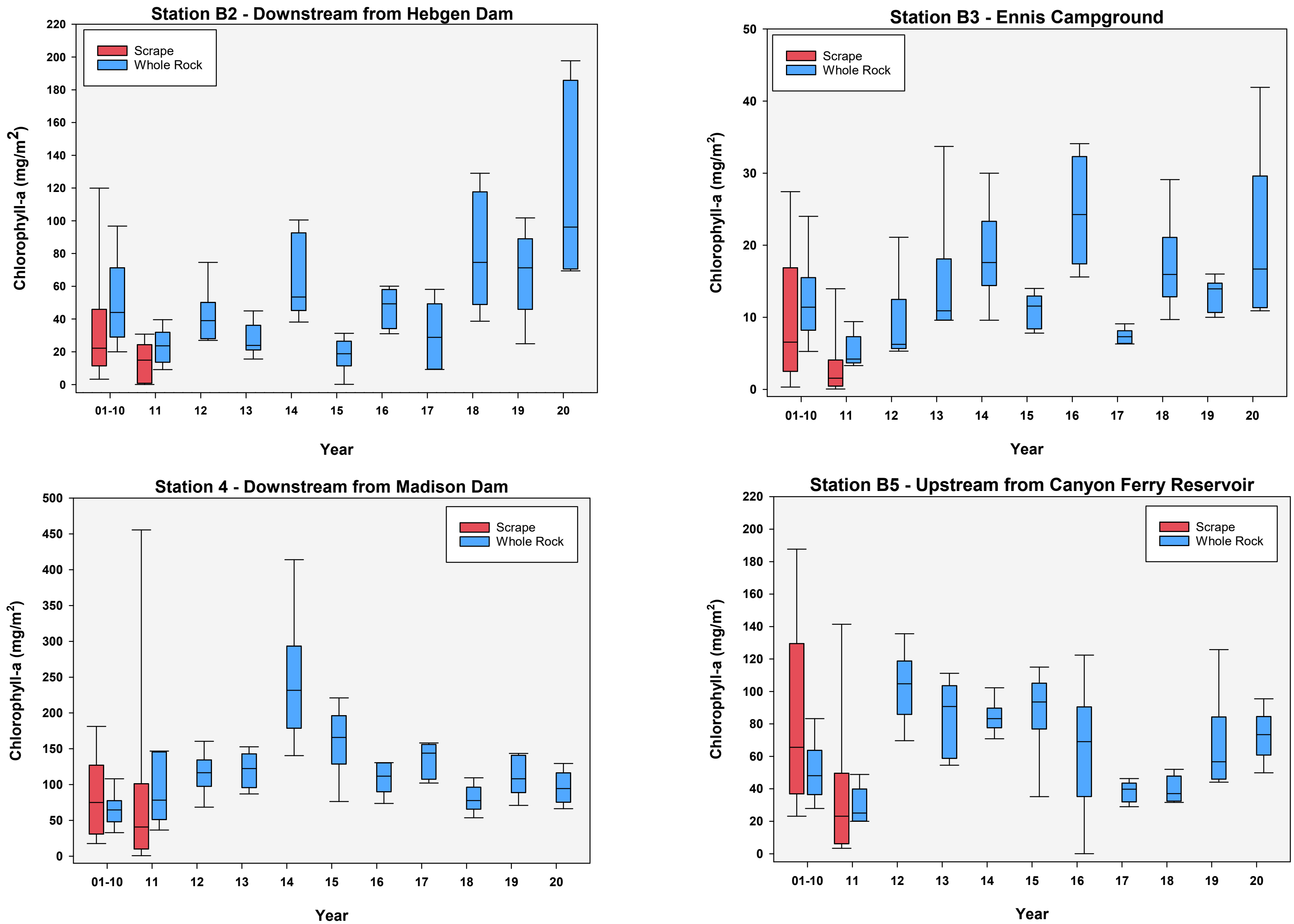
Station	N	Mean Rank	Sum of Ranks
B8	60	49.75	2985.00
B10	60	71.25	4275.00
Total	120		

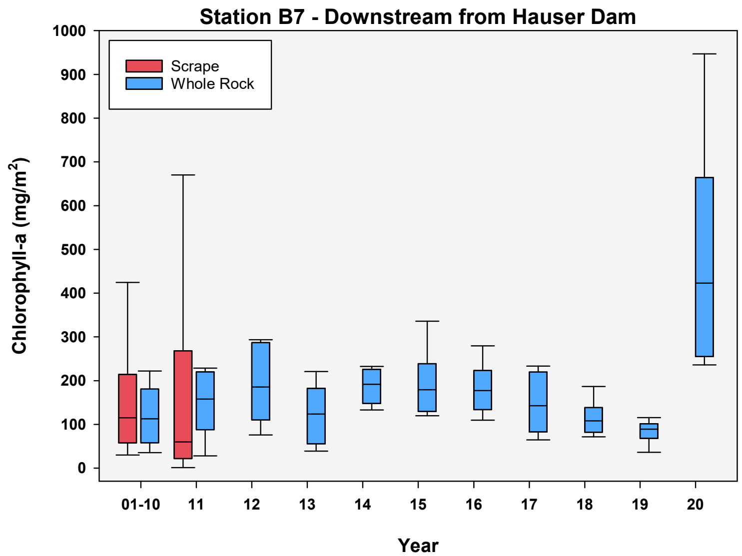
Table C-31: Mann–Whitney U test results for whole rock method chlorophyll-a concentrations at Stations B8 and B10 from 2011 to 2020.

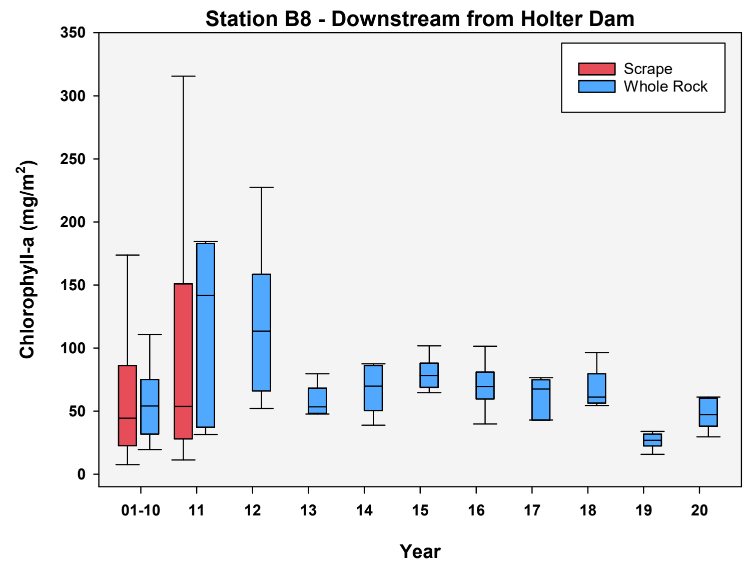
Statistic	Result
Mann-Whitney U	1155.000
Wilcoxon W	2985.000
Z	-3.385
Asymp. Sig. (2-tailed)	.001

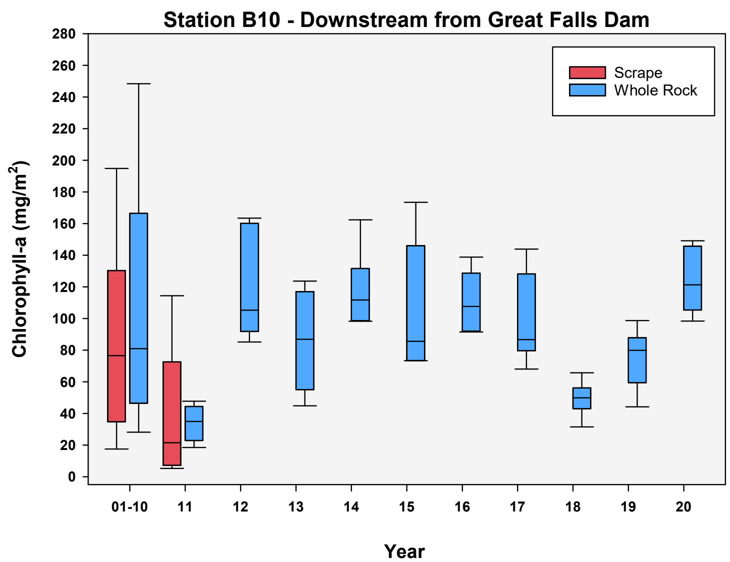
Appendix C.3 Temporal Graphs

Figure C-1: Chlorophyll-a (mg/m^2) for Biological Stations B2 to B10.









Note: This parameter has been scaled individually

Appendix D Diatom Metrics

Appendix D.1 Biological Integrity Results

Table D-1: Overall biological integrity and impairment ratings in August, 2011 to 2020.

Station	Year	Mountains		Plains	
		Rating	Impairment	Rating	Impairment
B2	2011	Good	Minor	Excellent	None
	2012	Good	Minor	Good	Minor
	2013	Good	Minor	Excellent	None
	2014	Good	Minor	Good	Minor
	2015	Good	Minor	Excellent	None
	2016	Poor	Severe	Fair	Moderate
	2017	Fair	Moderate	Fair	Moderate
	2018	Fair	Moderate	Excellent	None
	2019	Good	Minor	Good	Minor
	2020	Fair	Moderate	Excellent	None
B3	2011	Good	Minor	Excellent	None
	2012	Good	Minor	Excellent	None
	2013	Good	Minor	Excellent	None
	2014	Good	Minor	Excellent	None
	2015	Good	Minor	Excellent	None
	2016	Good	Minor	Excellent	None
	2017	Good	Minor	Good	Minor
	2018	Excellent	None	Excellent	None
	2019	Excellent	None	Excellent	None
	2020	Fair	Moderate	Excellent	None
4	2011	Excellent	None	Excellent	None
	2012	Good	Minor	Excellent	None
	2013	Good	Minor	Excellent	None
	2014	Fair	Moderate	Excellent	None
	2015	Fair	Moderate	Good	Minor
	2016	Good	Minor	Excellent	None
	2017	Good	Minor	Excellent	None
	2018	Good	Minor	Excellent	None
	2019	Good	Minor	Excellent	None
	2020	Good	Minor	Excellent	None
B5	2011	Fair	Moderate	Excellent	None
	2012	Excellent	None	Excellent	None
	2013	Good	Minor	Excellent	None
	2014	Excellent	None	Excellent	None
	2015	Fair	Moderate	Excellent	None
	2016	Good	Minor	Excellent	None
	2017	Good	Minor	Excellent	None
	2018	Good	Minor	Excellent	None
	2019	Excellent	None	Excellent	None
	2020	Good	Minor	Excellent	None

Station	Year	Mountains		Plains	
		Rating	Impairment	Rating	Impairment
B7	2011	Good	Minor	Excellent	None
	2012	Excellent	None	Excellent	None
	2013	Good	Minor	Excellent	None
	2014	Good	Minor	Excellent	None
	2015	Good	Minor	Good	Minor
	2016	Excellent	None	Good	Minor
	2017	Fair	Moderate	Excellent	None
	2018	Good	Minor	Good	Minor
	2019	Excellent	None	Good	Minor
	2020	Good	Minor	Good	Minor
B8	2011	Good	Minor	Good	Minor
	2012	Excellent	None	Good	Minor
	2013	Good	Minor	Excellent	None
	2014	Good	Minor	Good	Minor
	2015	Good	Minor	Good	Minor
	2016	Good	Minor	Good	Minor
	2017	Good	Minor	Good	Minor
	2018	Fair	Moderate	Fair	Moderate
	2019	Good	Minor	Good	Minor
	2020	Good	Minor	Good	Minor
B10	2011	Good	Minor	Excellent	None
	2012	Fair	Moderate	Good	Minor
	2013	Fair	Moderate	Excellent	None
	2014	Fair	Moderate	Good	Minor
	2015	Poor	Severe	Good	Minor
	2016	Fair	Moderate	Excellent	None
	2017	Good	Minor	Good	Minor
	2018	Good	Minor	Excellent	None
	2019	Good	Minor	Excellent	None
	2020	Fair	Moderate	Excellent	None

Appendix D.2 Upstream-Downstream Comparisons

Table D-2: Rank comparisons of chlorophyll-a concentrations between Stations B2 and B3 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Shannon Diversity	2	10	9.80	98.00
	3	10	11.20	112.00
	Total	20		
Pollution Tolerance Index	2	10	5.70	57.00
	3	10	15.30	153.00
	Total	20		
Siltation Index (%)	2	10	9.70	97.00
	3	10	11.30	113.00
	Total	20		
Disturbance Index (%)	2	10	9.20	92.00
	3	10	11.80	118.00
	Total	20		
Species Richness	2	10	9.00	90.00
	3	10	12.00	120.00
	Total	20		
Abundance of Dominant Species (%)	2	10	12.30	123.00
	3	10	8.70	87.00
	Total	20		
Abnormal Cells (%)	2	10	12.50	125.00
	3	10	8.50	85.00
	Total	20		

Table D-3: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B2 and B3 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Shannon Diversity	43.000	98.000	-0.529	0.597
Pollution Tolerance Index	2.000	57.000	-3.628	0.000
Siltation Index (%)	42.000	97.000	-0.605	0.545
Disturbance Index (%)	37.000	92.000	-0.983	0.326
Species Richness	35.000	90.000	-1.139	0.255
Abundance of Dominant Species (%)	32.000	87.000	-1.361	0.174
Abnormal Cells (%)	30.000	85.000	-1.617	0.106

Table D-4: Rank comparisons of chlorophyll-a concentrations between Stations B3 and 4 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Shannon Diversity	3	10	5.60	56.00
	4	10	15.40	154.00
	Total	20		
Pollution Tolerance Index	3	10	13.90	139.00
	4	10	7.10	71.00
	Total	20		
Siltation Index (%)	3	10	10.30	103.00
	4	10	10.70	107.00
	Total	20		
Disturbance Index (%)	3	10	12.90	129.00
	4	10	8.10	81.00
	Total	20		
Species Richness	3	10	5.70	57.00
	4	10	15.30	153.00
	Total	20		
Abundance of Dominant Species (%)	3	10	14.75	147.50
	4	10	6.25	62.50
	Total	20		
Abnormal Cells (%)	3	10	11.80	118.00
	4	10	9.20	92.00
	Total	20		

Table D-5: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B3 and 4 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Shannon Diversity	1.000	56.000	-3.704	0.000
Pollution Tolerance Index	16.000	71.000	-2.570	0.010
Siltation Index (%)	48.000	103.000	-0.151	0.880
Disturbance Index (%)	26.000	81.000	-1.814	0.070
Species Richness	2.000	57.000	-3.634	0.000
Abundance of Dominant Species (%)	7.500	62.500	-3.214	0.001
Abnormal Cells (%)	37.000	92.000	-1.215	0.224

Table D-6: Rank comparisons of chlorophyll-a concentrations between Stations 4 and B5 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Shannon Diversity	4	10	14.20	142.00
	5	10	6.80	68.00
	Total	20		
Pollution Tolerance Index	4	10	9.30	93.00
	5	10	11.70	117.00
	Total	20		
Siltation Index (%)	4	10	11.90	119.00
	5	10	9.10	91.00
	Total	20		
Disturbance Index (%)	4	10	8.00	80.00
	5	10	13.00	130.00
	Total	20		
Species Richness	4	10	13.35	133.50
	5	10	7.65	76.50
	Total	20		
Abundance of Dominant Species (%)	4	10	7.70	77.00
	5	10	13.30	133.00
	Total	20		
Abnormal Cells (%)	4	10	10.70	107.00
	5	10	10.30	103.00
	Total	20		

Table D-7: Mann–Whitney U test results for chlorophyll-a concentrations at Stations 4 and B5 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Shannon Diversity	13.000	68.000	-2.797	0.005
Pollution Tolerance Index	38.000	93.000	-0.907	0.364
Siltation Index (%)	36.000	91.000	-1.058	0.290
Disturbance Index (%)	25.000	80.000	-1.891	0.059
Species Richness	21.500	76.500	-2.159	0.031
Abundance of Dominant Species (%)	22.000	77.000	-2.117	0.034
Abnormal Cells (%)	48.000	103.000	-0.216	0.829

Table D-8: Rank comparisons of chlorophyll-a concentrations between Stations B5 and B7 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Shannon Diversity	5	10	15.20	152.00
	7	10	5.80	58.00
	Total	20		
Pollution Tolerance Index	5	10	8.40	84.00
	7	10	12.60	126.00
	Total	20		
Siltation Index (%)	5	10	11.80	118.00
	7	10	9.20	92.00
	Total	20		
Disturbance Index (%)	5	10	12.10	121.00
	7	10	8.90	89.00
	Total	20		
Species Richness	5	10	15.40	154.00
	7	10	5.60	56.00
	Total	20		
Abundance of Dominant Species (%)	5	10	7.50	75.00
	7	10	13.50	135.00
	Total	20		
Abnormal Cells (%)	5	10	11.50	115.00
	7	10	9.50	95.00
	Total	20		

Table D-9: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B5 and B7 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Shannon Diversity	3.000	58.000	-3.553	0.000
Pollution Tolerance Index	29.000	84.000	-1.587	0.112
Siltation Index (%)	37.000	92.000	-0.983	0.326
Disturbance Index (%)	34.000	89.000	-1.210	0.226
Species Richness	1.000	56.000	-3.708	0.000
Abundance of Dominant Species (%)	20.000	75.000	-2.268	0.023
Abnormal Cells (%)	40.000	95.000	-1.453	0.146

Table D-10: Rank comparisons of chlorophyll-a concentrations between Stations B7 and B8 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Shannon Diversity	7	10	11.50	115.00
	8	10	9.50	95.00
	Total	20		
Pollution Tolerance Index	7	10	10.20	102.00
	8	10	10.80	108.00
	Total	20		
Siltation Index (%)	7	10	10.60	106.00
	8	10	10.40	104.00
	Total	20		
Disturbance Index (%)	7	10	7.80	78.00
	8	10	13.20	132.00
	Total	20		
Species Richness	7	10	9.80	98.00
	8	10	11.20	112.00
	Total	20		
Abundance of Dominant Species (%)	7	10	8.40	84.00
	8	10	12.60	126.00
	Total	20		
Abnormal Cells (%)	7	10	9.00	90.00
	8	10	12.00	120.00
	Total	20		

Table D-11: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B7 and B8 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Shannon Diversity	40.000	95.000	-0.756	0.450
Pollution Tolerance Index	47.000	102.000	-0.227	0.821
Siltation Index (%)	49.000	104.000	-0.076	0.940
Disturbance Index (%)	23.000	78.000	-2.041	0.041
Species Richness	43.000	98.000	-0.532	0.595
Abundance of Dominant Species (%)	29.000	84.000	-1.587	0.112
Abnormal Cells (%)	35.000	90.000	-1.826	0.068

Table D-12: Rank comparisons of chlorophyll-a concentrations between Stations B8 and B10 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Shannon Diversity	8	10	6.20	62.00
	10	10	14.80	148.00
	Total	20		
Pollution Tolerance Index	8	10	14.60	146.00
	10	10	6.40	64.00
	Total	20		
Siltation Index (%)	8	10	6.30	63.00
	10	10	14.70	147.00
	Total	20		
Disturbance Index (%)	8	10	13.40	134.00
	10	10	7.60	76.00
	Total	20		
Species Richness	8	10	5.70	57.00
	10	10	15.30	153.00
	Total	20		
Abundance of Dominant Species (%)	8	10	12.80	128.00
	10	10	8.20	82.00
	Total	20		
Abnormal Cells (%)	8	10	11.60	116.00
	10	10	9.40	94.00
	Total	20		

Table D-13: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B8 and B10 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Shannon Diversity	7.000	62.000	-3.250	0.001
Pollution Tolerance Index	9.000	64.000	-3.099	0.002
Siltation Index (%)	8.000	63.000	-3.175	0.001
Disturbance Index (%)	21.000	76.000	-2.192	0.028
Species Richness	2.000	57.000	-3.633	0.000
Abundance of Dominant Species (%)	27.000	82.000	-1.739	0.082
Abnormal Cells (%)	39.000	94.000	-1.191	0.234

Appendix D.3 Correlation Matrices

Table D-14: Kendall's tau correlation matrix of diatom metrics collected at Station B2 from 2011 to 2020.

Metric	Statistic	Date	Mean Chlorophyll-a Replicate Whole Rock Concentration	Shannon Diversity	Pollution Tolerance Index	Siltation Index (%)	Disturbance Index (%)	Species Richness	Abundance of Dominant Species (%)	Abnormal Cells (%)
Date	Correlation Coefficient	1.000	0.556*	-0.200	-0.022	0.289	-0.378	0.111	-0.022	-0.725*
	Significance (2-tailed)	.	0.025	0.421	0.929	0.245	0.128	0.655	0.929	0.005
	N	10	10	10	10	10	10	10	10	10
Mean Chlorophyll-a Replicate Whole Rock Concentration	Correlation Coefficient	0.556*	1.000	-0.022	-0.022	0.467*	-0.467*	0.111	-0.111	-0.532*
	Significance (2-tailed)	0.025	.	0.929	0.929	0.060	0.060	0.655	0.655	0.041
	N	10	10	10	10	10	10	10	10	10
Shannon Diversity	Correlation Coefficient	-0.200	-0.022	1.000	0.733*	0.156	0.467*	0.600*	-0.689*	0.242
	Significance (2-tailed)	0.421	0.929	.	0.003	0.531	0.060	0.016	0.006	0.352
	N	10	10	10	10	10	10	10	10	10
Pollution Tolerance Index	Correlation Coefficient	-0.022	-0.022	0.733*	1.000	0.067	0.378	0.511*	-0.689*	0.048
	Significance (2-tailed)	0.929	0.929	0.003	.	0.788	0.128	0.040	0.006	0.852
	N	10	10	10	10	10	10	10	10	10
Siltation Index (%)	Correlation Coefficient	0.289	0.467*	0.156	0.067	1.000	-0.022	0.200	-0.378	-0.387
	Significance (2-tailed)	0.245	0.060	0.531	0.788	.	0.929	0.421	0.128	0.136
	N	10	10	10	10	10	10	10	10	10
Disturbance Index (%)	Correlation Coefficient	-0.378	-0.467*	0.467*	0.378	-0.022	1.000	0.067	-0.422*	0.290
	Significance (2-tailed)	0.128	0.060	0.060	0.128	0.929	.	0.788	0.089	0.264
	N	10	10	10	10	10	10	10	10	10
Species Richness	Correlation Coefficient	0.111	0.111	0.600*	0.511*	0.200	0.067	1.000	-0.467*	0.097
	Significance (2-tailed)	0.655	0.655	0.016	0.040	0.421	0.788	.	0.060	0.710
	N	10	10	10	10	10	10	10	10	10
Abundance of Dominant Species (%)	Correlation Coefficient	-0.022	-0.111	-0.689*	-0.689*	-0.378	-0.422*	-0.467*	1.000	0.048
	Significance (2-tailed)	0.929	0.655	0.006	0.006	0.128	0.089	0.060	.	0.852
	N	10	10	10	10	10	10	10	10	10
Abnormal Cells (%)	Correlation Coefficient	-0.725*	-0.532*	0.242	0.048	-0.387	0.290	0.097	0.048	1.000
	Significance (2-tailed)	0.005	0.041	0.352	0.852	0.136	0.264	0.710	0.852	.
	N	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed).
'Mean Chlorophyll-a Replicate Scrape Concentration' was removed because sample was collected only once in 2011 (n=1)

Table D-15: Kendall's tau correlation matrix of diatom metrics collected at Station B3 from 2011 to 2020.

Metric	Statistic	Date	Mean Chlorophyll-a Replicate Whole Rock Concentration	Shannon Diversity	Pollution Tolerance Index	Siltation Index (%)	Disturbance Index (%)	Species Richness	Abundance of Dominant Species (%)	Abnormal Cells (%)
Date	Correlation Coefficient	1.000	0.378	-0.333	0.067	0.067	-0.289	-0.230	0.333	-0.338
	Significance (2-tailed)	.	0.128	0.180	0.788	0.788	0.245	0.365	0.180	0.217
	N	10	10	10	10	10	10	10	10	10
Mean Chlorophyll-a Replicate Whole Rock Concentration	Correlation Coefficient	0.378	1.000	0.111	0.067	0.067	-0.111	0.046	-0.289	-0.394
	Significance (2-tailed)	0.128	.	0.655	0.788	0.788	0.655	0.856	0.245	0.150
	N	10	10	10	10	10	10	10	10	10
Shannon Diversity	Correlation Coefficient	-0.333	0.111	1.000	-0.111	0.244	0.333	0.874*	-0.644*	0.169
	Significance (2-tailed)	0.180	0.655	.	0.655	0.325	0.180	0.001	0.009	0.537
	N	10	10	10	10	10	10	10	10	10
Pollution Tolerance Index	Correlation Coefficient	0.067	0.067	-0.111	1.000	-0.156	-0.600*	-0.138	0.022	-0.451
	Significance (2-tailed)	0.788	0.788	0.655	.	0.531	0.016	0.587	0.929	0.100
	N	10	10	10	10	10	10	10	10	10
Siltation Index (%)	Correlation Coefficient	0.067	0.067	0.244	-0.156	1.000	-0.244	0.138	-0.156	0.282
	Significance (2-tailed)	0.788	0.788	0.325	0.531	.	0.325	0.587	0.531	0.304
	N	10	10	10	10	10	10	10	10	10
Disturbance Index (%)	Correlation Coefficient	-0.289	-0.111	0.333	-0.600*	-0.244	1.000	0.368	-0.067	0.282
	Significance (2-tailed)	0.245	0.655	0.180	0.016	0.325	.	0.147	0.788	0.304
	N	10	10	10	10	10	10	10	10	10
Species Richness	Correlation Coefficient	-0.230	0.046	0.874*	-0.138	0.138	0.368	1.000	-0.506*	0.175
	Significance (2-tailed)	0.365	0.856	0.001	0.587	0.587	0.147	.	0.046	0.533
	N	10	10	10	10	10	10	10	10	10
Abundance of Dominant Species (%)	Correlation Coefficient	0.333	-0.289	-0.644*	0.022	-0.156	-0.067	-0.506*	1.000	-0.056
	Significance (2-tailed)	0.180	0.245	0.009	0.929	0.531	0.788	0.046	.	0.837
	N	10	10	10	10	10	10	10	10	10
Abnormal Cells (%)	Correlation Coefficient	-0.338	-0.394	0.169	-0.451	0.282	0.282	0.175	-0.056	1.000
	Significance (2-tailed)	0.217	0.150	0.537	0.100	0.304	0.304	0.533	0.837	.
	N	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed).
'Mean Chlorophyll-a Replicate Scrape Concentration' was removed because sample was collected only once in 2011 (n=1)

Table D-16: Kendall's tau correlation matrix of diatom metrics collected at Station 4 from 2011 to 2020.

Metric	Statistic	Date	Mean Chlorophyll-a Replicate Whole Rock Concentration	Shannon Diversity	Pollution Tolerance Index	Siltation Index (%)	Disturbance Index (%)	Species Richness	Abundance of Dominant Species (%)	Abnormal Cells (%)
Date	Correlation Coefficient	1.000	-0.156	0.111	-0.156	0.156	0.556*	0.270	-0.244	-0.108
	Significance (2-tailed)	.	0.531	0.655	0.531	0.531	0.025	0.281	0.325	0.698
	N	10	10	10	10	10	10	10	10	10
Mean Chlorophyll-a Replicate Whole Rock Concentration	Correlation Coefficient	-0.156	1.000	0.111	-0.511*	0.333	0.022	-0.135	-0.333	-0.253
	Significance (2-tailed)	0.531	.	0.655	0.040	0.180	0.929	0.590	0.180	0.365
	N	10	10	10	10	10	10	10	10	10
Shannon Diversity	Correlation Coefficient	0.111	0.111	1.000	0.022	0.156	0.111	0.764*	0.289	0.398
	Significance (2-tailed)	0.655	0.655	.	0.929	0.531	0.655	0.002	0.245	0.154
	N	10	10	10	10	10	10	10	10	10
Pollution Tolerance Index	Correlation Coefficient	-0.156	-0.511*	0.022	1.000	-0.467*	-0.333	0.090	0.556*	-0.036
	Significance (2-tailed)	0.531	0.040	0.929	.	0.060	0.180	0.719	0.025	0.897
	N	10	10	10	10	10	10	10	10	10
Siltation Index (%)	Correlation Coefficient	0.156	0.333	0.156	-0.467*	1.000	-0.022	0.045	-0.289	-0.036
	Significance (2-tailed)	0.531	0.180	0.531	0.060	.	0.929	0.857	0.245	0.897
	N	10	10	10	10	10	10	10	10	10
Disturbance Index (%)	Correlation Coefficient	0.556*	0.022	0.111	-0.333	-0.022	1.000	0.135	-0.422*	0.108
	Significance (2-tailed)	0.025	0.929	0.655	0.180	0.929	.	0.590	0.089	0.698
	N	10	10	10	10	10	10	10	10	10
Species Richness	Correlation Coefficient	0.270	-0.135	0.764*	0.090	0.045	0.135	1.000	0.315	0.512*
	Significance (2-tailed)	0.281	0.590	0.002	0.719	0.857	0.590	.	0.209	0.069
	N	10	10	10	10	10	10	10	10	10
Abundance of Dominant Species (%)	Correlation Coefficient	-0.244	-0.333	0.289	0.556*	-0.289	-0.422*	0.315	1.000	0.325
	Significance (2-tailed)	0.325	0.180	0.245	0.025	0.245	0.089	0.209	.	0.244
	N	10	10	10	10	10	10	10	10	10
Abnormal Cells (%)	Correlation Coefficient	-0.108	-0.253	0.398	-0.036	-0.036	0.108	0.512*	0.325	1.000
	Significance (2-tailed)	0.698	0.365	0.154	0.897	0.897	0.698	0.069	0.244	.
	N	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed).
'Mean Chlorophyll-a Replicate Scrape Concentration' was removed because sample was collected only once in 2011 (n=1)

Table D-17: Kendall's tau correlation matrix of diatom metrics collected at Station B5 from 2011 to 2020.

Metric	Statistic	Date	Mean Chlorophyll-a Replicate Whole Rock Concentration	Shannon Diversity	Pollution Tolerance Index	Siltation Index (%)	Disturbance Index (%)	Species Richness	Abundance of Dominant Species (%)	Abnormal Cells (%)
Date	Correlation Coefficient	1.000	-0.156	-0.111	-0.156	-0.111	0.270	-0.180	-0.067	0.447
	Significance (2-tailed)	.	0.531	0.655	0.531	0.655	0.281	0.472	0.788	0.117
	N	10	10	10	10	10	10	10	10	10
Mean Chlorophyll-a Replicate Whole Rock Concentration	Correlation Coefficient	-0.156	1.000	0.422*	-0.067	-0.200	-0.135	0.315	-0.244	-0.224
	Significance (2-tailed)	0.531	.	0.089	0.788	0.421	0.590	0.209	0.325	0.433
	N	10	10	10	10	10	10	10	10	10
Shannon Diversity	Correlation Coefficient	-0.111	0.422*	1.000	-0.111	-0.067	0.000	0.629*	-0.556*	0.373
	Significance (2-tailed)	0.655	0.089	.	0.655	0.788	1.000	0.012	0.025	0.192
	N	10	10	10	10	10	10	10	10	10
Pollution Tolerance Index	Correlation Coefficient	-0.156	-0.067	-0.111	1.000	-0.556*	0.180	0.045	0.022	-0.075
	Significance (2-tailed)	0.531	0.788	0.655	.	0.025	0.472	0.857	0.929	0.794
	N	10	10	10	10	10	10	10	10	10
Siltation Index (%)	Correlation Coefficient	-0.111	-0.200	-0.067	-0.556*	1.000	-0.360	0.045	0.156	0.149
	Significance (2-tailed)	0.655	0.421	0.788	0.025	.	0.151	0.857	0.531	0.602
	N	10	10	10	10	10	10	10	10	10
Disturbance Index (%)	Correlation Coefficient	0.270	-0.135	0.000	0.180	-0.360	1.000	0.114	0.000	0.075
	Significance (2-tailed)	0.281	0.590	1.000	0.472	0.151	.	0.652	1.000	0.793
	N	10	10	10	10	10	10	10	10	10
Species Richness	Correlation Coefficient	-0.180	0.315	0.629*	0.045	0.045	0.114	1.000	-0.180	0.452
	Significance (2-tailed)	0.472	0.209	0.012	0.857	0.857	0.652	.	0.472	0.116
	N	10	10	10	10	10	10	10	10	10
Abundance of Dominant Species (%)	Correlation Coefficient	-0.067	-0.244	-0.556*	0.022	0.156	0.000	-0.180	1.000	-0.224
	Significance (2-tailed)	0.788	0.325	0.025	0.929	0.531	1.000	0.472	.	0.433
	N	10	10	10	10	10	10	10	10	10
Abnormal Cells (%)	Correlation Coefficient	0.447	-0.224	0.373	-0.075	0.149	0.075	0.452	-0.224	1.000
	Significance (2-tailed)	0.117	0.433	0.192	0.794	0.602	0.793	0.116	0.433	.
	N	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed).
'Mean Chlorophyll-a Replicate Scrape Concentration' was removed because sample was collected only once in 2011 (n=1)

Table D-18: Kendall's tau correlation matrix of diatom metrics collected at Station B7 from 2011 to 2020.

Metric	Statistic	Date	Mean Chlorophyll-a Replicate Whole Rock Concentration	Shannon Diversity	Pollution Tolerance Index	Siltation Index (%)	Disturbance Index (%)	Species Richness	Abundance of Dominant Species (%)	Abnormal Cells (%)
Date	Correlation Coefficient	1.000	-0.156	-0.600*	-0.067	-0.378	-0.200	-0.296	0.467*	.
	Significance (2-tailed)	.	0.531	0.016	0.788	0.128	0.421	0.241	0.060	.
	N	10	10	10	10	10	10	10	10	10
Mean Chlorophyll-a Replicate Whole Rock Concentration	Correlation Coefficient	-0.156	1.000	-0.156	0.556*	-0.200	0.156	-0.250	0.022	.
	Significance (2-tailed)	0.531	.	0.531	0.025	0.421	0.531	0.321	0.929	.
	N	10	10	10	10	10	10	10	10	10
Shannon Diversity	Correlation Coefficient	-0.600*	-0.156	1.000	-0.156	0.511*	0.333	0.614*	-0.689*	.
	Significance (2-tailed)	0.016	0.531	.	0.531	0.040	0.180	0.015	0.006	.
	N	10	10	10	10	10	10	10	10	10
Pollution Tolerance Index	Correlation Coefficient	-0.067	0.556*	-0.156	1.000	-0.378	0.067	-0.341	0.111	.
	Significance (2-tailed)	0.788	0.025	0.531	.	0.128	0.788	0.176	0.655	.
	N	10	10	10	10	10	10	10	10	10
Siltation Index (%)	Correlation Coefficient	-0.378	-0.200	0.511*	-0.378	1.000	0.111	0.477*	-0.467*	.
	Significance (2-tailed)	0.128	0.421	0.040	0.128	.	0.655	0.058	0.060	.
	N	10	10	10	10	10	10	10	10	10
Disturbance Index (%)	Correlation Coefficient	-0.200	0.156	0.333	0.067	0.111	1.000	0.023	-0.644*	.
	Significance (2-tailed)	0.421	0.531	0.180	0.788	0.655	.	0.928	0.009	.
	N	10	10	10	10	10	10	10	10	10
Species Richness	Correlation Coefficient	-0.296	-0.250	0.614*	-0.341	0.477*	0.023	1.000	-0.341	.
	Significance (2-tailed)	0.241	0.321	0.015	0.176	0.058	0.928	.	0.176	.
	N	10	10	10	10	10	10	10	10	10
Abundance of Dominant Species (%)	Correlation Coefficient	0.467*	0.022	-0.689*	0.111	-0.467*	-0.644*	-0.341	1.000	.
	Significance (2-tailed)	0.060	0.929	0.006	0.655	0.060	0.009	0.176	.	.
	N	10	10	10	10	10	10	10	10	10
Abnormal Cells (%)	Correlation Coefficient	.	.	.	.	.	.	.	.	.
	Significance (2-tailed)	.	.	.	.	.	.	.	.	.
	N	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed).

'Mean Chlorophyll-a Replicate Scrape Concentration' was removed because sample was collected only once in 2011 (n=1)

Table D-19: Kendall's tau correlation matrix of diatom metrics collected at Station B8 from 2011 to 2020.

Metric	Statistic	Date	Mean Chlorophyll-a Replicate Whole Rock Concentration	Shannon Diversity	Pollution Tolerance Index	Siltation Index (%)	Disturbance Index (%)	Species Richness	Abundance of Dominant Species (%)	Abnormal Cells (%)
Date	Correlation Coefficient	1.000	-0.600*	-0.422*	0.511*	-0.333	0.600*	0.276	0.644*	-0.093
	Significance (2-tailed)	.	0.016	0.089	0.040	0.180	0.016	0.277	0.009	0.737
	N	10	10	10	10	10	10	10	10	10
Mean Chlorophyll-a Replicate Whole Rock Concentration	Correlation Coefficient	-0.600*	1.000	0.022	-0.289	-0.067	-0.467*	-0.506*	-0.333	0.093
	Significance (2-tailed)	0.016	.	0.929	0.245	0.788	0.060	0.046	0.180	0.737
	N	10	10	10	10	10	10	10	10	10
Shannon Diversity	Correlation Coefficient	-0.422*	0.022	1.000	-0.289	0.644*	-0.200	0.276	-0.689*	-0.155
	Significance (2-tailed)	0.089	0.929	.	0.245	0.009	0.421	0.277	0.006	0.575
	N	10	10	10	10	10	10	10	10	10
Pollution Tolerance Index	Correlation Coefficient	0.511*	-0.289	-0.289	1.000	-0.378	0.822*	0.322	0.422*	-0.031
	Significance (2-tailed)	0.040	0.245	0.245	.	0.128	0.001	0.205	0.089	0.911
	N	10	10	10	10	10	10	10	10	10
Siltation Index (%)	Correlation Coefficient	-0.333	-0.067	0.644*	-0.378	1.000	-0.200	0.322	-0.333	-0.218
	Significance (2-tailed)	0.180	0.788	0.009	0.128	.	0.421	0.205	0.180	0.433
	N	10	10	10	10	10	10	10	10	10
Disturbance Index (%)	Correlation Coefficient	0.600*	-0.467*	-0.200	0.822*	-0.200	1.000	0.506*	0.511*	0.031
	Significance (2-tailed)	0.016	0.060	0.421	0.001	0.421	.	0.046	0.040	0.911
	N	10	10	10	10	10	10	10	10	10
Species Richness	Correlation Coefficient	0.276	-0.506*	0.276	0.322	0.322	0.506*	1.000	0.046	0.064
	Significance (2-tailed)	0.277	0.046	0.277	0.205	0.205	0.046	.	0.856	0.821
	N	10	10	10	10	10	10	10	10	10
Abundance of Dominant Species (%)	Correlation Coefficient	0.644*	-0.333	-0.689*	0.422*	-0.333	0.511*	0.046	1.000	0.093
	Significance (2-tailed)	0.009	0.180	0.006	0.089	0.180	0.040	0.856	.	0.737
	N	10	10	10	10	10	10	10	10	10
Abnormal Cells (%)	Correlation Coefficient	-0.093	0.093	-0.155	-0.031	-0.218	0.031	0.064	0.093	1.000
	Significance (2-tailed)	0.737	0.737	0.575	0.911	0.433	0.911	0.821	0.737	.
	N	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed).
'Mean Chlorophyll-a Replicate Scrape Concentration' was removed because sample was collected only once in 2011 (n=1)

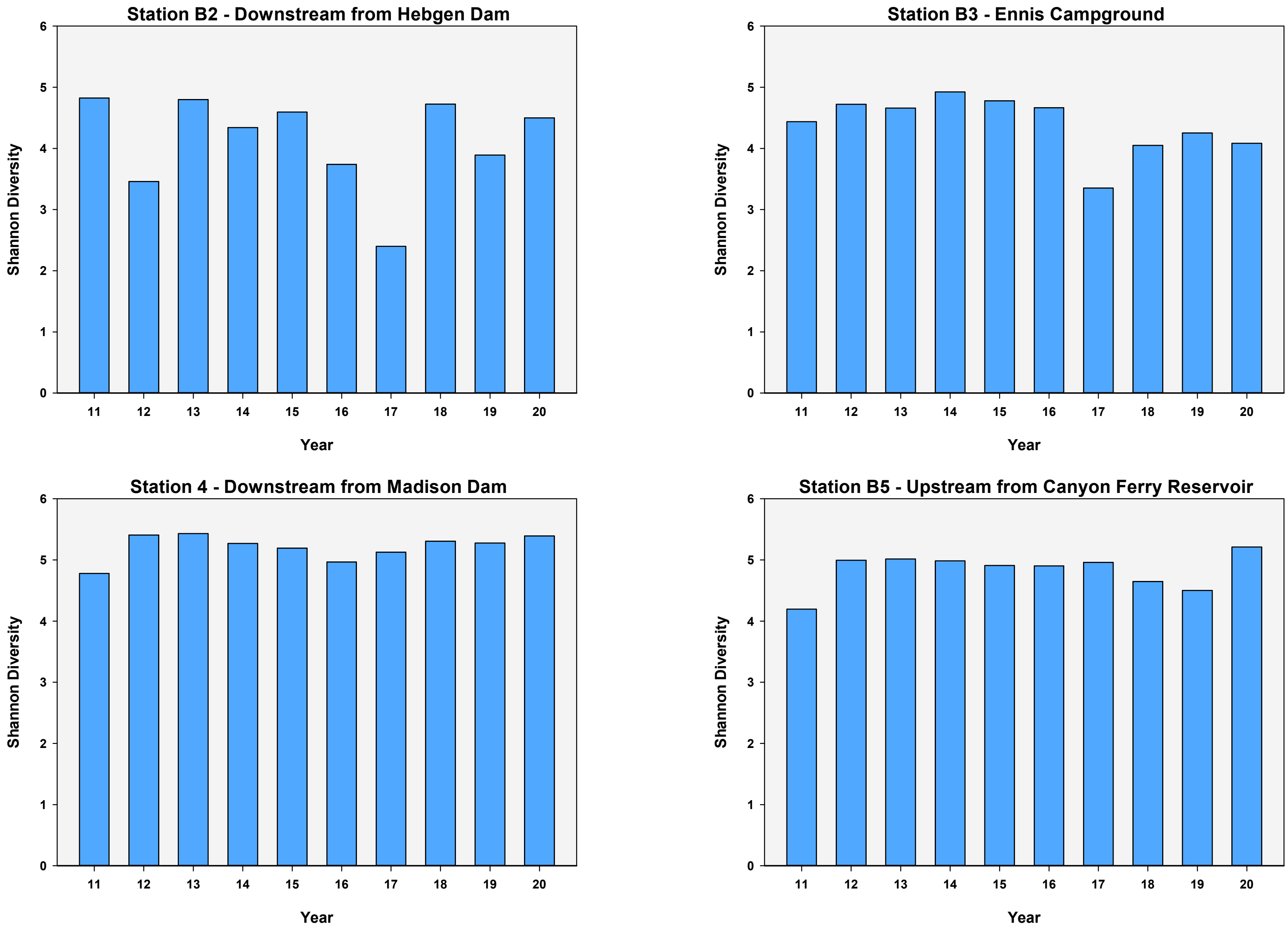
Table D-20: Kendall's tau correlation matrix of diatom metrics collected at Station B10 from 2011 to 2020.

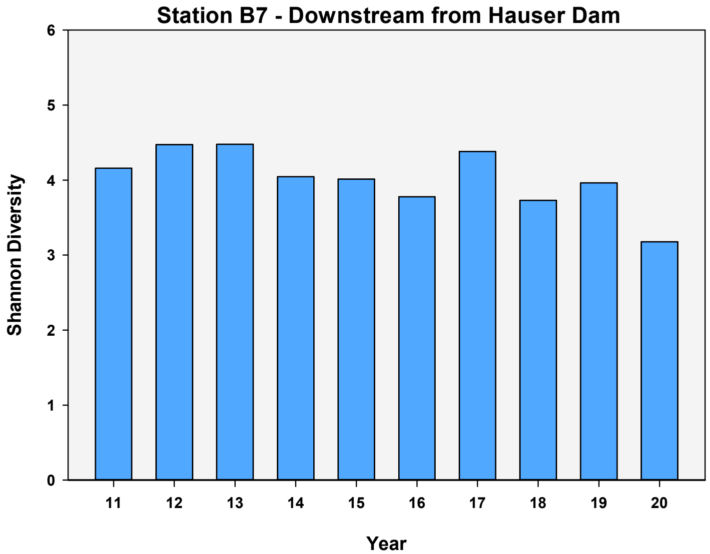
Metric	Statistic	Date	Mean Chlorophyll-a Replicate Whole Rock Concentration	Shannon Diversity	Pollution Tolerance Index	Siltation Index (%)	Disturbance Index (%)	Species Richness	Abundance of Dominant Species (%)	Abnormal Cells (%)
Date	Correlation Coefficient	1.000	0.022	0.067	0.111	-0.289	0.244	0.022	-0.022	-0.447
	Significance (2-tailed)	.	0.929	0.788	0.655	0.245	0.325	0.929	0.929	0.117
	N	10	10	10	10	10	10	10	10	10
Mean Chlorophyll-a Replicate Whole Rock Concentration	Correlation Coefficient	0.022	1.000	0.244	-0.422*	0.422*	0.244	0.200	-0.200	-0.447
	Significance (2-tailed)	0.929	.	0.325	0.089	0.089	0.325	0.421	0.421	0.117
	N	10	10	10	10	10	10	10	10	10
Shannon Diversity	Correlation Coefficient	0.067	0.244	1.000	0.067	0.022	0.467*	0.600*	-0.600*	-0.248
	Significance (2-tailed)	0.788	0.325	.	0.788	0.929	0.060	0.016	0.016	0.384
	N	10	10	10	10	10	10	10	10	10
Pollution Tolerance Index	Correlation Coefficient	0.111	-0.422*	0.067	1.000	-0.467*	0.156	0.200	0.067	0.447
	Significance (2-tailed)	0.655	0.089	0.788	.	0.060	0.531	0.421	0.788	0.117
	N	10	10	10	10	10	10	10	10	10
Siltation Index (%)	Correlation Coefficient	-0.289	0.422*	0.022	-0.467*	1.000	-0.067	-0.111	-0.067	-0.149
	Significance (2-tailed)	0.245	0.089	0.929	0.060	.	0.788	0.655	0.788	0.602
	N	10	10	10	10	10	10	10	10	10
Disturbance Index (%)	Correlation Coefficient	0.244	0.244	0.467*	0.156	-0.067	1.000	0.422*	-0.333	-0.348
	Significance (2-tailed)	0.325	0.325	0.060	0.531	0.788	.	0.089	0.180	0.223
	N	10	10	10	10	10	10	10	10	10
Species Richness	Correlation Coefficient	0.022	0.200	0.600*	0.200	-0.111	0.422*	1.000	-0.200	-0.248
	Significance (2-tailed)	0.929	0.421	0.016	0.421	0.655	0.089	.	0.421	0.384
	N	10	10	10	10	10	10	10	10	10
Abundance of Dominant Species (%)	Correlation Coefficient	-0.022	-0.200	-0.600*	0.067	-0.067	-0.333	-0.200	1.000	0.248
	Significance (2-tailed)	0.929	0.421	0.016	0.788	0.788	0.180	0.421	.	0.384
	N	10	10	10	10	10	10	10	10	10
Abnormal Cells (%)	Correlation Coefficient	-0.447	-0.447	-0.248	0.447	-0.149	-0.348	-0.248	0.248	1.000
	Significance (2-tailed)	0.117	0.117	0.384	0.117	0.602	0.223	0.384	0.384	.
	N	10	10	10	10	10	10	10	10	10

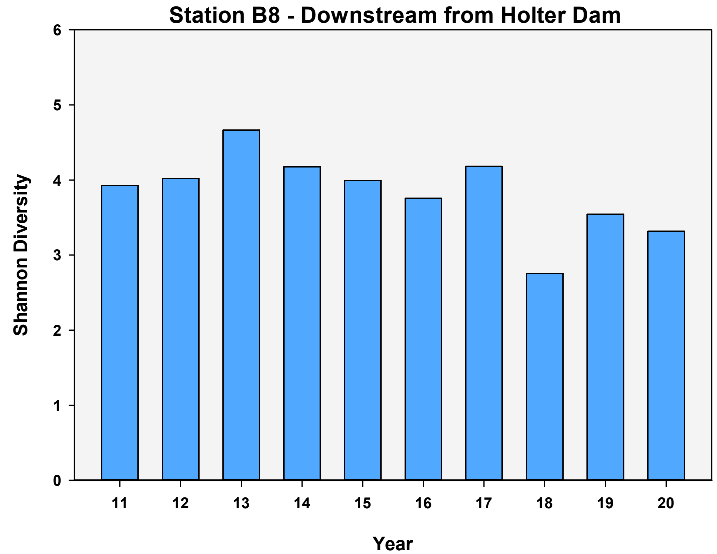
*Correlation is significant at the 0.10 level (2-tailed).
'Mean Chlorophyll-a Replicate Scrape Concentration' was removed because sample was collected only once in 2011 (n=1)

Appendix D.4 Temporal Graphs

Figure D-1: Shannon-Weaver Diversity Index for Biological Stations B2 to B10.




Station B7 - Downstream from Hauser Dam
Shannon Diversity
Year
0
1
2
3
4
5
6
11
12
13
14
15
16
17
18
19
20


Station B8 - Downstream from Holter Dam
Shannon Diversity
Year
0
1
2
3
4
5
6
11
12
13
14
15
16
17
18
19
20

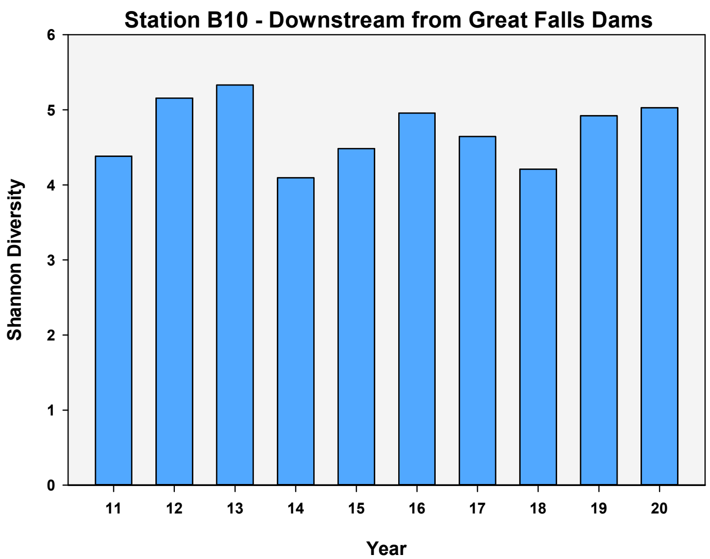
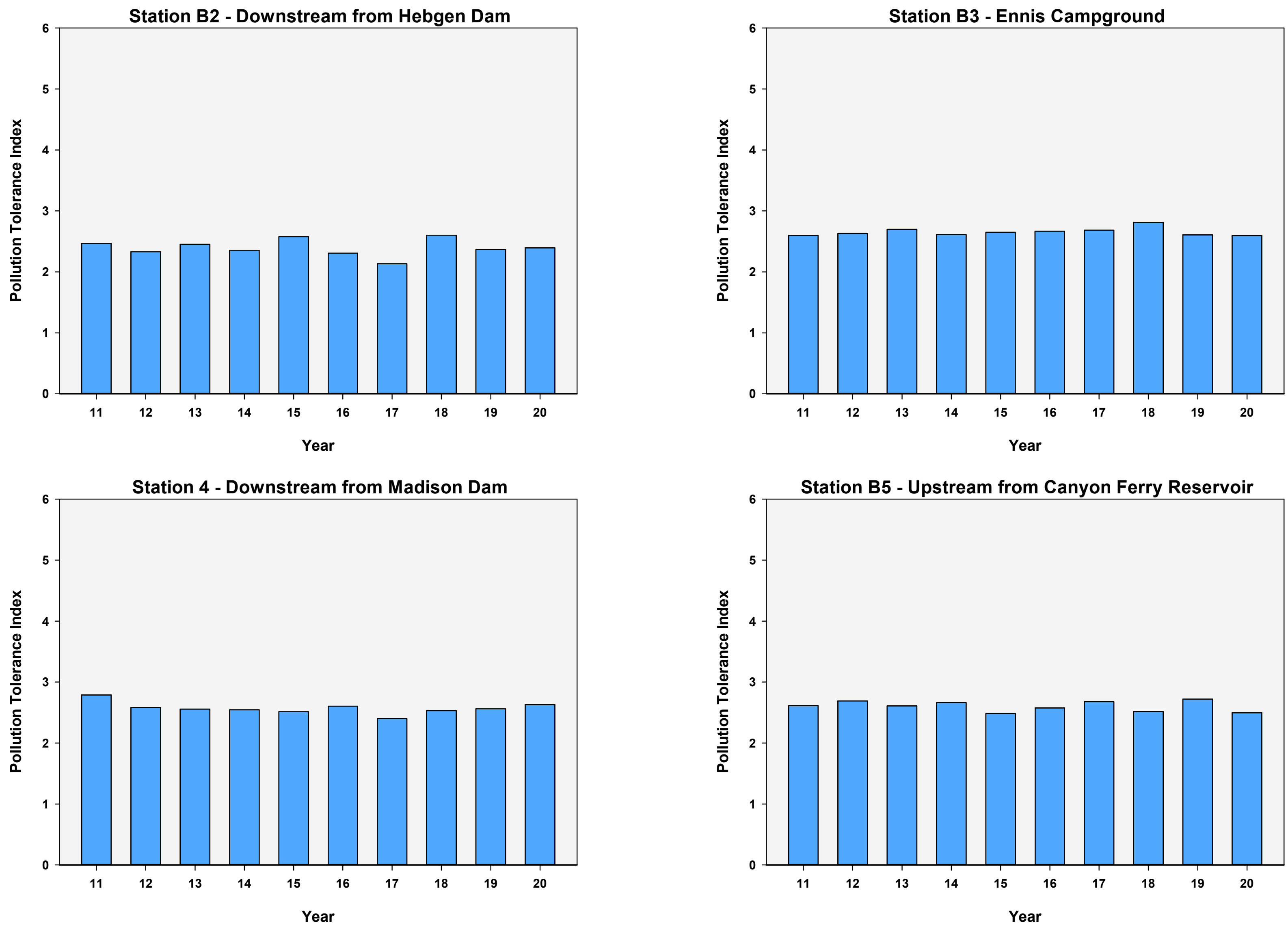
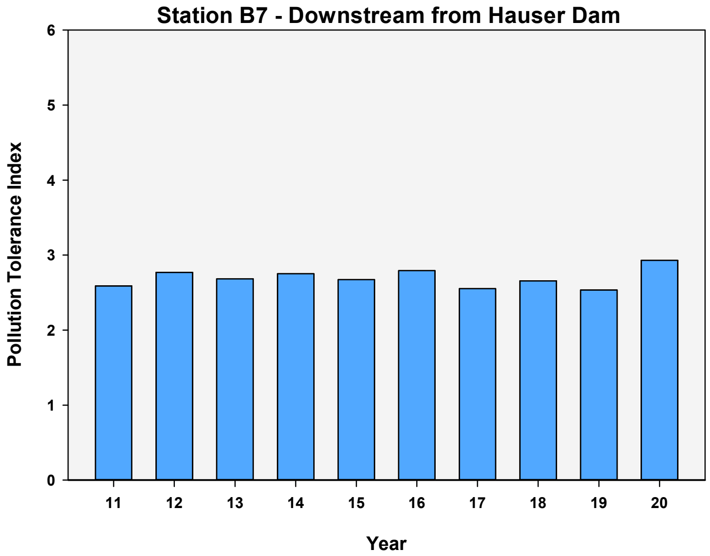
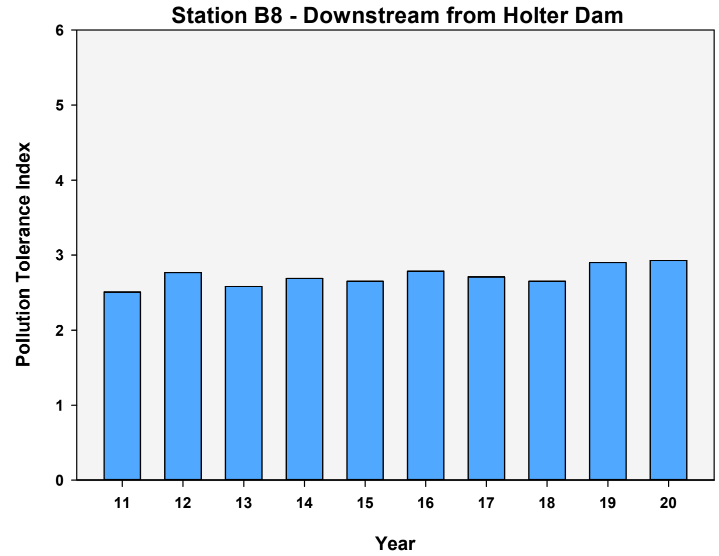

Station B10 - Downstream from Great Falls Dams
Shannon Diversity
Year
0
1
2
3
4
5
6
11
12
13
14
15
16
17
18
19
20

Figure D-2: Pollution Tolerance Index for Biological Stations B2 to B10.




Station B7 - Downstream from Hauser Dam
Pollution Tolerance Index
Year
0
1
2
3
4
5
6
11
12
13
14
15
16
17
18
19
20


Station B8 - Downstream from Holter Dam
Pollution Tolerance Index
Year
0
1
2
3
4
5
6
11
12
13
14
15
16
17
18
19
20

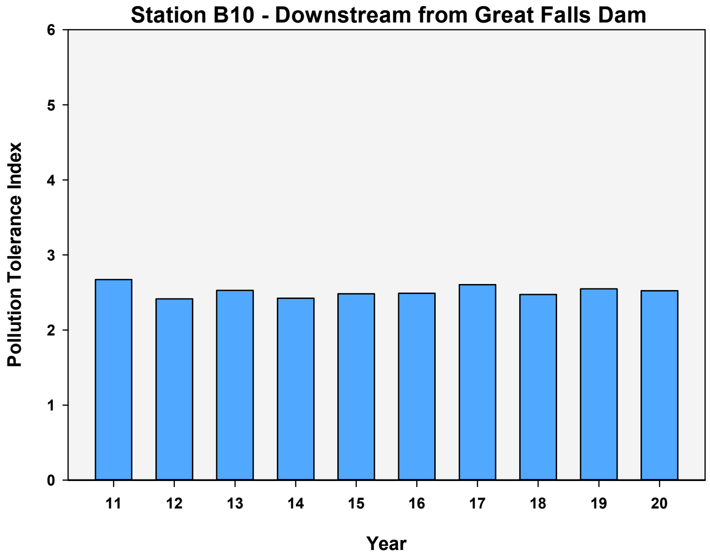
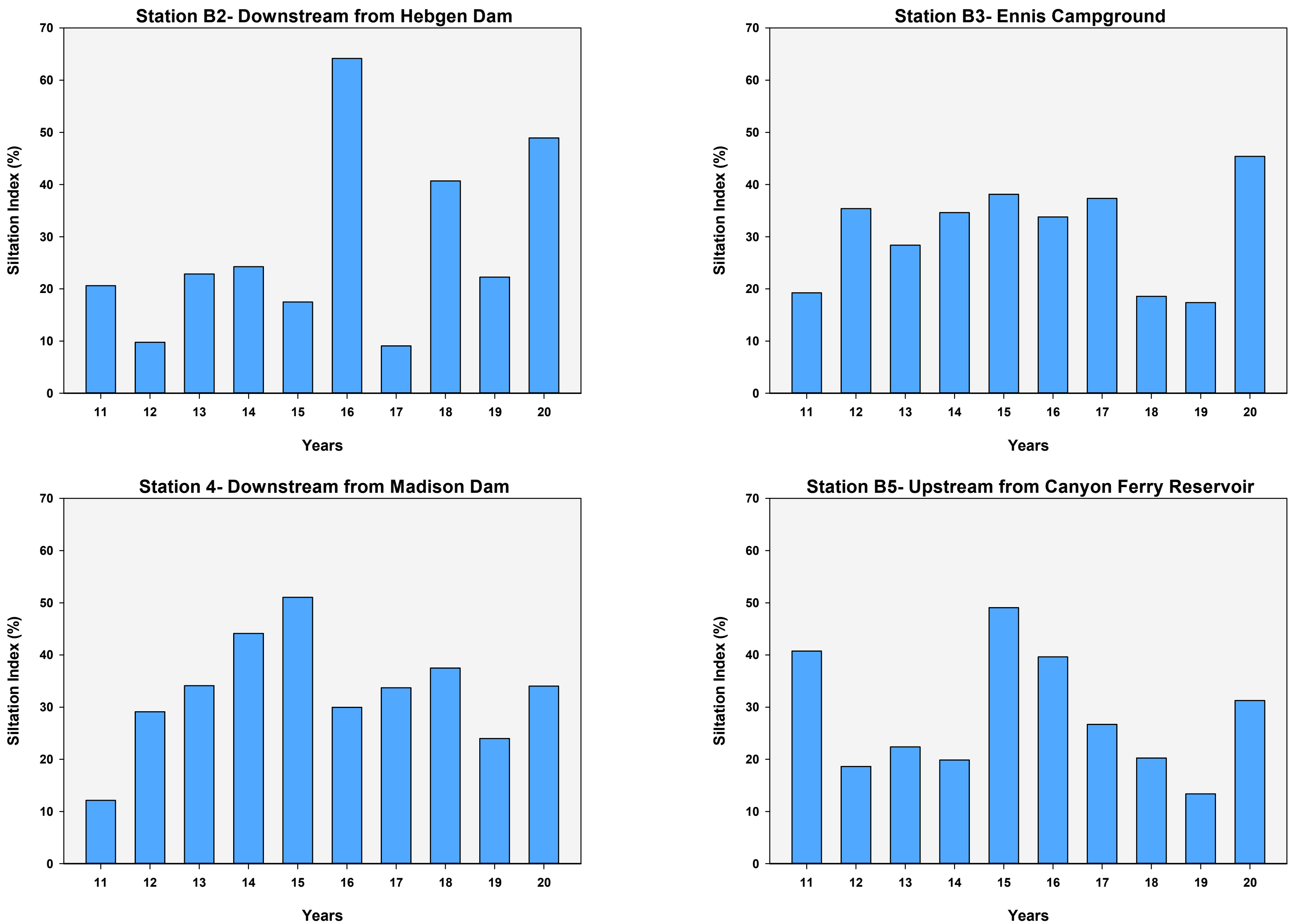
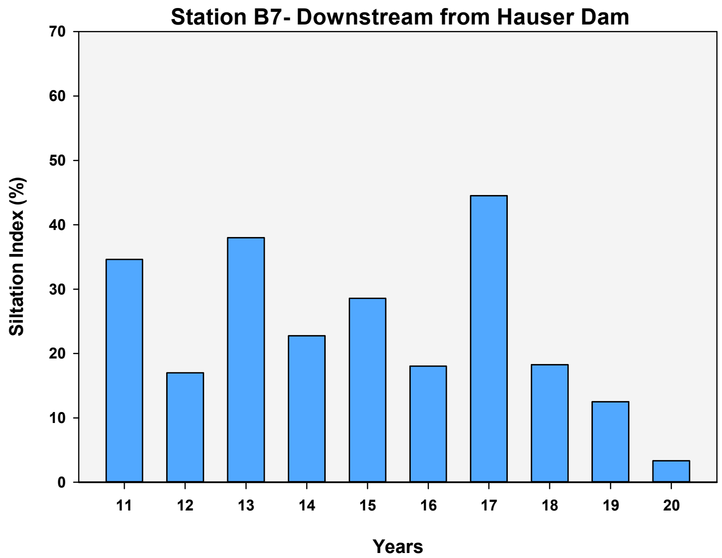
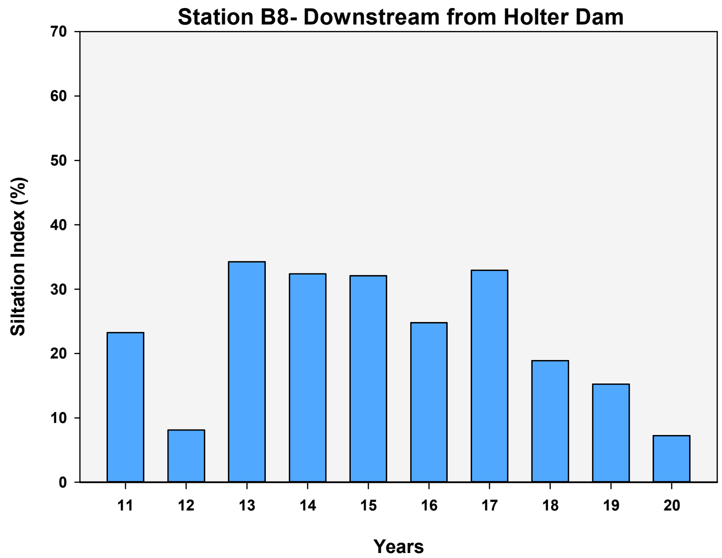

Station B10 - Downstream from Great Falls Dam
Pollution Tolerance Index
Year
0
1
2
3
4
5
6
11
12
13
14
15
16
17
18
19
20

Figure D-3: Siltation Index (%) for Biological Stations B2 to B10.




Station B7- Downstream from Hauser Dam
Siltation Index (%)
Years
0
10
20
30
40
50
60
70
11
12
13
14
15
16
17
18
19
20


Station B8- Downstream from Holter Dam
Siltation Index (%)
Years
0
10
20
30
40
50
60
70
11
12
13
14
15
16
17
18
19
20

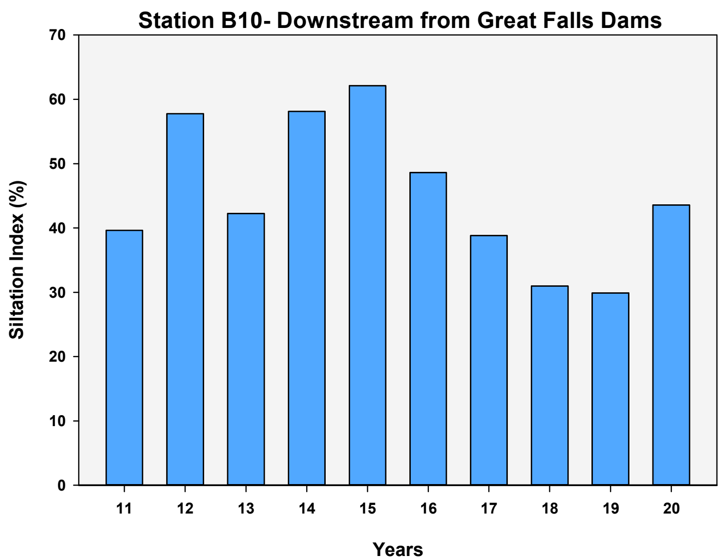
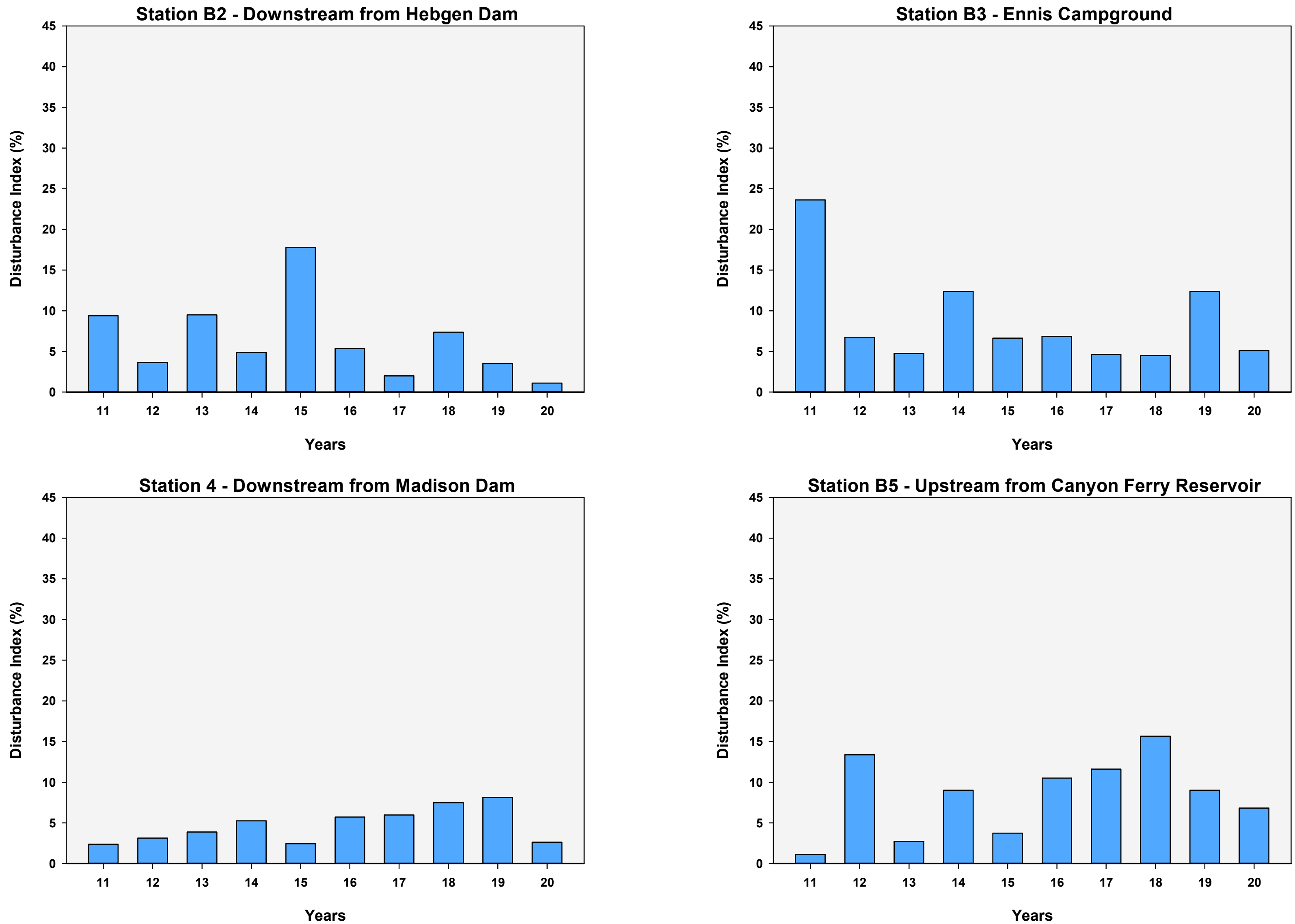
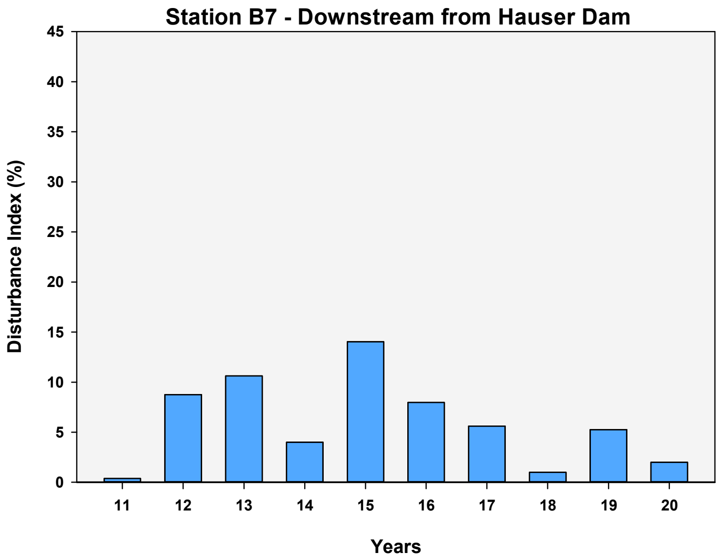
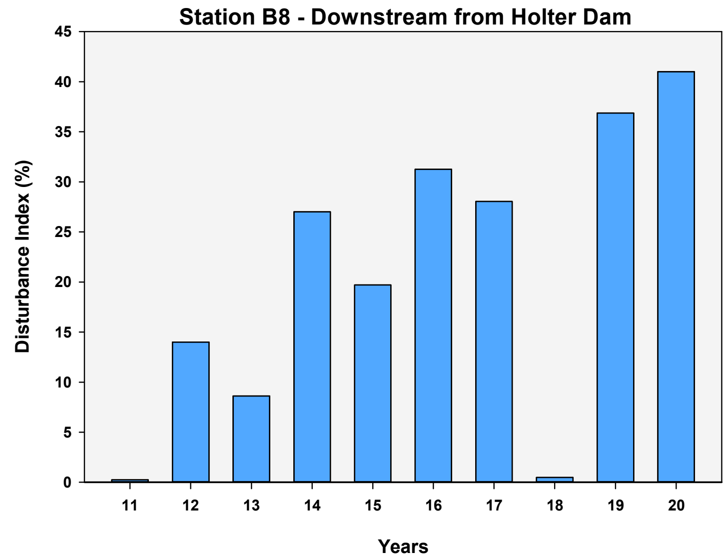

Station B10- Downstream from Great Falls Dams
Siltation Index (%)
Years
0
10
20
30
40
50
60
70
11
12
13
14
15
16
17
18
19
20

Figure D-4: Disturbance Index (%) for Biological Stations B2 to B10.




Station B7 - Downstream from Hauser Dam
Disturbance Index (%)
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20
Years


Station B8 - Downstream from Holter Dam
Disturbance Index (%)
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20
Years

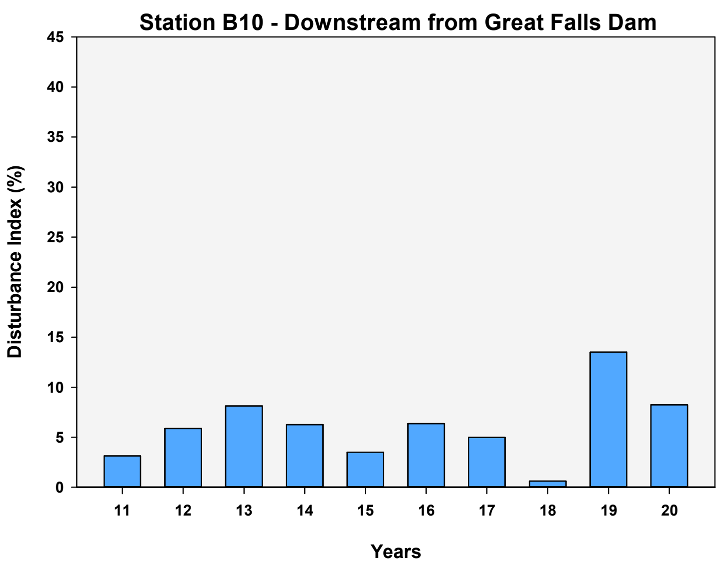
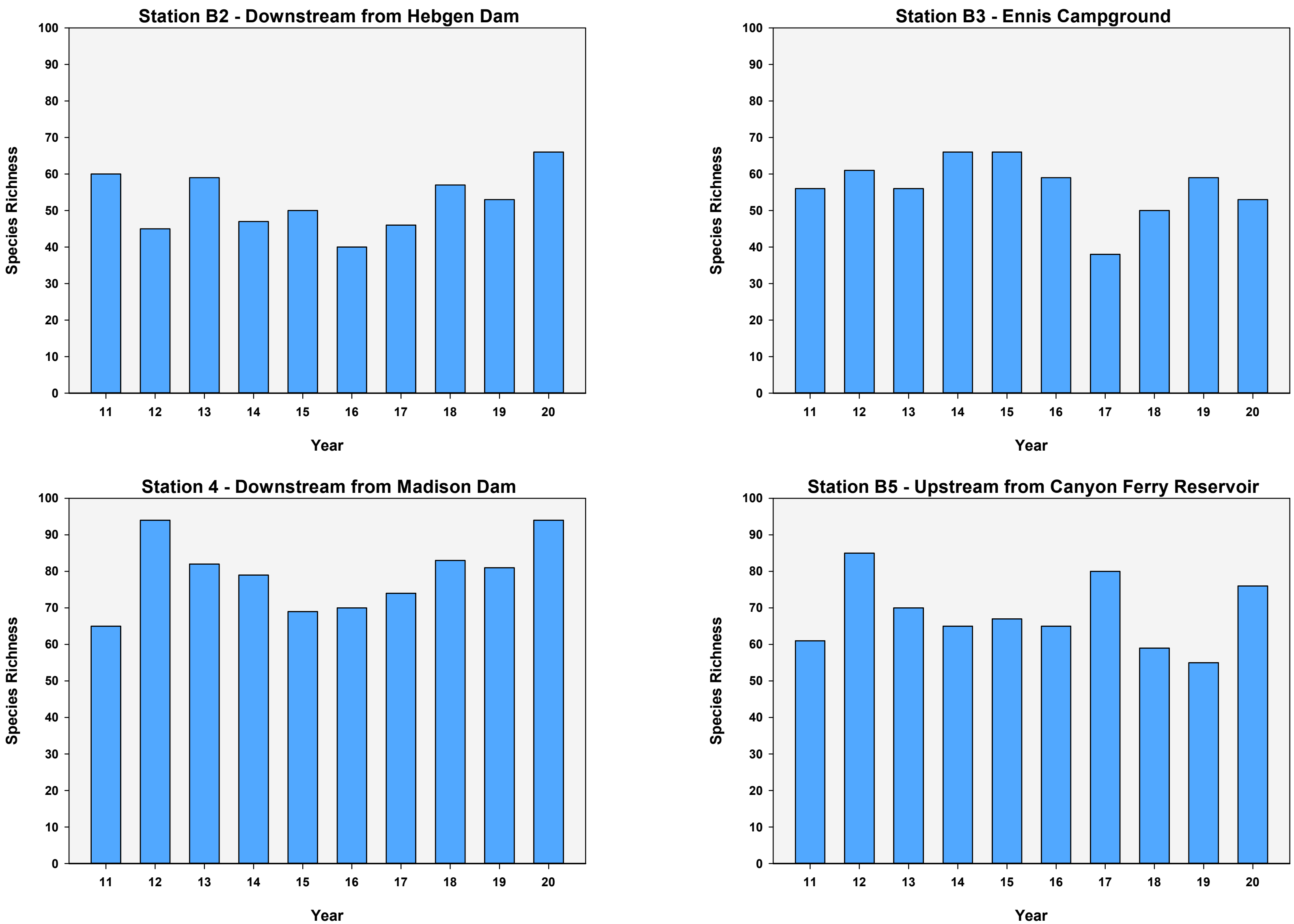
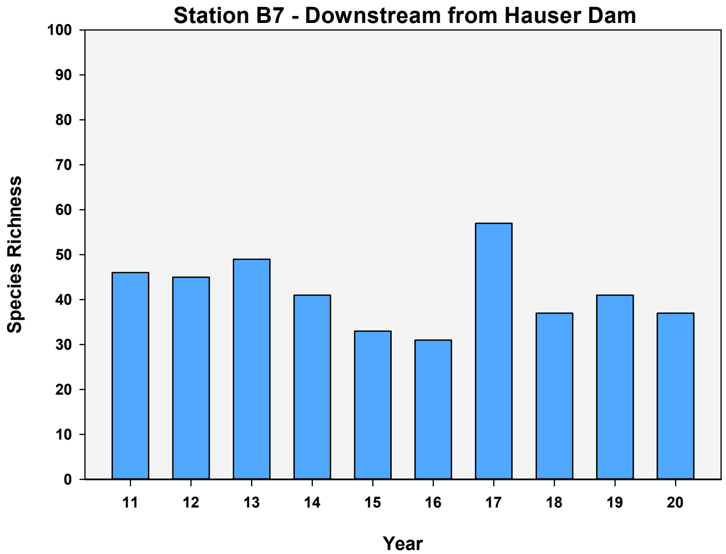
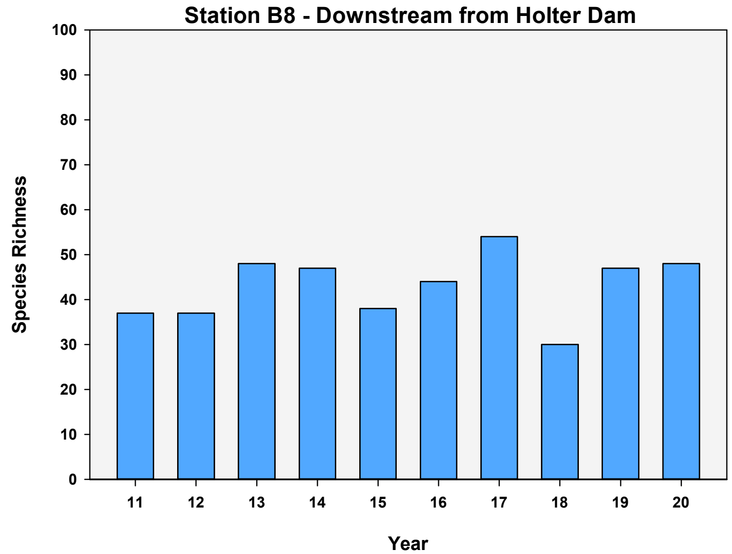

Station B10 - Downstream from Great Falls Dam
Disturbance Index (%)
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20
Years

Figure D-5: Species Richness for Biological Stations B2 to B10.




Station B7 - Downstream from Hauser Dam
Species Richness
Year
0
10
20
30
40
50
60
70
80
90
100
11
12
13
14
15
16
17
18
19
20


Station B8 - Downstream from Holter Dam
Species Richness
Year
0
10
20
30
40
50
60
70
80
90
100
11
12
13
14
15
16
17
18
19
20

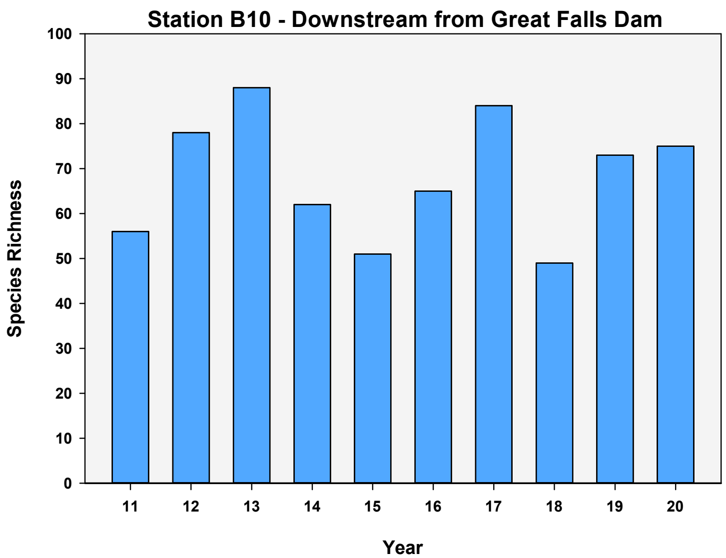
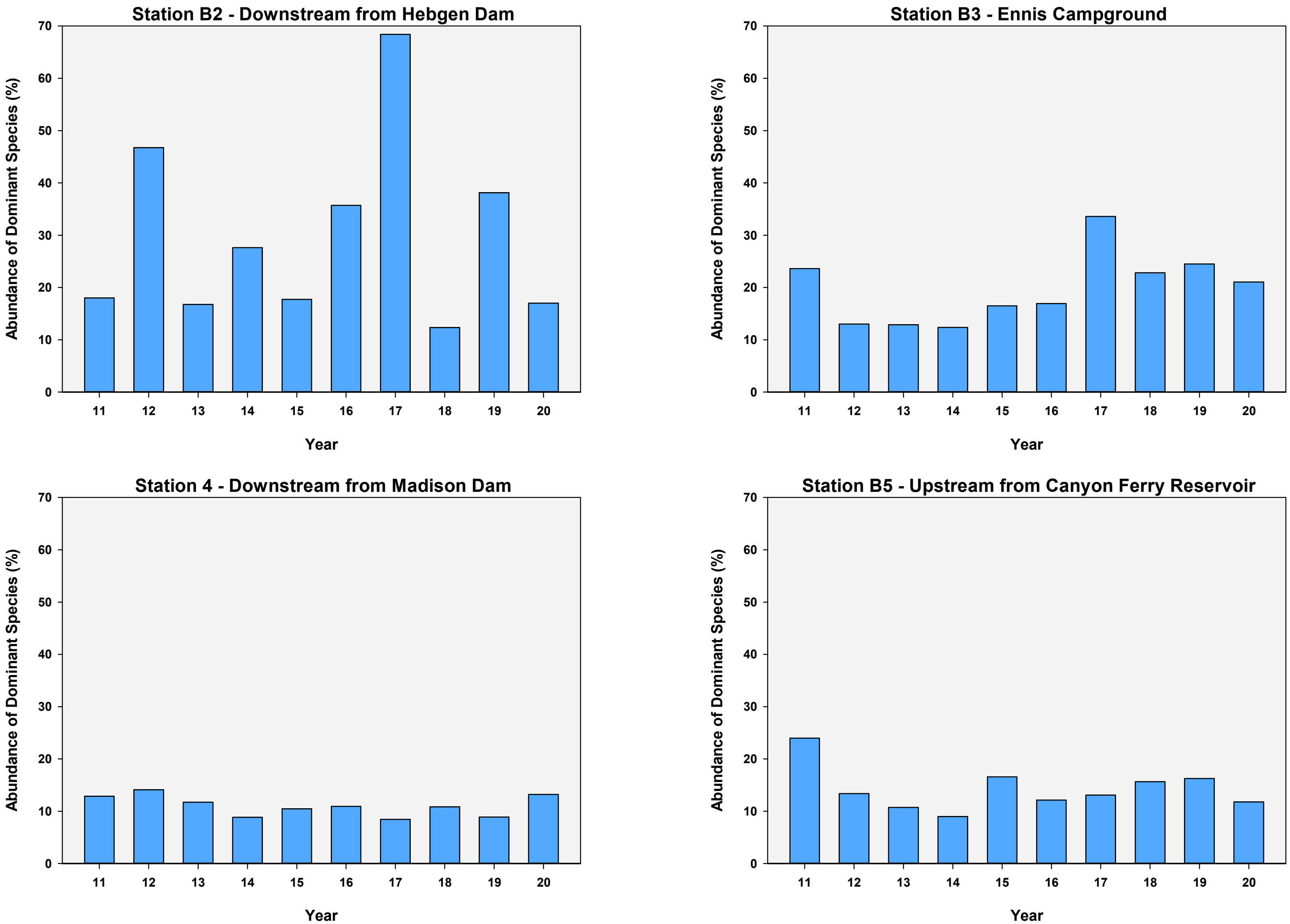
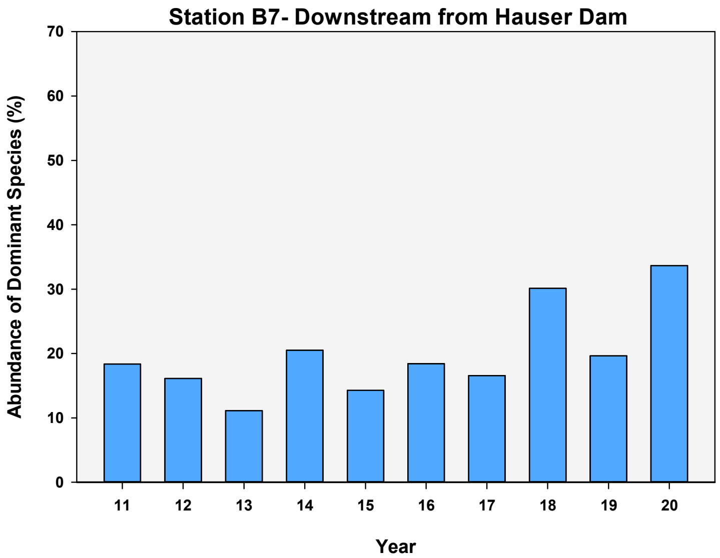
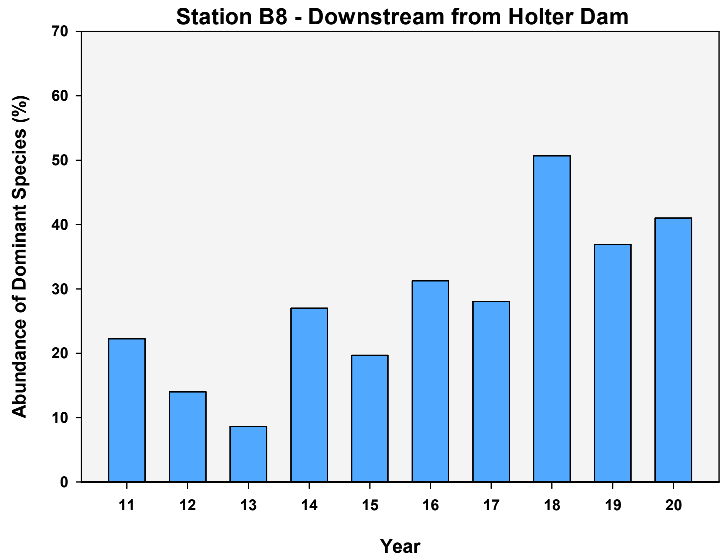

Station B10 - Downstream from Great Falls Dam
Species Richness
Year
0
10
20
30
40
50
60
70
80
90
100
11
12
13
14
15
16
17
18
19
20

Figure D-6: Abundance of Dominant Species (%) for Biological Stations B2 to B10.




Station B7- Downstream from Hauser Dam
Abundance of Dominant Species (%)
0
10
20
30
40
50
60
70
11
12
13
14
15
16
17
18
19
20
Year


Station B8 - Downstream from Holter Dam
Abundance of Dominant Species (%)
0
10
20
30
40
50
60
70
11
12
13
14
15
16
17
18
19
20
Year

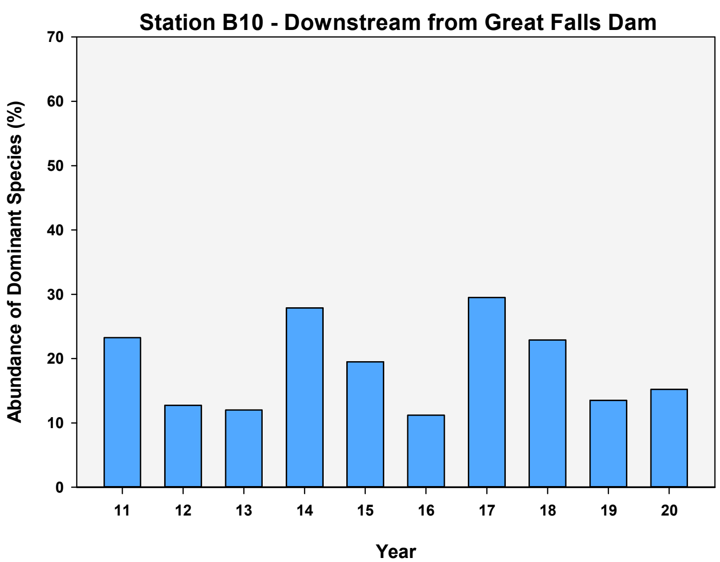
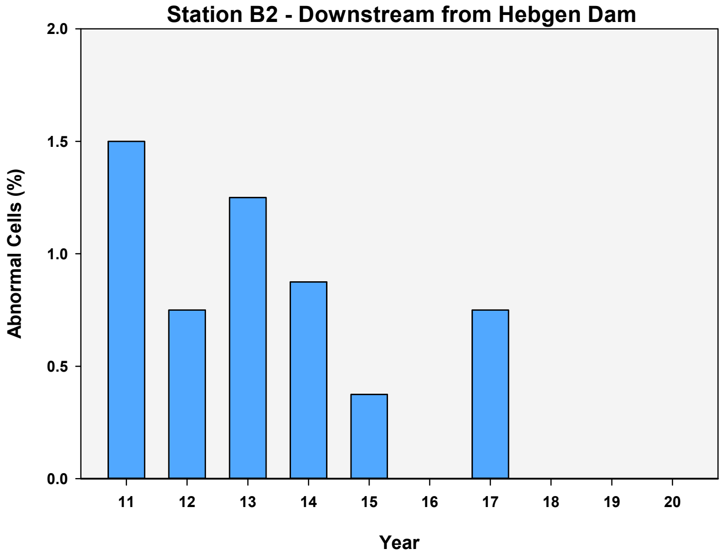
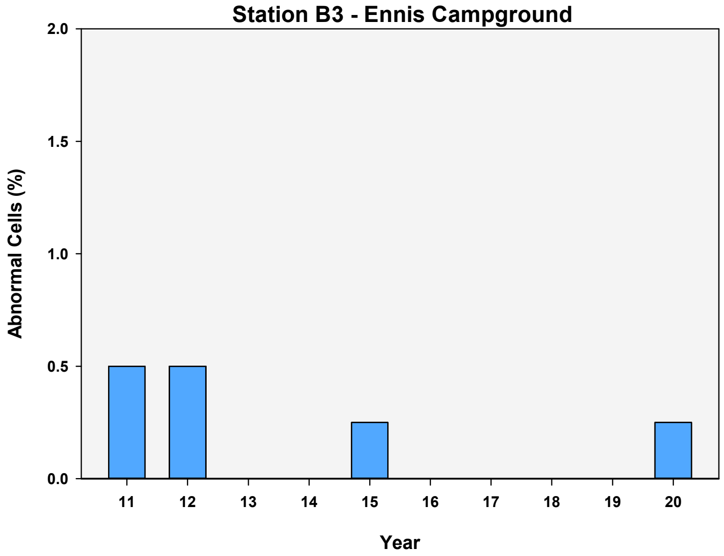
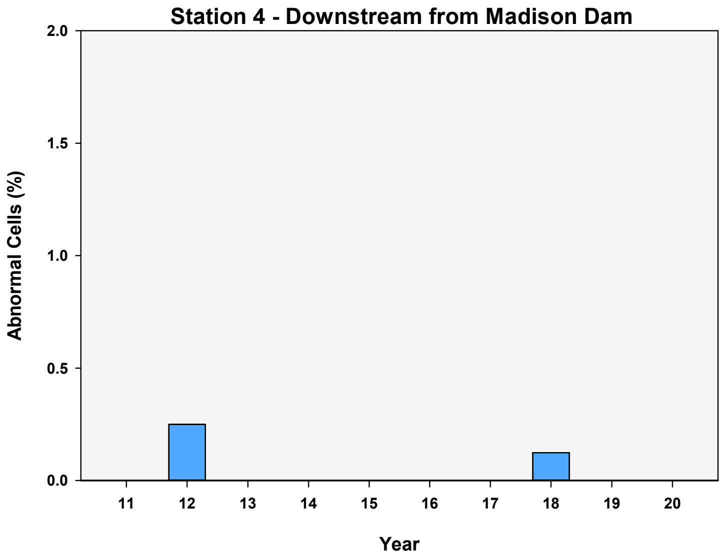
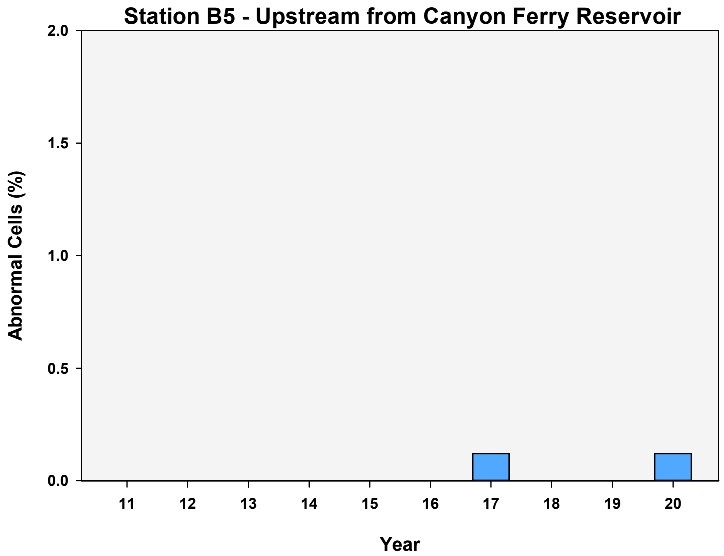

Station B10 - Downstream from Great Falls Dam
Abundance of Dominant Species (%)
0
10
20
30
40
50
60
70
11
12
13
14
15
16
17
18
19
20
Year

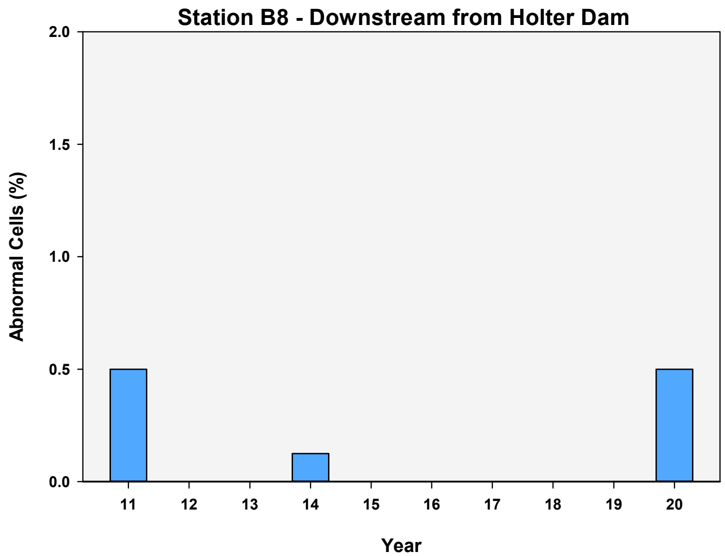
Figure D-7: Abnormal Cells (%) for Biological Stations B2 to B5, B8, and B10. All percentages were zero at Station B7 and a figure is not presented here.

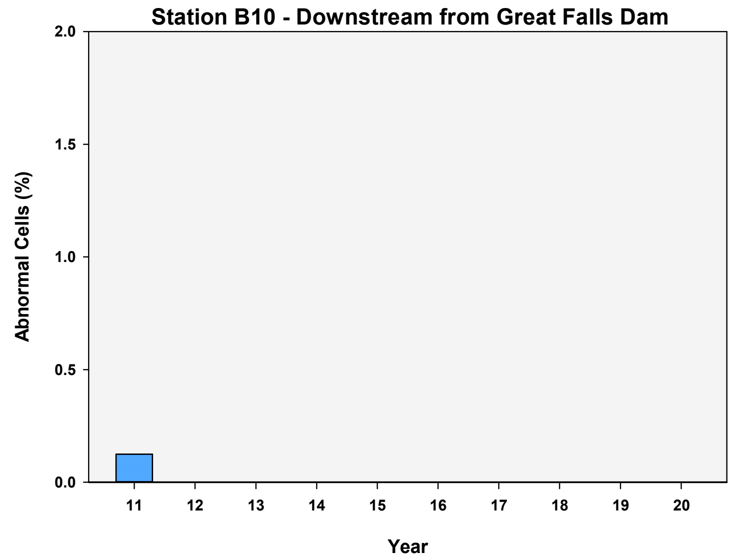









Station B8 - Downstream from Holter Dam
Abnormal Cells (%)
2.0
1.5
1.0
0.5
0.0
11
12
13
14
15
16
17
18
19
20
Year


Station B10 - Downstream from Great Falls Dam
Abnormal Cells (%)
2.0
1.5
1.0
0.5
0.0
11
12
13
14
15
16
17
18
19
20
Year

Appendix E Macroinvertebrate Metrics

Appendix E.1 Upstream-Downstream Comparisons

Table E-1: Rank comparisons of chlorophyll-a concentrations between Stations B1 and B2 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	B1	10	10.70	107.00
	B2	10	10.30	103.00
	Total	20		
Shannon Diversity[a]	B1	10	11.70	117.00
	B2	10	9.30	93.00
	Total	20		
Biotic Index[a]	B1	10	11.90	119.00
	B2	10	9.10	91.00
	Total	20		
EPT Richness[a]	B1	10	11.50	115.00
	B2	10	9.50	95.00
	Total	20		
Relative Abundance of EPT (%)[a]	B1	10	12.10	121.00
	B2	10	8.90	89.00
	Total	20		
Relative Abundance of Chironomidae (%)[a]	B1	10	9.30	93.00
	B2	10	11.70	117.00
	Total	20		
Community Density (0.25 m^2)[b]	B1	10	7.60	76.00
	B2	10	13.40	134.00
	Total	20		
Multimetric Assessment (Total)[c]	B1	10	12.90	129.00
	B2	10	8.10	81.00
	Total	20		
Multimetric Assessment (% of Possible)[c]	B1	10	12.90	129.00
	B2	10	8.10	81.00
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-2: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B1 and B2 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	48.000	103.000	-0.151	0.880
Shannon Diversity[a]	38.000	93.000	-0.907	0.364
Biotic Index[a]	36.000	91.000	-1.058	0.290
EPT Richness[a]	40.000	95.000	-0.757	0.449
Relative Abundance of EPT (%)[a]	34.000	89.000	-1.211	0.226
Relative Abundance of Chironomidae (%)[a]	38.000	93.000	-0.914	0.361
Community Density (0.25 m^2)[b]	21.000	76.000	-2.192	0.028
Multimetric Assessment (Total)[c]	26.000	81.000	-1.835	0.066
Multimetric Assessment (% of Possible)[c]	26.000	81.000	-1.835	0.066

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-3: Rank comparisons of chlorophyll-a concentrations between Stations B1 and F2 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	B2	10	10.00	100.00
	F1	10	11.00	110.00
	Total	20		
Shannon Diversity[a]	B2	10	10.30	103.00
	F1	10	10.70	107.00
	Total	20		
Biotic Index[a]	B2	10	7.75	77.50
	F1	10	13.25	132.50
	Total	20		
EPT Richness[a]	B2	10	9.45	94.50
	F1	10	11.55	115.50
	Total	20		
Relative Abundance of EPT (%)[a]	B2	10	14.60	146.00
	F1	10	6.40	64.00
	Total	20		
Relative Abundance of Chironomidae (%)[a]	B2	10	10.15	101.50
	F1	10	10.85	108.50
	Total	20		
Community Density (0.25 m^2)[b]	B2	10	6.70	67.00
	F1	10	14.30	143.00
	Total	20		
Multimetric Assessment (Total)[c]	B2	10	11.75	117.50
	F1	10	9.25	92.50
	Total	20		
Multimetric Assessment (% of Possible)[c]	B2	10	11.75	117.50
	F1	10	9.25	92.50
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-4: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B1 and F2 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	45.000	100.000	-0.378	0.705
Shannon Diversity[a]	48.000	103.000	-0.151	0.880
Biotic Index[a]	22.500	77.500	-2.080	0.038
EPT Richness[a]	39.500	94.500	-0.795	0.427
Relative Abundance of EPT (%)[a]	9.000	64.000	-3.099	0.002
Relative Abundance of Chironomidae (%)[a]	46.500	101.500	-0.265	0.791
Community Density (0.25 m^2)[b]	12.000	67.000	-2.873	0.004
Multimetric Assessment (Total)[c]	37.500	92.500	-0.952	0.341
Multimetric Assessment (% of Possible)[c]	37.500	92.500	-0.952	0.341

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-5: Rank comparisons of chlorophyll-a concentrations between Stations F1 and B3 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	F1	10	7.50	75.00
	B3	10	13.50	135.00
	Total	20		
Shannon Diversity[a]	F1	10	8.10	81.00
	B3	10	12.90	129.00
	Total	20		
Biotic Index[a]	F1	10	15.40	154.00
	B3	10	5.60	56.00
	Total	20		
EPT Richness[a]	F1	10	6.70	67.00
	B3	10	14.30	143.00
	Total	20		
Relative Abundance of EPT (%)[a]	F1	10	5.60	56.00
	B3	10	15.40	154.00
	Total	20		
Relative Abundance of Chironomidae (%)[a]	F1	10	14.40	144.00
	B3	10	6.60	66.00
	Total	20		
Community Density (0.25 m^2)[b]	F1	10	14.70	147.00
	B3	10	6.30	63.00
	Total	20		
Multimetric Assessment (Total)[c]	F1	10	5.50	55.00
	B3	10	15.50	155.00
	Total	20		
Multimetric Assessment (% of Possible)[c]	F1	10	5.50	55.00
	B3	10	15.50	155.00
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-6: Mann–Whitney *U* test results for chlorophyll-a concentrations at Stations F1 and B3 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	20.000	75.000	-2.269	0.023
Shannon Diversity[a]	26.000	81.000	-1.815	0.070
Biotic Index[a]	1.000	56.000	-3.704	0.000
EPT Richness[a]	12.000	67.000	-2.876	0.004
Relative Abundance of EPT (%)[a]	1.000	56.000	-3.705	0.000
Relative Abundance of Chironomidae (%)[a]	11.000	66.000	-2.960	0.003
Community Density (0.25 m^2)[b]	8.000	63.000	-3.175	0.001
Multimetric Assessment (Total)[c]	0.000	55.000	-3.803	0.000
Multimetric Assessment (% of Possible)[c]	0.000	55.000	-3.803	0.000

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-7: Rank comparisons of chlorophyll-a concentrations between Stations B3 and 4 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	B3	10	14.60	146.00
	4	10	6.40	64.00
	Total	20		
Shannon Diversity[a]	B3	10	15.10	151.00
	4	10	5.90	59.00
	Total	20		
Biotic Index[a]	B3	10	5.50	55.00
	4	10	15.50	155.00
	Total	20		
EPT Richness[a]	B3	10	15.50	155.00
	4	10	5.50	55.00
	Total	20		
Relative Abundance of EPT (%)[a]	B3	10	15.40	154.00
	4	10	5.60	56.00
	Total	20		
Relative Abundance of Chironomidae (%)[a]	B3	10	5.90	59.00
	4	10	15.10	151.00
	Total	20		
Community Density (0.25 m^2)[b]	B3	10	5.50	55.00
	4	10	15.50	155.00
	Total	20		
Multimetric Assessment (Total)[c]	B3	10	15.50	155.00
	4	10	5.50	55.00
	Total	20		
Multimetric Assessment (% of Possible)[c]	B3	10	15.50	155.00
	4	10	5.50	55.00
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-8: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B3 and 4 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	9.000	64.000	-3.100	0.002
Shannon Diversity[a]	4.000	59.000	-3.477	0.001
Biotic Index[a]	0.000	55.000	-3.780	0.000
EPT Richness[a]	0.000	55.000	-3.781	0.000
Relative Abundance of EPT (%)[a]	1.000	56.000	-3.705	0.000
Relative Abundance of Chironomidae (%)[a]	4.000	59.000	-3.502	0.000
Community Density (0.25 m^2)[b]	0.000	55.000	-3.780	0.000
Multimetric Assessment (Total)[c]	0.000	55.000	-3.795	0.000
Multimetric Assessment (% of Possible)[c]	0.000	55.000	-3.795	0.000

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-9: Rank comparisons of chlorophyll-a concentrations between Stations 4 and F3 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	4	10	6.10	61.00
	F3	10	14.90	149.00
	Total	20		
Shannon Diversity[a]	4	10	5.60	56.00
	F3	10	15.40	154.00
	Total	20		
Biotic Index[a]	4	10	15.30	153.00
	F3	10	5.70	57.00
	Total	20		
EPT Richness[a]	4	10	5.60	56.00
	F3	10	15.40	154.00
	Total	20		
Relative Abundance of EPT (%)[a]	4	10	6.10	61.00
	F3	10	14.90	149.00
	Total	20		
Relative Abundance of Chironomidae (%)[a]	4	10	12.70	127.00
	F3	10	8.30	83.00
	Total	20		
Community Density (0.25 m^2)[b]	4	10	15.30	153.00
	F3	10	5.70	57.00
	Total	20		
Multimetric Assessment (Total)[c]	4	10	5.65	56.50
	F3	10	15.35	153.50
	Total	20		
Multimetric Assessment (% of Possible)[c]	4	10	5.65	56.50
	F3	10	15.35	153.50
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-10: Mann–Whitney U test results for chlorophyll-a concentrations at Stations 4 and F3 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	6.000	61.000	-3.327	0.001
Shannon Diversity[a]	1.000	56.000	-3.704	0.000
Biotic Index[a]	2.000	57.000	-3.628	0.000
EPT Richness[a]	1.000	56.000	-3.705	0.000
Relative Abundance of EPT (%)[a]	6.000	61.000	-3.326	0.001
Relative Abundance of Chironomidae (%)[a]	28.000	83.000	-1.666	0.096
Community Density (0.25 m^2)[b]	2.000	57.000	-3.628	0.000
Multimetric Assessment (Total)[c]	1.500	56.500	-3.698	0.000
Multimetric Assessment (% of Possible)[c]	1.500	56.500	-3.698	0.000

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-11: Rank comparisons of chlorophyll-a concentrations between Stations F3 and F4 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	F3	10	11.65	116.50
	F4	10	9.35	93.50
	Total	20		
Shannon Diversity[a]	F3	10	10.60	106.00
	F4	10	10.40	104.00
	Total	20		
Biotic Index[a]	F3	10	11.70	117.00
	F4	10	9.30	93.00
	Total	20		
EPT Richness[a]	F3	10	11.05	110.50
	F4	10	9.95	99.50
	Total	20		
Relative Abundance of EPT (%)[a]	F3	10	6.55	65.50
	F4	10	14.45	144.50
	Total	20		
Relative Abundance of Chironomidae (%)[a]	F3	10	14.25	142.50
	F4	10	6.75	67.50
	Total	20		
Community Density (0.25 m^2)[b]	F3	10	7.20	72.00
	F4	10	13.80	138.00
	Total	20		
Multimetric Assessment (Total)[c]	F3	10	9.20	92.00
	F4	10	11.80	118.00
	Total	20		
Multimetric Assessment (% of Possible)[c]	F3	10	9.20	92.00
	F4	10	11.80	118.00
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-12: Mann–Whitney U test results for chlorophyll-a concentrations at Stations F3 and F4 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	38.500	93.500	-0.870	0.384
Shannon Diversity[a]	49.000	104.000	-0.076	0.940
Biotic Index[a]	38.000	93.000	-0.907	0.364
EPT Richness[a]	44.500	99.500	-0.416	0.677
Relative Abundance of EPT (%)[a]	10.500	65.500	-2.989	0.003
Relative Abundance of Chironomidae (%)[a]	12.500	67.500	-2.842	0.004
Community Density (0.25 m^2)[b]	17.000	72.000	-2.495	0.013
Multimetric Assessment (Total)[c]	37.000	92.000	-1.020	0.308
Multimetric Assessment (% of Possible)[c]	37.000	92.000	-1.020	0.308

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-13: Rank comparisons of chlorophyll-a concentrations between Stations F4 and F5 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	F4	10	11.75	117.50
	B5	10	9.25	92.50
	Total	20		
Shannon Diversity[a]	F4	10	12.25	122.50
	B5	10	8.75	87.50
	Total	20		
Biotic Index[a]	F4	10	7.70	77.00
	B5	10	13.30	133.00
	Total	20		
EPT Richness[a]	F4	10	9.80	98.00
	B5	10	11.20	112.00
	Total	20		
Relative Abundance of EPT (%)[a]	F4	10	11.95	119.50
	B5	10	9.05	90.50
	Total	20		
Relative Abundance of Chironomidae (%)[a]	F4	10	8.90	89.00
	B5	10	12.10	121.00
	Total	20		
Community Density (0.25 m^2)[b]	F4	10	11.40	114.00
	B5	10	9.60	96.00
	Total	20		
Multimetric Assessment (Total)[c]	F4	10	12.55	125.50
	B5	10	8.45	84.50
	Total	20		
Multimetric Assessment (% of Possible)[c]	F4	10	12.55	125.50
	B5	10	8.45	84.50
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-14: Mann–Whitney U test results for chlorophyll-a concentrations at Stations F4 and F5 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	37.500	92.500	-0.946	0.344
Shannon Diversity[a]	32.500	87.500	-1.323	0.186
Biotic Index[a]	22.000	77.000	-2.117	0.034
EPT Richness[a]	43.000	98.000	-0.531	0.596
Relative Abundance of EPT (%)[a]	35.500	90.500	-1.098	0.272
Relative Abundance of Chironomidae (%)[a]	34.000	89.000	-1.214	0.225
Community Density (0.25 m^2)[b]	41.000	96.000	-0.680	0.496
Multimetric Assessment (Total)[c]	29.500	84.500	-1.573	0.116
Multimetric Assessment (% of Possible)[c]	29.500	84.500	-1.573	0.116

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-15: Rank comparisons of chlorophyll-a concentrations between Stations B5 and B7 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	B5	10	15.50	155.00
	B7	10	5.50	55.00
	Total	20		
Shannon Diversity[a]	B5	10	15.40	154.00
	B7	10	5.60	56.00
	Total	20		
Biotic Index[a]	B5	10	5.90	59.00
	B7	10	15.10	151.00
	Total	20		
EPT Richness[a]	B5	10	15.50	155.00
	B7	10	5.50	55.00
	Total	20		
Relative Abundance of EPT (%)[a]	B5	10	15.25	152.50
	B7	10	5.75	57.50
	Total	20		
Relative Abundance of Chironomidae (%)[a]	B5	10	11.05	110.50
	B7	10	9.95	99.50
	Total	20		
Community Density (0.25 m^2)[b]	B5	10	6.50	65.00
	B7	10	14.50	145.00
	Total	20		
Multimetric Assessment (Total)[c]	B5	10	15.40	154.00
	B7	10	5.60	56.00
	Total	20		
Multimetric Assessment (% of Possible)[c]	B5	10	15.40	154.00
	B7	10	5.60	56.00
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-16: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B5 and B7 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	0.000	55.000	-3.785	0.000
Shannon Diversity[a]	1.000	56.000	-3.704	0.000
Biotic Index[a]	4.000	59.000	-3.477	0.001
EPT Richness[a]	0.000	55.000	-3.784	0.000
Relative Abundance of EPT (%)[a]	2.500	57.500	-3.593	0.000
Relative Abundance of Chironomidae (%)[a]	44.500	99.500	-0.417	0.676
Community Density (0.25 m^2)[b]	10.000	65.000	-3.024	0.002
Multimetric Assessment (Total)[c]	1.000	56.000	-3.721	0.000
Multimetric Assessment (% of Possible)[c]	1.000	56.000	-3.721	0.000

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-17: Rank comparisons of chlorophyll-a concentrations between Stations B7 and B8 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	B7	10	8.50	85.00
	B8	10	12.50	125.00
	Total	20		
Shannon Diversity[a]	B7	10	8.90	89.00
	B8	10	12.10	121.00
	Total	20		
Biotic Index[a]	B7	10	8.60	86.00
	B8	10	12.40	124.00
	Total	20		
EPT Richness[a]	B7	10	9.30	93.00
	B8	10	11.70	117.00
	Total	20		
Relative Abundance of EPT (%)[a]	B7	10	8.80	88.00
	B8	10	12.20	122.00
	Total	20		
Relative Abundance of Chironomidae (%)[a]	B7	10	11.25	112.50
	B8	10	9.75	97.50
	Total	20		
Community Density (0.25 m^2)[b]	B7	10	8.10	81.00
	B8	10	12.90	129.00
	Total	20		
Multimetric Assessment (Total)[c]	B7	10	8.60	86.00
	B8	10	12.40	124.00
	Total	20		
Multimetric Assessment (% of Possible)[c]	B7	10	8.60	86.00
	B8	10	12.40	124.00
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-18: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B7 and B8 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	30.000	85.000	-1.514	0.130
Shannon Diversity[a]	34.000	89.000	-1.209	0.226
Biotic Index[a]	31.000	86.000	-1.436	0.151
EPT Richness[a]	38.000	93.000	-0.910	0.363
Relative Abundance of EPT (%)[a]	33.000	88.000	-1.288	0.198
Relative Abundance of Chironomidae (%)[a]	42.500	97.500	-0.569	0.569
Community Density (0.25 m^2)[b]	26.000	81.000	-1.814	0.070
Multimetric Assessment (Total)[c]	31.000	86.000	-1.446	0.148
Multimetric Assessment (% of Possible)[c]	31.000	86.000	-1.446	0.148

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-19: Rank comparisons of chlorophyll-a concentrations between Stations B8 and B10 from 2011 to 2020.

Analyte	Station	N	Mean Rank	Sum of Ranks
Taxa Richness[a]	B8	10	5.50	55.00
	B10	10	15.50	155.00
	Total	20		
Shannon Diversity[a]	B8	10	6.00	60.00
	B10	10	15.00	150.00
	Total	20		
Biotic Index[a]	B8	10	14.40	144.00
	B10	10	6.60	66.00
	Total	20		
EPT Richness[a]	B8	10	5.50	55.00
	B10	10	15.50	155.00
	Total	20		
Relative Abundance of EPT (%)[a]	B8	10	6.20	62.00
	B10	10	14.80	148.00
	Total	20		
Relative Abundance of Chironomidae (%)[a]	B8	10	7.90	79.00
	B10	10	13.10	131.00
	Total	20		
Community Density (0.25 m^2)[b]	B8	10	15.50	155.00
	B10	10	5.50	55.00
	Total	20		
Multimetric Assessment (Total)[c]	B8	10	6.55	65.50
	B10	10	14.45	144.50
	Total	20		
Multimetric Assessment (% of Possible)[c]	B8	10	6.55	65.50
	B10	10	14.45	144.50
	Total	20		

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Table E-20: Mann–Whitney U test results for chlorophyll-a concentrations at Stations B8 and B10 from 2011 to 2020.

Analyte	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Taxa Richness[a]	0.000	55.000	-3.782	0.000
Shannon Diversity[a]	5.000	60.000	-3.402	0.001
Biotic Index[a]	11.000	66.000	-2.948	0.003
EPT Richness[a]	0.000	55.000	-3.784	0.000
Relative Abundance of EPT (%)[a]	7.000	62.000	-3.253	0.001
Relative Abundance of Chironomidae (%)[a]	24.000	79.000	-1.970	0.049
Community Density (0.25 m^2)[b]	0.000	55.000	-3.780	0.000
Multimetric Assessment (Total)[c]	10.500	65.500	-2.993	0.003
Multimetric Assessment (% of Possible)[c]	10.500	65.500	-2.993	0.003

[a]Subsample of 300
[b]Pooled sample
[c]Metric Score
Note: No Amphipoda or Isopoda collected at all sites.

Appendix E.2 Correlation Matrices

Table E-21: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station B1 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m^2)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.156	0.156	0.467*	0.090	-0.494*	0.193	0.111	-0.074	-0.074
	Significance (2-tailed)	.	0.531	0.531	0.060	0.719	0.048	0.459	0.655	0.780	0.780
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.156	1.000	0.733*	-0.022	0.764*	-0.270	0.725*	-0.200	0.613*	0.613*
	Significance (2-tailed)	0.531	.	0.003	0.929	0.002	0.281	0.005	0.421	0.020	0.020
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	0.156	0.733*	1.000	0.067	0.494*	-0.360	0.629*	-0.022	0.417	0.417
	Significance (2-tailed)	0.531	0.003	.	0.788	0.048	0.151	0.016	0.929	0.114	0.114
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	0.467*	-0.022	0.067	1.000	-0.045	-0.539*	-0.048	0.022	-0.417	-0.417
	Significance (2-tailed)	0.060	0.929	0.788	.	0.857	0.031	0.853	0.929	0.114	0.114
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.090	0.764*	0.494*	-0.045	1.000	-0.295	0.514*	-0.315	0.595*	0.595*
	Significance (2-tailed)	0.719	0.002	0.048	0.857	.	0.241	0.051	0.209	0.025	0.025
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	-0.494*	-0.270	-0.360	-0.539*	-0.295	1.000	-0.269	0.180	0.099	0.099
	Significance (2-tailed)	0.048	0.281	0.151	0.031	0.241	.	0.307	0.472	0.709	0.709
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	0.193	0.725*	0.629*	-0.048	0.514*	-0.269	1.000	-0.290	0.480*	0.480*
	Significance (2-tailed)	0.459	0.005	0.016	0.853	0.051	0.307	.	0.267	0.084	0.084
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m^2)[b]	Correlation Coefficient	0.111	-0.200	-0.022	0.022	-0.315	0.180	-0.290	1.000	-0.172	-0.172
	Significance (2-tailed)	0.655	0.421	0.929	0.929	0.209	0.472	0.267	.	0.515	0.515
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	-0.074	0.613*	0.417	-0.417	0.595*	0.099	0.480*	-0.172	1.000	1.000
	Significance (2-tailed)	0.780	0.020	0.114	0.114	0.025	0.709	0.084	0.515	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	-0.074	0.613*	0.417	-0.417	0.595*	0.099	0.480*	-0.172	1.000	1.000
	Significance (2-tailed)	0.780	0.020	0.114	0.114	0.025	0.709	0.084	0.515	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

Table E-22: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station B2 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m^2)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.511*	0.289	-0.244	0.539*	-0.067	0.467*	0.378	0.114	0.114
	Significance (2-tailed)	.	0.040	0.245	0.325	0.031	0.788	0.060	0.128	0.652	0.652
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.511*	1.000	0.422*	-0.022	0.719*	-0.378	0.778*	0.156	0.205	0.205
	Significance (2-tailed)	0.040	.	0.089	0.929	0.004	0.128	0.002	0.531	0.417	0.417
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	0.289	0.422*	1.000	-0.333	0.539*	-0.511*	0.467*	-0.156	0.432*	0.432*
	Significance (2-tailed)	0.245	0.089	.	0.180	0.031	0.040	0.060	0.531	0.087	0.087
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	-0.244	-0.022	-0.333	1.000	-0.315	-0.156	-0.067	-0.244	-0.477*	-0.477*
	Significance (2-tailed)	0.325	0.929	0.180	.	0.209	0.531	0.788	0.325	0.058	0.058
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.539*	0.719*	0.539*	-0.315	1.000	-0.225	0.674*	0.315	0.414	0.414
	Significance (2-tailed)	0.031	0.004	0.031	0.209	.	0.369	0.007	0.209	0.103	0.103
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	-0.067	-0.378	-0.511*	-0.156	-0.225	1.000	-0.333	0.378	-0.023	-0.023
	Significance (2-tailed)	0.788	0.128	0.040	0.531	0.369	.	0.180	0.128	0.928	0.928
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	0.467*	0.778*	0.467*	-0.067	0.674*	-0.333	1.000	0.111	0.159	0.159
	Significance (2-tailed)	0.060	0.002	0.060	0.788	0.007	0.180	.	0.655	0.528	0.528
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m^2)[b]	Correlation Coefficient	0.378	0.156	-0.156	-0.244	0.315	0.378	0.111	1.000	0.023	0.023
	Significance (2-tailed)	0.128	0.531	0.531	0.325	0.209	0.128	0.655	.	0.928	0.928
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.114	0.205	0.432*	-0.477*	0.414	-0.023	0.159	0.023	1.000	1.000
	Significance (2-tailed)	0.652	0.417	0.087	0.058	0.103	0.928	0.528	0.928	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.114	0.205	0.432*	-0.477*	0.414	-0.023	0.159	0.023	1.000	1.000
	Significance (2-tailed)	0.652	0.417	0.087	0.058	0.103	0.928	0.528	0.928	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

Table E-23: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station F1 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m^2)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.244	-0.180	0.111	0.135	-0.022	-0.225	0.644*	0.094	0.094
	Significance (2-tailed)	.	0.325	0.472	0.655	0.590	0.929	0.369	0.009	0.714	0.714
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.244	1.000	0.539*	-0.378	0.629*	0.378	0.539*	-0.022	0.519*	0.519*
	Significance (2-tailed)	0.325	.	0.031	0.128	0.012	0.128	0.031	0.929	0.044	0.044
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	-0.180	0.539*	1.000	-0.539*	0.705*	0.539*	0.523*	-0.360	0.405	0.405
	Significance (2-tailed)	0.472	0.031	.	0.031	0.005	0.031	0.038	0.151	0.118	0.118
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	0.111	-0.378	-0.539*	1.000	-0.584*	-0.822*	-0.270	0.289	-0.471*	-0.471*
	Significance (2-tailed)	0.655	0.128	0.031	.	0.020	0.001	0.281	0.245	0.067	0.067
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.135	0.629*	0.705*	-0.584*	1.000	0.674*	0.295	-0.045	0.548*	0.548*
	Significance (2-tailed)	0.590	0.012	0.005	0.020	.	0.007	0.241	0.857	0.035	0.035
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	-0.022	0.378	0.539*	-0.822*	0.674*	1.000	0.090	-0.200	0.660*	0.660*
	Significance (2-tailed)	0.929	0.128	0.031	0.001	0.007	.	0.719	0.421	0.010	0.010
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	-0.225	0.539*	0.523*	-0.270	0.295	0.090	1.000	-0.449*	0.072	0.072
	Significance (2-tailed)	0.369	0.031	0.038	0.281	0.241	0.719	.	0.072	0.783	0.783
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m^2)[b]	Correlation Coefficient	0.644*	-0.022	-0.360	0.289	-0.045	-0.200	-0.449*	1.000	0.047	0.047
	Significance (2-tailed)	0.009	0.929	0.151	0.245	0.857	0.421	0.072	.	0.855	0.855
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.094	0.519*	0.405	-0.471*	0.548*	0.660*	0.072	0.047	1.000	1.000
	Significance (2-tailed)	0.714	0.044	0.118	0.067	0.035	0.010	0.783	0.855	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.094	0.519*	0.405	-0.471*	0.548*	0.660*	0.072	0.047	1.000	1.000
	Significance (2-tailed)	0.714	0.044	0.118	0.067	0.035	0.010	0.783	0.855	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

Table E-24: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station B3 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m²)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	-0.244	-0.333	-0.511*	-0.333	0.494*	0.024	0.022	0.172	0.172
	Significance (2-tailed)	.	0.325	0.180	0.040	0.180	0.048	0.927	0.929	0.515	0.515
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	-0.244	1.000	0.733*	0.200	0.467*	-0.270	0.310	-0.422*	0.123	0.123
	Significance (2-tailed)	0.325	.	0.003	0.421	0.060	0.281	0.231	0.089	0.642	0.642
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	-0.333	0.733*	1.000	0.200	0.733*	-0.180	0.072	-0.511*	0.319	0.319
	Significance (2-tailed)	0.180	0.003	.	0.421	0.003	0.472	0.782	0.040	0.227	0.227
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	-0.511*	0.200	0.200	1.000	0.022	-0.539*	0.119	-0.156	-0.319	-0.319
	Significance (2-tailed)	0.040	0.421	0.421	.	0.929	0.031	0.645	0.531	0.227	0.227
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	-0.333	0.467*	0.733*	0.022	1.000	0.090	-0.119	-0.422*	0.564*	0.564*
	Significance (2-tailed)	0.180	0.060	0.003	0.929	.	0.719	0.645	0.089	0.032	0.032
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	0.494*	-0.270	-0.180	-0.539*	0.090	1.000	-0.435*	0.225	0.595*	0.595*
	Significance (2-tailed)	0.048	0.281	0.472	0.031	0.719	.	0.096	0.369	0.025	0.025
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	0.024	0.310	0.072	0.119	-0.119	-0.435*	1.000	-0.024	-0.237	-0.237
	Significance (2-tailed)	0.927	0.231	0.782	0.645	0.645	0.096	.	0.927	0.390	0.390
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m²)[b]	Correlation Coefficient	0.022	-0.422*	-0.511*	-0.156	-0.422*	0.225	-0.024	1.000	-0.025	-0.025
	Significance (2-tailed)	0.929	0.089	0.040	0.531	0.089	0.369	0.927	.	0.926	0.926
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.172	0.123	0.319	-0.319	0.564*	0.595*	-0.237	-0.025	1.000	1.000
	Significance (2-tailed)	0.515	0.642	0.227	0.227	0.032	0.025	0.390	0.926	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.172	0.123	0.319	-0.319	0.564*	0.595*	-0.237	-0.025	1.000	1.000
	Significance (2-tailed)	0.515	0.642	0.227	0.227	0.032	0.025	0.390	0.926	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

Table E-25: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station 4 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m^2)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.494*	0.378	-0.244	0.405	0.111	0.828*	0.378	0.135	0.135
	Significance (2-tailed)	.	0.048	0.128	0.325	0.106	0.655	0.001	0.128	0.590	0.590
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.494*	1.000	0.494*	-0.539*	0.795*	0.315	0.349	0.090	0.523*	0.523*
	Significance (2-tailed)	0.048	.	0.048	0.031	0.002	0.209	0.172	0.719	0.038	0.038
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	0.378	0.494*	1.000	-0.511*	0.360	0.111	0.230	0.200	0.494*	0.494*
	Significance (2-tailed)	0.128	0.048	.	0.040	0.151	0.655	0.364	0.421	0.048	0.048
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	-0.244	-0.539*	-0.511*	1.000	-0.405	-0.600*	-0.092	-0.156	-0.809*	-0.809*
	Significance (2-tailed)	0.325	0.031	0.040	.	0.106	0.016	0.717	0.531	0.001	0.001
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.405	0.795*	0.360	-0.405	1.000	0.225	0.233	0.045	0.386	0.386
	Significance (2-tailed)	0.106	0.002	0.151	0.106	.	0.369	0.362	0.857	0.125	0.125
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	0.111	0.315	0.111	-0.600*	0.225	1.000	0.046	0.022	0.494*	0.494*
	Significance (2-tailed)	0.655	0.209	0.655	0.016	0.369	.	0.856	0.929	0.048	0.048
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	0.828*	0.349	0.230	-0.092	0.233	0.046	1.000	0.276	0.000	0.000
	Significance (2-tailed)	0.001	0.172	0.364	0.717	0.362	0.856	.	0.276	1.000	1.000
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m^2)[b]	Correlation Coefficient	0.378	0.090	0.200	-0.156	0.045	0.022	0.276	1.000	-0.045	-0.045
	Significance (2-tailed)	0.128	0.719	0.421	0.531	0.857	0.929	0.276	.	0.857	0.857
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.135	0.523*	0.494*	-0.809*	0.386	0.494*	0.000	-0.045	1.000	1.000
	Significance (2-tailed)	0.590	0.038	0.048	0.001	0.125	0.048	1.000	0.857	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.135	0.523*	0.494*	-0.809*	0.386	0.494*	0.000	-0.045	1.000	1.000
	Significance (2-tailed)	0.590	0.038	0.048	0.001	0.125	0.048	1.000	0.857	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

Table E-26: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station F3 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m^2)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.289	0.600*	-0.111	0.422*	0.067	0.045	0.333	0.051	0.051
	Significance (2-tailed)	.	0.245	0.016	0.655	0.089	0.788	0.857	0.180	0.847	0.847
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.289	1.000	0.422*	-0.644*	0.778*	0.511*	-0.405	0.067	0.562*	0.562*
	Significance (2-tailed)	0.245	.	0.089	0.009	0.002	0.040	0.106	0.788	0.034	0.034
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	0.600*	0.422*	1.000	-0.156	0.467*	0.111	-0.045	0.111	0.102	0.102
	Significance (2-tailed)	0.016	0.089	.	0.531	0.060	0.655	0.857	0.655	0.699	0.699
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	-0.111	-0.644*	-0.156	1.000	-0.600*	-0.778*	0.584*	0.111	-0.869*	-0.869*
	Significance (2-tailed)	0.655	0.009	0.531	.	0.016	0.002	0.020	0.655	0.001	0.001
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.422*	0.778*	0.467*	-0.600*	1.000	0.467*	-0.449*	0.111	0.562*	0.562*
	Significance (2-tailed)	0.089	0.002	0.060	0.016	.	0.060	0.072	0.655	0.034	0.034
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	0.067	0.511*	0.111	-0.778*	0.467*	1.000	-0.360	0.022	0.869*	0.869*
	Significance (2-tailed)	0.788	0.040	0.655	0.002	0.060	.	0.151	0.929	0.001	0.001
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	0.045	-0.405	-0.045	0.584*	-0.449*	-0.360	1.000	0.360	-0.698*	-0.698*
	Significance (2-tailed)	0.857	0.106	0.857	0.020	0.072	0.151	.	0.151	0.009	0.009
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m^2)[b]	Correlation Coefficient	0.333	0.067	0.111	0.111	0.111	0.022	0.360	1.000	-0.153	-0.153
	Significance (2-tailed)	0.180	0.788	0.655	0.655	0.655	0.929	0.151	.	0.562	0.562
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.051	0.562*	0.102	-0.869*	0.562*	0.869*	-0.698*	-0.153	1.000	1.000
	Significance (2-tailed)	0.847	0.034	0.699	0.001	0.034	0.001	0.009	0.562	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.051	0.562*	0.102	-0.869*	0.562*	0.869*	-0.698*	-0.153	1.000	1.000
	Significance (2-tailed)	0.847	0.034	0.699	0.001	0.034	0.001	0.009	0.562	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

Table E-27: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station F4 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m^2)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.333	0.200	-0.225	0.614*	0.250	-0.068	0.244	0.484*	0.484*
	Significance (2-tailed)	.	0.180	0.421	0.369	0.015	0.321	0.787	0.325	0.064	0.064
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.333	1.000	0.778*	0.315	0.659*	-0.250	0.523*	0.289	0.145	0.145
	Significance (2-tailed)	0.180	.	0.002	0.209	0.009	0.321	0.038	0.245	0.579	0.579
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	0.200	0.778*	1.000	0.360	0.614*	-0.386	0.477*	0.156	0.000	0.000
	Significance (2-tailed)	0.421	0.002	.	0.151	0.015	0.125	0.058	0.531	1.000	1.000
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	-0.225	0.315	0.360	1.000	-0.046	-0.782*	0.460*	0.270	-0.611*	-0.611*
	Significance (2-tailed)	0.369	0.209	0.151	.	0.856	0.002	0.070	0.281	0.020	0.020
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.614*	0.659*	0.614*	-0.046	1.000	0.023	0.163	0.341	0.421	0.421
	Significance (2-tailed)	0.015	0.009	0.015	0.856	.	0.928	0.525	0.176	0.113	0.113
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	0.250	-0.250	-0.386	-0.782*	0.023	1.000	-0.581*	-0.023	0.643*	0.643*
	Significance (2-tailed)	0.321	0.321	0.125	0.002	0.928	.	0.023	0.928	0.015	0.015
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	-0.068	0.523*	0.477*	0.460*	0.163	-0.581*	1.000	0.114	-0.371	-0.371
	Significance (2-tailed)	0.787	0.038	0.058	0.070	0.525	0.023	.	0.652	0.162	0.162
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m^2)[b]	Correlation Coefficient	0.244	0.289	0.156	0.270	0.341	-0.023	0.114	1.000	-0.145	-0.145
	Significance (2-tailed)	0.325	0.245	0.531	0.281	0.176	0.928	0.652	.	0.579	0.579
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.484*	0.145	0.000	-0.611*	0.421	0.643*	-0.371	-0.145	1.000	1.000
	Significance (2-tailed)	0.064	0.579	1.000	0.020	0.113	0.015	0.162	0.579	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.484*	0.145	0.000	-0.611*	0.421	0.643*	-0.371	-0.145	1.000	1.000
	Significance (2-tailed)	0.064	0.579	1.000	0.020	0.113	0.015	0.162	0.579	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

Table E-28: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station B5 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m^2)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.405	0.067	-0.111	0.023	-0.022	-0.180	0.378	0.141	0.141
	Significance (2-tailed)	.	0.106	0.788	0.655	0.928	0.929	0.472	0.128	0.583	0.583
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.405	1.000	0.584*	-0.405	0.552*	0.225	-0.159	0.270	0.501*	0.501*
	Significance (2-tailed)	0.106	.	0.020	0.106	0.030	0.369	0.528	0.281	0.054	0.054
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	0.067	0.584*	1.000	-0.333	0.614*	0.289	-0.225	0.156	0.519*	0.519*
	Significance (2-tailed)	0.788	0.020	.	0.180	0.015	0.245	0.369	0.531	0.044	0.044
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	-0.111	-0.405	-0.333	1.000	-0.568*	-0.689*	0.494*	-0.200	-0.801*	-0.801*
	Significance (2-tailed)	0.655	0.106	0.180	.	0.024	0.006	0.048	0.421	0.002	0.002
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.023	0.552*	0.614*	-0.568*	1.000	0.523*	-0.414	0.341	0.699*	0.699*
	Significance (2-tailed)	0.928	0.030	0.015	0.024	.	0.038	0.103	0.176	0.007	0.007
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	-0.022	0.225	0.289	-0.689*	0.523*	1.000	-0.674*	0.422*	0.754*	0.754*
	Significance (2-tailed)	0.929	0.369	0.245	0.006	0.038	.	0.007	0.089	0.003	0.003
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	-0.180	-0.159	-0.225	0.494*	-0.414	-0.674*	1.000	-0.539*	-0.667*	-0.667*
	Significance (2-tailed)	0.472	0.528	0.369	0.048	0.103	0.007	.	0.031	0.010	0.010
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m^2)[b]	Correlation Coefficient	0.378	0.270	0.156	-0.200	0.341	0.422*	-0.539*	1.000	0.330	0.330
	Significance (2-tailed)	0.128	0.281	0.531	0.421	0.176	0.089	0.031	.	0.200	0.200
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.141	0.501*	0.519*	-0.801*	0.699*	0.754*	-0.667*	0.330	1.000	1.000
	Significance (2-tailed)	0.583	0.054	0.044	0.002	0.007	0.003	0.010	0.200	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.141	0.501*	0.519*	-0.801*	0.699*	0.754*	-0.667*	0.330	1.000	1.000
	Significance (2-tailed)	0.583	0.054	0.044	0.002	0.007	0.003	0.010	0.200	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

Table E-29: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station B7 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m²)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.460*	0.244	-0.600*	0.449*	0.315	-0.068	-0.111	0.424*	0.424*
	Significance (2-tailed)	.	0.070	0.325	0.016	0.072	0.209	0.787	0.655	0.099	0.099
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.460*	1.000	0.736*	-0.690*	0.744*	0.768*	0.447*	-0.184	0.854*	0.854*
	Significance (2-tailed)	0.070	.	0.004	0.007	0.004	0.003	0.083	0.469	0.001	0.001
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	0.244	0.736*	1.000	-0.467*	0.629*	0.854*	0.614*	-0.244	0.660*	0.660*
	Significance (2-tailed)	0.325	0.004	.	0.060	0.012	0.001	0.015	0.325	0.010	0.010
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	-0.600*	-0.690*	-0.467*	1.000	-0.494*	-0.494*	-0.114	0.067	-0.707*	-0.707*
	Significance (2-tailed)	0.016	0.007	0.060	.	0.048	0.048	0.652	0.788	0.006	0.006
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.449*	0.744*	0.629*	-0.494*	1.000	0.705*	0.230	0.045	0.644*	0.644*
	Significance (2-tailed)	0.072	0.004	0.012	0.048	.	0.005	0.365	0.857	0.013	0.013
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	0.315	0.768*	0.854*	-0.494*	0.705*	1.000	0.460*	-0.180	0.787*	0.787*
	Significance (2-tailed)	0.209	0.003	0.001	0.048	0.005	.	0.070	0.472	0.002	0.002
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	-0.068	0.447*	0.614*	-0.114	0.230	0.460*	1.000	-0.659*	0.289	0.289
	Significance (2-tailed)	0.787	0.083	0.015	0.652	0.365	0.070	.	0.009	0.268	0.268
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m²)[b]	Correlation Coefficient	-0.111	-0.184	-0.244	0.067	0.045	-0.180	-0.659*	1.000	-0.047	-0.047
	Significance (2-tailed)	0.655	0.469	0.325	0.788	0.857	0.472	0.009	.	0.855	0.855
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.424*	0.854*	0.660*	-0.707*	0.644*	0.787*	0.289	-0.047	1.000	1.000
	Significance (2-tailed)	0.099	0.001	0.010	0.006	0.013	0.002	0.268	0.855	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.424*	0.854*	0.660*	-0.707*	0.644*	0.787*	0.289	-0.047	1.000	1.000
	Significance (2-tailed)	0.099	0.001	0.010	0.006	0.013	0.002	0.268	0.855	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

Table E-30: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station B8 from 2011 to 2020.

		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m^2)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.360	0.244	-0.467*	0.523*	0.296	-0.386	0.111	0.705*	0.705*
	Significance (2-tailed)	.	0.151	0.325	0.060	0.038	0.241	0.125	0.655	0.005	0.005
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.360	1.000	0.674*	-0.494*	0.506*	0.598*	-0.138	-0.270	0.598*	0.598*
	Significance (2-tailed)	0.151	.	0.007	0.048	0.046	0.019	0.587	0.281	0.019	0.019
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	0.244	0.674*	1.000	-0.511*	0.477*	0.568*	-0.159	-0.378	0.477*	0.477*
	Significance (2-tailed)	0.325	0.007	.	0.040	0.058	0.024	0.528	0.128	0.058	0.058
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	-0.467*	-0.494*	-0.511*	1.000	-0.432*	-0.750*	-0.114	0.156	-0.523*	-0.523*
	Significance (2-tailed)	0.060	0.048	0.040	.	0.087	0.003	0.652	0.531	0.038	0.038
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.523*	0.506*	0.477*	-0.432*	1.000	0.488*	-0.465*	-0.250	0.837*	0.837*
	Significance (2-tailed)	0.038	0.046	0.058	0.087	.	0.056	0.069	0.321	0.001	0.001
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	0.296	0.598*	0.568*	-0.750*	0.488*	1.000	0.070	-0.432*	0.535*	0.535*
	Significance (2-tailed)	0.241	0.019	0.024	0.003	0.056	.	0.785	0.087	0.037	0.037
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	-0.386	-0.138	-0.159	-0.114	-0.465*	0.070	1.000	0.068	-0.349	-0.349
	Significance (2-tailed)	0.125	0.587	0.528	0.652	0.069	0.785	.	0.787	0.173	0.173
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m^2)[b]	Correlation Coefficient	0.111	-0.270	-0.378	0.156	-0.250	-0.432*	0.068	1.000	-0.159	-0.159
	Significance (2-tailed)	0.655	0.281	0.128	0.531	0.321	0.087	0.787	.	0.528	0.528
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.705*	0.598*	0.477*	-0.523*	0.837*	0.535*	-0.349	-0.159	1.000	1.000
	Significance (2-tailed)	0.005	0.019	0.058	0.038	0.001	0.037	0.173	0.528	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.705*	0.598*	0.477*	-0.523*	0.837*	0.535*	-0.349	-0.159	1.000	1.000
	Significance (2-tailed)	0.005	0.019	0.058	0.038	0.001	0.037	0.173	0.528	.	.
	N	10	10	10	10	10	10	10	10	10	10

*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

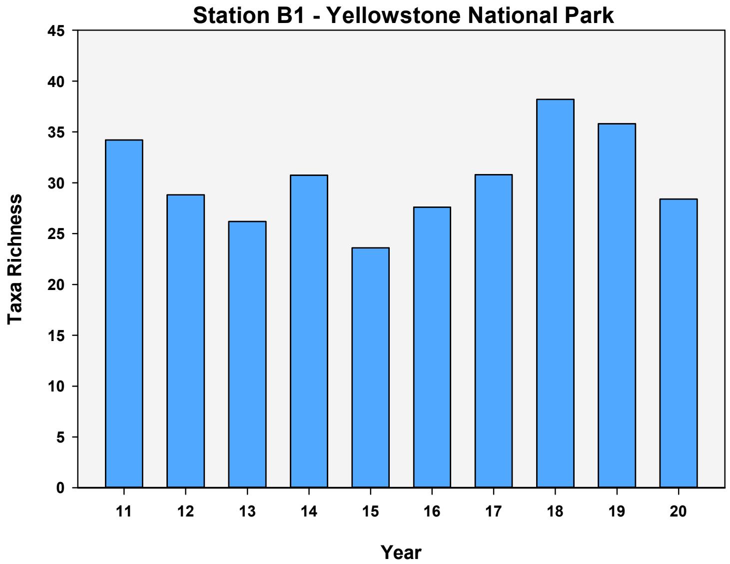
Table E-31: Kendall's tau correlation matrix of macroinvertebrate metrics collected at Station B10 from 2011 to 2020.

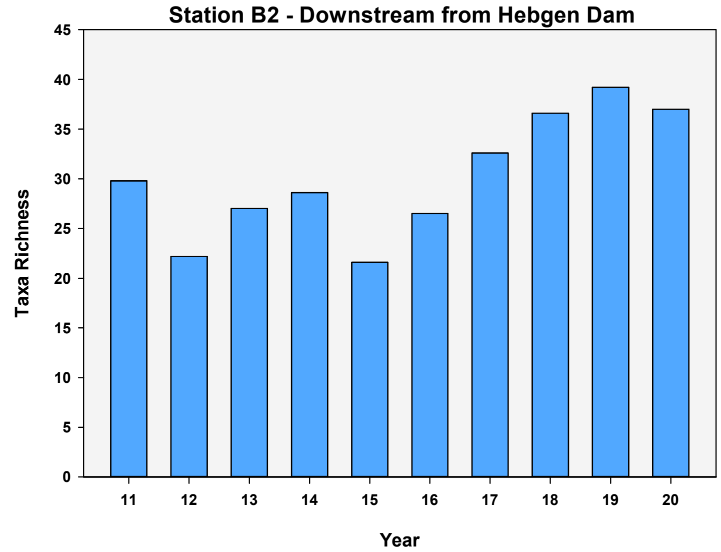
		Date	Taxa Richness[a]	Shannon Diversity[a]	Biotic Index[a]	EPT Richness[a]	Relative Abundance of EPT[a] (%)	Relative Abundance of Chironomidae (%)[a]	Community Density (0.25 m²)[b]	Multimetric Assessment (Total)[c]	Multimetric Assessment (% of Possible)[c]
Date	Correlation Coefficient	1.000	0.539*	0.422*	-0.111	0.494*	0.156	-0.315	0.600*	0.414	0.414
	Significance (2-tailed)	.	0.031	0.089	0.655	0.048	0.531	0.209	0.016	0.103	0.103
	N	10	10	10	10	10	10	10	10	10	10
Taxa Richness[a]	Correlation Coefficient	0.539*	1.000	0.584*	-0.135	0.750*	0.090	-0.159	0.629*	0.442*	0.442*
	Significance (2-tailed)	0.031	.	0.020	0.590	0.003	0.719	0.528	0.012	0.084	0.084
	N	10	10	10	10	10	10	10	10	10	10
Shannon Diversity[a]	Correlation Coefficient	0.422*	0.584*	1.000	0.111	0.449*	-0.067	-0.090	0.289	0.368	0.368
	Significance (2-tailed)	0.089	0.020	.	0.655	0.072	0.788	0.719	0.245	0.147	0.147
	N	10	10	10	10	10	10	10	10	10	10
Biotic Index[a]	Correlation Coefficient	-0.111	-0.135	0.111	1.000	-0.360	-0.956*	0.719*	-0.422*	-0.552*	-0.552*
	Significance (2-tailed)	0.655	0.590	0.655	.	0.151	0.000	0.004	0.089	0.030	0.030
	N	10	10	10	10	10	10	10	10	10	10
EPT Richness[a]	Correlation Coefficient	0.494*	0.750*	0.449*	-0.360	1.000	0.315	-0.386	0.494*	0.651*	0.651*
	Significance (2-tailed)	0.048	0.003	0.072	0.151	.	0.209	0.125	0.048	0.011	0.011
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of EPT (%)a	Correlation Coefficient	0.156	0.090	-0.067	-0.956*	0.315	1.000	-0.764*	0.378	0.552*	0.552*
	Significance (2-tailed)	0.531	0.719	0.788	0.000	0.209	.	0.002	0.128	0.030	0.030
	N	10	10	10	10	10	10	10	10	10	10
Relative Abundance of Chironomidae (%)[a]	Correlation Coefficient	-0.315	-0.159	-0.090	0.719*	-0.386	-0.764*	1.000	-0.449*	-0.628*	-0.628*
	Significance (2-tailed)	0.209	0.528	0.719	0.004	0.125	0.002	.	0.072	0.014	0.014
	N	10	10	10	10	10	10	10	10	10	10
Community Density (0.25 m²)[b]	Correlation Coefficient	0.600*	0.629*	0.289	-0.422*	0.494*	0.378	-0.449*	1.000	0.460*	0.460*
	Significance (2-tailed)	0.016	0.012	0.245	0.089	0.048	0.128	0.072	.	0.070	0.070
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (Total)[c]	Correlation Coefficient	0.414	0.442*	0.368	-0.552*	0.651*	0.552*	-0.628*	0.460*	1.000	1.000
	Significance (2-tailed)	0.103	0.084	0.147	0.030	0.011	0.030	0.014	0.070	.	.
	N	10	10	10	10	10	10	10	10	10	10
Multimetric Assessment, (% of Possible)[c]	Correlation Coefficient	0.414	0.442*	0.368	-0.552*	0.651*	0.552*	-0.628*	0.460*	1.000	1.000
	Significance (2-tailed)	0.103	0.084	0.147	0.030	0.011	0.030	0.014	0.070	.	.
	N	10	10	10	10	10	10	10	10	10	10

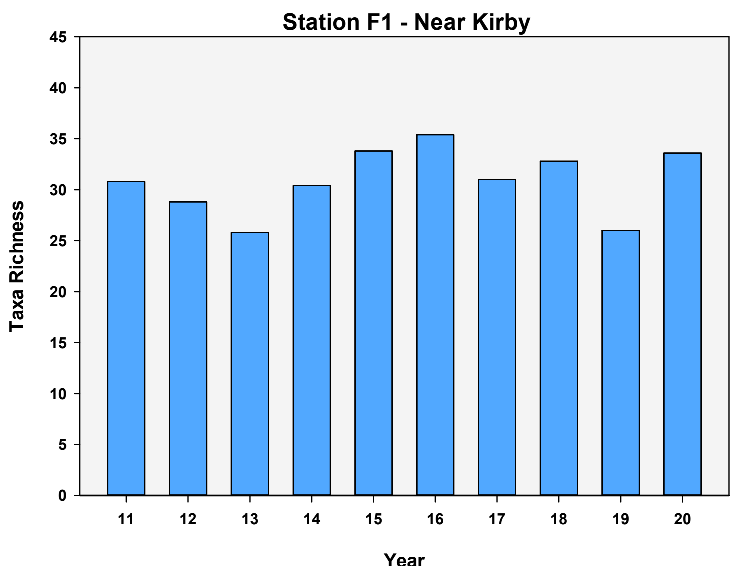
*Correlation is significant at the 0.10 level (2-tailed)
[a]Subsample of 300
[b]Pooled sample; n=0 for Ratio of Amphipoda to Isopoda at all sites
[c]Metric Score
Note: Ratio of amphipoda to isopoda was not included because N=0 in all years at all stations.

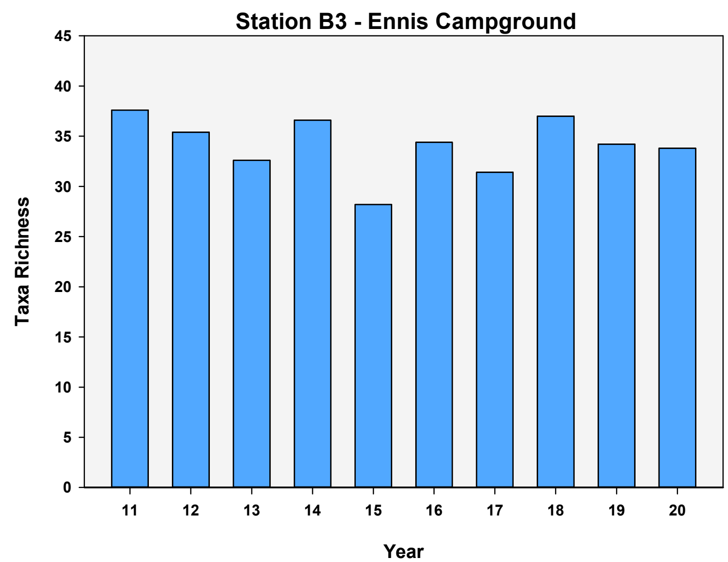
Appendix E.3 Temporal Graphs

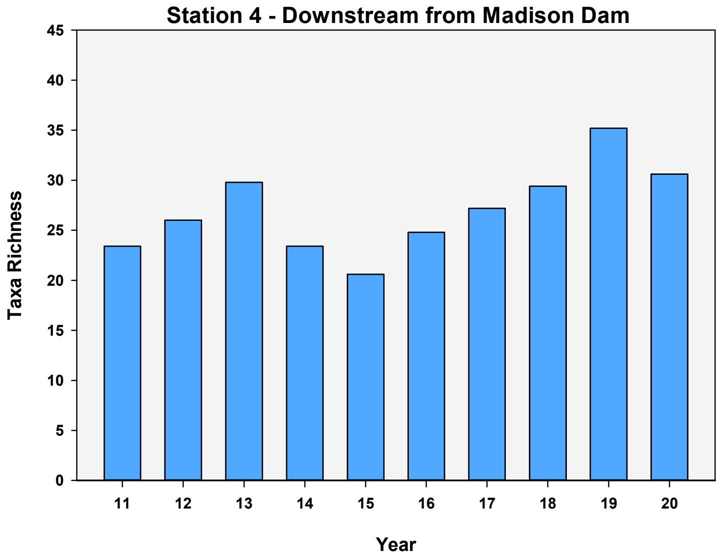
Figure E-1: Taxa Richness for Biological Stations B1 to B10.

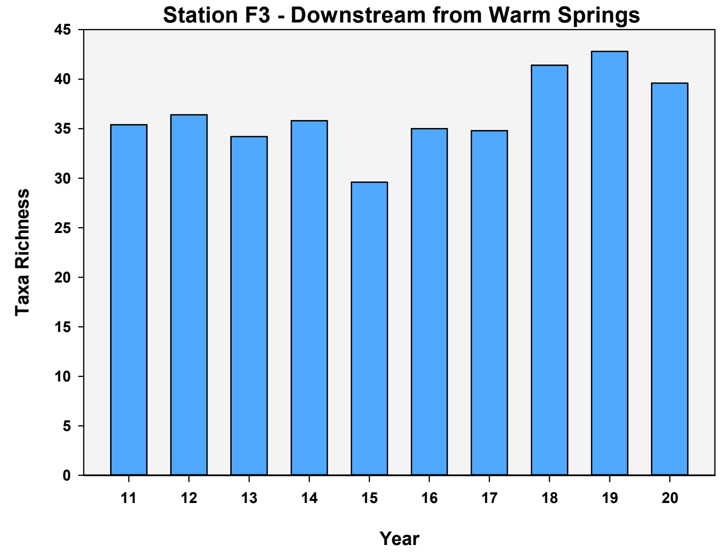


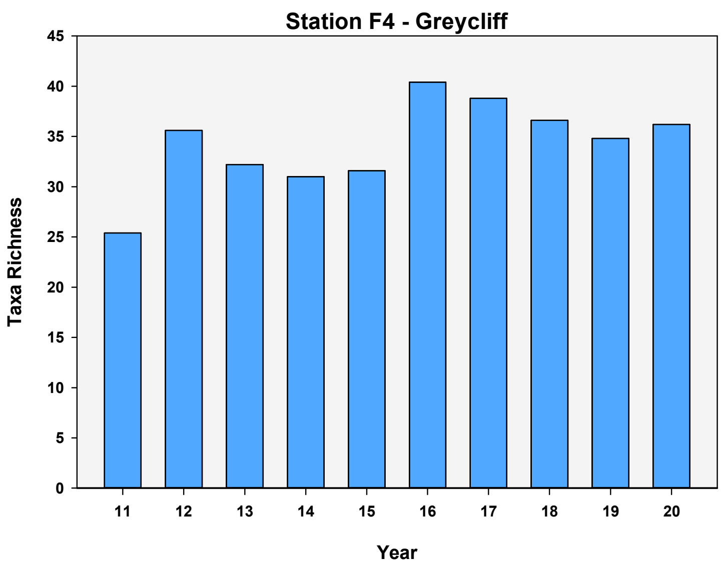


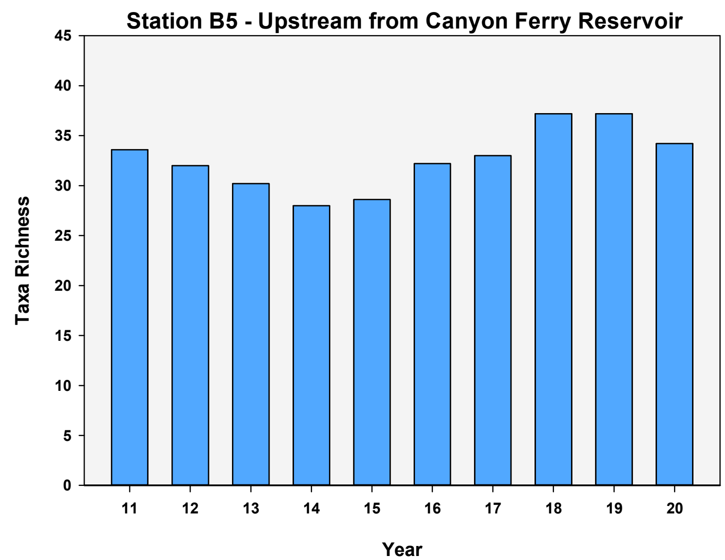


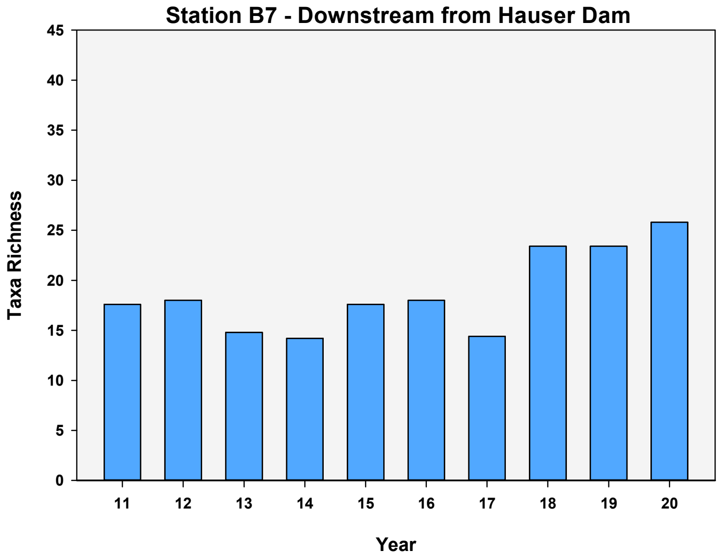



Station 4 - Downstream from Madison Dam
Taxa Richness
Year
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20

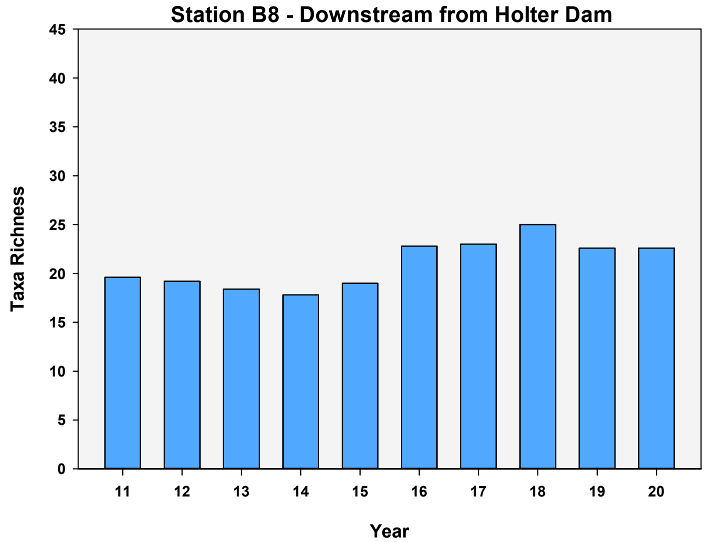

Station F3 - Downstream from Warm Springs
Taxa Richness
Year
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20


Station F4 - Greycliff
Taxa Richness
Year
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20

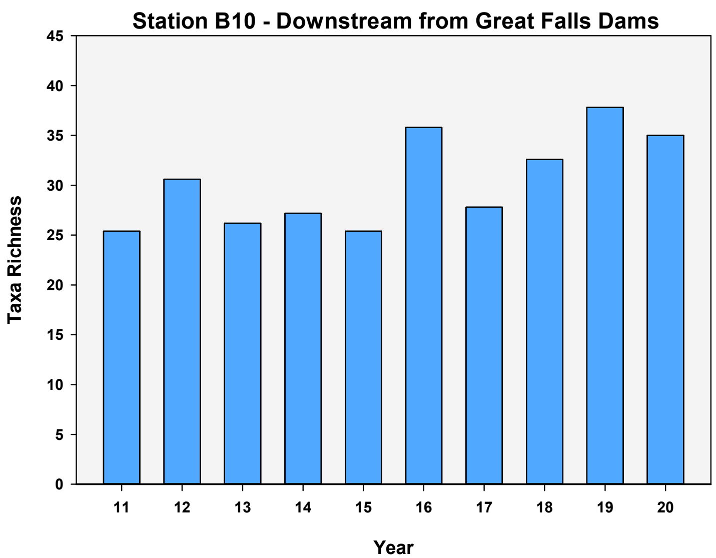

Station B5 - Upstream from Canyon Ferry Reservoir
Taxa Richness
Year
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20



Station B7 - Downstream from Hauser Dam
Taxa Richness
Year
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20

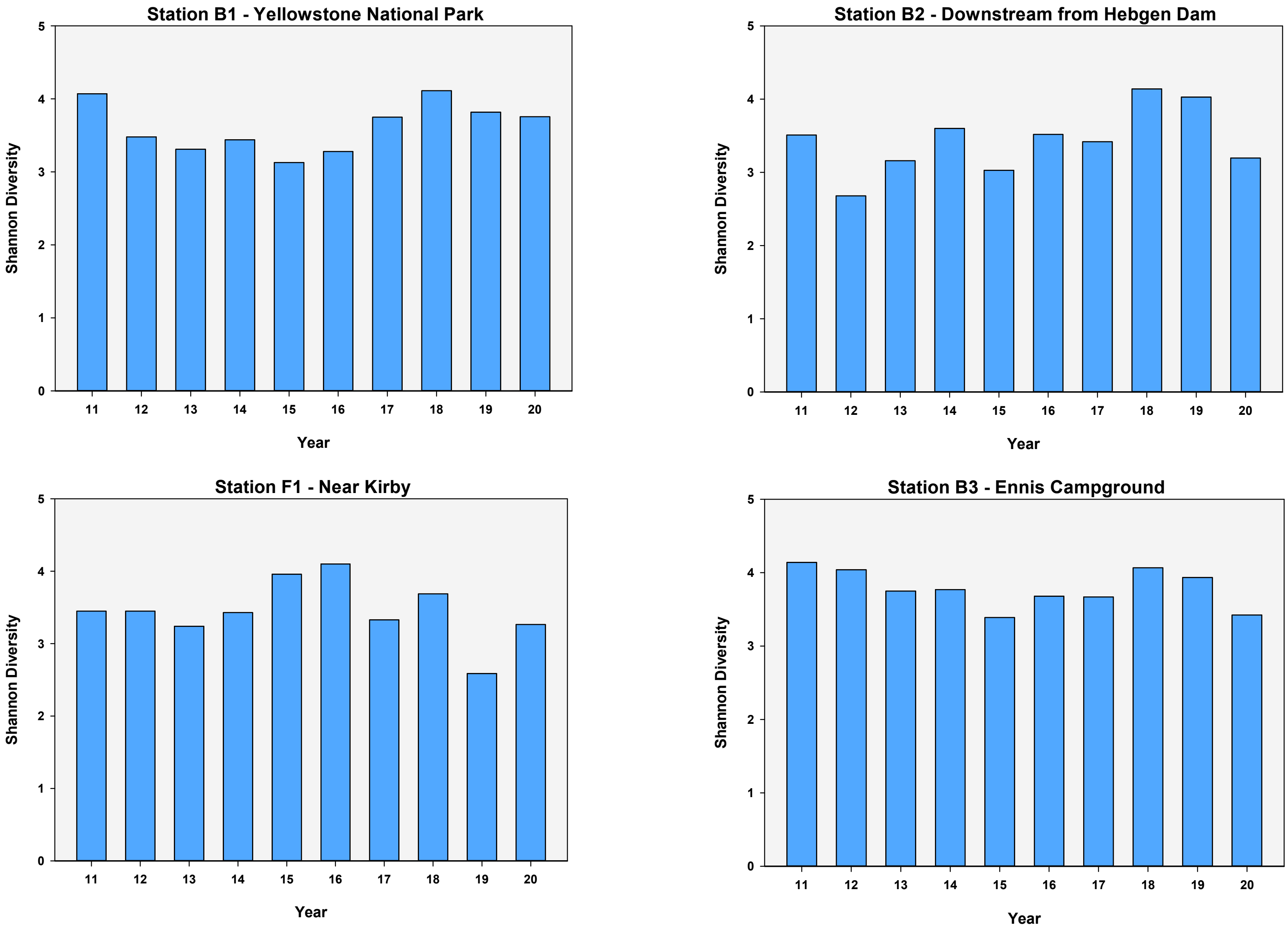


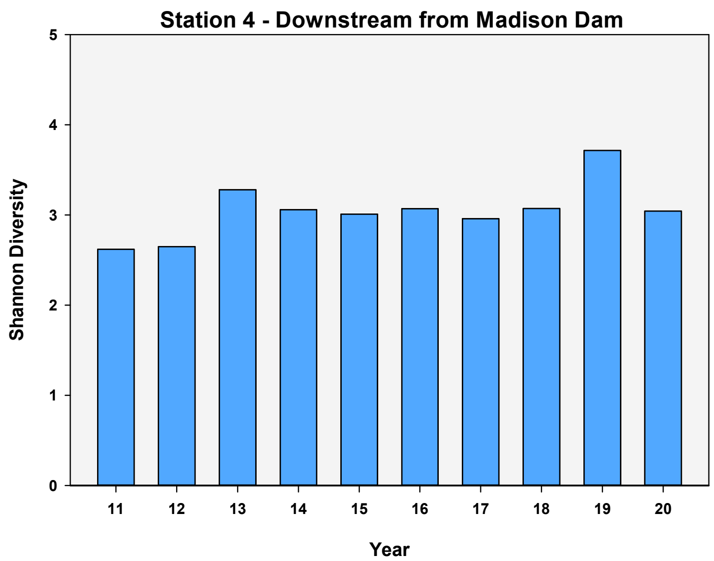
Station B8 - Downstream from Holter Dam
Taxa Richness
Year
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20

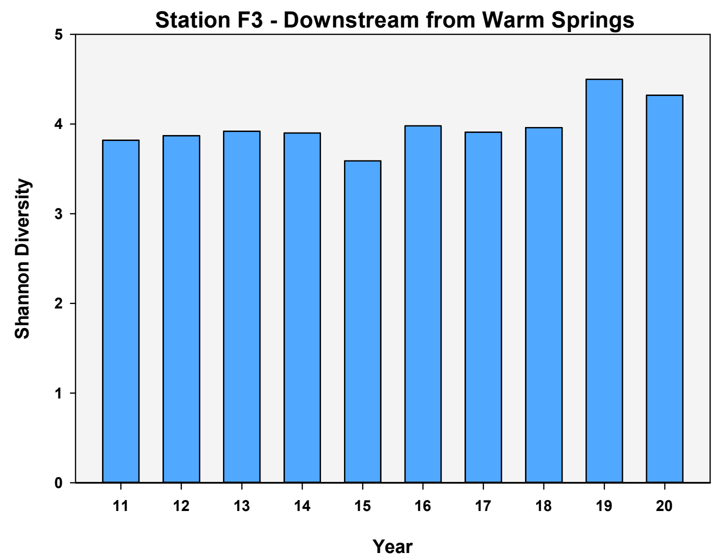


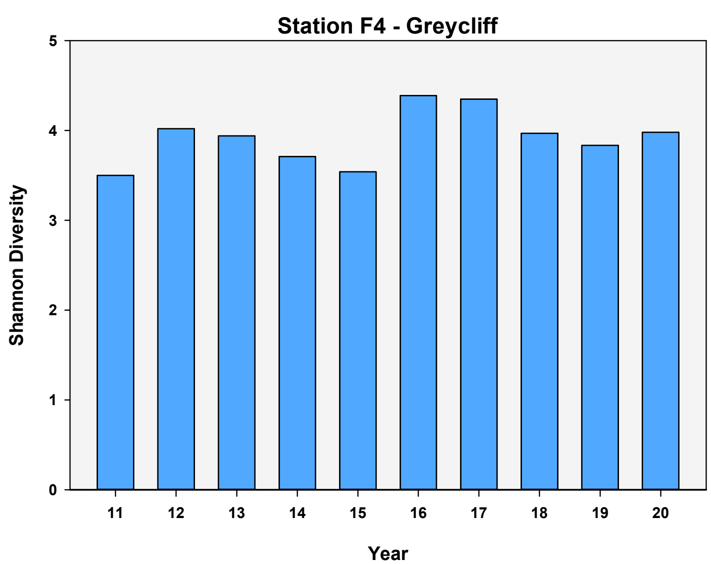
Station B10 - Downstream from Great Falls Dams
Taxa Richness
Year
0
5
10
15
20
25
30
35
40
45
11
12
13
14
15
16
17
18
19
20

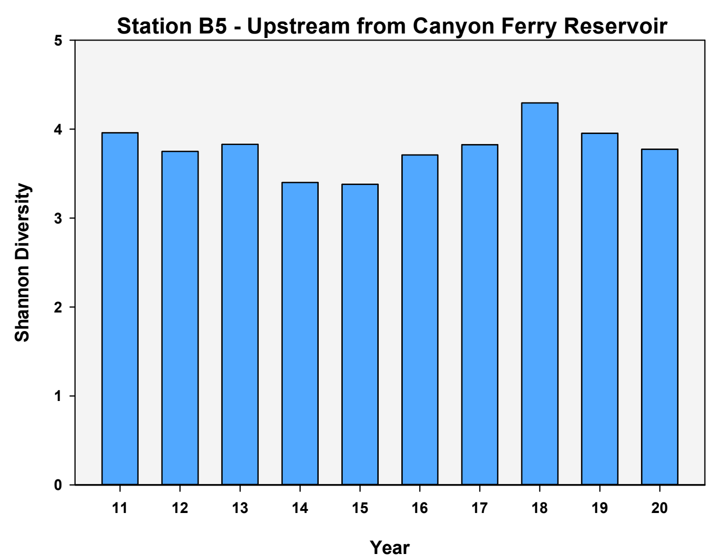
Figure E-2: Shannon Diversity for Biological Stations B1 to B10.

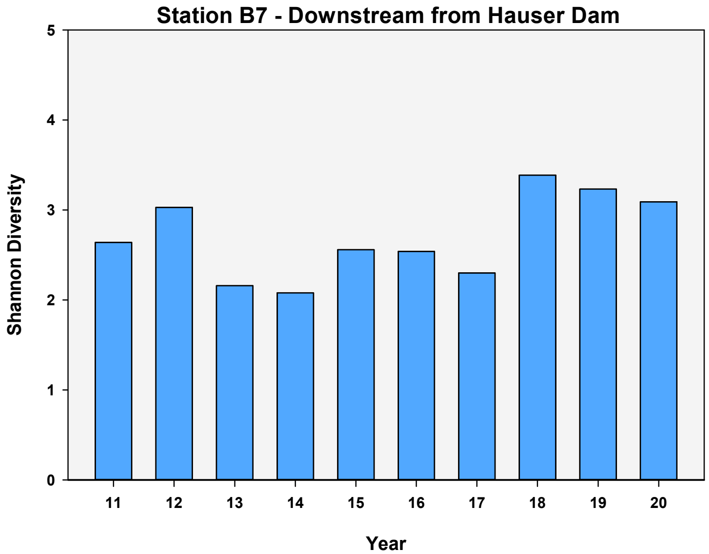


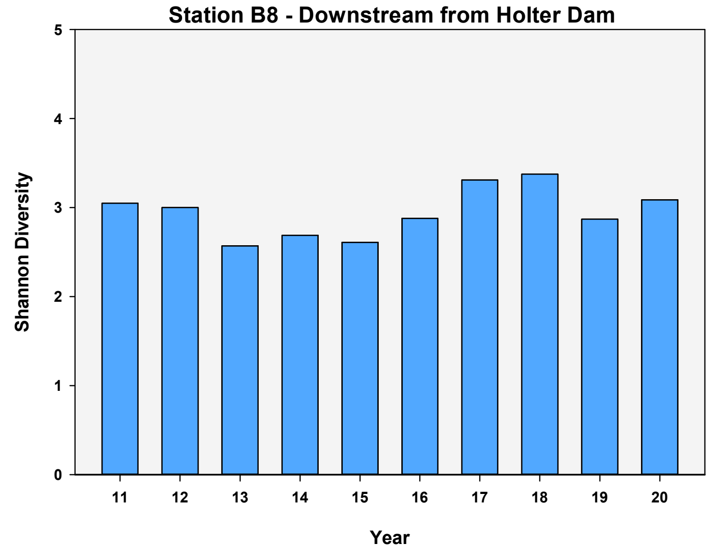

Station 4 - Downstream from Madison Dam
Shannon Diversity
Year
0
1
2
3
4
5
11
12
13
14
15
16
17
18
19
20


Station F3 - Downstream from Warm Springs
Shannon Diversity
Year
0
1
2
3
4
5
11
12
13
14
15
16
17
18
19
20


Station F4 - Greycliff
Shannon Diversity
Year
0
1
2
3
4
5
11
12
13
14
15
16
17
18
19
20


Station B5 - Upstream from Canyon Ferry Reservoir
Shannon Diversity
Year
0
1
2
3
4
5
11
12
13
14
15
16
17
18
19
20


Station B7 - Downstream from Hauser Dam
Shannon Diversity
0
1
2
3
4
5
11
12
13
14
15
16
17
18
19
20
Year


Station B8 - Downstream from Holter Dam
Shannon Diversity
0
1
2
3
4
5
11
12
13
14
15
16
17
18
19
20
Year

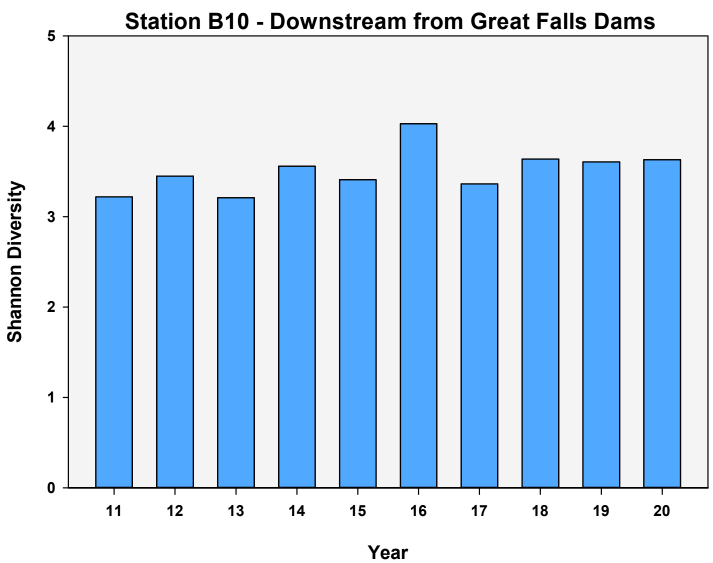
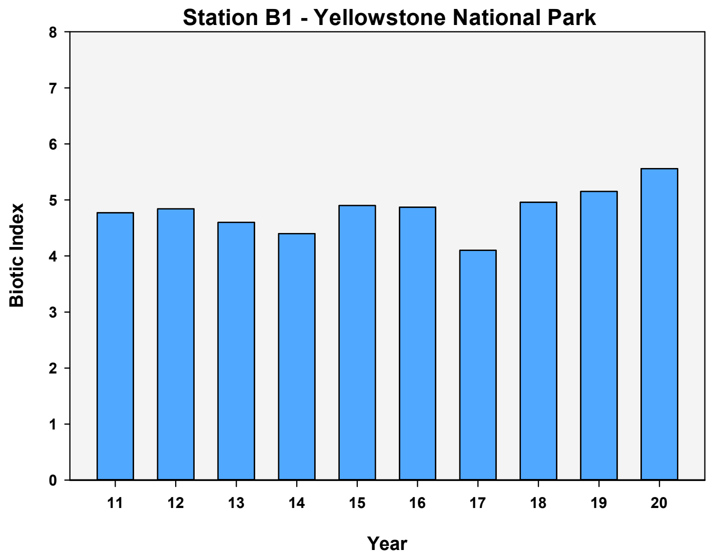
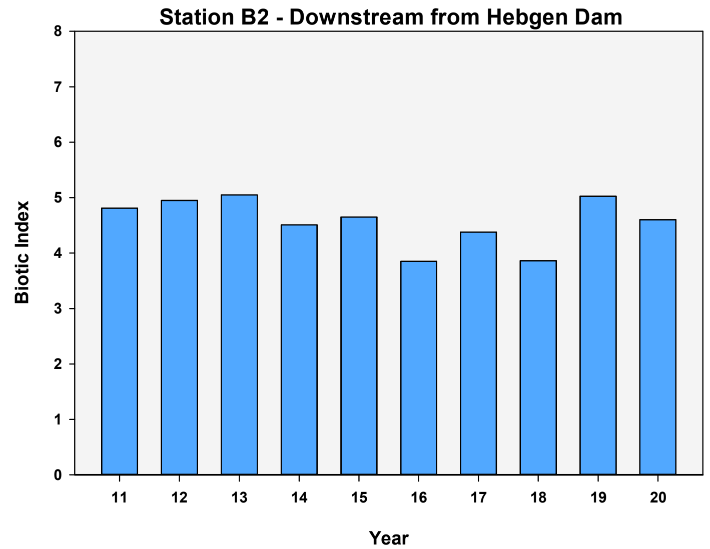
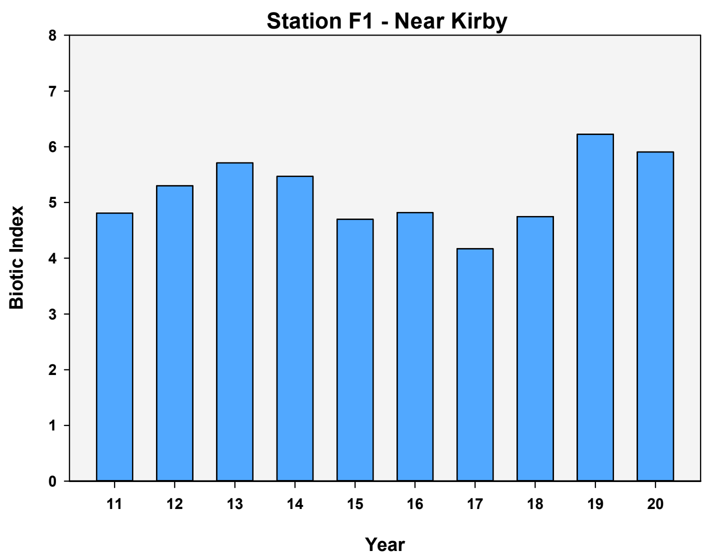
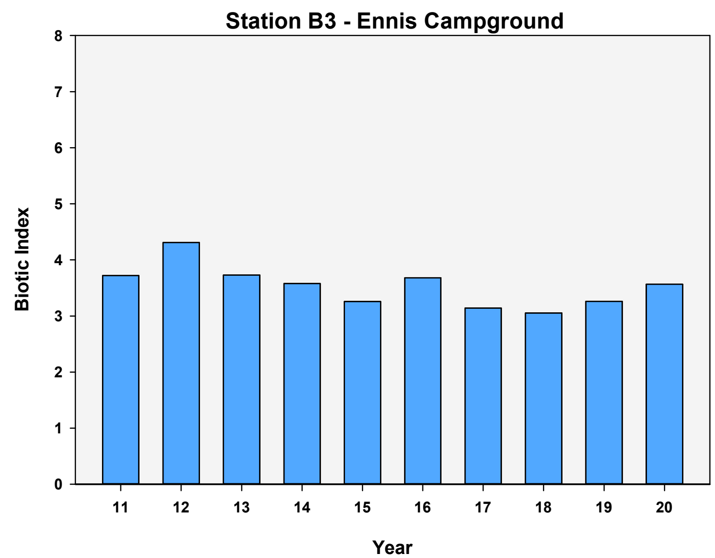

Station B10 - Downstream from Great Falls Dams
Shannon Diversity
0
1
2
3
4
5
11
12
13
14
15
16
17
18
19
20
Year

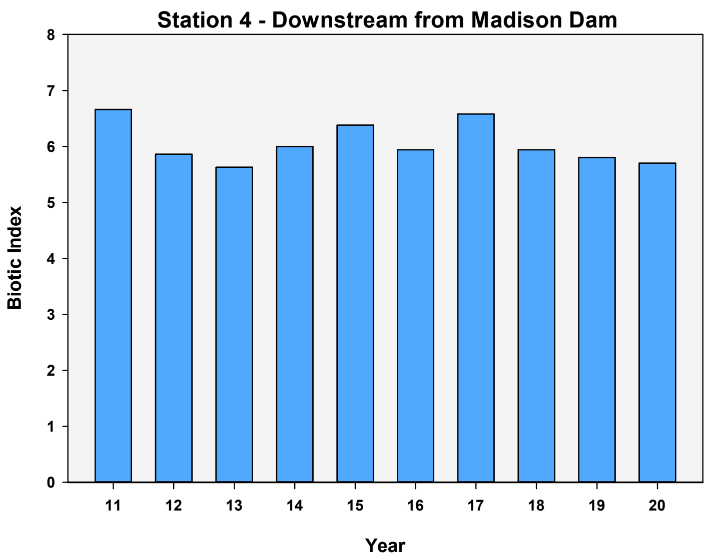
Figure E-3: Biotic Index for Biological Stations B1 to B10.

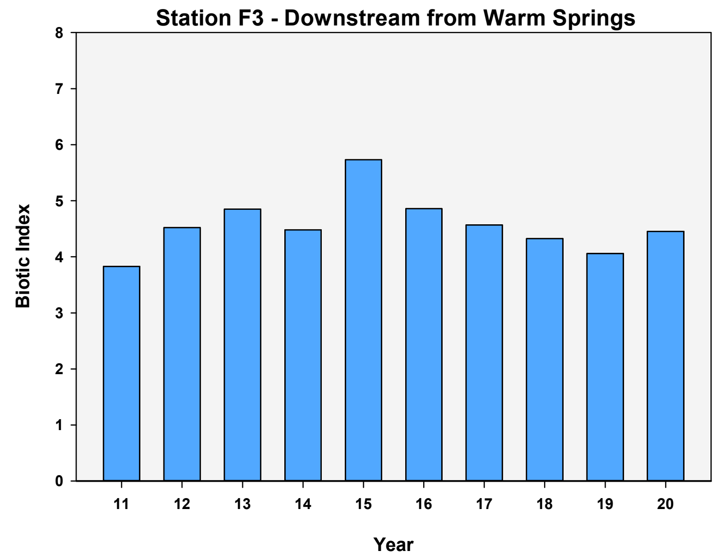


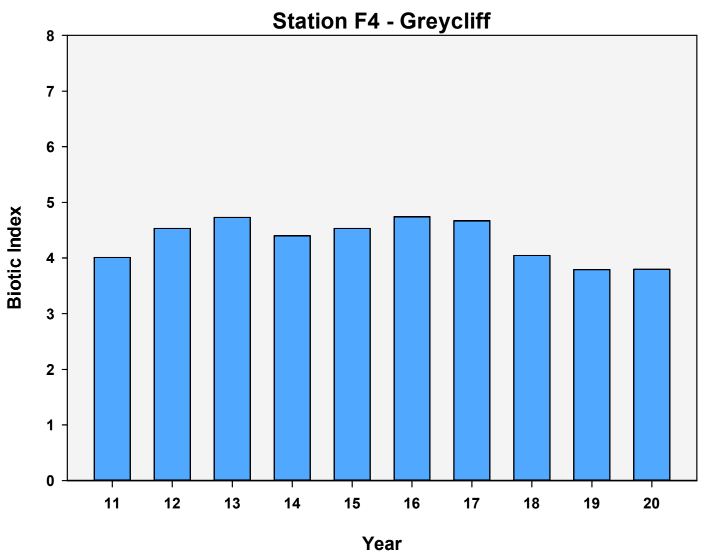


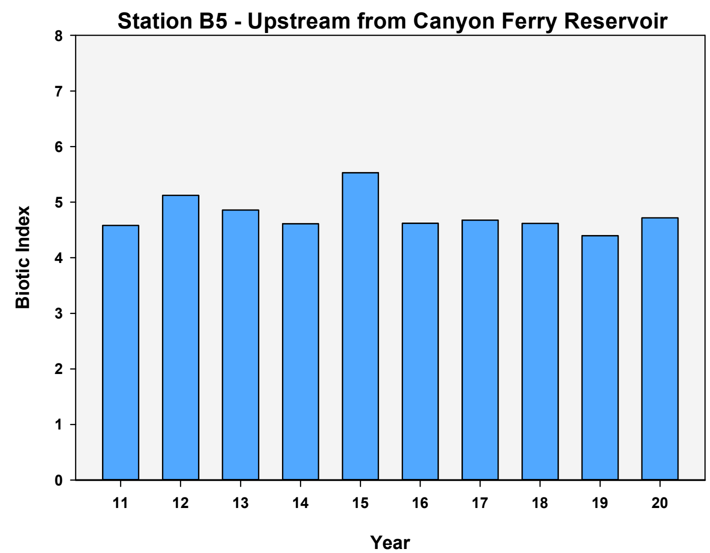


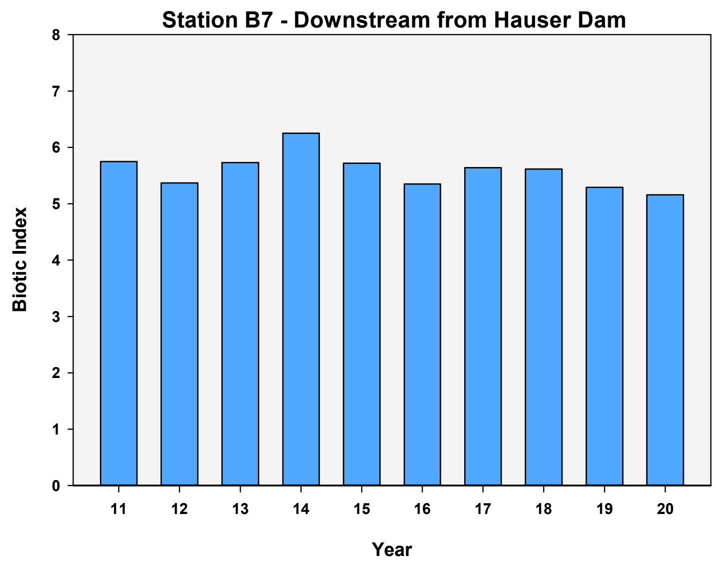


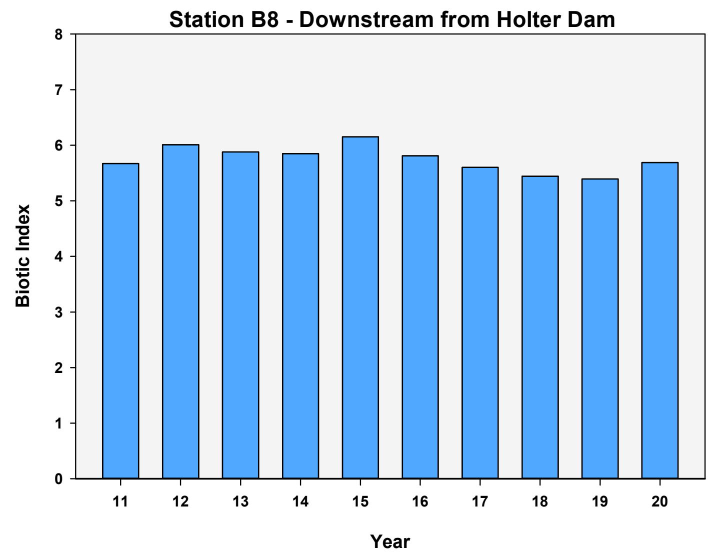

Station 4 - Downstream from Madison Dam
Biotic Index
Year
11
12
13
14
15
16
17
18
19
20


Station F3 - Downstream from Warm Springs
Biotic Index
Year
11
12
13
14
15
16
17
18
19
20


Station F4 - Greycliff
Biotic Index
Year
11
12
13
14
15
16
17
18
19
20


Station B5 - Upstream from Canyon Ferry Reservoir
Biotic Index
Year
11
12
13
14
15
16
17
18
19
20


Station B7 - Downstream from Hauser Dam
Biotic Index
0
1
2
3
4
5
6
7
8
11
12
13
14
15
16
17
18
19
20
Year


Station B8 - Downstream from Holter Dam
Biotic Index
0
1
2
3
4
5
6
7
8
11
12
13
14
15
16
17
18
19
20
Year

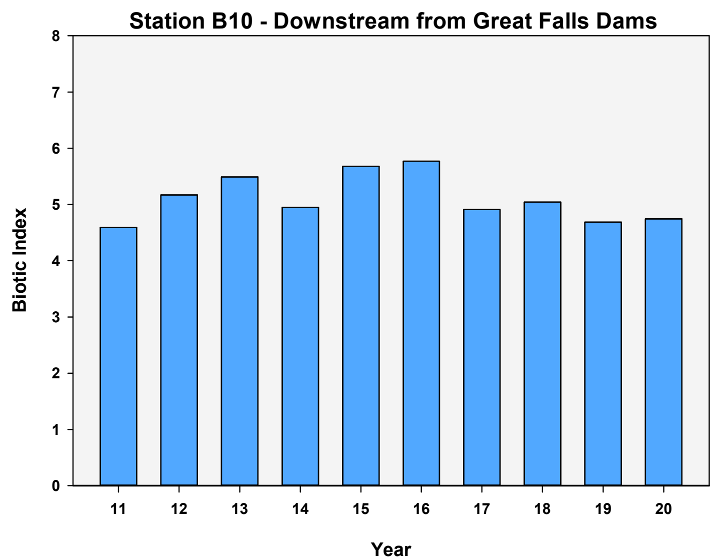
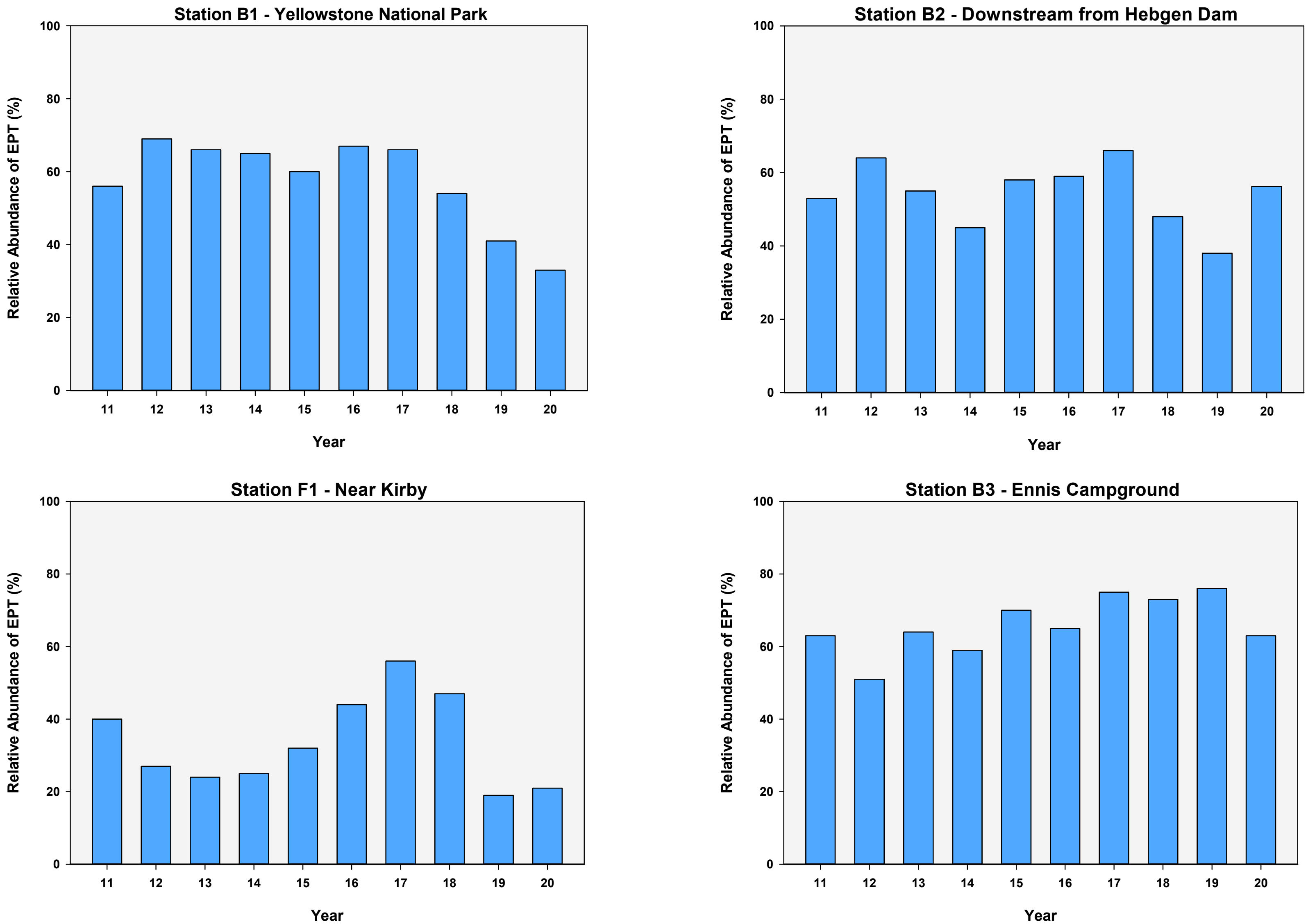
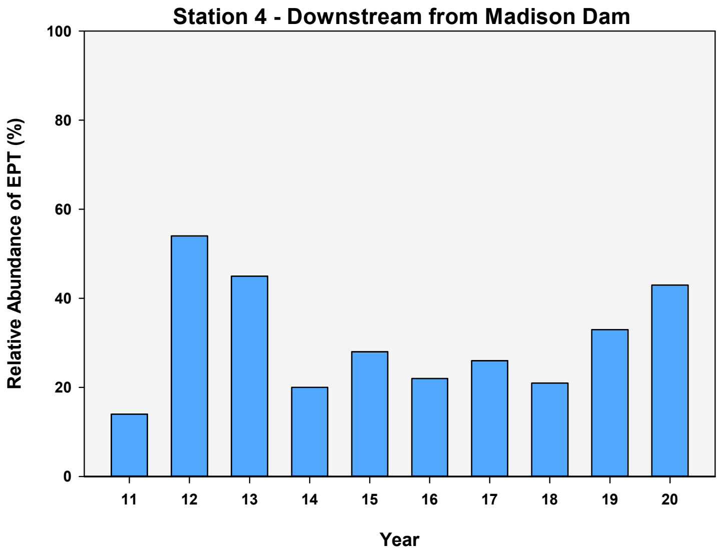
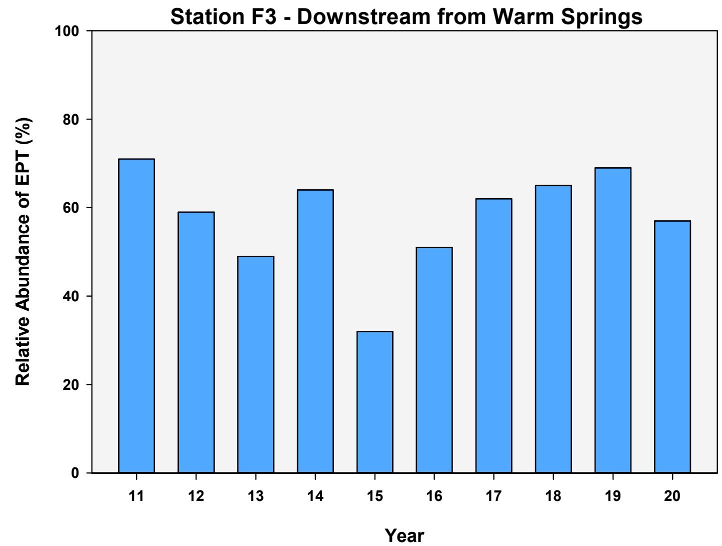
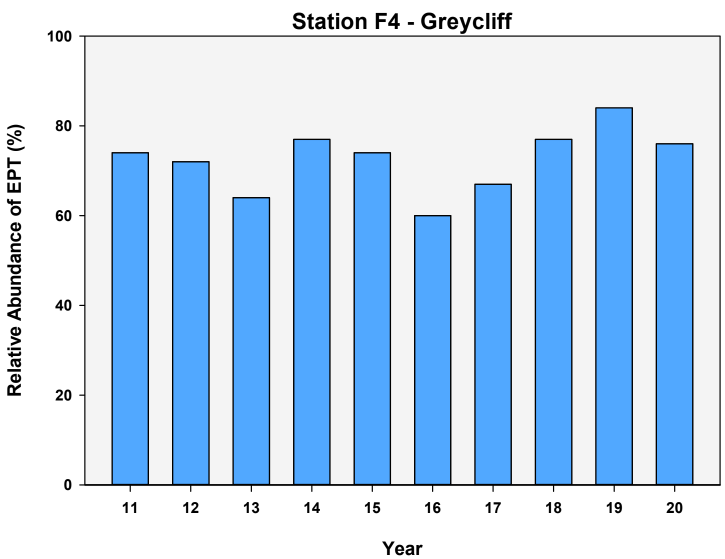

Station B10 - Downstream from Great Falls Dams
Biotic Index
0
1
2
3
4
5
6
7
8
11
12
13
14
15
16
17
18
19
20
Year

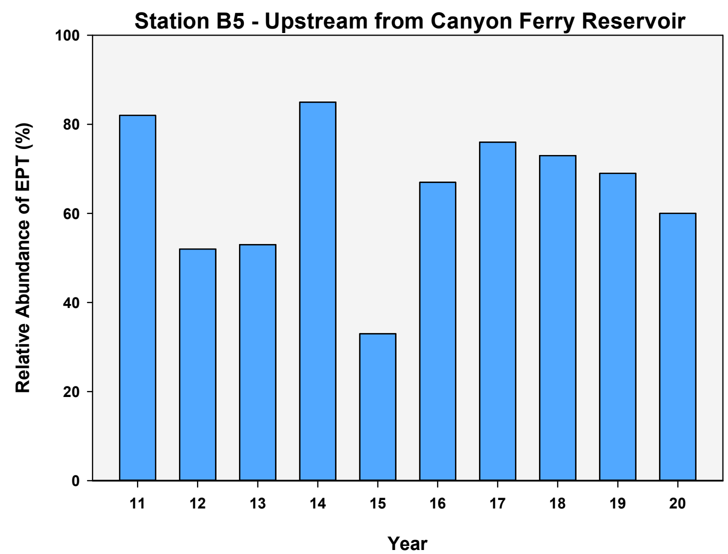
Figure E-4: Relative Abundance of EPT (%) for Biological Stations B1 to B10.

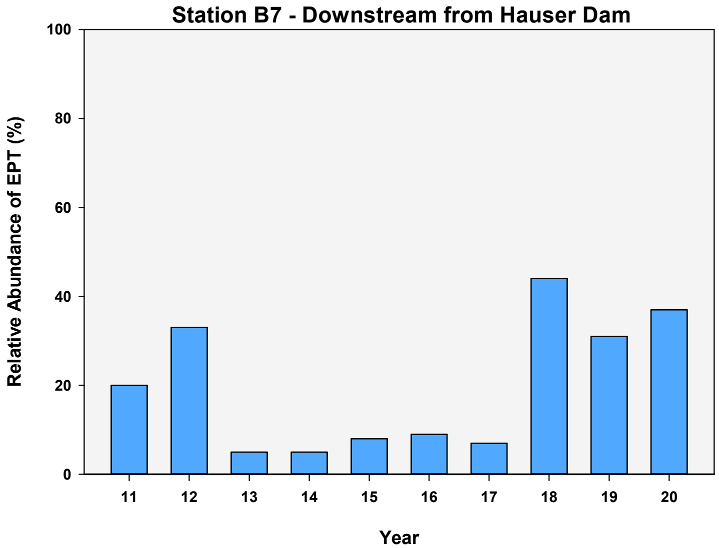


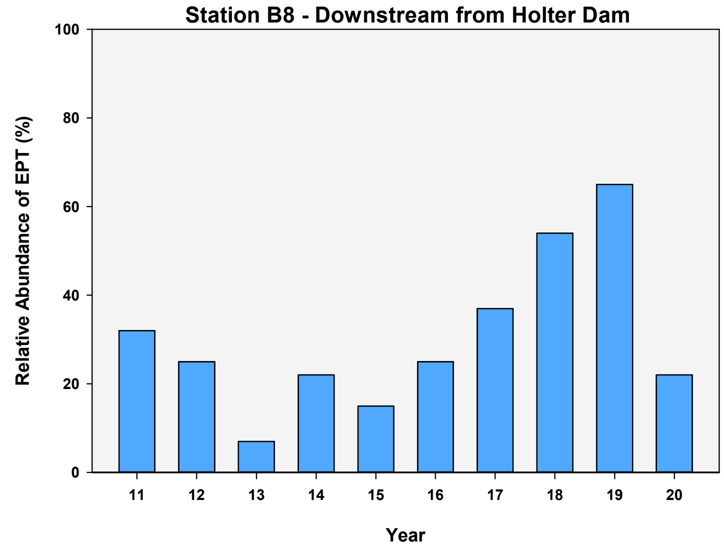

Station 4 - Downstream from Madison Dam
Relative Abundance of EPT (%)
0
20
40
60
80
100
11
12
13
14
15
16
17
18
19
20
Year


Station F3 - Downstream from Warm Springs
Relative Abundance of EPT (%)
0
20
40
60
80
100
11
12
13
14
15
16
17
18
19
20
Year


Station F4 - Greycliff
Relative Abundance of EPT (%)
0
20
40
60
80
100
11
12
13
14
15
16
17
18
19
20
Year


Station B5 - Upstream from Canyon Ferry Reservoir
Relative Abundance of EPT (%)
0
20
40
60
80
100
11
12
13
14
15
16
17
18
19
20
Year


Station B7 - Downstream from Hauser Dam
Relative Abundance of EPT (%)
0
20
40
60
80
100
11
12
13
14
15
16
17
18
19
20
Year


Station B8 - Downstream from Holter Dam
Relative Abundance of EPT (%)
0
20
40
60
80
100
11
12
13
14
15
16
17
18
19
20
Year

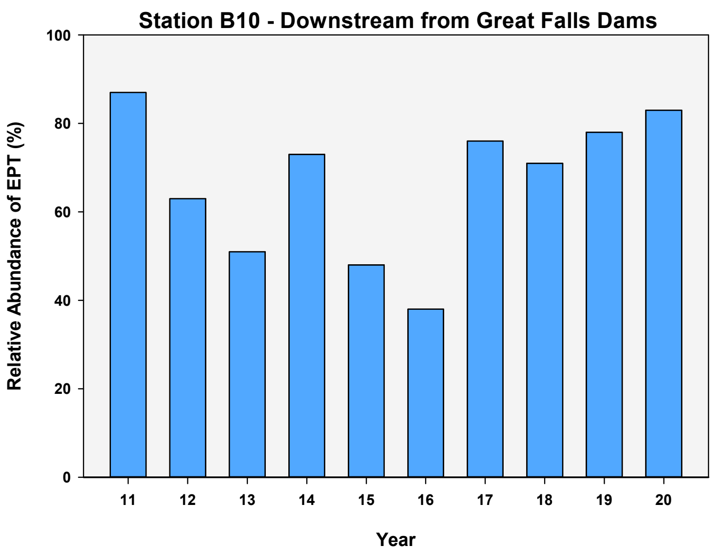
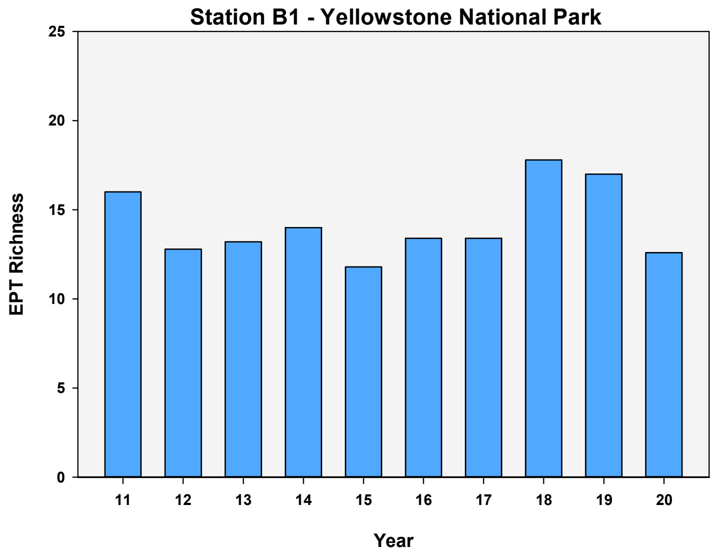
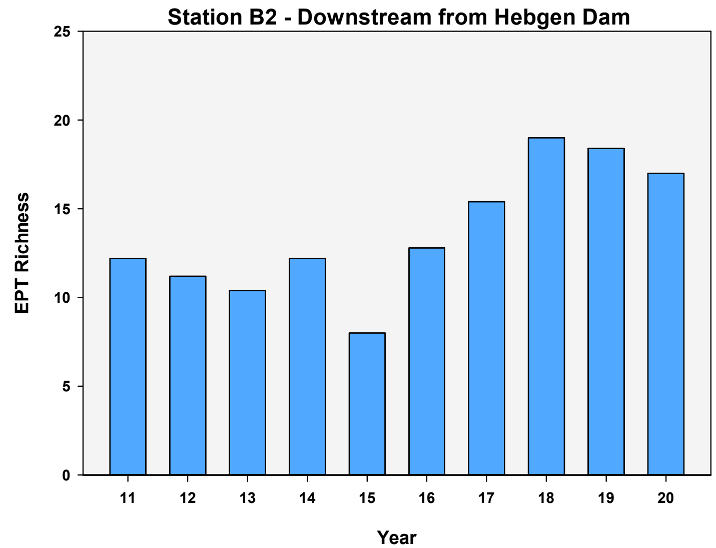
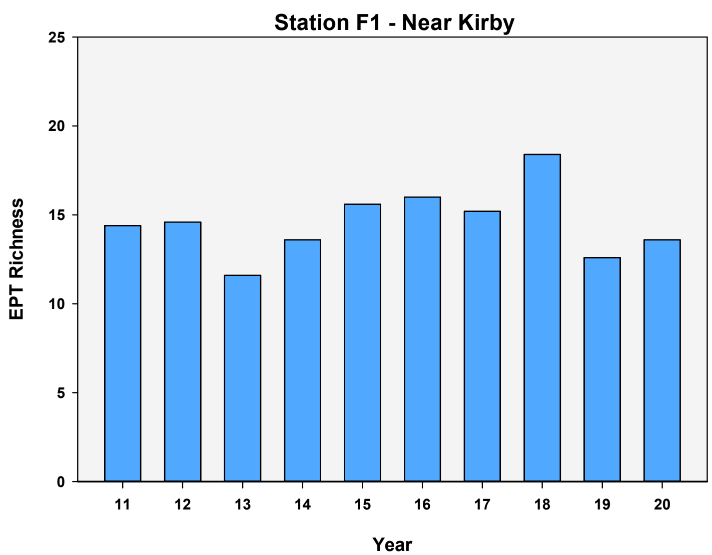
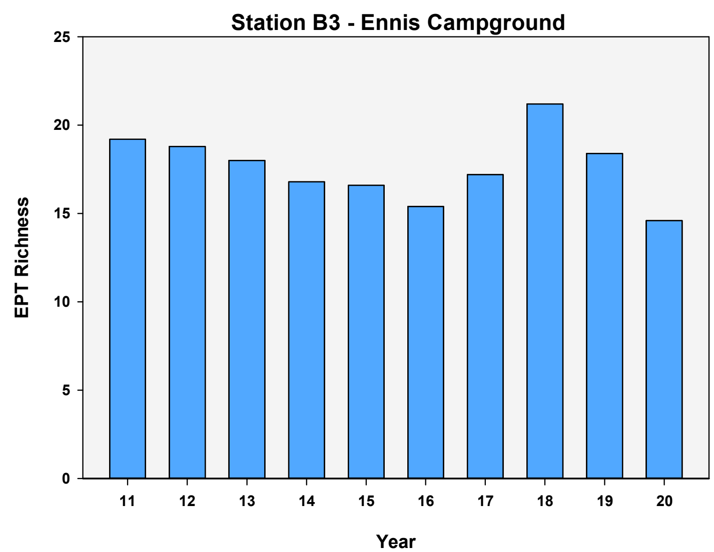

Station B10 - Downstream from Great Falls Dams
Relative Abundance of EPT (%)
0
20
40
60
80
100
11
12
13
14
15
16
17
18
19
20
Year

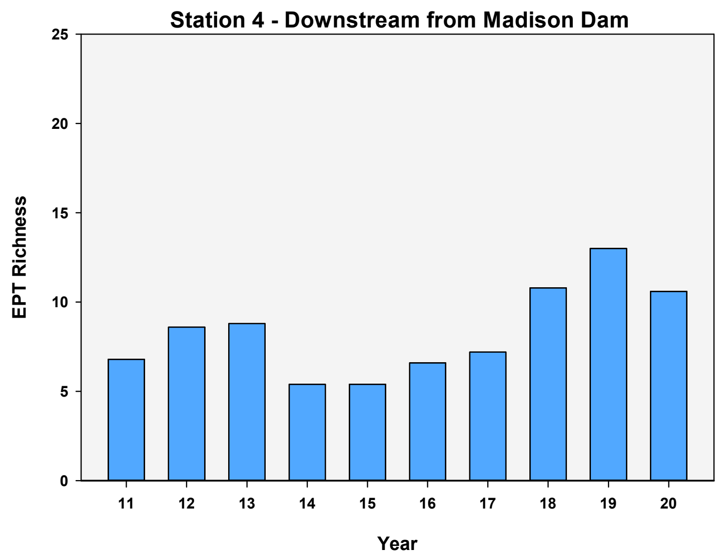
Figure E-5: EPT Richness for Biological Stations B1 to B10.

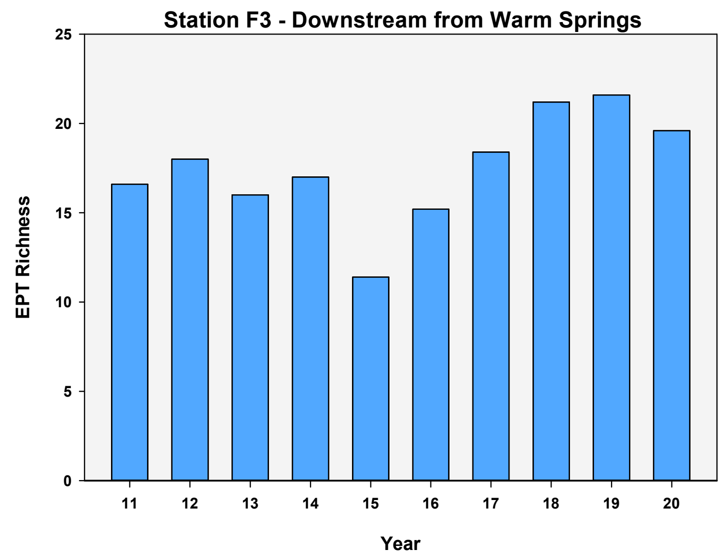


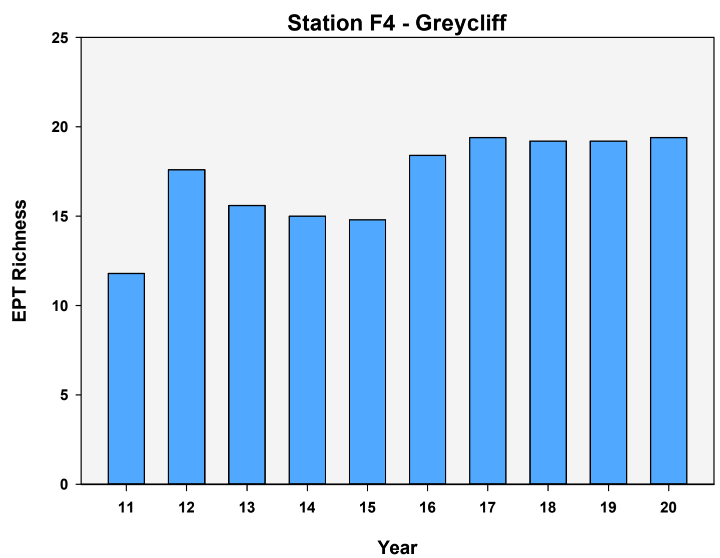


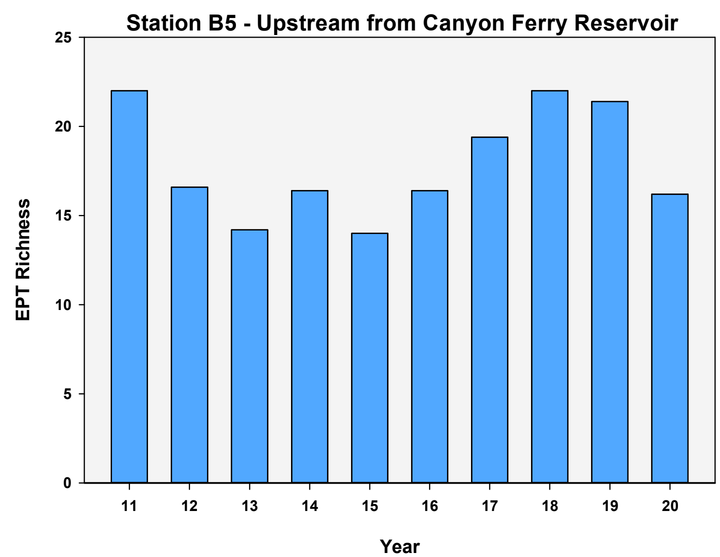


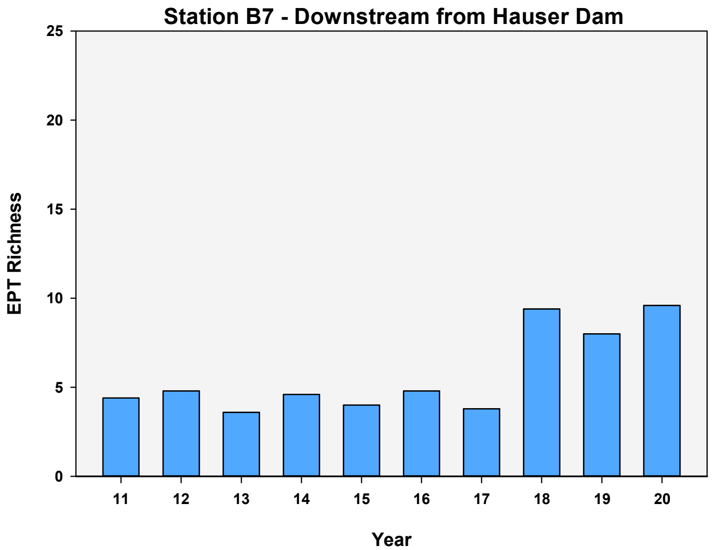


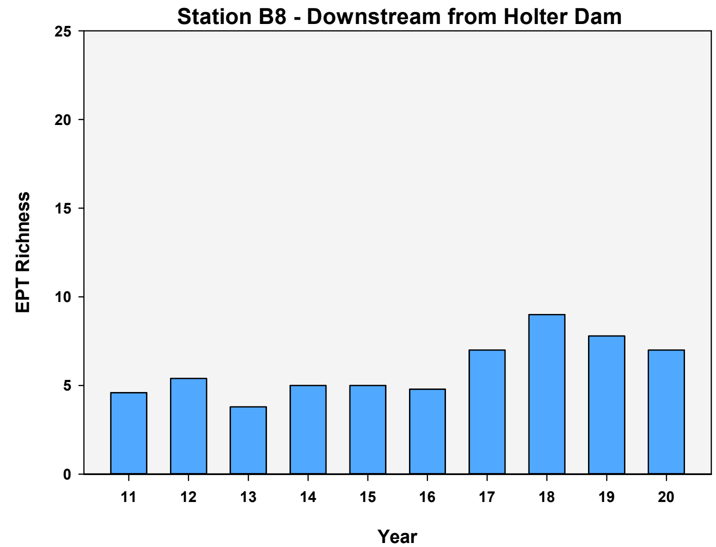

Station 4 - Downstream from Madison Dam
EPT Richness
Year
0
5
10
15
20
25
11
12
13
14
15
16
17
18
19
20


Station F3 - Downstream from Warm Springs
EPT Richness
Year
0
5
10
15
20
25
11
12
13
14
15
16
17
18
19
20


Station F4 - Greycliff
EPT Richness
Year
0
5
10
15
20
25
11
12
13
14
15
16
17
18
19
20


Station B5 - Upstream from Canyon Ferry Reservoir
EPT Richness
Year
0
5
10
15
20
25
11
12
13
14
15
16
17
18
19
20


Station B7 - Downstream from Hauser Dam
EPT Richness
Year
0
5
10
15
20
25
11
12
13
14
15
16
17
18
19
20


Station B8 - Downstream from Holter Dam
EPT Richness
Year
0
5
10
15
20
25
11
12
13
14
15
16
17
18
19
20

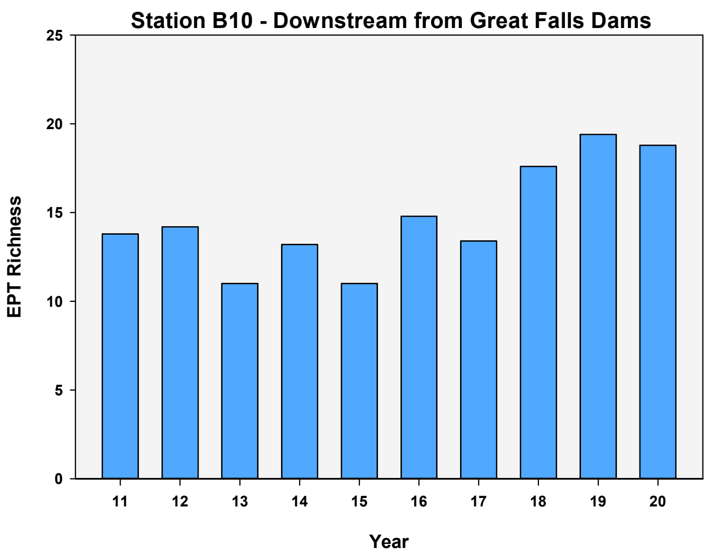
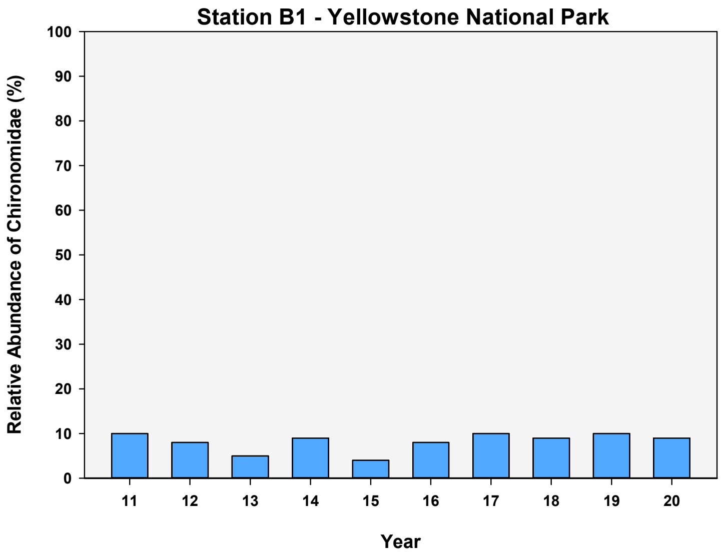
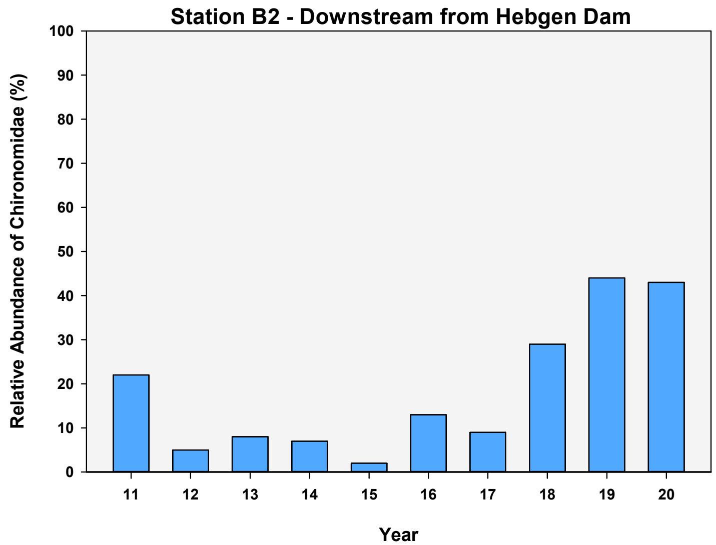
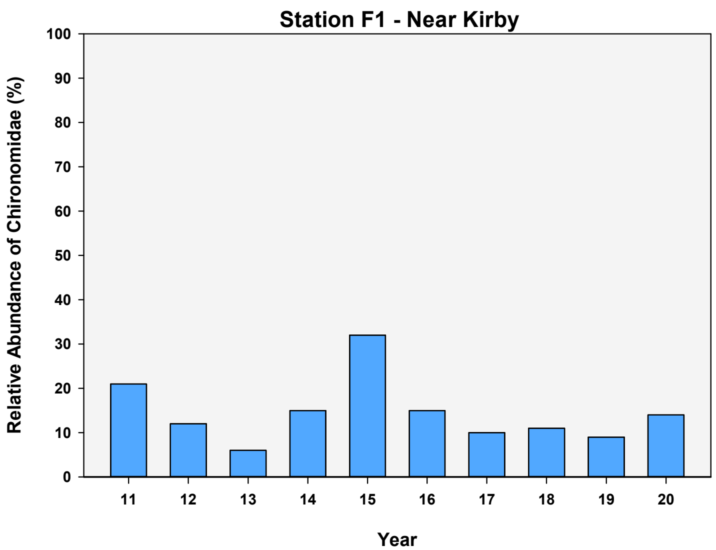
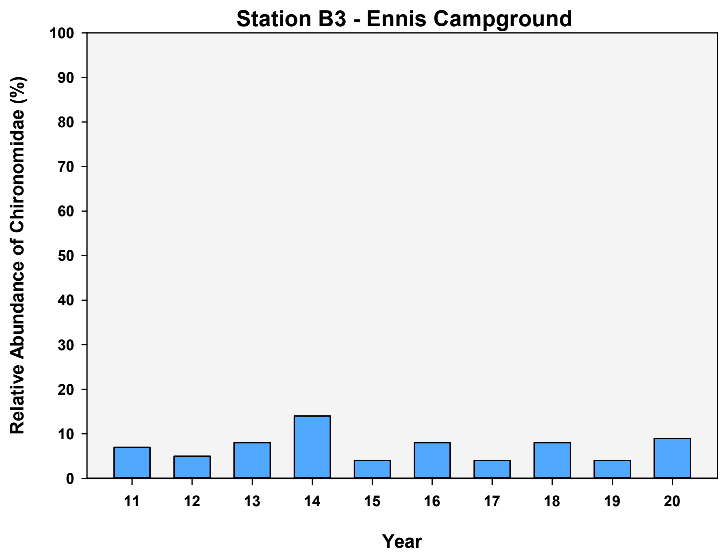

Station B10 - Downstream from Great Falls Dams
EPT Richness
Year
0
5
10
15
20
25
11
12
13
14
15
16
17
18
19
20

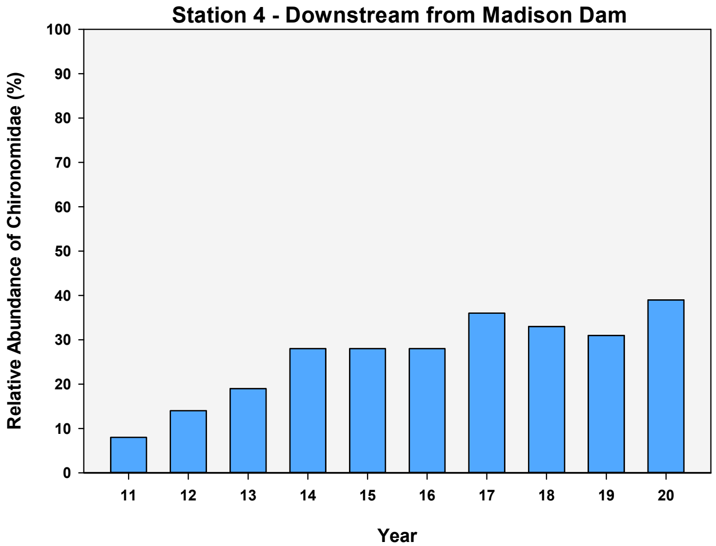
Figure E-6: Relative Abundance of Chironomidae (%) for Biological Stations B1 to B10.



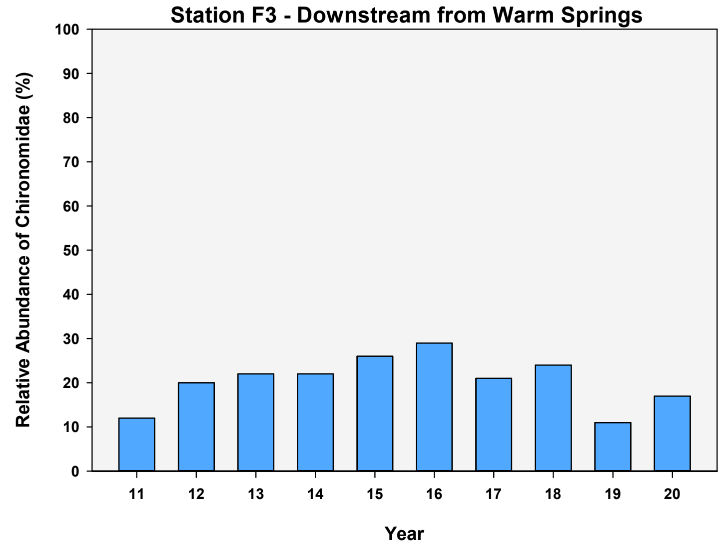




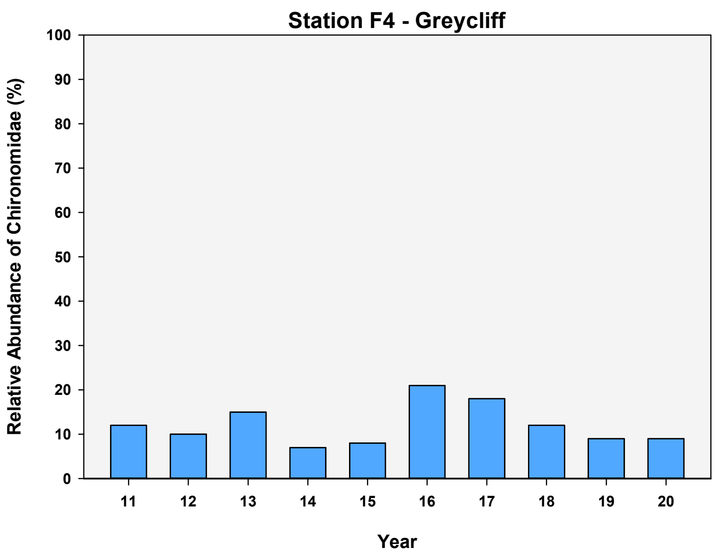




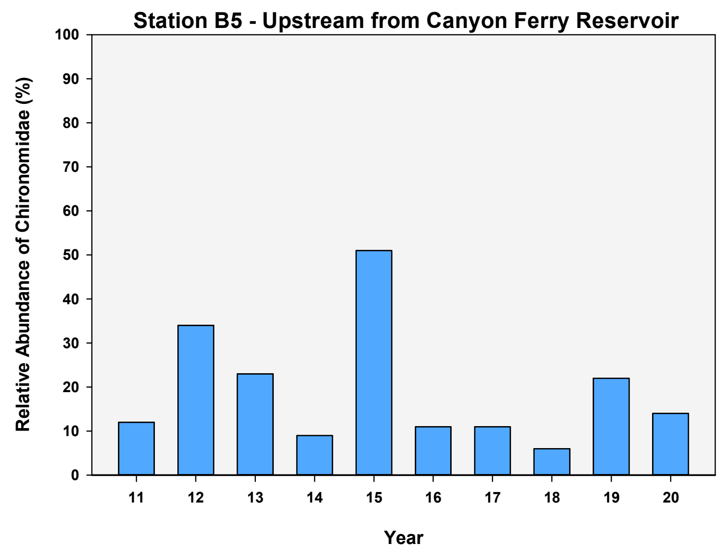
Station 4 - Downstream from Madison Dam
Relative Abundance of Chironomidae (%)
100
90
80
70
60
50
40
30
20
10
0
11
12
13
14
15
16
17
18
19
20
Year



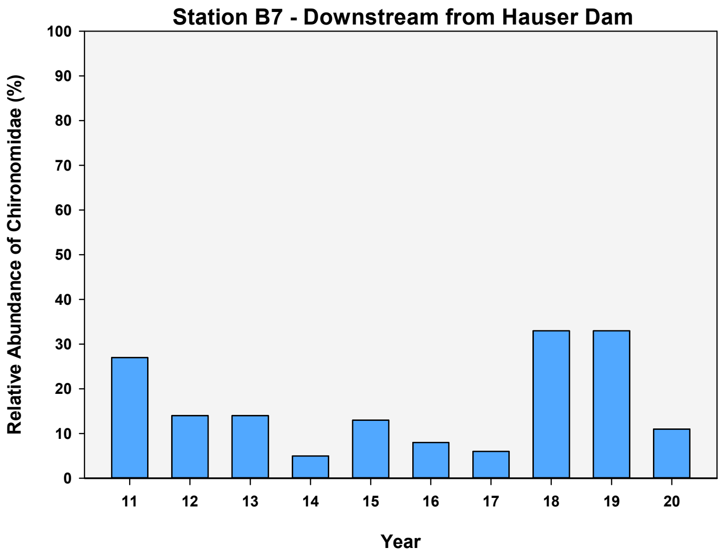
Station F3 - Downstream from Warm Springs
Relative Abundance of Chironomidae (%)
100
90
80
70
60
50
40
30
20
10
0
11
12
13
14
15
16
17
18
19
20
Year

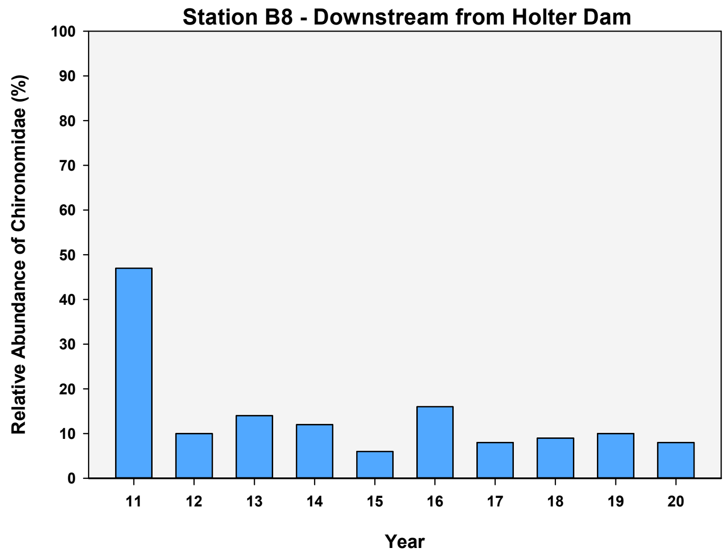


Station F4 - Greycliff
Relative Abundance of Chironomidae (%)
100
90
80
70
60
50
40
30
20
10
0
11
12
13
14
15
16
17
18
19
20
Year



Station B5 - Upstream from Canyon Ferry Reservoir
Relative Abundance of Chironomidae (%)
100
90
80
70
60
50
40
30
20
10
0
11
12
13
14
15
16
17
18
19
20
Year


Station B7 - Downstream from Hauser Dam
Relative Abundance of Chironomidae (%)
100
90
80
70
60
50
40
30
20
10
0
11
12
13
14
15
16
17
18
19
20
Year


Station B8 - Downstream from Holter Dam
Relative Abundance of Chironomidae (%)
100
90
80
70
60
50
40
30
20
10
0
11
12
13
14
15
16
17
18
19
20
Year

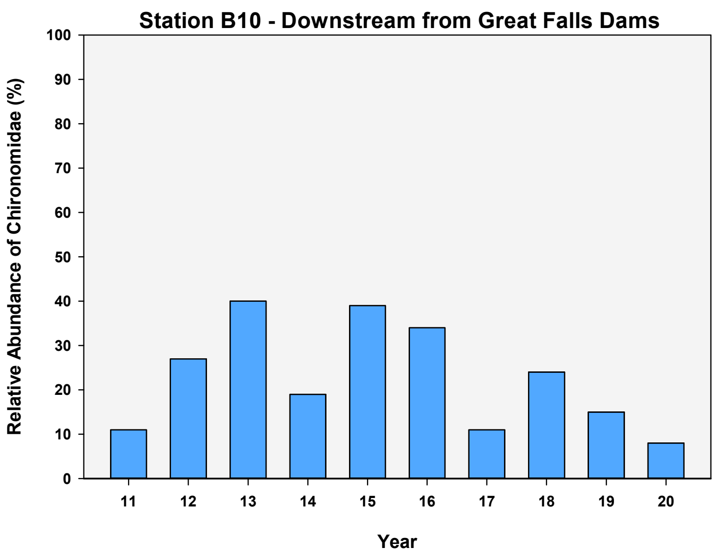
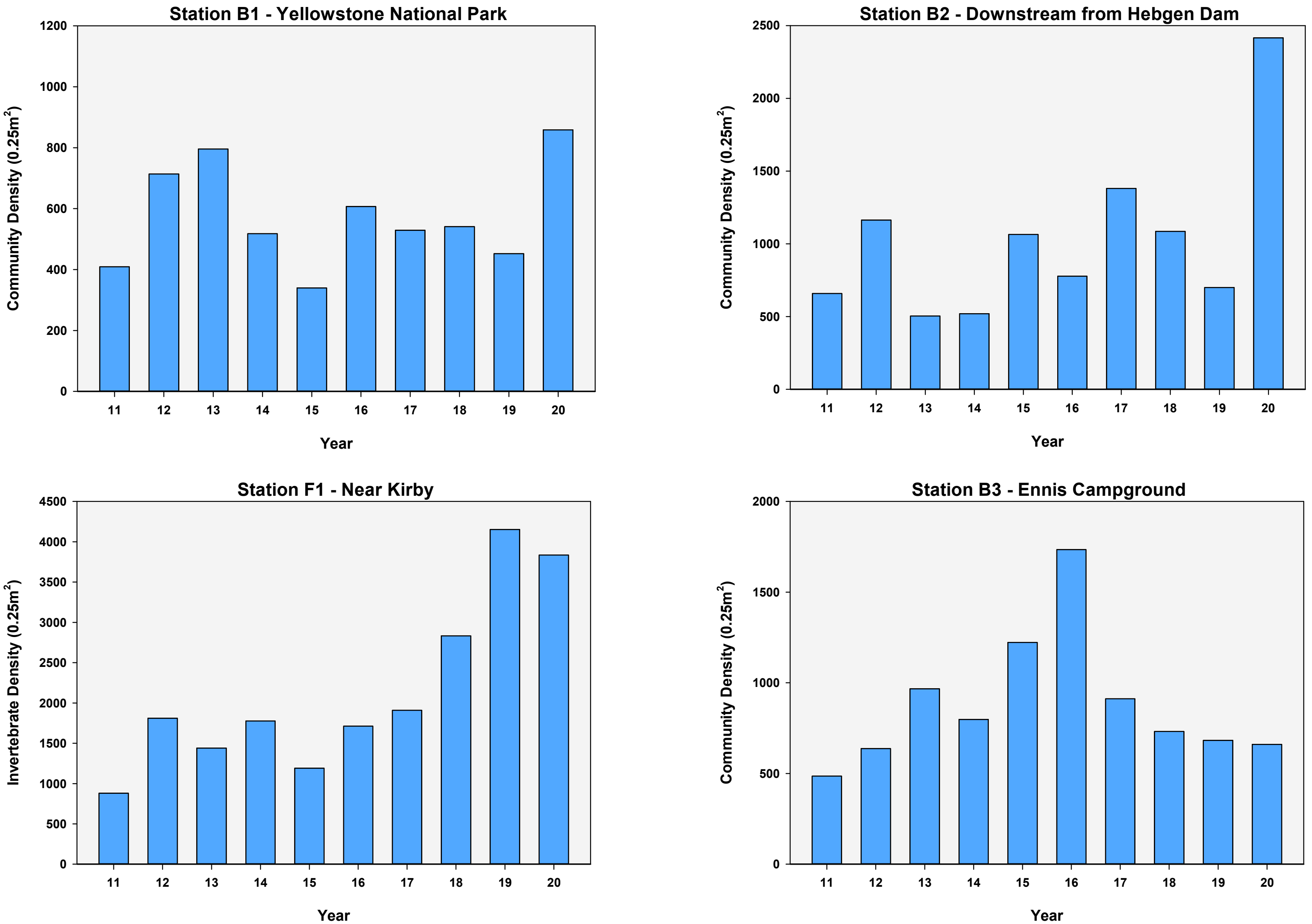
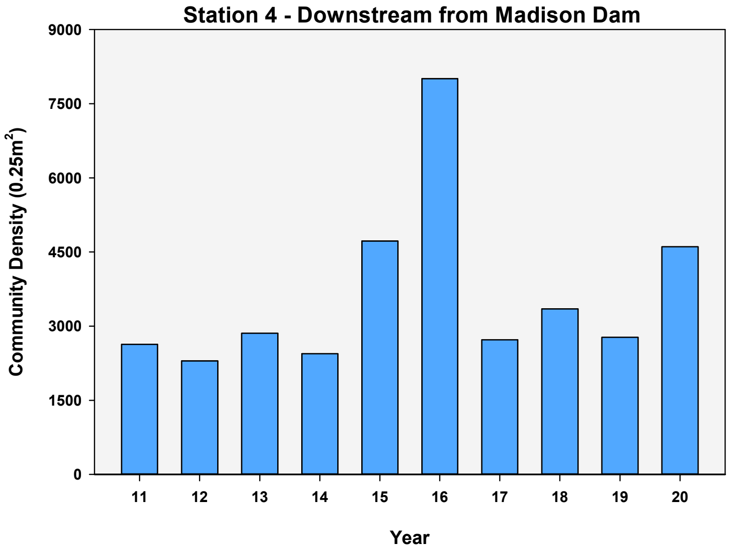
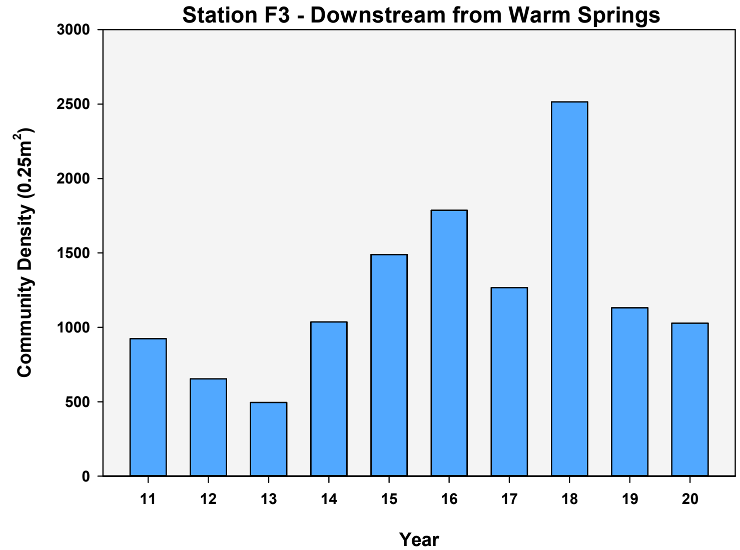
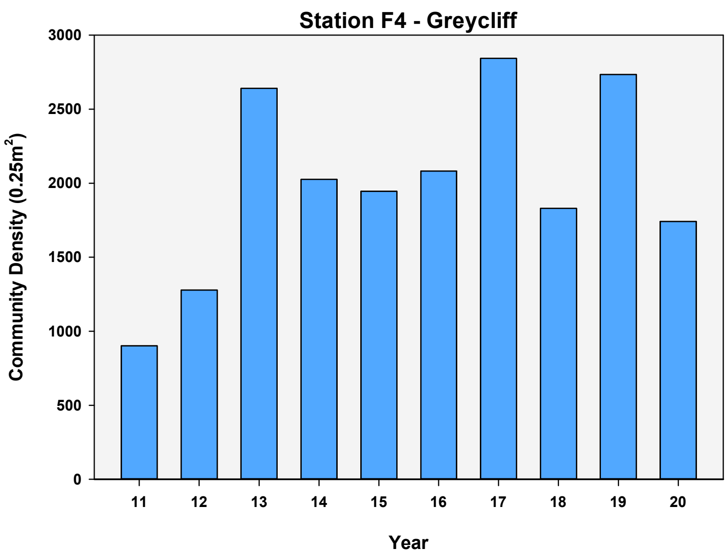

Station B10 - Downstream from Great Falls Dams
Relative Abundance of Chironomidae (%)
100
90
80
70
60
50
40
30
20
10
0
11
12
13
14
15
16
17
18
19
20
Year

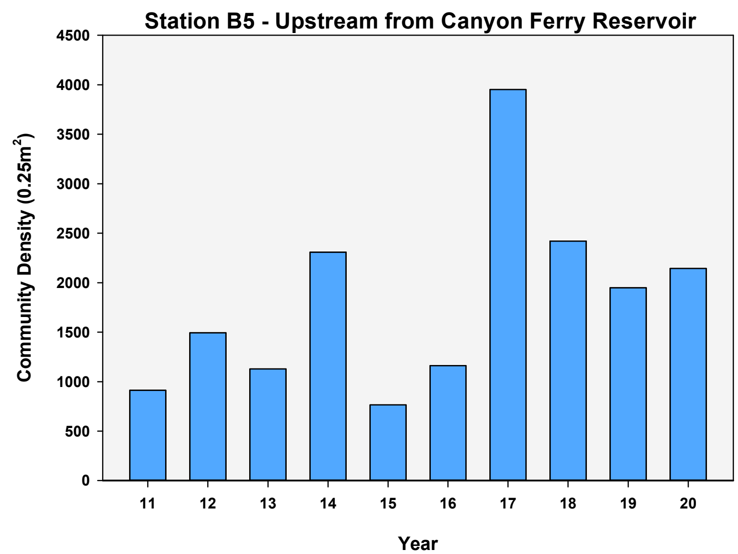
Figure E-7: Community Density (0.25m²) for Biological Stations B1 to B10.

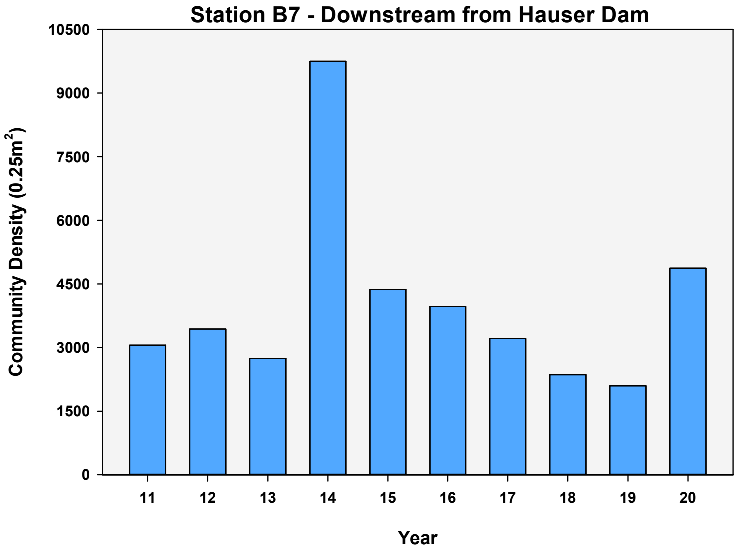


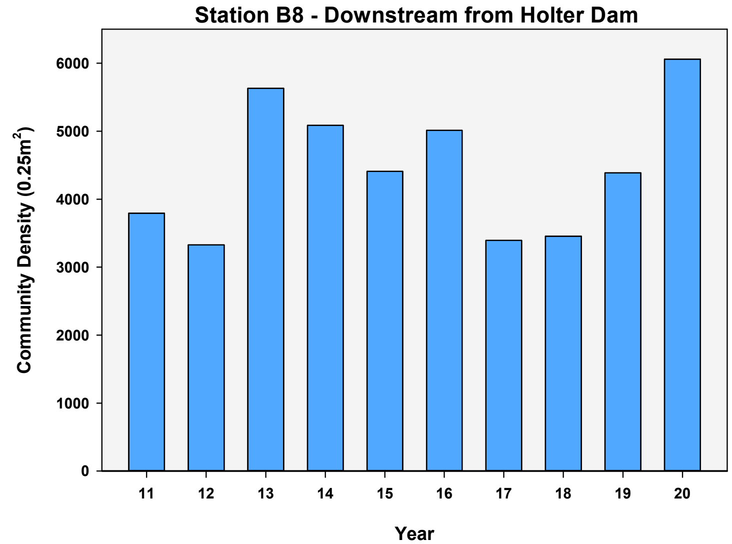

Station 4 - Downstream from Madison Dam
Community Density (0.25m2)
Year
0
1500
3000
4500
6000
7500
9000
11
12
13
14
15
16
17
18
19
20

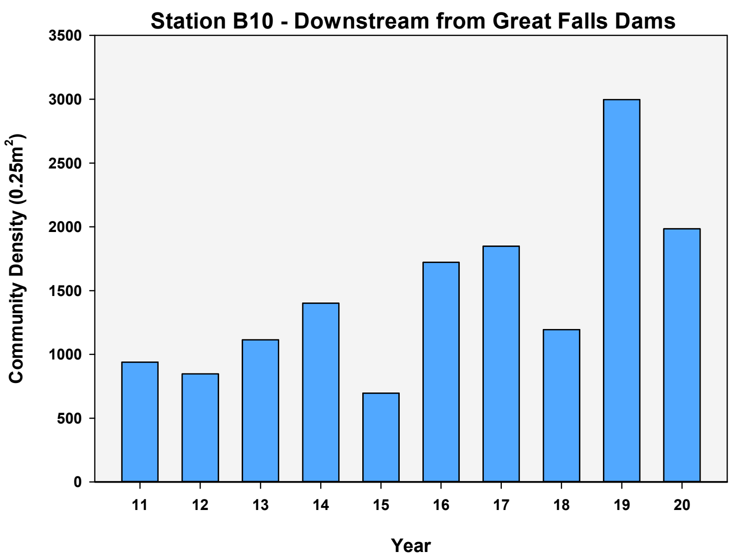

Station F3 - Downstream from Warm Springs
Community Density (0.25m2)
Year
0
500
1000
1500
2000
2500
3000
11
12
13
14
15
16
17
18
19
20


Station F4 - Greycliff
Community Density (0.25m2)
Year
0
500
1000
1500
2000
2500
3000
11
12
13
14
15
16
17
18
19
20


Station B5 - Upstream from Canyon Ferry Reservoir
Community Density (0.25m2)
Year
0
500
1000
1500
2000
2500
3000
3500
4000
4500
11
12
13
14
15
16
17
18
19
20







Note: This parameter has been scaled individually

GEI Consultants