

Waterbody Field Report

Ketchikan Creek, Hoadley Creek, and Carlanna Creek, Ketchikan, Alaska

Prepared by: R Bellmore¹ and I Arvanitis²



¹ Southeast Alaska Watershed Coalition, project #ACWA-23-06 funded by DEC from an EPA pass-through grant.

² Ketchikan Indian Community, Cultural Resources Department

Abstract

Ketchikan, Hoadley, and Carlanna Creeks are urban streams located in Ketchikan, AK. All three were monitored for common urban pollutants, including dissolved metals, nutrients, and bacteria (fecal coliform and *E. coli*), as well as conventional water quality parameters, including hardness, alkalinity, major ions, pH, dissolved oxygen, temperature, specific conductivity, turbidity. Monitoring occurred in reference locations upstream of urban development and in urban locations downstream of development during 2023 and 2024. Most water quality parameters were within expected ranges and met water quality criteria across all sites. However, fecal coliform concentrations exceeded water quality criteria for drinking water supply in Ketchikan, Hoadley, and Carlanna Creeks during 2023 and 2024. Carlanna and Hoadley Creeks exceeded water quality criteria for aquaculture in 2023 only. Microbial Source Tracking indicated the presence of fecal bacteria from dogs, birds, and ruminants (e.g. deer, goats) in all three streams, and the presence of fecal bacteria from humans in Ketchikan Creek. Of the dissolved metals analyzed (cadmium, chromium, copper, lead and zinc), only copper and zinc had concentrations that were consistently above the method detection limit and could be quantified. Hardness-based criteria for copper were exceeded at the upstream reference Carlanna site, downstream urban Hoadley site, and downstream urban Ketchikan sites. No exceedances of hardness-based criteria for zinc were observed in any of the sites. Overall, comparisons of water quality parameters between upstream “reference” and downstream urban sites showed patterns of increasing specific conductivity and individual ions downstream, which may be due to high concentrations of salts and other minerals in urban runoff. Copper and zinc concentrations also increased downstream. These metals are also associated with urban sources and runoff, although there are known copper deposits in the local geology that impact water quality and could be contributing to observed patterns.

Basic Waterbody Information

Table 1. Basic waterbody information.

Assessment Unit Name	Carlanna Creek	Hoadley Creek	Ketchikan Creek
Assessment Unit ID	AK_R_1010204_001	AK_R_1010204_002	AK_R_1010204_003
Location Description	Tongass Narrows-Frontal Clarence Strait; Hydrologic Unit Code 12: HUC190101020403		Ketchikan; Hydrologic Unit Code 12: HUC190101020402
Water Type	Freshwater stream		
Area sampled (points)	55.368521, -131.691741 55.358070, -131.695340	55.358964, -131.679784 55.353731, -131.688087	55.344245, -131.632391 55.343944, -131.632512 55.343996, -131.639956 55.342920, -131.643740 55.345655, -131.637271
Area sampled description	Outflow of Carlanna Lake (CC01); just upstream of Tongass Ave. (CC02).	by Jackson Heights and Jackson St. (HC01); just upstream of Tongass Ave. (HC02).	By KPU building (KC01); below the hydropower penstock outfall (KC01B); by Park Ave and Freeman St. (KC02); by the state museum (KC03); in Schoenbar Creek just downstream of the second culvert (Schoenbar)
Time of year sampled	Spring, summer, fall 2023, spring, summer, fall 2024		

Water Quality Evaluation

Background

Ketchikan, Hoadley, and Carlanna Creeks are located in Ketchikan, AK, with their lower reaches flowing through a heavily urbanized landscape (Figure 1). Basic water body details are provided in Table 1. Previous water quality and sediment monitoring efforts in 2013, 2014, and 2018 assessed common urban pollutants, including nutrients (ammonia-N, nitrate+nitrite-N, total and dissolved phosphorus), metals (cadmium, chromium, copper, lead, zinc), polycyclic aromatic hydrocarbons (PAHs), settleable solids, and dissolved organic carbon. Additional water quality characteristics included alkalinity, hardness, pH, dissolved oxygen, turbidity, and temperature. Past water quality sampling indicated elevated dissolved metals and fecal bacteria (ARRI, 2014; DEC, 2022a), particularly in Ketchikan and Hoadley Creeks, but sampling frequency was insufficient to conduct impairment assessments. All three urban streams are classified as Category 3 waterbodies, with data or information insufficient to determine whether the Alaska Water Quality Standards (WQS) for any designated uses are attained. Additional water sampling was conducted in 2023 – 2024 to evaluate the impacts of urban runoff on water quality in these streams.



Figure 1. Overview of project location with the lower portions of Carlanna, Hoadley and Ketchikan Creeks highlighted in blue.

Objective

This project was designed to assess water quality due to urban development and stormwater runoff within Ketchikan, Hoadley, and Carlanna Creeks. It included water quality monitoring and assessment in the three streams at an upstream reference site and downstream urban location(s). This monitoring is designed to collect sufficient data to determine the health of these waters based on Alaska Water Quality Standards. The data can also be used to inform restoration options, if needed. This monitoring captured common urban pollutants in water, including those found to be of concern in previous studies. This report is not intended to serve as a waterbody impairment evaluation.

Methods

Sample locations mirrored the locations from the initial assessments and included a total of 7 creek sites: one background reference site upstream of urban development in each stream, and one downstream of urban development in Hoadley and Carlanna Creeks and two within and downstream of urban development in Ketchikan Creek (Figure 2). Additionally, samples were collected from Schoenbar Creek, a tributary that enters Ketchikan Creek upstream of KC02, and a second upstream “reference” site (KC01B) located just downstream of KC01 and below the outfall of the hydropower penstock³, which can contribute a relatively large portion of flow to the stream, especially during lower-flow periods. The Schoenbar and KCO1B sites were initiated on August 19, 2024 and sampled five times. Photos of the sampling sites are included in Appendix A.

Sampling events captured all flow regimes (spring runoff, summer base flow and fall storm events) and are listed in Appendix B. On five dates in 2023 and 7 dates in 2024, water samples were analyzed for alkalinity, hardness, settleable solids, dissolved organic carbon, sodium, calcium, magnesium, nitrate-nitrite-N, ammonium-N, dissolved and total phosphorus, and dissolved metals (cadmium, chromium, copper, lead, and zinc). Water samples were analyzed for chloride and sulfate once on 8/19/2024 to support biotic ligand modeling for copper bioavailability. During two 30-day periods in both 2023 and 2024, five to six samples from the most downstream urban sites were collected and analyzed for fecal coliform and *E. coli*. In situ monitoring of dissolved oxygen, water and air temperature, turbidity, pH, and specific conductivity accompanied all sample collection dates and locations. Samples were collected from the most downstream urban locations (CC02, HC02, KC03) and analyzed using Microbial Source Tracking (MST) once per year (July 19, 2023 and August 27, 2024) to determine the presence of fecal bacteria from human, dog, bird, and ruminant (e.g. deer, goat) sources.

Samples for water quality analyses other than bacteria were shipped overnight to AmTest, Inc., in Kirkland, WA in a cooler on ice to meet holding times and within temperature requirements. Bacteria samples were held in a cooler with ice and delivered to R&M Engineering in Ketchikan, AK upon completion of sampling for immediate analysis. Samples for MST were shipped overnight in a cooler following the 2023 sampling event to LuminUltra Technologies, Inc. in Linthicum Heights, MD. In 2024,

³ Reconnaissance monitoring with an in situ probe on 6/18/2024 indicted penstock outfall water had a different conductivity signature (lower) than the stream water just upstream at KC01, suggesting other water quality parameters may also be different. The water in the penstock is directly from Ketchikan Lake, while stream water has had more time to interact with sediments and minerals, and integrates drainage from the watershed between the lake and the penstock, which alters water quality characteristics compared with lake water.

MST samples were filtered and preserved in the lab according to procedures from LuminUltra and shipped without refrigeration.

Table 2. Site locations and descriptions

Site	Latitude	Longitude	Description
CC01	55.368521	-131.691741	Carlanna Creek reference site, just downstream of Carlanna Lake
CC02	55.358070	-131.695340	Carlanna Creek urban site, just upstream of Tongass Ave
HC01	55.358964	-131.679784	Hoadley Creek reference site, just upstream of the intersection of Jackson St. and Jackson Heights
HC02	55.353731	-131.688087	Hoadley Creek urban site, just upstream of Tongass Ave
KC01	55.344245	-131.632391	Ketchikan Creek reference site, just upstream of the power plant water diversion return
KC01B	55.343940	-131.632510	Ketchikan Creek reference site, just downstream of the penstock diversion outfall
KC02	55.343996	-131.639956	Ketchikan Creek mid-urban site, just upstream of the Harris St. bridge
KC03	55.342920	-131.643740	Ketchikan Creek lower urban site, by the museum
Schoenbar	55.345660	-131.637270	Schoenbar Creek across from Schoenbar Middle School



Figure 2. Sampling locations on Ketchikan (KC) and Schoenbar Creeks (top) and Carlanna (CC) and Hoadley (HC) Creeks (bottom). The outfall of the Ketchikan Lakes Hydro Project penstock is indicated between KC01 and KC01B.

Quality Assurance Review

Field staff followed procedures for sample collection as outlined in the project's previously approved Alaska Department of Environmental Conservation (DEC) Quality Assurance Project Plan (QAPP) (available upon request from DEC). All samples met the requirements for handling and reporting outlined in the project QAPP, including the 6-hour field holding time for bacteria samples, except for settleable solids sampled 7/10/2023, which exceeded the holding time due to a shipping delay. Samples were shipped to the lab with completed Chain of Custody forms. All field equipment used to collect in situ measurements were calibrated prior to use in the field and calibration logs and records were completed.

Twelve sampling events for water quality analyses (except fecal bacteria) were scheduled for seven sites during 2023 and 2024. All samples were collected and delivered to the laboratory except for HC02 during one event (9/23/24) due to dangerously high water, for a completeness of 98%. Fecal bacteria sampling at three locations was scheduled for four rounds of five to six events within 30 days – two in 2023 and two in 2024. The target was at least five samples per 30-day sampling round. Samples from all sites for six sampling events were delivered to the laboratory for analyses during round 1 (July 2023); during round 2 (October 2023), six sampling events occurred, and all except one sample were delivered due to access issues; during round 3 (May 2024) all five samples from all sites were delivered; during round 4 (August 2024) all five samples from all sites were delivered, for 100% completeness.

Field duplicates were collected for dissolved metals for one sampling site per sampling event, and for fecal coliform and E. coli for one sampling site per sampling event. Method blanks and matrix spikes were performed by AmTest for all water quality analytes.

Relative Percent Difference (RPD)

Precision was measured using relative percent difference (RPD) between a routine sample and its paired field duplicate and calculated as follows:

$$RPD = 100 * (A - B) / [(A + B) / 2]$$

Where A is the routine sample result and B is the paired field duplicate result. The precision goal for this project was an RPD < 20% for all paired samples for dissolved metals and <60% for fecal coliform and E. coli. RPD was evaluated for sample pairs only when both were above the practical quantitation limit (PQL), could be quantified, and if at least one sample was above two times the PQL. Most paired duplicates, including all for cadmium, chromium, and lead, had one or more samples with one or more value below the PQL and/or no values above two times the PQL. For copper, 66% of paired samples had RPD < 20%, while only 20% of paired zinc samples had RPD < 20% (Table 3). For most pairs that exceeded 20%, one or both concentrations were close to two times the PQL.

Table 3. RPD results for dissolved metals.

Analyte	# of duplicate pairs collected	# analyzed for RPD	RPD target	% of pairs > RPD target
Cadmium	12	0	20%	NA
Chromium	12	0	20%	NA
Copper	12	3	20%	66.67%
Lead	12	0	20%	NA
Zinc	12	5	20%	20%
Fecal coliform	22	21	60%	9.5%
E. coli	22	19	60%	10.5%

Results

In Situ Data

In situ water quality measurements associated with sampling events did not indicate concerns with dissolved oxygen, pH, temperature, turbidity, or specific conductivity across sites (Figure 3, Table 4). Dissolved oxygen concentrations were all between 7 and 17 mg/l (Figure 3, Table 4), the target range to support salmonids (DEC, 2025). Turbidity was generally low – below 2 NTU across sites (Figure 3), although several slightly elevated turbidity measurements were observed during high flow periods and while adult salmon were present and disturbing the streambed (Figure C. 1, Figure C. 4, Figure C. 7). pH values ranged from 6.5 to 7.5, except at CC02, where pH values were slightly lower (Figure 3, Table 4). Water temperature varied seasonally as expected and was inversely related to dissolved oxygen concentration across sites (Figure C. 1, Figure C. 4, Figure C. 7). The most downstream urban locations showed the most variability over time for specific conductivity (Figure 6), but high conductivity measurements were not synchronous across sites. Specific conductivity at CC02 and HC02 tended to covary, with higher specific conductivity during moderate flows, possibly after longer dry spells. KC03's highest specific conductivity value was measured during spring snowmelt, when road salt may have been an important contributor (Figure C. 7.).

Differences between reference and urban sites were apparent for Carlanna Creek for pH, specific conductivity, and dissolved oxygen, which generally increased downstream (Figure 3, Figure C. 1). The upper Carlanna Creek site is at the outlet of a lake, which appears to be strongly affected by runoff through organic-rich soils that contribute low-conductivity, low-pH water. For example, the lowest pH and second lowest specific conductivity values at CC01 were measured during a very large fall storm event (9/23/24) that was associated with the highest discharge of all sampling events. Water contributions from a large tributary and urban sources may explain increases in pH and specific conductivity from the upper to lower Carlanna Creek sampling locations. Similar to Carlanna Creek, specific conductivity values were also generally higher at HC02 than HC01 (Figure 3, Figure C. 4), possibly due to salts and other mineral inputs from the urban area and a small tributary between sampling locations.

Differences between KC01 (original reference location) and KC01B (located just downstream of KC01 but integrates inputs from the hydropower penstock) indicated that inputs from the penstock likely lower stream water specific conductivity and pH compared to just upstream at KC01 (Figure 3, Table 4). The

inlet for the penstock is in Ketchikan Lake, and water quality there is likely dominated by runoff through organic rich soils, similar to Carlanna Lake. Specific conductivity generally increased downstream from KC01B, potentially due to inputs from urban sources of salts and other minerals, including in Schoenbar Creek, and other runoff from the watershed. Turbidity values were also slightly elevated at KC03 compared to the upstream sites (Figure 3, Table 4), particularly during summer months, which may be due to adult salmon disturbing the streambed in the lower reaches. Dissolved oxygen was supersaturated at KC01B during all sampling events, likely due to turbulence at the penstock outfall just upstream.

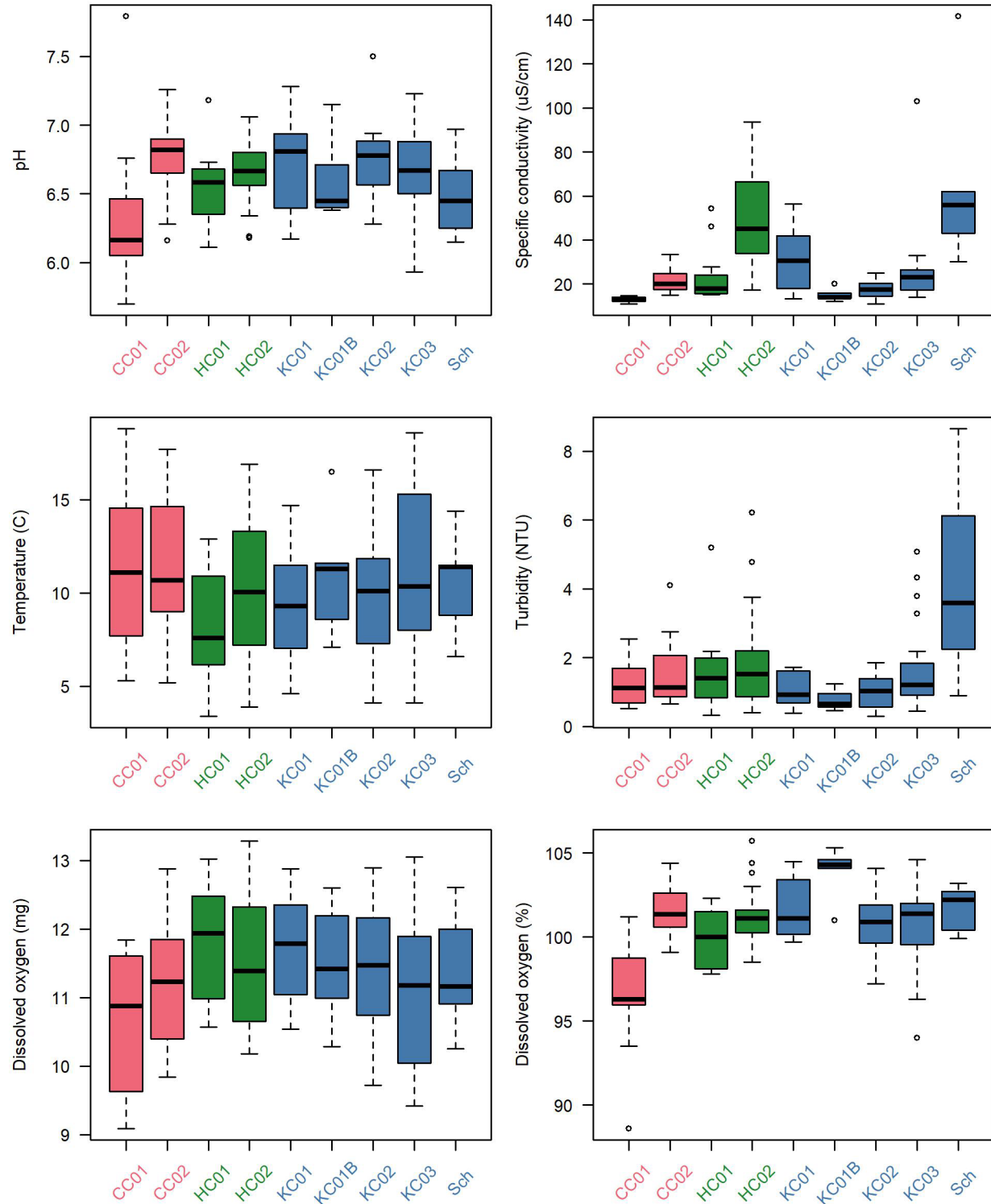


Figure 3. In situ measurements of pH, specific conductivity, dissolved oxygen, turbidity, and water temperature across all sampling sites and dates. "Sch" = Schoenbar Creek.

Table 4. Summary statistics for in situ water quality measurements for all sites and sampling dates.

Site	statistic	pH	Specific conductivity (uS/cm)	Dissolved oxygen (mg)	Dissolved oxygen (%)	Turbidity (NTU)	Temperature (°C)
CC01	mean	6.32	13.1	10.68	96.5	1.26	11.4
	median	6.17	13.4	10.88	96.3	1.13	11.1
	range	5.7 - 7.79	11 - 14.6	9.09 - 11.84	88.6 - 101.2	0.52 - 2.55	5.3 - 18.8
CC02	mean	6.77	21.5	11.26	101.6	1.47	11.2
	median	6.82	20.0	11.23	101.4	1.13	10.7
	range	6.16 - 7.26	15 - 33.4	9.84 - 12.88	99.1 - 104.4	0.66 - 4.1	5.2 - 17.7
HC01	mean	6.56	24.1	11.80	100.0	1.66	8.2
	median	6.59	18.0	11.94	100.0	1.40	7.6
	range	6.11 - 7.18	15.2 - 54.2	10.57 - 13.02	97.8 - 102.3	0.33 - 5.19	3.4 - 12.9
HC02	mean	6.67	50.2	11.54	101.2	1.85	9.9
	median	6.67	45.3	11.39	101.1	1.52	10.1
	range	6.18 - 7.06	17.2 - 93.5	10.18 - 13.28	98.5 - 105.7	0.4 - 6.22	3.9 - 16.9
KC01	mean	6.71	30.3	11.70	101.7	1.07	9.5
	median	6.81	30.7	11.79	101.1	0.92	9.3
	range	6.17 - 7.28	13.2 - 56.4	10.54 - 12.88	99.7 - 104.5	0.38 - 1.72	4.6 - 14.7
KC01B	mean	6.62	15.1	11.50	103.9	0.79	11.0
	median	6.45	13.9	11.42	104.3	0.66	11.3
	range	6.38 - 7.15	12.2 - 20	10.28 - 12.6	101 - 105.3	0.46 - 1.24	7.1 - 16.5
KC02	mean	6.76	17.4	11.43	100.8	1.06	10.1
	median	6.78	17.5	11.48	100.9	1.03	10.1
	range	6.28 - 7.5	11 - 25.1	9.72 - 12.89	97.2 - 104.1	0.3 - 1.86	4.1 - 16.6
KC03	mean	6.67	25.0	11.07	100.8	1.65	11.3
	median	6.67	23.2	11.18	101.4	1.21	10.4
	range	5.93 - 7.23	13.9 - 103	9.42 - 13.05	94 - 104.6	0.45 - 5.08	4.1 - 18.6
Schoenbar	mean	6.50	66.5	11.39	101.7	4.38	10.5
	median	6.45	55.8	11.16	102.2	3.59	11.4
	range	6.15 - 6.97	30.1 - 141.5	10.25 - 12.61	99.9 - 103.2	0.89 - 8.65	6.6 - 14.4

Water Quality Standards (18 AAC 70, DEC, 2025, Appendix D)

pH: Between 6.5 and 8.5 for growth and propagation of fish, shellfish and other aquatic life.

Dissolved oxygen: Between 7 and 17 mg/l, and may not exceed 110% for growth and propagation of fish, shellfish and other aquatic life.

Turbidity: May not exceed 5 NTU above natural conditions of 50 NTU or less for drinking water; may not exceed 25 NTU above natural conditions for aquaculture and growth and propagation of fish, shellfish, and other aquatic life.

Temperature: May not exceed 13 °C for salmon spawning and egg incubation, 15 °C for rearing and migration, 20 °C at any time.

Specific conductivity: no WQS.

Bacteria Concentrations

Fecal coliform concentrations were generally lowest in Carlanna and Hoadley Creeks and highest in Ketchikan Creek (Figure 4, Table 5, Table 6). In Carlanna Creek, they ranged from below detection (1 CFU/100 ml) to 672, with a median of 13 CFU/100 ml across both years. Fecal coliform concentrations in Hoadley Creek ranged from 2 to 630, with median of 22 across both years, while Ketchikan Creek ranged from 3 to >400⁴, with median of 67.5 across both years.

For aquaculture, the Alaska Water Quality Standards indicate that fecal coliform should not exceed 400 CFU/100 ml more than 10% of the time (2 or more samples per year in this study). Concentrations were above 400 in Hoadley and Carlanna Creeks twice during 2023 sampling, but only once in Ketchikan Creek (Figure 4, Table 5, Table 6). Fecal coliform did not exceed 400 CFU/100 ml in any creek during 2024 sampling. For drinking water supply, fecal coliform concentrations should not exceed 40 CFU/100 ml more than 10% of the time. This threshold was exceeded in all creeks during both years (Figure 4, Table 5, Table 6).

The Alaska Water Quality Standards indicate that the geometric mean of fecal coliform should not exceed 200 CFU/100 ml in a 30-day period for aquaculture/cooked fish, and not more than 20 CFU/100 ml for drinking water supply/raw fish consumption. The highest 30-day geometric mean for fecal coliform in Carlanna Creek was 34.1 CFU/100 ml, in July of 2023, which was the only geometric mean that exceeded water quality criteria for drinking water/raw fish consumption there (Figure 4, Table 5, Table 6). In Hoadley Creek, the highest geometric mean was 102.0 CFU/100 ml, also in July of 2023; this 30-day period and another in May 2024⁵ also exceeded the drinking water standard (Table 5, Table 6). In Ketchikan Creek, the highest 30-day geometric mean of fecal coliform was 106.6 in May of 2024; two additional 30-day geometric means exceeded the drinking water criteria (Table 5, Table 6). 30-day geometric means did not exceed criteria for aquaculture/cooked fish at any site during any sampling period (Figure 4, Table 5, Table 6).

E. coli concentrations showed a similar spatial pattern as fecal coliform, with the lowest concentrations in Carlanna and Hoadley Creeks and highest in Ketchikan Creek (Figure 5, Table 5, Table 6). They ranged from below detection (1 CFU/100 ml) to 614 in Carlanna, with a median of 14 CFU/100 ml across both years. *E. coli* concentrations in Hoadley Creek ranged from below detection to 510, with a median of 18 across both years, while Ketchikan Creek ranged from 4 to 401, with median of 78.5 across both years. The highest 30-day geometric mean for *E. coli* in Carlanna Creek was 45.5 in July 2023, 93.3 in Hoadley Creek in July 2023, and 87.1 in Ketchikan Creek in May of 2024 (Table 5, Table 6).

For primary recreation, not more than 10% of *E. coli* samples may exceed 410 CFU/100 ml, and the geometric mean may not exceed 126 CFU/100 ml during a 30-day period. There was only one instance of *E. coli* exceeding 410 CFU/100 ml in Hoadley and Carlanna Creeks in 2023, and none in 2024, although during July 19, 2023, all sites exceeded the upper detection limit of 400 CFU/100 ml for that analysis. There were no instances of the geometric mean exceeding 126 CFU/100 ml for any site (Figure 5, Table 5, Table 6).

⁴ Results from all sites exceeded the upper quantitation limit of 400 CFU/100 ml for fecal coliform and *E. coli* because samples were not diluted sufficiently prior to analysis to quantify higher values. These are included as 401 CFU/100 ml in figures and analyses in this report.

⁵ During this month, a temporary encampment was established near KC02 following the seasonal closure of a nearby homeless shelter.

Table 5. 2023 bacteria results summary and comparison to water quality criteria for drinking water, aquaculture, and contact recreation.

Site	Characteristic	Range	Median	30 day Geomeans	% > 40 CFU/100 ml	% > 400 CFU/100 ml	% > 410 CFU/100 ml
CC02	Fecal coliform	BDL – 672	13	34.1 , 12.3	36%	18%	nr
HC02	Fecal coliform	2 – 630	24.5	102.0 , 8.3	42%	17%	nr
KC03	Fecal coliform	4 – >400	31	66.3 , 17.9	42%	8%	nr
CC02	E. coli	BDL – 614	14	45.5, 9.9	nr	nr	9%
HC02	E. coli	BDL – 510	22.5	93.3, 7.9	nr	nr	8%
KC03	E. coli	4 – >400	31	58.4, 21.0	nr	nr	0%

BDL = below detection limit (1 CFU/100 ml)

nr = not relevant to water quality criteria

Values in bold indicate water quality criteria exceedances.

Table 6. 2024 bacteria results summary and comparison to water quality criteria for drinking water, aquaculture, and contact recreation.

Site	Characteristic	Range	Median	30 day Geomeans	% > 40 CFU/100 ml	% > 400 CFU/100 ml	% > 410 CFU/100 ml
CC02	Fecal coliform	2 – 252	11	12.4, 19.1	30%	0%	nr
HC02	Fecal coliform	3 – 127	15.5	21.0 , 15.6	30%	0%	nr
KC03	Fecal coliform	36 – 376	98	106.6 , 89.9	90%	0%	nr
CC02	E. coli	2 – 209	12.5	10.0, 21.7	nr	nr	0%
HC02	E. coli	2 - 101	15.5	15.0, 15.0	nr	nr	0%
KC03	E. coli	19 - 278	91.5	87.1, 92.7	nr	nr	0%

BDL = below detection limit (1 CFU/100 ml)

nr = not relevant to water quality criteria

Values in bold indicate water quality criteria exceedances.

Water Quality Standards (18 AAC 70, DEC, 2025, Appendix D)

Drinking water: Not more than 10% of fecal coliform samples may exceed 40 CFU/100 ml; 30-day geometric mean may not exceed 20 CFU/100 ml.

Aquaculture: Not more than 10% of fecal coliform samples may exceed 400 CFU/100 ml; 30-day geometric mean may not exceed 200 CFU/100 ml.

Contact recreation: Not more than 10% of E. coli samples may exceed 410 CFU/100 ml; 30-day geometric mean may not exceed 126 CFU/100 ml.

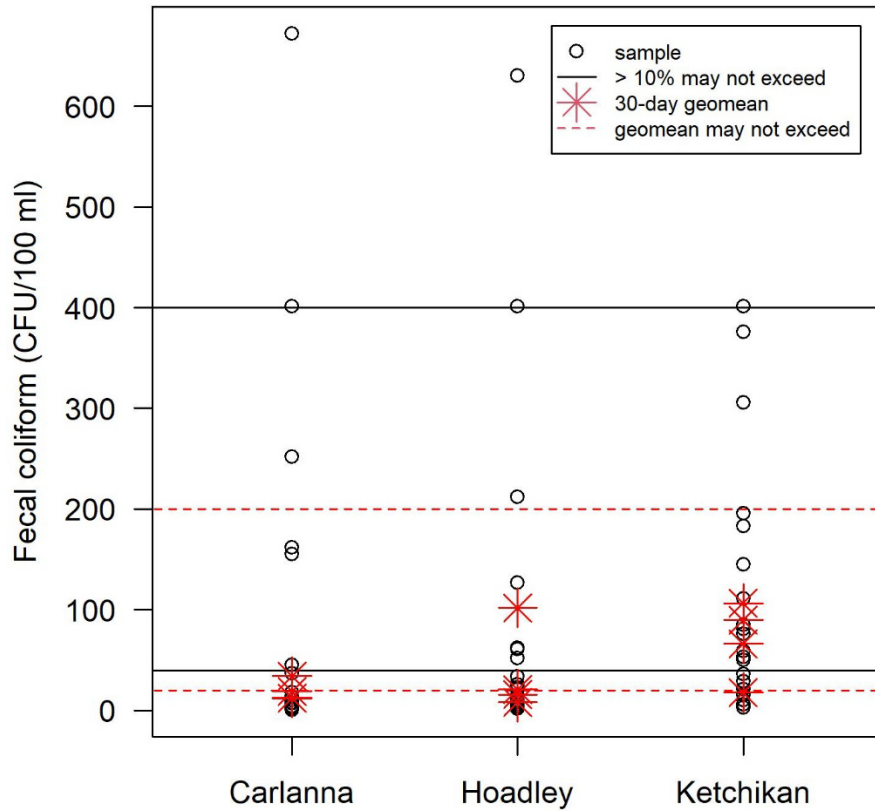


Figure 4. Fecal coliform concentrations for all samples collected across 2023 and 2024, and geometric means for four 30-day periods. The black lines at 400 and 40 CFU/100 ml correspond to the acute criteria for aquaculture and drinking water, respectively, and the dotted red lines at 200 and 20 CFU/100 ml correspond to the chronic criteria for aquaculture and drinking water, respectively.

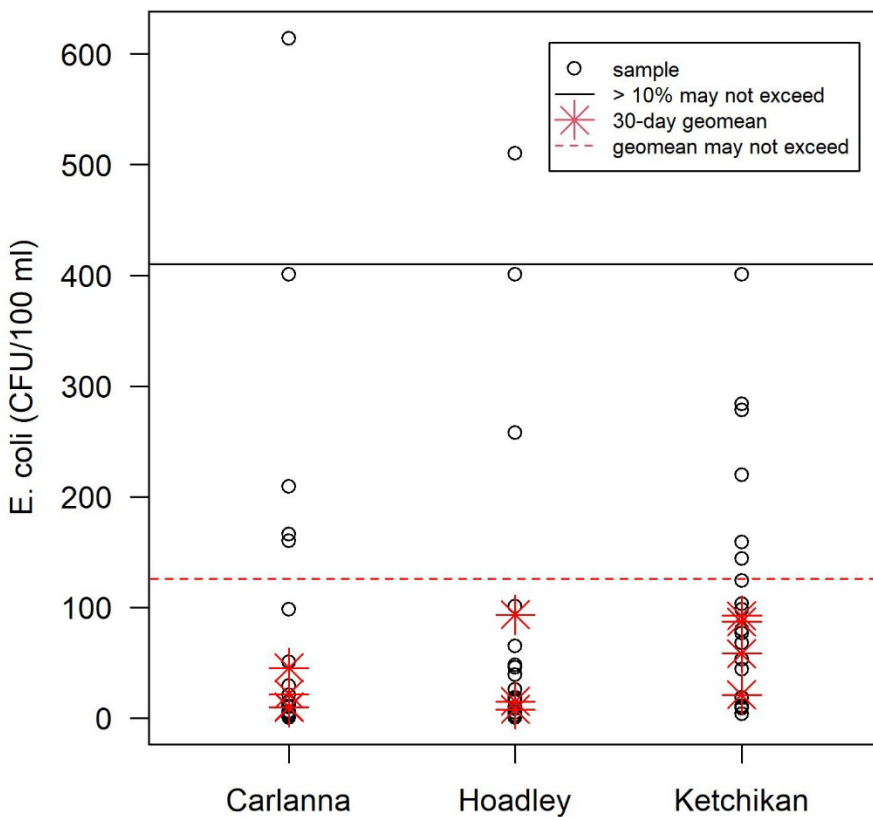


Figure 5. E. coli concentrations for all samples collected across 2023 and 2024, and geometric means for four 30-day periods. The black line at 410 CFU/100 ml and dotted red line at 126 correspond to the acute and chronic water quality criteria for contact recreation, respectively.

Microbial Source Tracking Results

Samples were analyzed for MST on July 19, 2023, when fecal coliform and *E. coli* concentrations were all above 400 CFU/100 ml, and August 27, 2024, when fecal coliform and *E. coli* concentrations were all below 100 in Ketchikan and Hoadley Creeks, but above 200 in Carlanna Creek. In 2023, fecal bacteria from birds, dogs, and ruminants were detected at all locations, with only ruminants being quantifiable, and fecal bacteria from humans were detected in Ketchikan Creek (Table 7) but not quantifiable. In 2024, fecal bacteria from ruminants were detected in Carlanna Creek but not quantifiable. No other DNA markers were detected in 2024. The July 2023 sampling occurred during the “first flush” of a large summer storm event following a dry period. In contrast, the August 2024 event occurred during the end of a large two-day storm event when many pollutants may have already been washed from the watershed, which may have contributed to differences observed between years.

Table 7. MST results from a single sampling event in 2023 and 2024.

Site	Source	Result (copies/100 ml)	
		7/19/2023	8/27/2024
CC02	Bird	DNQ* (<500)	ND**
HC02	Bird	DNQ (<500)	ND
KC03	Bird	DNQ (<500)	ND
CC02	Dog	DNQ (<500)	ND
HC02	Dog	DNQ (<500)	ND
KC03	Dog	7100	ND
CC02	Human	ND	ND
HC02	Human	ND	ND
KC03	Human	DNQ (<500)	ND
CC02	Ruminant	2600	DNQ (<1880)
HC02	Ruminant	3170	ND
KC03	Ruminant	DNQ (<500)	ND

*DNQ = Did Not Quantify (source was detected with a value above the limit of detection, but below the limit of quantification)

**ND = Not Detected

Nutrients, Dissolved Organic Carbon, Alkalinity, Hardness and Other Ions

Across all sampling sites and events, alkalinity, hardness and ions (Ca, Cl, Mg, and Na) were all strongly correlated with one another (Figure E. 1). Sampling sites had relatively low alkalinity and hardness compared to other streams in the region⁶. However, concentrations were generally higher downstream than upstream (excluding KC01) (Figure 6, Table 8), indicating inputs of dissolved solids from urban or other natural sources between the reference and urban sampling locations. Concentrations of settleable solids were below detection limit (0.1 ml/l) for all sampling events and sites (Table 8).

Nutrients (ammonia-nitrogen, nitrate+nitrite-nitrogen, total and dissolved phosphorus) and dissolved organic carbon concentrations were generally low did not indicate water quality concerns (DEC, 2022b) (Figure 7, Table 9). However, concentrations of nitrate-nitrite and phosphorus generally increased from up to downstream in Hoadley, while in Carlanna, only nitrate showed an increase from up to downstream (Figure 7, Table 9). In Ketchikan Creek, ammonium and phosphorus concentrations were generally higher downstream than upstream Figure 7, Table 9). Dissolved organic carbon concentrations did not have strong spatial patterns (Figure 7), but the highest concentrations were observed during high flow events, including the large events on September 17 and 23, 2024 (Figure C. 3, Figure C. 6, Figure C. 9).

⁶ Compared to values from 1990 onward for southeast Alaska streams included in the national Water Quality Portal <https://www.waterqualitydata.us/beta>.

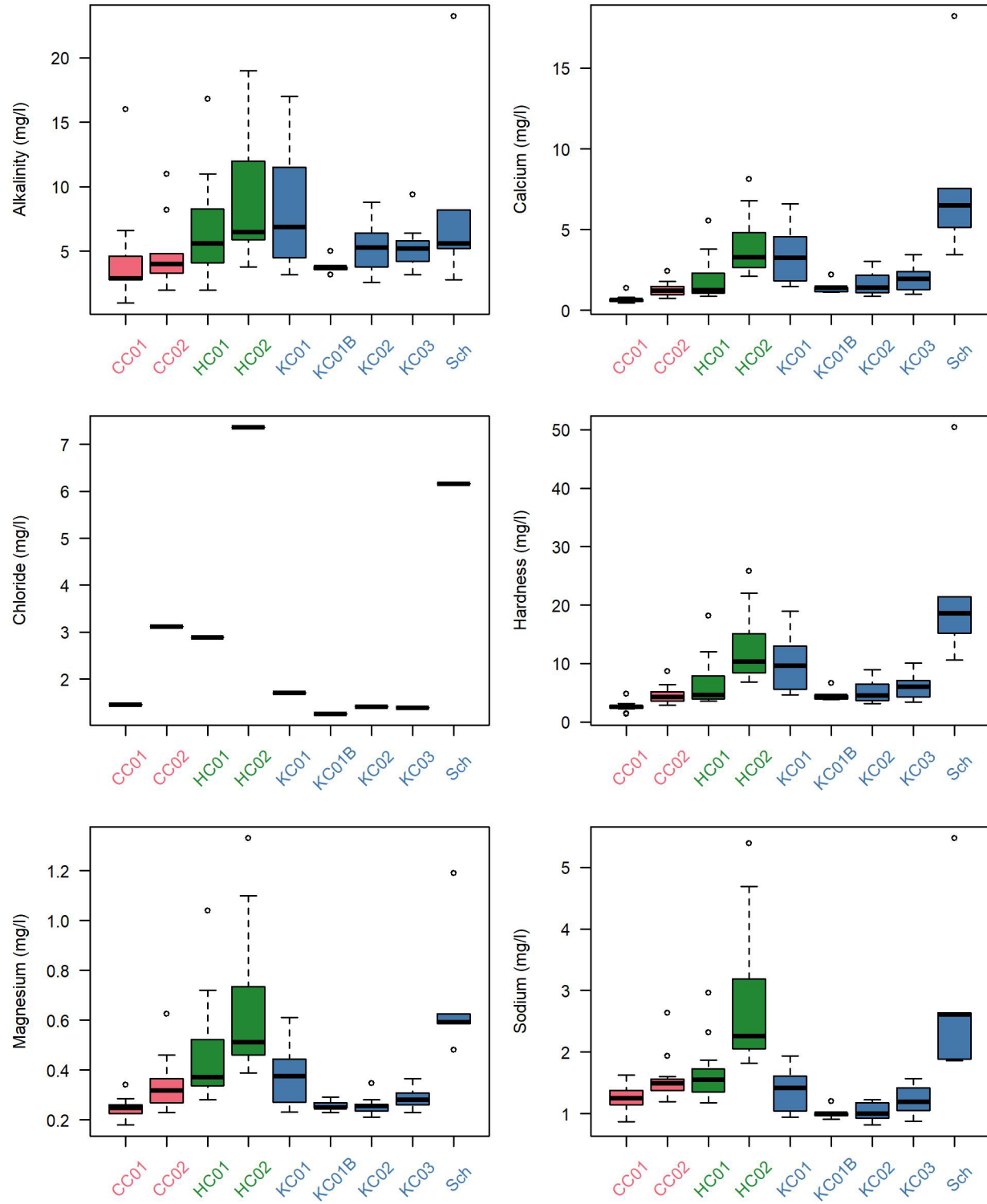


Figure 6. Distributions of alkalinity, calcium, chloride, hardness, magnesium, and sodium concentrations across sampling locations. Note that the hydropower penstock outfall is below KC01 and is integrated into KC01B. Chloride concentration was analyzed only once.

Table 8. Summary statistics for alkalinity, hardness, settleable solids, and ions for each sampling site.

Site	statistic	Alkalinity (mg/l)	Chloride (mg/l)	Hardness (mg/l)	Magnesium (mg/l)	Settleable Solids (ml/l)	Sodium (mg/l)	Sulfate (mg/l)
CC01	mean	4.3	1.45	2.63	0.245	0.05	1.26	0.54
CC01	median	2.9	1.45	2.60	0.249	0.05	1.26	0.54
CC01	range	1-16	NA	1.40 - 4.82	0.180 - 0.340	0.05 - 0.05	0.87 - 1.63	NA
CC02	mean	4.7	3.12	4.64	0.343	0.05	1.57	3.56
CC02	median	4.0	3.12	4.31	0.318	0.05	1.50	3.56
CC02	range	2-11	NA	2.91 - 8.64	0.230 - 0.625	0.05 - 0.05	1.19 - 2.64	NA
HC01	mean	6.8	2.89	6.83	0.475	0.05	1.68	4.86
HC01	median	5.6	2.89	4.65	0.371	0.05	1.55	4.86
HC01	range	2 - 16.8	NA	3.58 - 18.2	0.280 - 1.040	0.05 - 0.05	1.18 - 2.96	NA
HC02	mean	8.7	7.36	12.51	0.640	0.05	2.78	8.32
HC02	median	6.5	7.36	10.35	0.511	0.05	2.27	8.32
HC02	range	3.8 - 19	NA	6.80 - 25.80	0.387 - 1.330	0.05 - 0.05	1.82 - 5.39	NA
KC01	mean	8.2	1.71	9.97	0.377	0.05	1.38	4.66
KC01	median	6.9	1.71	9.65	0.375	0.05	1.42	4.66
KC01	range	3.2 - 17	NA	4.65 - 19.00	0.231 - 0.610	0.05 - 0.05	0.94 - 1.94	NA
KC02	mean	5.3	1.41	5.16	0.256	0.05	1.03	1.58
KC02	median	5.3	1.41	4.59	0.256	0.05	1.01	1.58
KC02	range	2.6 - 8.8	NA	3.10 - 8.97	0.210 - 0.346	0.05 - 0.05	0.82 - 1.23	NA
KC03	mean	5.2	1.39	6.01	0.283	0.05	1.23	1.53
KC03	median	5.2	1.39	6.02	0.280	0.05	1.20	1.53
KC03	range	3.2 - 9.4	NA	3.40 - 10.10	0.230 - 0.365	0.05 - 0.05	0.88 - 1.57	NA
KC01B	mean	3.9	1.26	4.69	0.257	0.05	1.02	0.96
KC01B	median	3.8	1.26	4.44	0.249	0.05	1.00	0.96
KC01B	range	3.2 - 5	NA	3.87 - 6.70	0.229 - 0.292	0.05 - 0.05	0.914 - 1.2	NA
Schoenbar	mean	9.0	6.16	23.24	0.695	0.05	2.89	31.5
Schoenbar	median	5.6	6.16	18.60	0.593	0.05	2.61	31.5
Schoenbar	range	2.8 - 23.2	NA	10.60 - 50.40	0.481 - 1.190	0.05 - 0.05	1.86 - 5.47	NA

Water Quality Standards (18 AAC 70, DEC, 2025, Appendix D)

Chloride: May not exceed 250 mg/l for drinking water

Sulfate: May not exceed 250 mg/l for drinking water

Settleable Solids: No measurable increase above natural conditions for drinking water; no imposed loads that will interfere with established water supply treatment levels for aquaculture

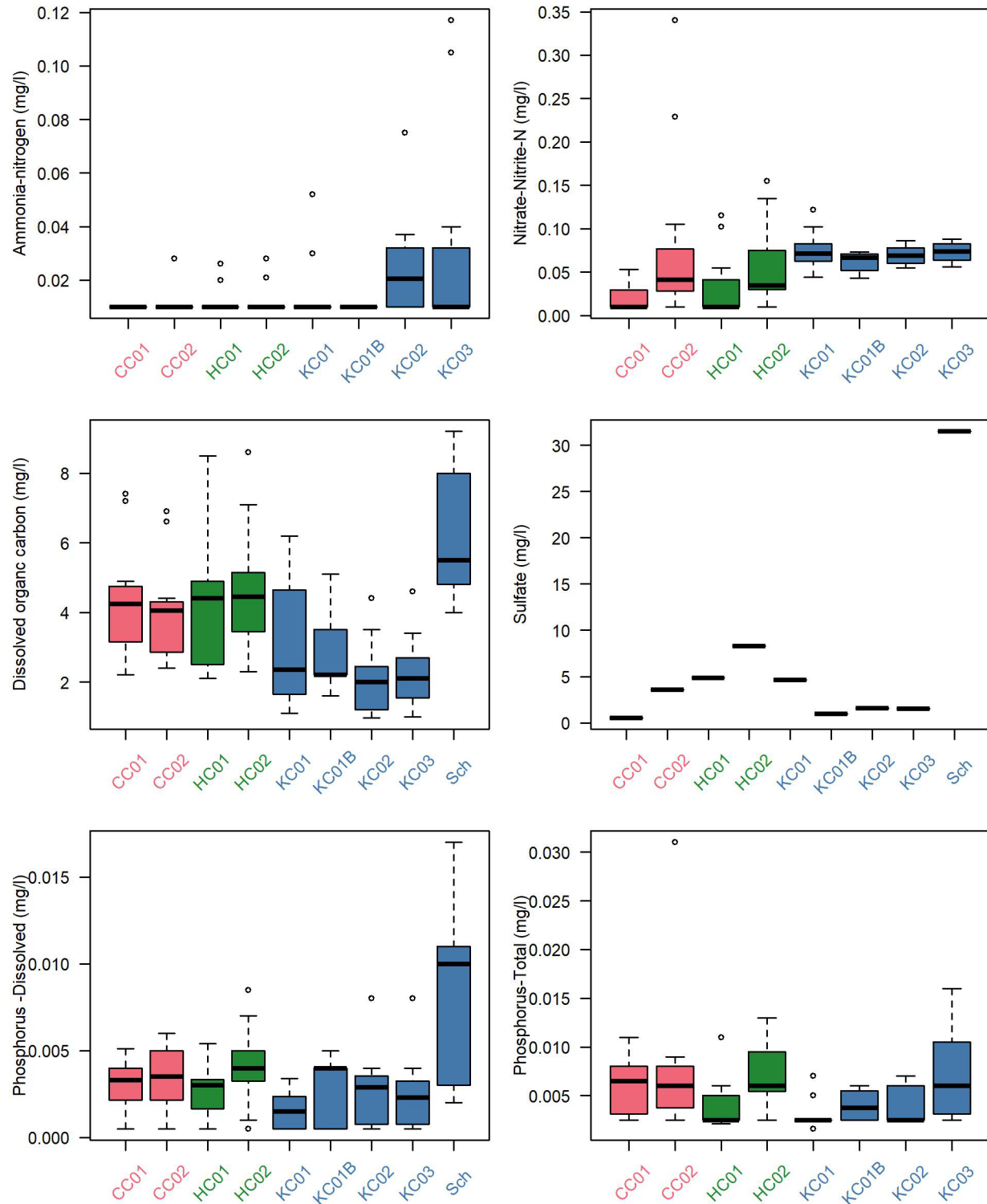


Figure 7. Distributions of ammonia-nitrogen, nitrate-nitrite-nitrogen, dissolved organic carbon, sulfate, and total and dissolved phosphorus across all sampling locations. Note that the hydropower penstock outfall is below KC01 and is integrated into KC01B. Sulfate concentration was analyzed only once.

Table 9. Summary statistics for nutrients and dissolved organic carbon for each site.

Site	statistic	Ammonia-nitrogen (mg/l)	Nitrate-Nitrite-N (mg/l)	Dissolved organic carbon (mg/l)	Phosphorus-Total (mg/l)	Phosphorus - Dissolved (mg/l)
CC01	mean	0.01	0.020	4.3	0.006	0.0031
	median	0.01	0.010	4.3	0.007	0.0033
	range	0.01 - 0.01	0.010 - 0.053	2.2 - 7.4	0.0025 - 0.011	0.0005 - 0.0051
CC02	mean	0.01	0.081	4.0	0.008	0.0034
	median	0.01	0.042	4.1	0.006	0.0035
	range	0.01 - 0.028	0.010 - 0.34	2.4 - 6.9	0.0025 - 0.031	0.0005 - 0.006
HC01	mean	0.01	0.034	4.3	0.004	0.0027
	median	0.01	0.010	4.4	0.003	0.0030
	range	0.01 - 0.026	0.010 - 0.115	2.1 - 8.5	0.0021 - 0.011	0.0005 - 0.0054
HC02	mean	0.01	0.056	4.6	0.007	0.0042
	median	0.01	0.035	4.5	0.006	0.0040
	range	0.01 - 0.028	0.010 - 0.155	2.3 - 8.6	0.0025 - 0.013	0.0005 - 0.0085
KC01	mean	0.02	0.075	3.0	0.003	0.0016
	median	0.01	0.072	2.4	0.003	0.0015
	range	0.01 - 0.052	0.044 - 0.122	1.1 - 6.2	0.0016 - 0.007	0.0005 - 0.0034
KC02	mean	0.02	0.070	2.1	0.004	0.0027
	median	0.02	0.069	2.0	0.003	0.0029
	range	0.01 - 0.075	0.055 - 0.086	0.97 - 4.4	0.0024 - 0.007	0.0005 - 0.008
KC03	mean	0.031	0.073	2.3	0.007	0.0025
	median	0.01	0.074	2.1	0.006	0.0023
	range	0.01 - 0.117	0.056 - 0.088	0.99 - 4.6	0.0025 - 0.016	0.0005 - 0.008
KC01B	mean	0.01	0.061	2.9	0.004	0.0028
	median	0.01	0.067	2.2	0.004	0.0040
	range	0.01 - 0.01	0.043 - 0.073	1.6 - 5.1	0.0025 - 0.006	0.0005 - 0.005
Schoenbar	mean	NA	NA	6.3	NaN	0.0086
	median	NA	NA	5.5	NA	0.0100
	range	NA	NA	4 - 9.2	NA	0.002 - 0.017

Water quality standards (18 AAC 70, DEC, 2022b, Appendix D)

Ammonium-nitrogen: Acute criteria for waters with salmon ranges from 32.6-13.3 mg/l for pH 6.5-7.5; chronic criteria for waters with salmon ranges from 6.06-3.97 mg/l for pH 6.5-7.5 @ 16°C.

Nitrate+nitrite-nitrogen: <10 mg/l for drinking water.

Dissolved Metals

Samples from KC01, KC02, KC03, HC01, HC02, CC01, and CC02 were analyzed for dissolved metals 12 times during 2023 (5 events) and 2024 (7 events) (Appendix B). Schoenbar and KC01B were added for the final five events. Cadmium and chromium concentrations were below detection limit (0.05 µg/l, and 0.2 µg/l, respectively) for all sites and sampling events (Figure 8, Table 10). Additionally, lead concentrations were below detection limit (0.2 µg/l) for all sampling events except one – July 10, 2023, when samples from both Carlanna Creek sites, HC02 and KC03 were slightly elevated, but they did not exceed hardness-based acute criteria, or chronic criteria that were above the detection limit.

Copper concentrations were frequently above the detection limit (0.2 µg/l) at all sampling locations, and concentrations tended to be higher at downstream sites than upstream sites (Figure 8, Figure 9, Figure 10, Figure 11), with median concentrations increasing from 0.24 to 0.42 at CC01 and CC02, respectively, from 0.24 to 0.95 at HC01 and HC02, respectively, and from 0.31 to 0.35 to 1.71 at KC01B, KC02, and KC03, respectively (Table 10). Copper concentrations were elevated in Schoenbar Creek compared to all other sampling sites (median 19.5 µg/l, Figure 8, Table 10). However, Schoenbar Creek, which enters Ketchikan Creek between KC01B and KC02, appeared to have little effect on copper concentrations at KC02, which were quite similar to KC01 and KC01B (Figure 8). The increase in copper concentration from KC02 and KC03 may be due to urban sources, or other geologic sources in the watershed.

Multiple exceedances of hardness-based copper criteria were observed in all three streams (Figure 12), including the reference site at Carlanna (CC01), the urban site in Hoadley (HC02), the two urban sites in Ketchikan Creek (KC02 and KC03), and Schoenbar creek. Concentrations exceeded hardness-based chronic criteria at CC01 (3/12 times), HC02 (4/12 times), KC02 (1/12), KC03 (8/12), and Schoenbar (5/5). Concentrations exceed hardness-based acute-criteria at CC01 (3/12 times), HC02 (1/12 times), KC03 (8/12 times), and Schoenbar (5/5 times).

Zinc concentrations were also frequently above the detection limit at all sites, with concentrations generally higher at the downstream urban sites ((Figure 8, , Figure 9, Figure 10, Figure 11, Table 10). Median concentrations increased from 0.76 to 0.80 at CC01 and CC02, respectively, and from 0.66 to 2.0 at HC01 to HC02 (Table 10). The median zinc concentration at KC03 (1.58) was higher than any of the upstream sites, and Schoenbar Creek had the highest zinc concentrations of any site (median 3.0). However, no hardness-based criteria for zinc were exceeded during the study.

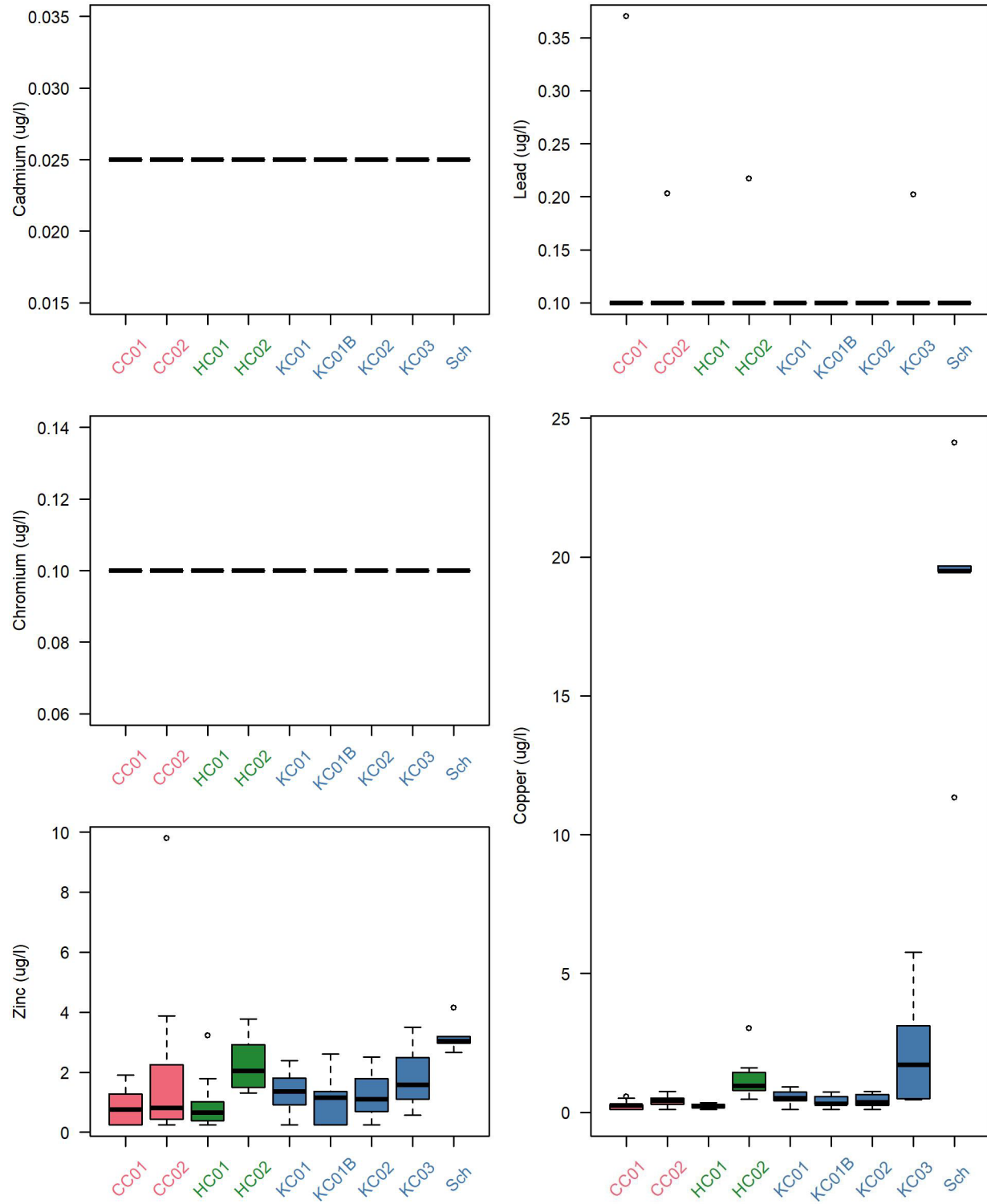


Figure 8. Distributions of cadmium (all below detection limit of 0.05 $\mu\text{g/l}$), chromium (all below detection limit of 0.2 $\mu\text{g/ml}$), copper, lead (nearly all below detection limit of 0.2 $\mu\text{g/l}$), and zinc concentrations at all sampling sites. Note that results below detection limits are plotted as half of the detection limit, so all values for cadmium are 0.025 $\mu\text{g/l}$ and all for chromium and most for lead are 0.10 $\mu\text{g/l}$.

Table 10. Summary statistics for dissolved metals at each sampling site. Results that were below the detection limit shown as half the detection limit.

Site	statistic	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Lead (µg/l)	Zinc (µg/l)
CC01	mean	BDL*	BDL	0.25	0.123	0.847
CC01	median	BDL	BDL	0.24	BDL	0.759
CC01	range	NA	NA	0.1 - 0.57	BDL - 0.37	BDL - 1.91
CC02	mean	BDL	BDL	0.41	0.109	1.903
CC02	median	BDL	BDL	0.42	BDL	0.804
CC02	range	NA	NA	0.1 - 0.76	BDL - 0.203	BDL - 9.79
HC01	mean	BDL	BDL	0.23	BDL	0.925
HC01	median	BDL	BDL	0.24	BDL	0.660
HC01	range	NA	NA	0.1 - 0.35	NA	BDL - 3.232
HC02	mean	BDL	BDL	1.18	0.110	2.224
HC02	median	BDL	BDL	0.95	BDL	2.038
HC02	range	NA	NA	0.47 - 3.02	BDL - 0.217	1.301 - 3.777
KC01	mean	BDL	BDL	0.56	BDL	1.340
KC01	median	BDL	BDL	0.52	BDL	1.363
KC01	range	NA	NA	0.1 - 0.92	NA	BDL - 2.38
KC01B	mean	BDL	BDL	0.40	BDL	1.122
KC01B	median	BDL	BDL	0.31	BDL	1.154
KC01B	range	NA	NA	0.1 - 0.724	NA	BDL - 2.606
KC02	mean	BDL	BDL	0.40	BDL	1.196
KC02	median	BDL	BDL	0.35	BDL	1.102
KC02	range	NA	NA	0.1 - 0.752	NA	BDL - 2.514
KC03	mean	BDL	BDL	2.16	0.109	1.836
KC03	median	BDL	BDL	1.71	BDL	1.575
KC03	range	NA	NA	0.45 - 5.773	BDL - 0.202	0.573 - 3.5
Schoenbar	mean	BDL	BDL	18.82	BDL	3.204
Schoenbar	median	BDL	BDL	19.50	BDL	3.034
Schoenbar	range	NA	NA	11.34 - 24.12	NA	2.666 - 4.156

BDL = below detection limit:

Cadmium detection limit: 0.05 µg/l

Chromium detection limit: 0.2 µg/l

Copper detection limit: 0.2 µg/l

Lead detection limit: 0.2 µg/l

Zinc detection limit: 0.5 µg/l

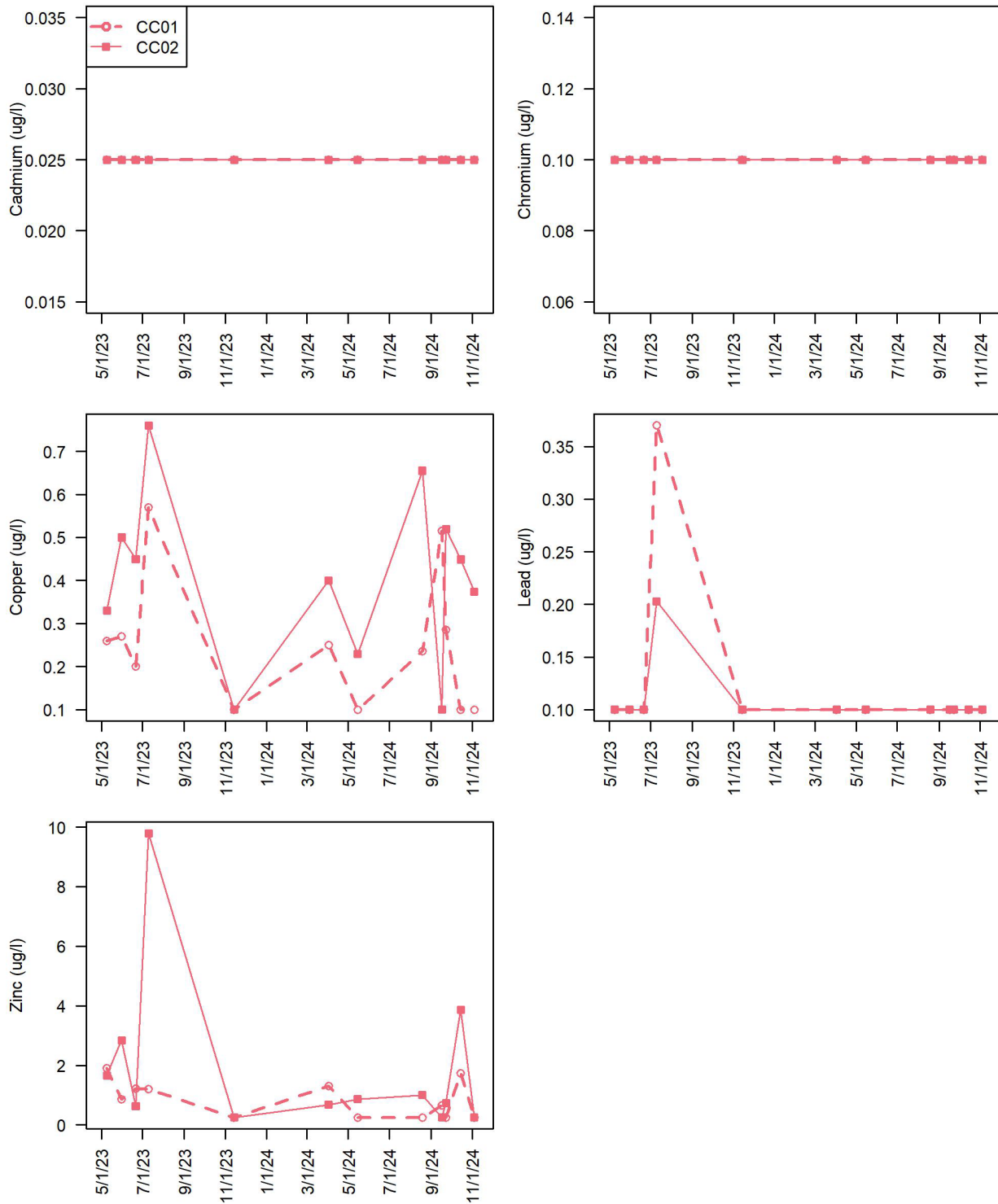


Figure 9. Metal concentrations in Carlanna Creek at CC01 and CC02 over time.

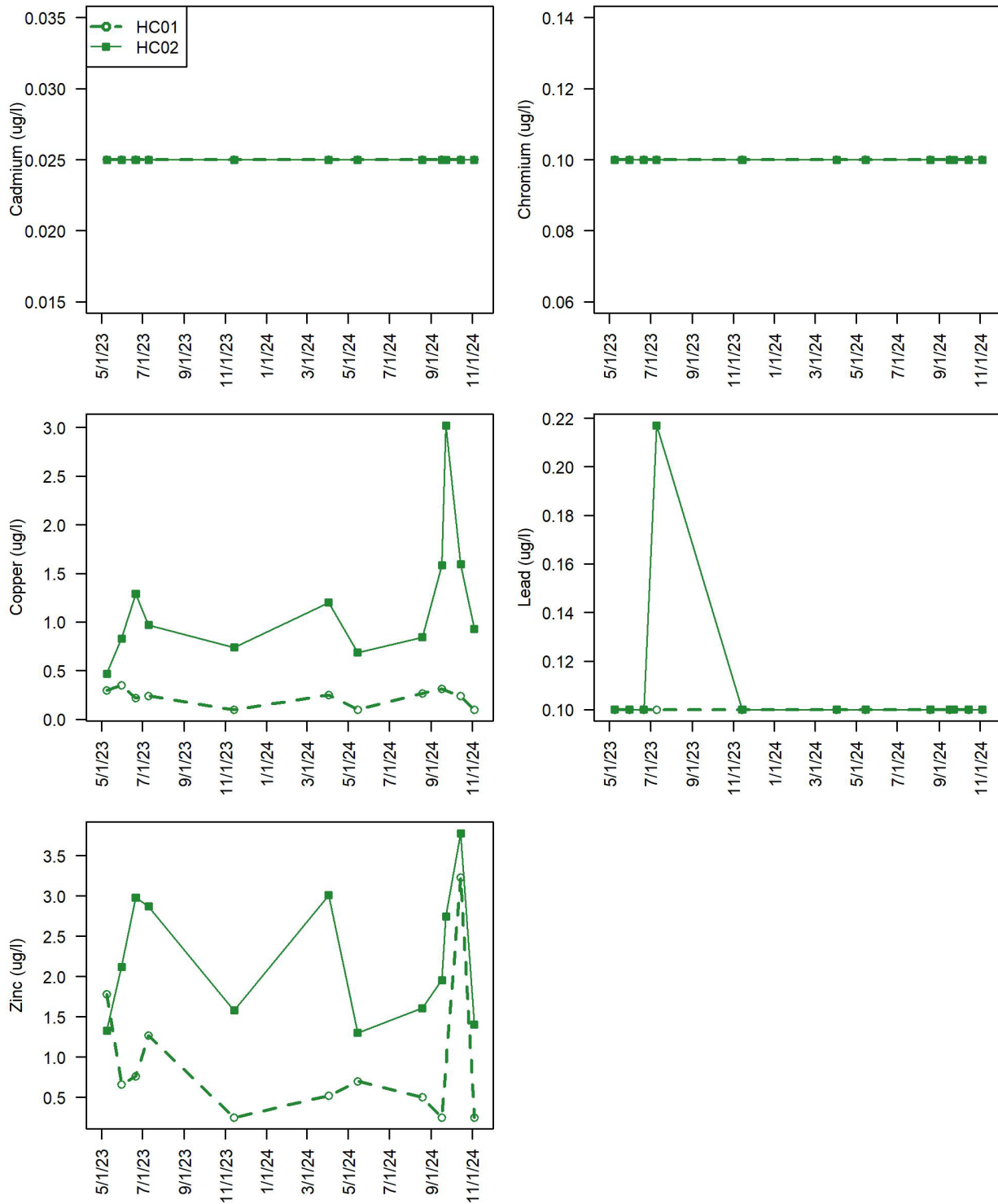


Figure 10. Metal concentrations in Hoadley Creek at HC01 and HC02 over time.

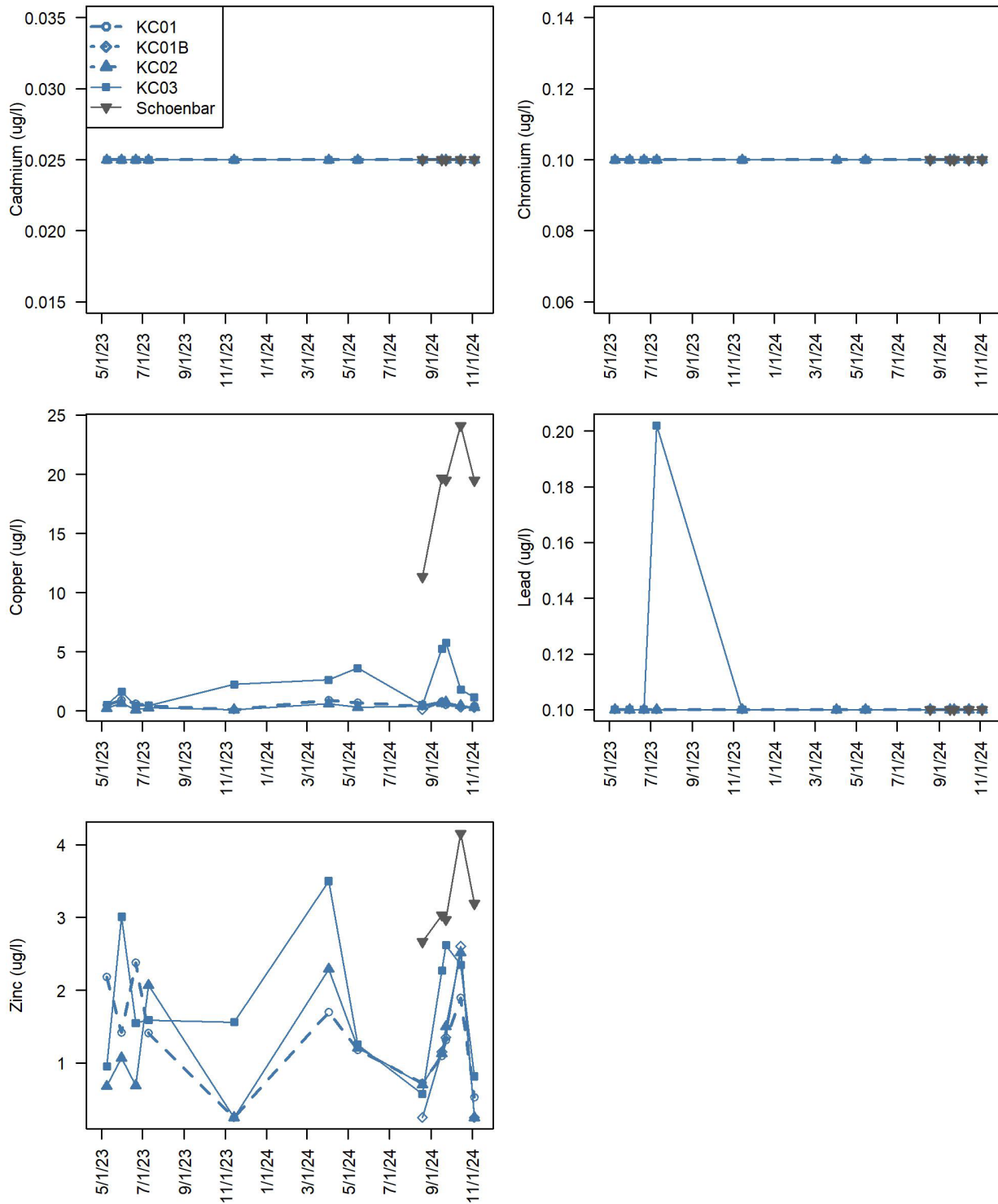


Figure 11. Metal concentrations in Ketchikan Creek at KC01, KC01B, KC02, KC03 and Schoenbar over time.

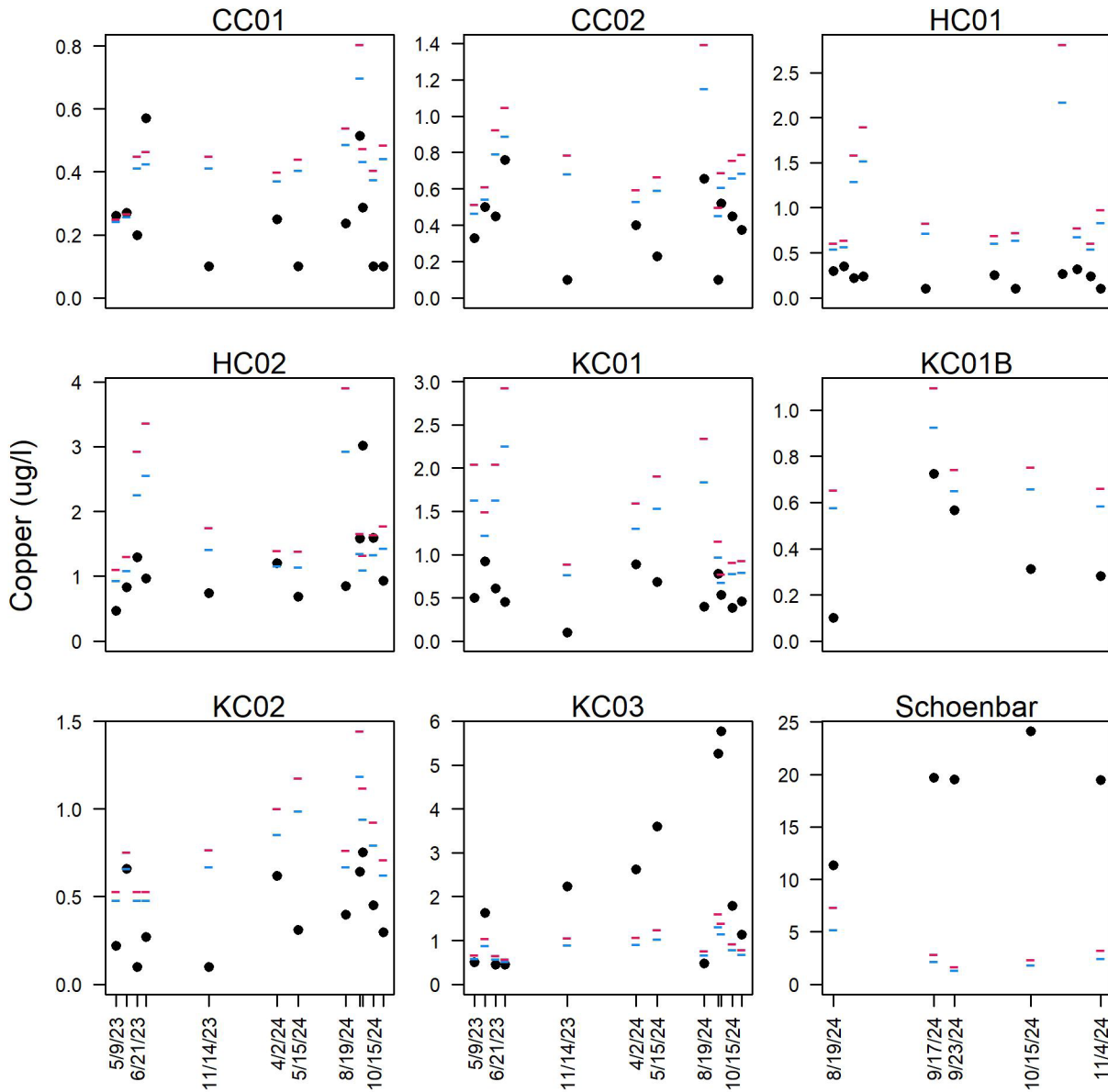


Figure 12. Copper concentrations at each site (black dot) compared to hardness-based chronic (blue line) and acute (red line) criteria. Hardness-based criteria were calculated as described in DEC 2022b and shown in Appendix D.

Conclusion

Ketchikan, Hoadley, and Carlanna Creeks were monitored for common urban pollutants, including dissolved metals, nutrients, and bacteria (fecal coliform and *E. coli*), as well as conventional water quality parameters, including hardness, alkalinity, major ions, pH, dissolved oxygen, temperature, specific conductivity, turbidity. Monitoring occurred in reference locations upstream of urban development and in urban locations downstream of development during 2023 and 2024. Samples were collected in accordance with the project QAPP, and sampling completion was sufficient to allow for impairment assessments.

Most water quality parameters were within expected ranges and met water quality criteria across all sites. However, fecal coliform concentrations exceeded water quality criteria for drinking water in Ketchikan, Hoadley, and Carlanna Creeks during 2023 and 2024. Carlanna and Hoadley Creeks exceeded water quality criteria for aquaculture in 2023 only. Microbial Source Tracking indicated the presence of fecal bacteria from dogs, birds, and ruminants (e.g. deer, goats) in all three streams, and the presence of fecal bacteria from humans in Ketchikan Creek. Of the dissolved metals analyzed (cadmium, chromium, copper, lead and zinc), only copper and zinc had concentrations that were consistently above the method detection limit and could be quantified. Hardness-based criteria for copper were exceeded at the upstream reference Carlanna site but not the downstream urban site, despite higher concentrations downstream. Hardness-based criteria for copper were also exceeded at the downstream urban Hoadley site, and downstream urban Ketchikan sites, where concentrations were also higher than the upstream sites. No exceedances of hardness-based criteria for zinc were observed in any of the sites.

Overall, comparisons of water quality parameters between upstream “reference” and downstream urban sites showed patterns of increasing specific conductivity and individual ions downstream, which may be due to high concentrations of salts and other minerals in urban runoff. Copper and zinc concentrations also increased downstream. These metals are also associated with urban sources and runoff, although there are known copper deposits in the local geology that impact water quality and could be contributing to observed patterns.

The lower watersheds of all three creeks are highly developed with extensive pavement and stormwater drainage systems. Additionally, many sections of the riparian areas are developed, and damage to vegetation is common, especially along Hoadley and Ketchikan creeks. Identifying opportunities to divert runoff from the storm drain system and treat it, as well as restoring as much native riparian vegetation as possible could help improve water quality in Ketchikan’s urban streams.

Citations

DEC (2022a). Alaska Department of Environmental Conservation Waterbody Field Report. Ketchikan Creeks, Ketchikan, Alaska. Available online at: <file:///C:/Users/SAWC%20User/Downloads/2018-ketchikan-creeks-field-report.pdf>.

DEC (2022b). Alaska water quality criteria manual for toxic and other deleterious organic and inorganic substances, Alaska Department of Environmental Conservation, as amended through September 8, 2022.

DEC (2025) 18 AAC 70 Water Quality Standards Amended as of January 8, 2025, Alaska Department of Environmental Conservation. Available online at: <https://dec.alaska.gov/media/eovgrgs5/18-aac-70.pdf>.

ARRI (2014) Ketchikan Creeks Stormwater Quality Assessment. Available online at: <https://dec.alaska.gov/media/16765/ketchikan-creeks-2014-adec.pdf>.

Appendix A. Photos of sampling locations

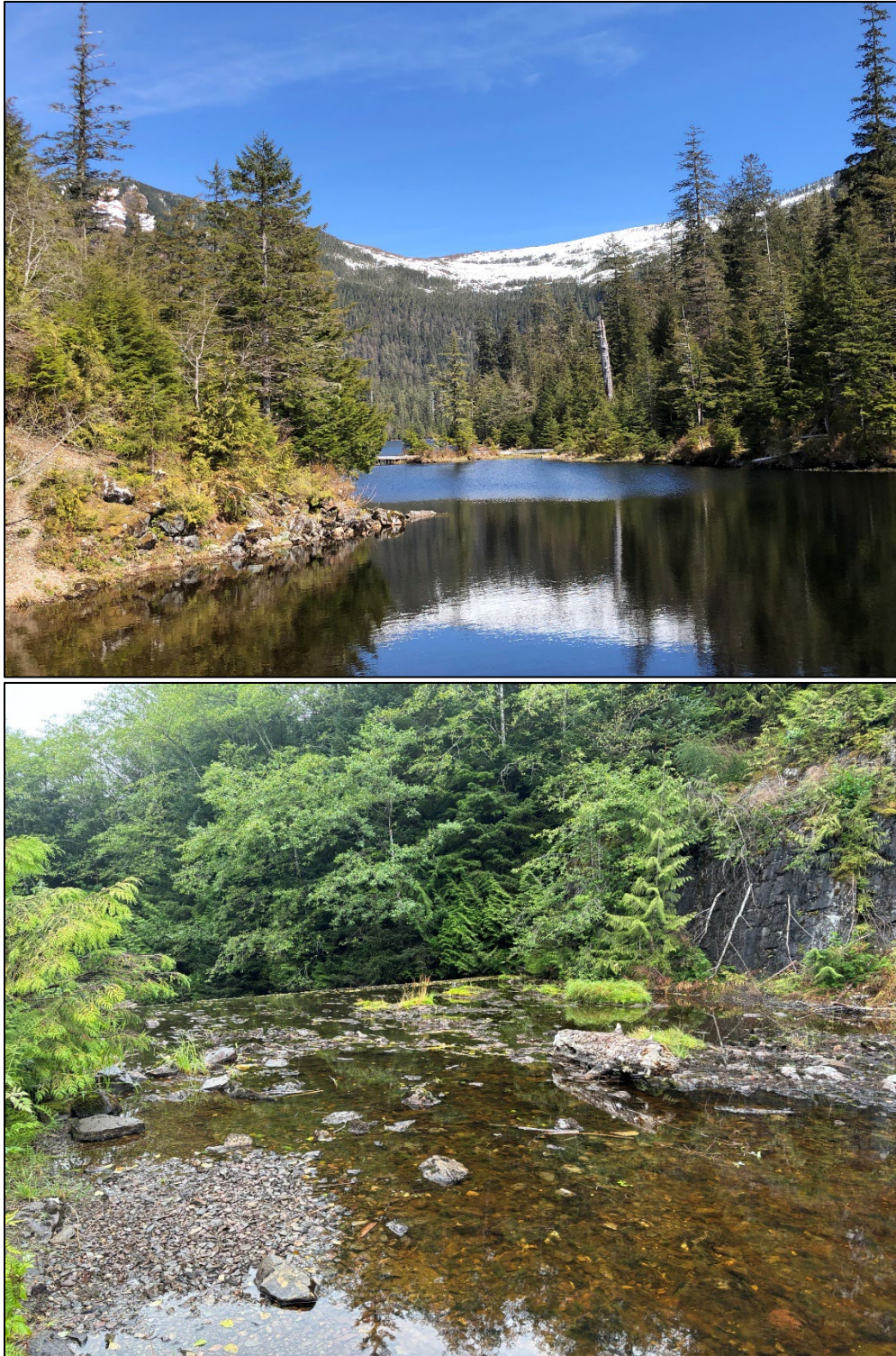


Figure A. 1. Photos at CC01 looking upstream 5/9/23 (top) and downstream 8/19/24 (bottom) from the sampling site.

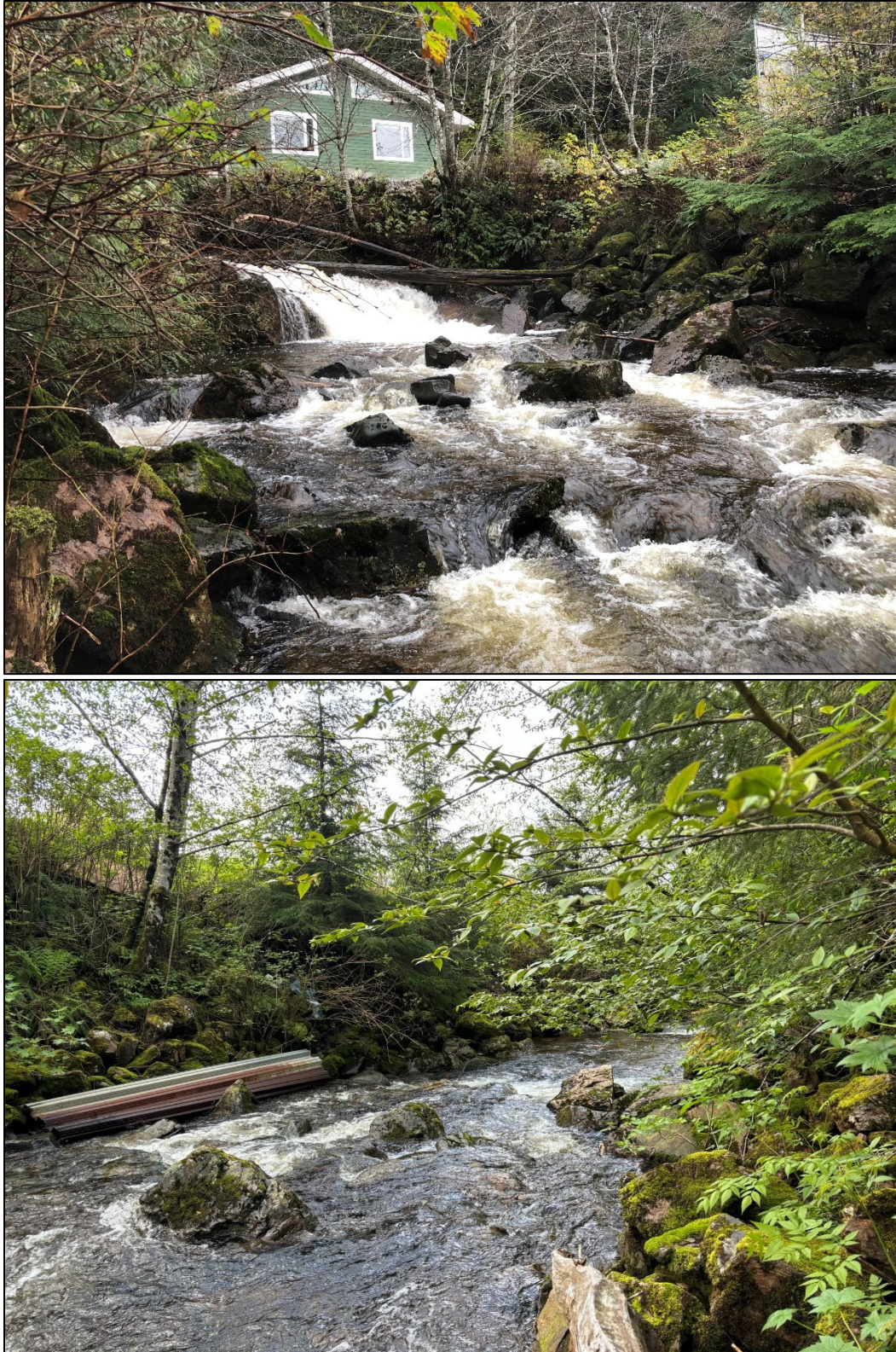


Figure A. 2. Photos at CC02 looking upstream 10/19/23 (top) and downstream 5/15/24 (bottom) from the sampling site.



Figure A. 3. Photos at HC01 looking upstream 4/2/24 (top) and downstream 4/2/24 (bottom) from the sampling site.



Figure A. 4. Photos at HC02 looking upstream 10/10/23 (top) and downstream 10/26/23 (bottom) from the sampling site.



Figure A. 5. Photos at KC01 looking upstream (top) and downstream (bottom) from the sampling site.



Figure A. 6. Photos from KC01B looking upstream 8/19/24 (top) and downstream 8/19/24 (bottom) from the sampling site.



Figure A. 7. Photos from KC02 looking upstream 9/17/24 (top) and downstream 9/17/24 (bottom) from the sampling site.



Figure A. 8. Photos from KC03 looking upstream 7/13/23 (top) and downstream 7/17/23 (bottom) of the sampling site.



Figure A. 9. Photos from Schoenbar looking upstream 10/15/24 (top) and downstream 11/4/24 (bottom) of the sampling site.

Appendix B. Sample Dates and flow conditions

Date	Samples* Collected For:	Flow conditions	Prior 24 hour precip (in)	Notes
5/9/2023	WQ	Spring melt	0	
5/31/2023	WQ	Spring	0.81	
6/21/2023	WQ	Summer low	0	
7/10/2023	WQ, bacteria	Summer low	0	
7/13/2023	Bacteria	Summer low	0	
7/17/2023	Bacteria	Summer moderate	0	
7/19/2023	bacteria, MST	Summer storm event	2.84	
7/31/2023	Bacteria	Summer high flow	NA	
8/8/2023	Bacteria	Summer storm	3.18	
10/2/2023	Bacteria	Fall	0.53	
10/10/2023	Bacteria	Fall storm event	0.79	
10/19/2023	Bacteria	Fall storm event	1.07	
10/24/2023	Bacteria	Fall	0	
10/26/2023	Bacteria	Fall	0	Access to CC02 blocked and no sample taken.
10/31/2023	Bacteria	Fall	0	
11/14/2023	WQ	Fall storm event	0.57	
4/2/2024	WQ	Spring melt	1.13	
5/14/2024	bacteria	Spring melt	0.92	
5/15/2024	WQ	Spring	0.15	
5/21/2024	bacteria	Spring	0	
5/23/2024	bacteria	Spring rain	NA	raining all day; weather stations down
5/29/2024	bacteria	Spring	NA	weather stations down
5/30/2024	bacteria	Spring	0.28	
7/29/2024	bacteria	Summer low	0	
8/5/2024	bacteria	Summer low	0	
8/8/2024	bacteria	Summer low	0	
8/19/2024	WQ, bacteria	Summer low	0.01	
8/27/2024	bacteria, MST	summer moderate	0	2.45" 2 days prior
9/17/2024	WQ	Fall storm event	0.85	
9/23/2024	WQ	Fall storm event	1.53	Very high discharge; samples could not be safely collected at HC01
10/15/2024	WQ	Fall storm event	0.82	additional 0.77" during sampling
11/4/2024	WQ	Fall	0.35	

*WQ = all water quality characteristics except for fecal bacteria. Bacteria = fecal coliform and E. coli. MST = Microbial Source Tracking.

Appendix C. Water quality parameters over time

Carlanna Creek

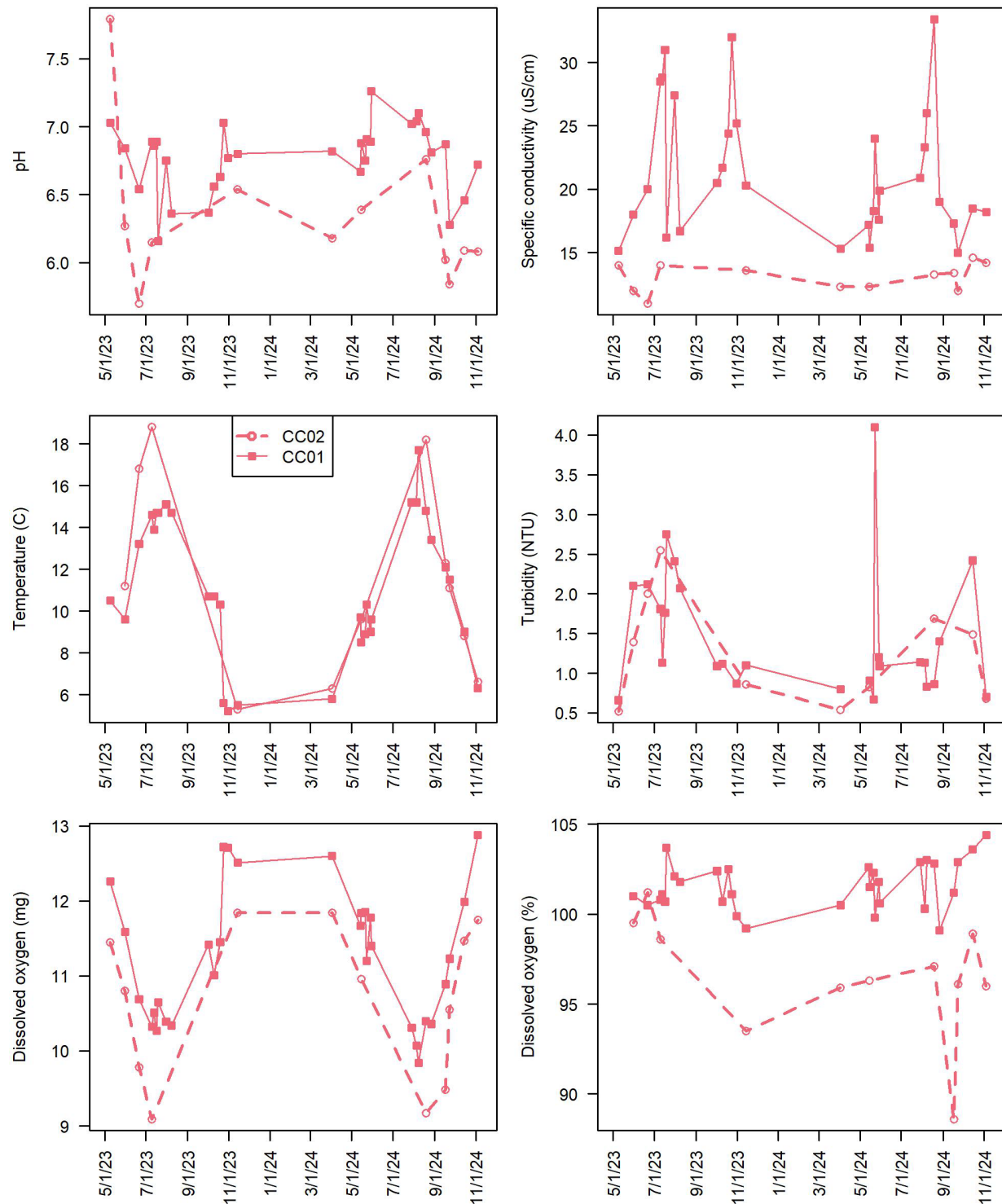


Figure C. 1. In situ water quality parameters across sampling dates in Carlanna Creek.

Carlanna Creek

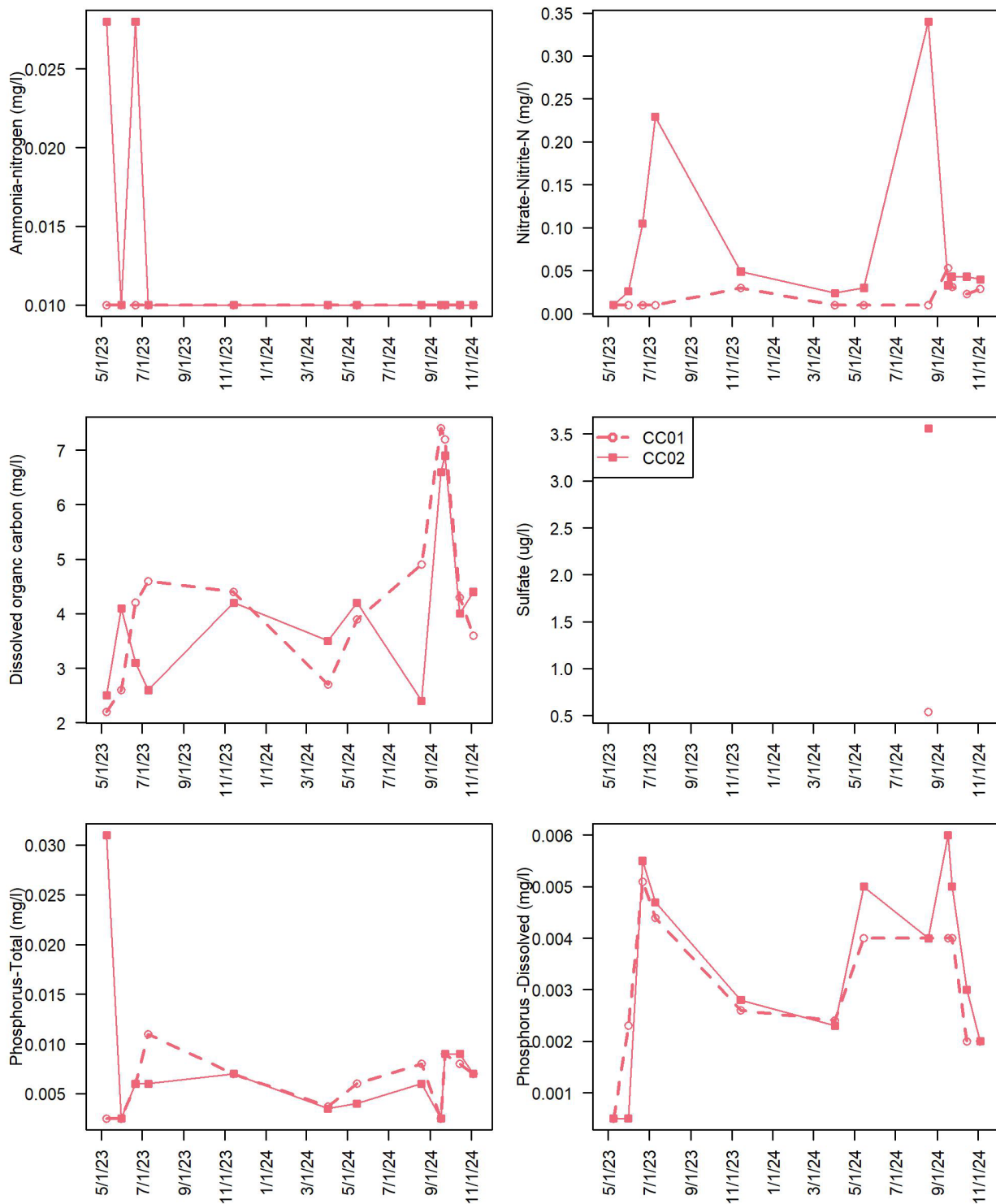


Figure C. 3. Ammonia-N, Nitrate-nitrite-N, dissolved organic carbon, sulfate, and total and dissolved phosphorus over time in Carlanna Creek at CC01 and CC02.

Hoadley Creek

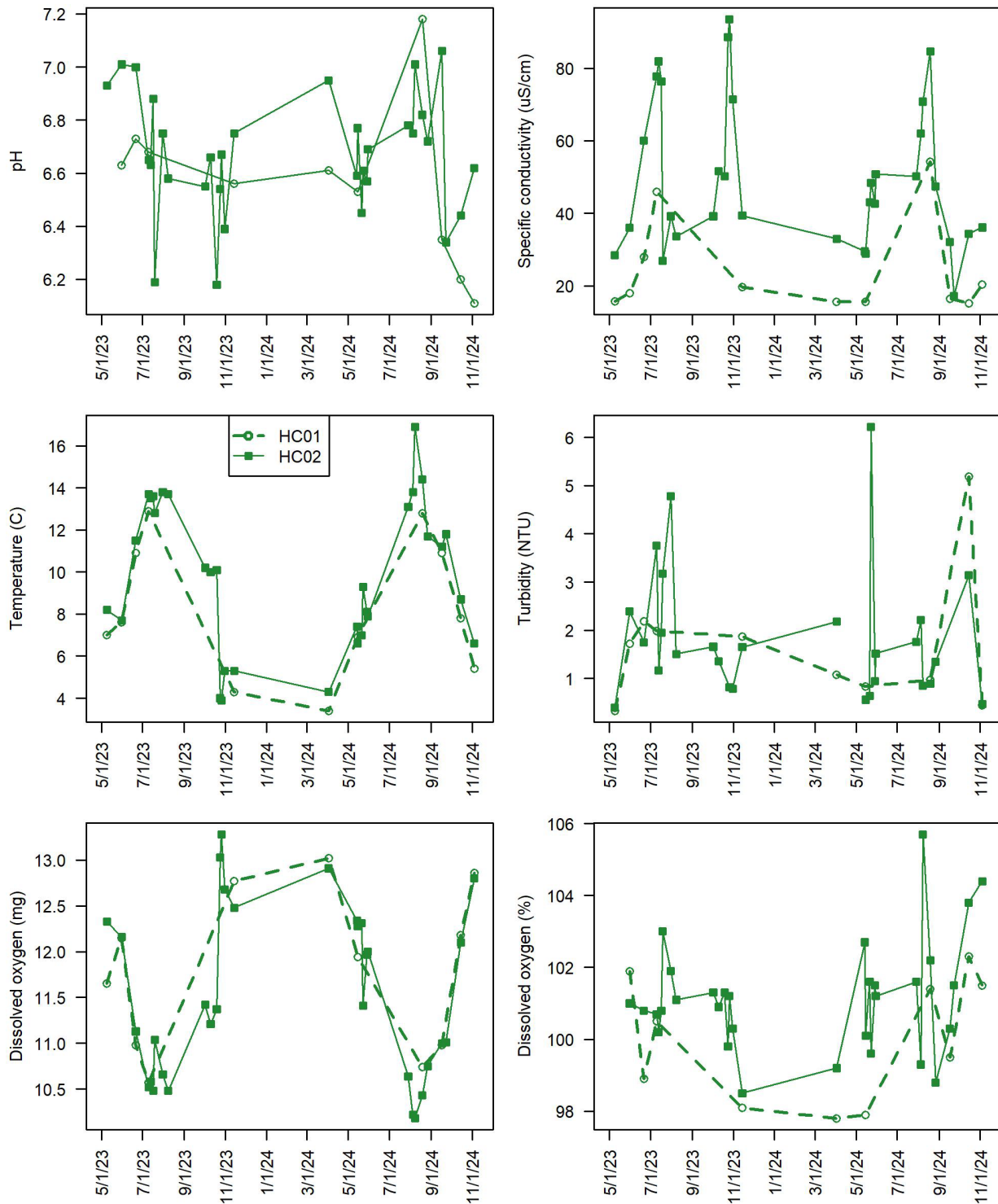


Figure C. 4. In situ water quality parameters across sampling dates in Hoadley Creek.

Hoadley Creek

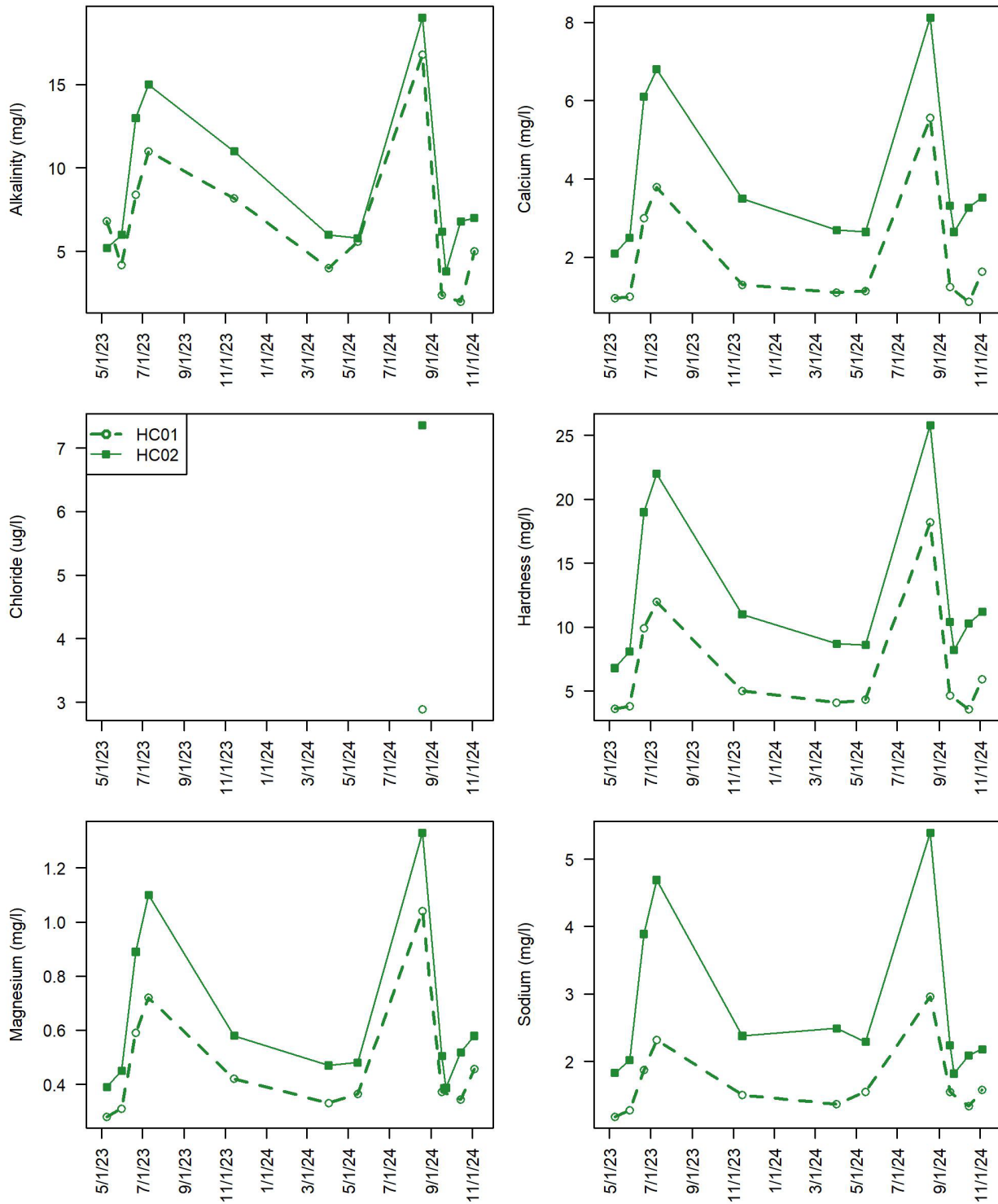


Figure C. 5. Alkalinity, calcium, chloride, hardness, magnesium, and sodium over time in Hoadley Creek at HC01 and HC02.

Hoadley Creek

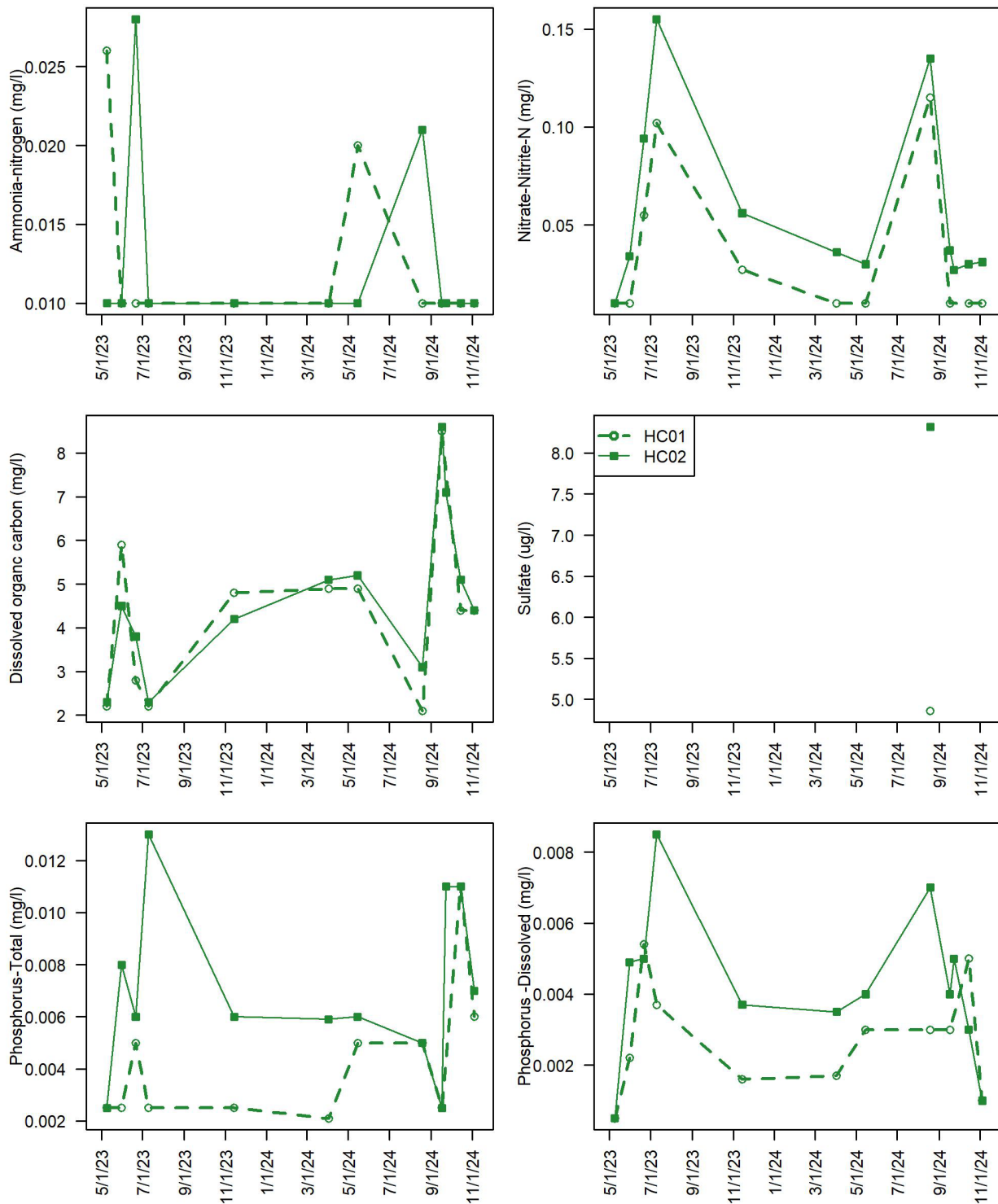


Figure C. 6. Ammonia-N, Nitrate-nitrite-N, dissolved organic carbon, sulfate, and total and dissolved phosphorus over time in Hoadley Creek at HC01 and HC02.

Ketchikan Creek

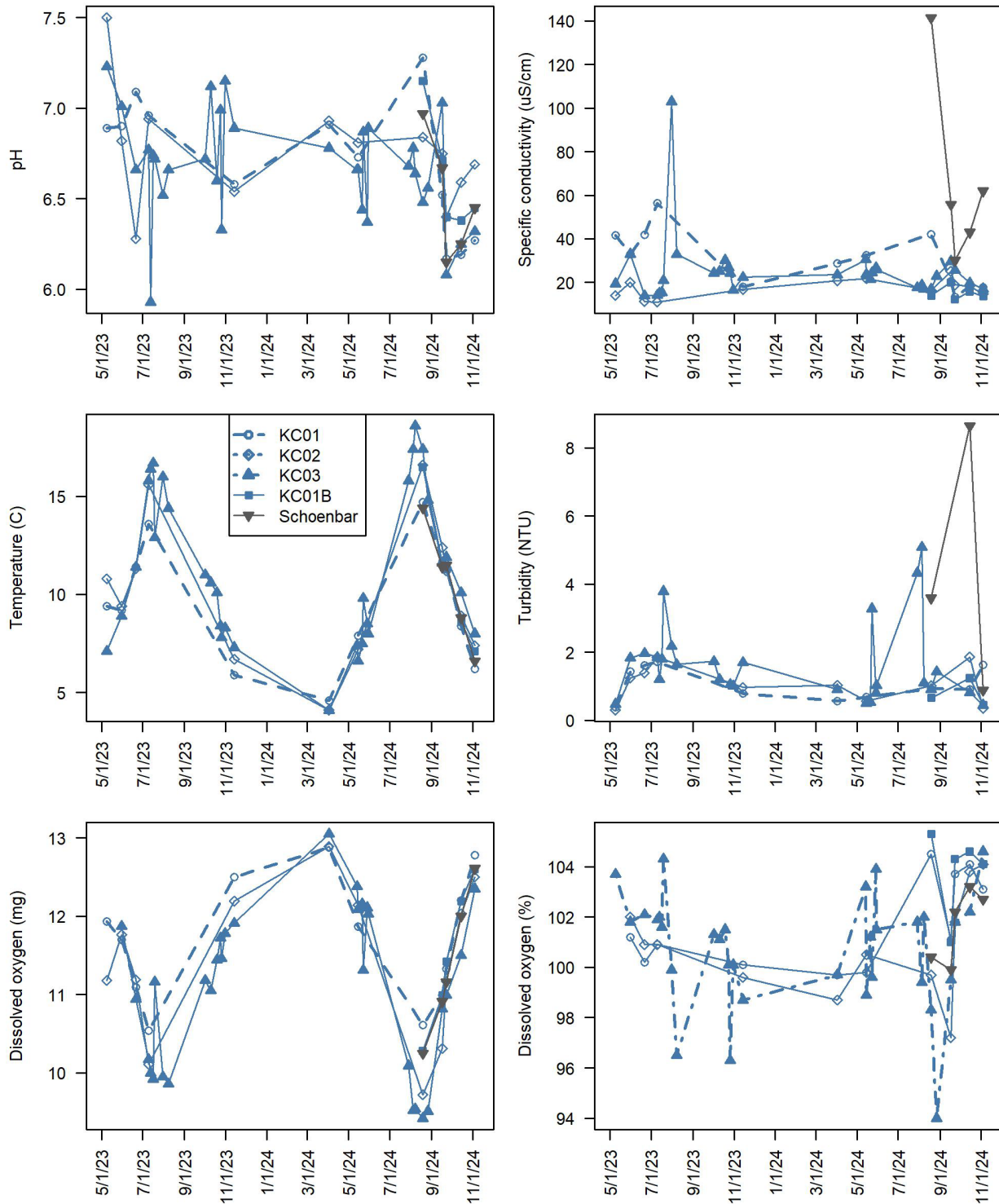


Figure C. 7. In situ water quality parameters across sampling dates in Ketchikan Creek.

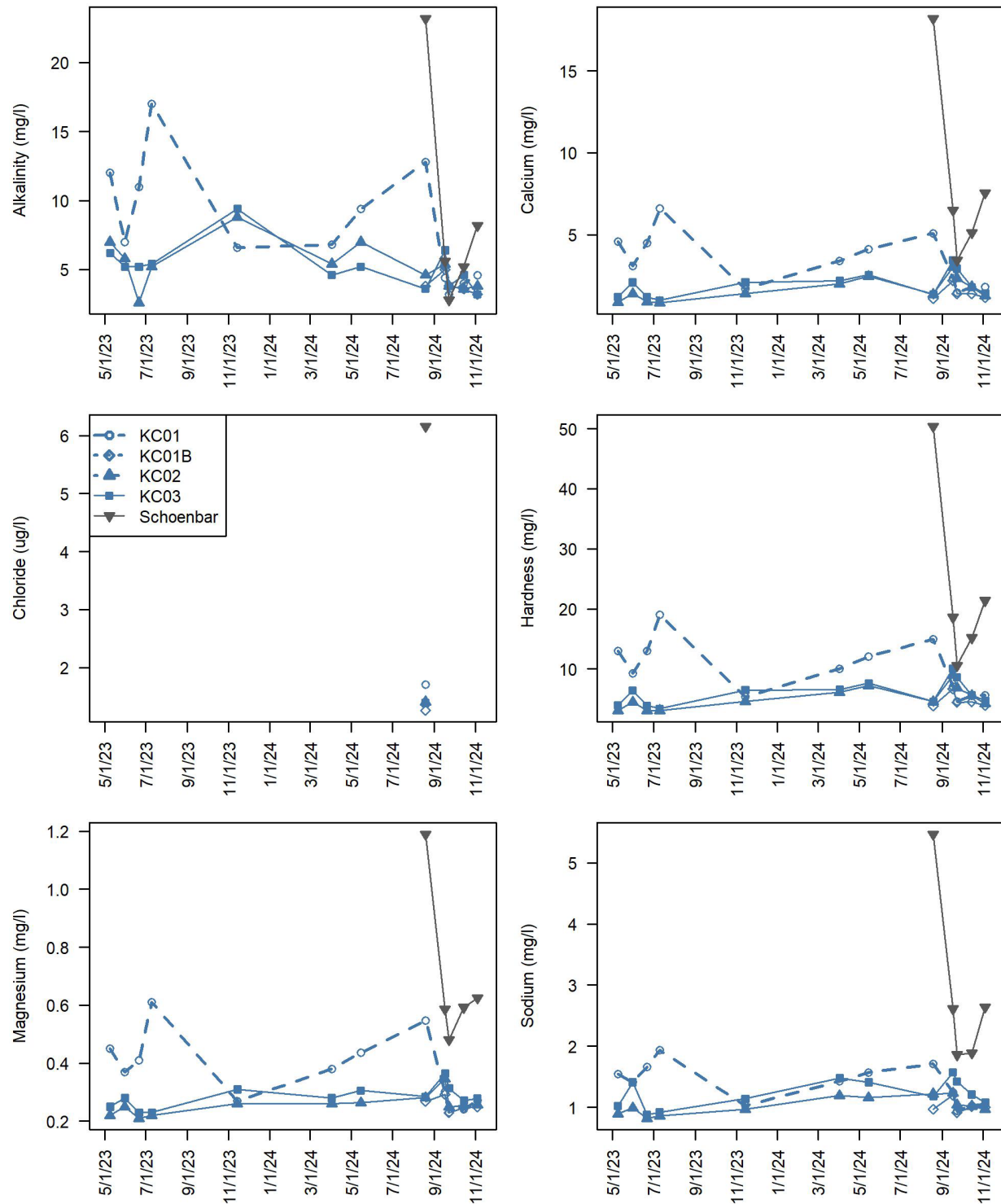


Figure C. 8. Alkalinity, calcium, chloride, hardness, magnesium, and sodium over time in Ketchikan Creek watershed at KC01, KC01B, KC02, KC03, and Schoenbar Creek.

Ketchikan Creek

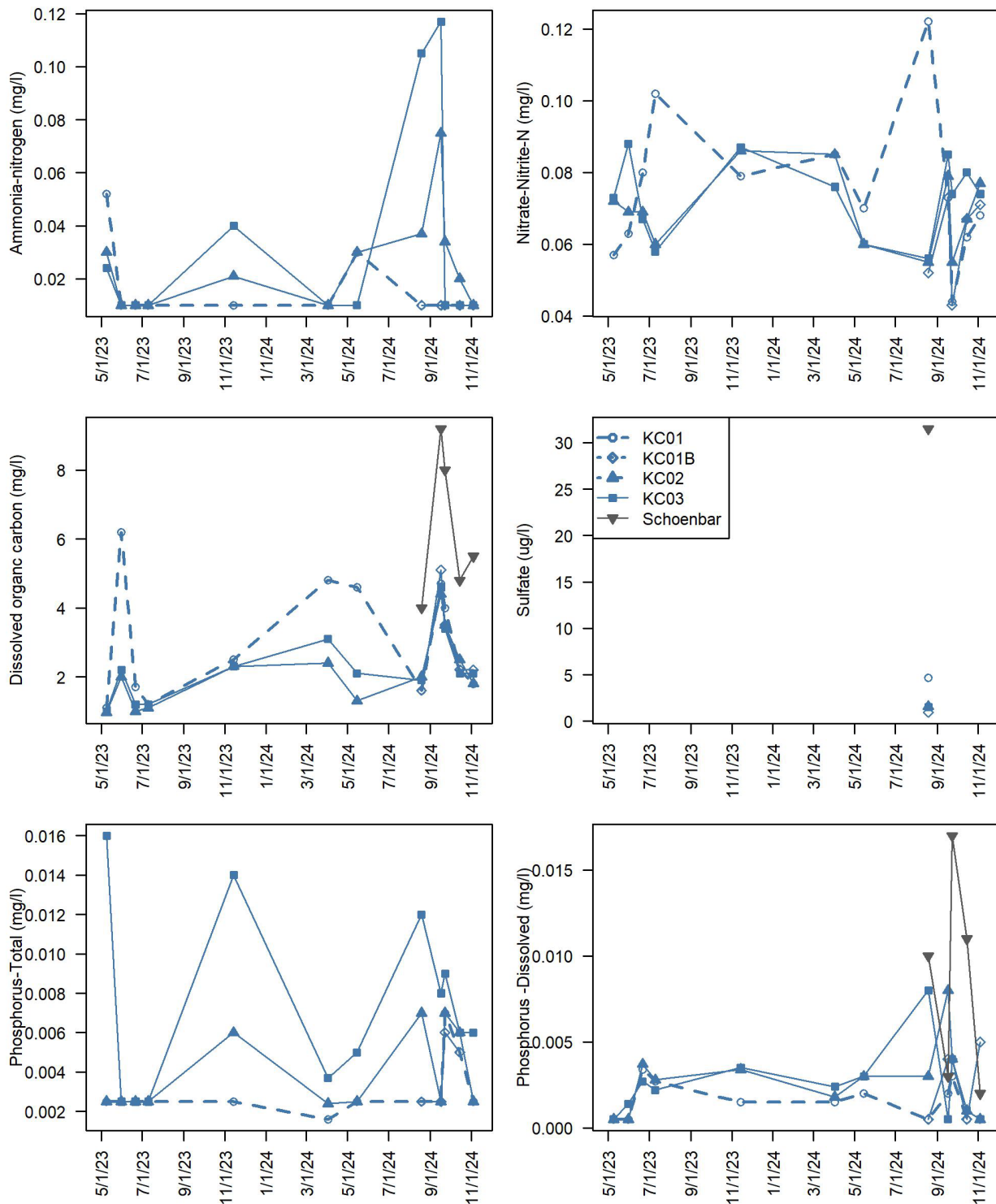


Figure C. 9. Ammonia-N, Nitrate-nitrite-N, dissolved organic carbon, sulfate, and total and dissolved phosphorus over time in Ketchikan Creek watershed at KC01, KC01B, KC02, KC03, and Schoenbar Creek.

Appendix D. Water Quality Standards 18 AAC 70

Register 250, JULY 2024

ENVIRONMENTAL CONSERVATION

Water Quality Standards for Designated Uses	
POLLUTANT & WATER USE	CRITERIA
(3) DISSOLVED GAS, FOR FRESH WATER USES	
(A) Water Supply (i) drinking, culinary, and food processing	Dissolved oxygen (D.O.) must be greater than or equal to 4 mg/l (this does not apply to lakes or reservoirs in which supplies are taken from below the thermocline, or to groundwater).
(A) Water Supply (ii) agriculture, including irrigation and stock watering	D.O. must be greater than 3 mg/l in surface waters.
(A) Water Supply (iii) aquaculture	D.O. must be greater than 7 mg/l in surface waters. The concentration of total dissolved gas may not exceed 110% of saturation at any point of sample collection.
(A) Water Supply (iv) industrial	May not cause detrimental effects on established water supply treatment levels.
(B) Water Recreation (i) contact recreation	D.O. must be greater than or equal to 4 mg/l.
(B) Water Recreation (ii) secondary recreation	Same as (3)(B)(i).
(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	D.O. must be greater than 7 mg/l in waters used by anadromous or resident fish. In no case may D.O. be less than 5 mg/l to a depth of 20 cm in the interstitial waters of gravel used by anadromous or resident fish for spawning (see note 2). For waters not used by anadromous or resident fish, D.O. must be greater than or equal to 5 mg/l. In no case may D.O. be greater than 17 mg/l. The concentration of total dissolved gas may not exceed 110% of saturation at any point of sample collection.

Register 250, JULY 2024

ENVIRONMENTAL CONSERVATION

Water Quality Standards for Designated Uses	
POLLUTANT & WATER USE	CRITERIA
	aquatic life, except as authorized by this chapter. Substances may not be present in concentrations that individually or in combination impart undesirable odor or taste to fish or other aquatic organisms, as determined by either bioassay or organoleptic tests.
(12) TURBIDITY, FOR FRESH WATER USES (criteria are not applicable to groundwater)	
(A) Water Supply (i) drinking, culinary, and food processing	May not exceed 5 nephelometric turbidity units (NTU) above natural conditions when the natural turbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 25 NTU.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	May not cause detrimental effects on indicated use.
(A) Water Supply (iii) aquaculture	May not exceed 25 NTU above natural conditions. For all lake waters, may not exceed 5 NTU above natural conditions.
(A) Water Supply (iv) industrial	May not cause detrimental effects on established water supply treatment levels.
(B) Water Recreation (i) contact recreation	May not exceed 5 NTU above natural conditions when the natural turbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 15 NTU. May not exceed 5 NTU above natural turbidity for all lake waters.
(B) Water Recreation (ii) secondary recreation	May not exceed 10 NTU above natural conditions when natural turbidity is 50 NTU or less, and may not have more than 20% increase in turbidity when the natural turbidity is greater than 50 NTU, not to exceed a maximum increase of 15 NTU. For all lake waters, turbidity may not exceed 5 NTU above natural turbidity.
(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	Same as (12)(A)(iii).

Register 250, JULY 2024

ENVIRONMENTAL CONSERVATION

Water Quality Standards for Designated Uses	
POLLUTANT & WATER USE	CRITERIA
(6) pH, FOR FRESH WATER USES (variation of pH for water naturally outside the specified range must be toward the range)	
(A) Water Supply (i) drinking, culinary, and food processing	May not be less than 6.0 or greater than 8.5.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	May not be less than 5.0 or greater than 9.0.
(A) Water Supply (iii) aquaculture	May not be less than 6.5 or greater than 8.5. May not vary more than 0.5 pH unit from natural conditions.
(A) Water Supply (iv) industrial	May not be less than 5.0 or greater than 9.0.
(B) Water Recreation (i) contact recreation	May not be less than 6.5 or greater than 8.5. If the natural condition pH is outside this range, substances may not be added that cause an increase in the buffering capacity of the water.
(B) Water Recreation (ii) secondary recreation	Same as (6)(A)(iv).
(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	May not be less than 6.5 or greater than 8.5. May not vary more than 0.5 pH unit from natural conditions.

Register 250, JULY 2024

ENVIRONMENTAL CONSERVATION

Water Quality Standards for Designated Uses	
POLLUTANT & WATER USE	CRITERIA
(10) TEMPERATURE, FOR FRESH WATER USES	
(A) Water Supply (i) drinking, culinary, and food processing	May not exceed 15° C.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	May not exceed 30° C.
(A) Water Supply (iii) aquaculture	May not exceed 20° C at any time. The following maximum temperatures may not be exceeded, where applicable: Migration routes 15° C Spawning areas 13° C Rearing areas 15° C Egg & fry incubation 13° C For all other waters, the weekly average temperature may not exceed site-specific requirements needed to preserve normal species diversity or to prevent appearance of nuisance organisms.
(A) Water Supply (iv) industrial	May not exceed 25° C.
(B) Water Recreation (i) contact recreation	Same as (10)(A)(ii).
(B) Water Recreation (ii) secondary recreation	Not applicable.
(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	Same as (10)(A)(iii).

Register 250, JULY 2024

ENVIRONMENTAL CONSERVATION

Water Quality Standards for Designated Uses	
POLLUTANT & WATER USE	CRITERIA
(2) BACTERIA, FOR FRESH WATER USES (See note 1)	
(A) Water Supply (i) drinking, culinary, and food processing	In a 30-day period, the geometric mean may not exceed 20 fecal coliform/100 ml, and not more than 10% of the samples may exceed 40 fecal coliform/100 ml. For groundwater, the fecal coliform concentration must be less than 1 fecal coliform/100 ml, using the fecal coliform Membrane Filter Technique, or less than 3 fecal coliform/100 ml, using the fecal coliform most probable number (MPN) technique.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	In a 30-day period, the geometric mean of samples may not exceed 200 fecal coliform/100 ml, and not more than 10% of the samples may exceed 400 fecal coliform/100 ml. For products not normally cooked and for dairy sanitation of unpasteurized products, the criteria for drinking water supply, (2)(A)(i), apply.
(A) Water Supply (iii) aquaculture	For products normally cooked, the geometric mean of samples taken in a 30-day period may not exceed 200 fecal coliform/100 ml, and not more than 10% of the samples may exceed 400 fecal coliform/100 ml. For products not normally cooked, the criteria for drinking water supply, (2)(A)(i), apply.
(A) Water Supply (iv) industrial	Where worker contact is present, the geometric mean of samples taken in a 30-day period may not exceed 200 fecal coliform/100 ml, and not more than 10% of the samples may exceed 400 fecal coliform/100 ml.
(B) Water Recreation (i) contact recreation	In a 30-day period, the geometric mean of samples may not exceed 126 <i>Escherichia coli</i> (<i>E. coli</i>) colony forming units (CFU)/ 100ml, and not more than 10% of the samples may exceed a statistical threshold value (STV) of 410 <i>E. coli</i> CFU/100 ml.
(B) Water Recreation (ii) secondary recreation	In a 30-day period, the geometric mean of samples may not exceed 200 fecal coliform/100 ml, and not more than 10% of the total samples may exceed 400 fecal coliform/100 ml.
(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	Not applicable.

Register 250, JULY 2024

ENVIRONMENTAL CONSERVATION

Water Quality Standards for Designated Uses	
POLLUTANT & WATER USE	CRITERIA
(4) DISSOLVED INORGANIC SUBSTANCES, FOR FRESH WATER USES	
(A) Water Supply (i) drinking, culinary, and food processing	Total dissolved solids (TDS) from all sources may not exceed 500 mg/l. Neither chlorides nor sulfates may exceed 250 mg/l.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	TDS may not exceed 1,000 mg/l. sodium adsorption ratio must be less than 2.5, sodium percentage less than 60%, and residual carbonate less than 1.25 milliequivalents/liter (see note 6).
(A) Water Supply (iii) aquaculture	TDS may not exceed 1,000 mg/l. A concentration of TDS may not be present in water if that concentration causes or reasonably could be expected to cause an adverse effect to aquatic life (see note 12).
(A) Water Supply (iv) industrial	No amounts above natural conditions that can cause corrosion, scaling, or process problems.
(B) Water Recreation (i) contact recreation	Not applicable.
(B) Water Recreation (ii) secondary recreation	Not applicable.
(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	Same as (4)(A)(iii).

Register 250, JULY 2024

ENVIRONMENTAL CONSERVATION

Water Quality Standards for Designated Uses	
POLLUTANT & WATER USE	CRITERIA
(9) SEDIMENT, FOR FRESH WATER USES (criteria are not applicable to groundwater)	
(A) Water Supply (i) drinking, culinary, and food processing	No measurable increase in concentration of settleable solids above natural conditions, as measured by the volumetric Imhoff cone method (see note 11).
(A) Water Supply (ii) agriculture, including irrigation and stock watering	For sprinkler irrigation, water must be free of particles of 0.074 mm or coarser. For irrigation or water spreading, may not exceed 200 mg/l for an extended period of time.
(A) Water Supply (iii) aquaculture	No imposed loads that will interfere with established water supply treatment levels.
(A) Water Supply (iv) industrial	Same as (9)(A)(iii).
(B) Water Recreation (i) contact recreation	Same as (9)(A)(i).
(B) Water Recreation (ii) secondary recreation	May not pose hazards to incidental human contact or cause interference with the use.
(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	The percent accumulation of fine sediment in the range of 0.1 mm to 4.0 mm in the gravel bed of waters used by anadromous or resident fish for spawning may not be increased more than 5% by weight above natural conditions (as shown from grain size accumulation graph). In no case may the 0.1 mm to 4.0 mm fine sediment range in those gravel beds exceed a maximum of 30% by weight (as shown from grain size accumulation graph) (see notes 3 and 4). In all other surface waters no sediment loads (suspended or deposited) that can cause adverse effects on aquatic animal or plant life, their reproduction or habitat may be present.

Department of Environmental Conservation
 Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances
 FINAL

WATER QUALITY CRITERIA FOR TOXICS AND OTHER DELETERIOUS SUBSTANCES (µg/l unless shown otherwise)

Pollutant CAS Number	Type of Pollutant	Drinking Water ¹	Stock- water ²	Irrigation Water ³	Aquatic Life for Fresh Water		Aquatic Life for Marine Water		Human Health for Consumption of:		References ⁴
					Acute (CMC)	Chronic (CCC)	Acute (CMC)	Chronic (CCC)	Water + Aquatic Organisms	Aquatic Organisms Only	
Nickel 7440020	INORG	— ⁵⁶	—	200	See Appendix A (1-hr avg) ¹¹ <i>dissolved</i> ^{20, 25}	See Appendix A (4-day avg) ¹² <i>dissolved</i> ^{20, 25}	74 See Appendix B (1-hr avg) ¹¹ <i>dissolved</i> ^{41, 57}	8.2 See Appendix B (4-day avg) ¹² <i>dissolved</i> ^{41, 58}	610 ⁵	4,600 ⁵	Drinking Water: 18 AAC 80.300(b) 60 FR 33929 63 FR 10273 Irrigation: EPA Blue Book Aquatic Life: 57 FR 60848 60 FR 22228 65 FR 31682 67 FR 79091 69 FR 63079 EPA 440-5-80-060 EPA 440-5-86-004 EPA 820-B-96-001 EPA 822-Z-99-001 EPA NRWQC 2006 Human Health: 65 FR 31682 67 FR 79091 EPA 440-5-80-060 EPA 822-Z-99-001 EPA NRWQC 2006
Nitrate (as nitrogen) 14797558	INORG	10,000	—	—	—	—	—	—	—	—	Drinking Water: 18 AAC 80.300(b)
Nitrite (as nitrogen) 14797650	INORG	1,000	—	—	—	—	—	—	—	—	Drinking Water: 18 AAC 80.300(b)
Total Nitrate and Nitrite (as nitrogen)	INORG	10,000	—	—	—	—	—	—	—	—	Drinking Water: 18 AAC 80.300(b)
Nitrobenzene 98953	SVOC	—	—	—	—	—	—	—	17 ⁵	1,900 ^{5, 32}	Human Health: 57 FR 60848 65 FR 31682 EPA 440-5-80-061 EPA 822-Z-99-001

Department of Environmental Conservation

Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances
FINAL**APPENDIX C. ACUTE, FRESHWATER AMMONIA CRITERIA**

The one-hour average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CMC (acute criterion) calculated using the following equations. The acute criterion for total ammonia for freshwater aquatic life in Table I of this manual must be based on the following criteria: ^{11,74}

pH	Total Ammonia Nitrogen in mg-N/L	
	Acute Criteria with Salmonids Present	Acute Criteria with Salmonids Absent
	$Acute = \frac{0.275}{1 + 10^{7.204 - pH}} + \frac{39.0}{1 + 10^{pH - 7.204}}$	$Acute = \frac{0.411}{1 + 10^{7.204 - pH}} + \frac{58.4}{1 + 10^{pH - 7.204}}$
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.65	14.4
7.8	8.11	12.1
7.9	6.77	10.1
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

Department of Environmental Conservation

Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances
FINAL**APPENDIX D. CHRONIC, FRESHWATER AMMONIA CRITERIA**

Based on pH and Temperature When Early Life Stages of Fish are Present^{15, 74}

The thirty-day average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CCC (chronic criterion) calculated using the following equations.¹⁵ The chronic criterion for total ammonia for the fresh water aquatic life criteria in Table I of this manual must be based on the table below when early stages of fish are present:

Total Ammonia in mg-N/L										
Chronic = $\left(\frac{0.0577}{1 + 10^{7.688 - \text{pH}}} + \frac{2.487}{1 + 10^{\text{pH} - 7.688}} \right) * \text{MIN} (2.85, 1.45 * 10^{0.028(25-T)})$										
pH	Temperature									
	0°C	14°C	16°C	18°C	20°C	22°C	24°C	26°C	28°C	30°C
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.422	0.389	0.342	0.300	0.264	0.232	0.204	0.179

Department of Environmental Conservation
Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances
FINAL

**APPENDIX A. PARAMETERS FOR CALCULATING FRESHWATER
DISSOLVED METALS CRITERIA THAT ARE HARDNESS-DEPENDENT** ⁷³

Metal ²⁵	m _A	b _A	m _C	b _C	Freshwater Conversion Factors (CF)	
					Acute (CMC) ¹¹	Chronic (CCC) ¹²
Arsenic	—	—	—	—	1.000	1.000
Cadmium	1.0166	-3.924	0.7409	-4.719	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]
Chromium III	0.819	3.7256	0.819	0.6848	0.316	0.860
Chromium VI	—	—	—	—	0.982	0.962
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]
[MERCURY]	—	—	—	—	[0.85] —	[0.85] —
Nickel	0.846	2.255	0.846	0.0584	0.998	0.997
Silver	1.72	-6.59	—	—	0.85	—
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

Hardness-dependent criteria may be calculated from the following for freshwater metals:

$$\text{Acute (dissolved)} = \exp \{m_A[\ln(\text{hardness})] + b_A\} \text{ (CF)}$$

$$\text{Chronic (dissolved)} = \exp \{m_C[\ln(\text{hardness})] + b_C\} \text{ (CF)}$$

**APPENDIX B. CONVERSION FACTORS FOR SALTWATER DISSOLVED
METALS CRITERIA** ⁷³

Metal	Saltwater Conversion Factors (CF)	
	Acute (CMC) ¹¹	Chronic (CCC) ¹²
Arsenic	1.000	1.000
Cadmium	0.994	0.994
Chromium VI	0.993	0.993
Copper	0.83	0.83
Lead	0.951	0.951
Mercury	0.85	0.85
Nickel	0.990	0.990
Selenium	0.998	0.998
Silver	0.85	—
Zinc	0.946	0.946

Appendix E. Correlations matrix for alkalinity, hardness and ions

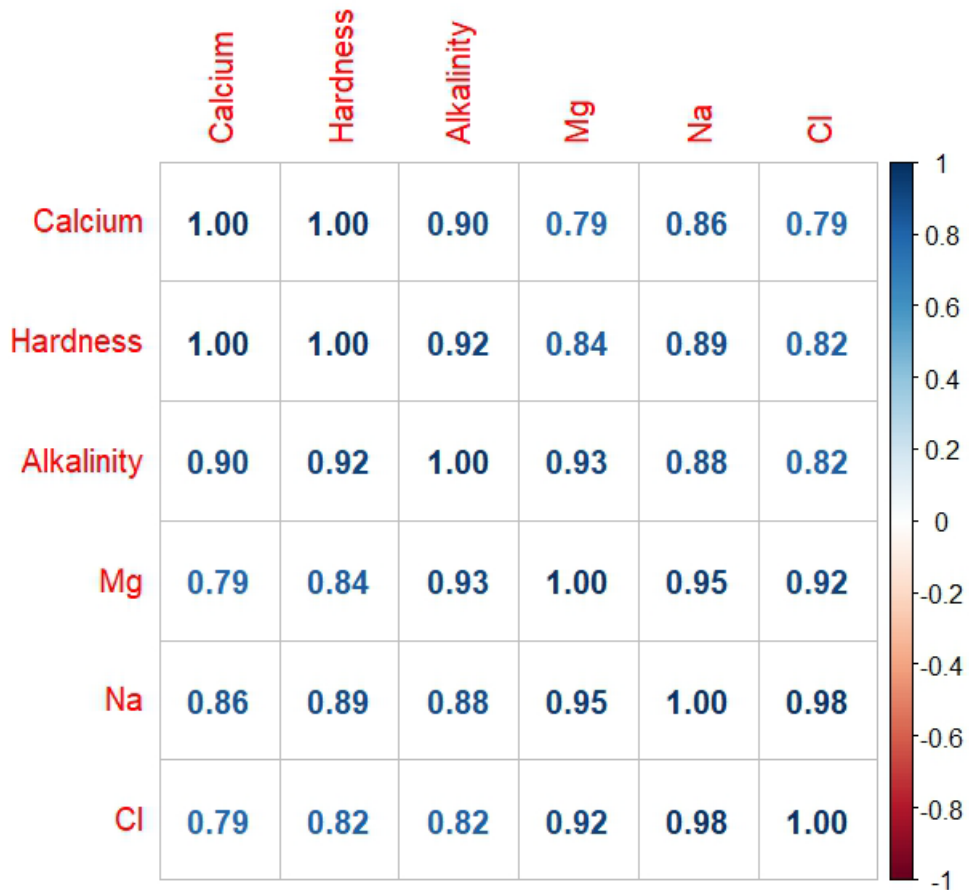


Figure E. 1. Correlation plot for dissolved ions, hardness and alkalinity across sites and sampling events.

Appendix F. Water Quality Data

In situ data

Table 1. In situ water quality data. Values that are outside the bounds of water quality criteria for pH for propagation of fish, shellfish and other aquatic life (6.5-8.5) are in bold. For temperature, values above 15°C (rearing and migration) are in bold.

Site	Date	pH	Specific conductivity (µS/cm)	Turbidity (NTU)	Dissolved oxygen (mg/l)	Dissolved oxygen (%)	Water Temperature (°C)	Air Temperature (°C)
CC01	5/9/2023	7.79	14.0	0.52	11.45	NA	NA	NA
CC01	5/31/2023	6.27	12.0	1.39	10.80	99.5	11.2	8.9
CC01	6/21/2023	5.70	11.0	2.00	9.78	101.2	16.8	16.6
CC01	7/10/2023	6.15	14.0	2.55	9.09	98.6	18.8	14.0
CC01	11/14/2023	6.54	13.6	0.86	11.84	93.5	5.3	5.3
CC01	4/2/2024	6.18	12.3	0.54	11.84	95.9	6.3	5.4
CC01	5/15/2024	6.39	12.3	0.83	10.96	96.3	9.6	10.3
CC01	8/19/2024	6.76	13.3	1.69	9.17	97.1	18.2	15.6
CC01	9/17/2024	6.02	13.4	NA	9.48	88.6	12.3	12.4
CC01	9/23/2024	5.84	12.0	NA	10.55	96.1	11.1	12.5
CC01	10/15/2024	6.09	14.6	1.49	11.47	98.9	8.8	7.7
CC01	11/4/2024	6.08	14.2	0.68	11.75	96.0	6.6	7.1
CC02	5/9/2023	7.03	15.2	0.66	12.26	NA	10.5	NA
CC02	5/31/2023	6.84	18.0	2.10	11.59	101.0	9.6	8.9
CC02	6/21/2023	6.54	20.0	2.12	10.69	100.5	13.2	15.5
CC02	7/10/2023	6.89	28.5	1.81	10.32	100.8	14.6	13.0
CC02	7/13/2023	6.86	28.8	1.13	10.51	101.1	13.9	16.2
CC02	7/17/2023	6.89	31.0	1.76	10.27	100.7	14.7	16.1
CC02	7/19/2023	6.16	16.2	2.75	10.65	103.7	14.7	14.7
CC02	7/31/2023	6.75	27.4	2.41	10.39	102.1	15.1	14.0
CC02	8/8/2023	6.36	16.7	2.07	10.34	101.8	14.7	14.9
CC02	10/2/2023	6.37	20.5	1.09	11.42	102.4	10.7	11.0
CC02	10/10/2023	6.56	21.7	1.12	11.01	100.7	10.7	11.4
CC02	10/19/2023	6.63	24.4	NA	11.45	102.5	10.3	10.9
CC02	10/24/2023	7.03	32.0	NA	12.72	101.1	5.6	5.4
CC02	10/31/2023	6.77	25.2	0.87	12.71	99.9	5.2	5.2
CC02	11/14/2023	6.80	20.3	1.10	12.51	99.2	5.5	6.1
CC02	4/2/2024	6.82	15.3	0.80	12.60	100.5	5.8	5.4
CC02	5/14/2024	6.67	17.2	NA	11.67	102.6	9.7	10.4
CC02	5/15/2024	6.88	15.4	0.91	11.84	101.5	8.5	9.5
CC02	5/21/2024	6.75	18.3	0.67	11.85	102.3	8.9	8.9
CC02	5/23/2024	6.91	24.0	4.10	11.20	99.8	10.3	10.0
CC02	5/29/2024	6.89	17.6	1.20	11.78	101.8	9.0	8.8
CC02	5/30/2024	7.26	19.9	1.09	11.40	100.6	9.6	10.4
CC02	7/29/2024	7.02	20.9	1.14	10.31	102.9	15.2	15.7
CC02	8/5/2024	7.04	23.3	1.13	10.07	100.3	15.2	16.1
CC02	8/8/2024	7.10	26.0	0.83	9.84	103.0	17.7	18.2

Site	Date	pH	Specific conductivity (µS/cm)	Turbidity (NTU)	Dissolved oxygen (mg/l)	Dissolved oxygen (%)	Water Temperature (°C)	Air Temperature (°C)
CC02	8/19/2024	6.96	33.4	0.86	10.40	102.8	14.8	14.5
CC02	8/27/2024	6.81	19.0	1.40	10.36	99.1	13.4	14.0
CC02	9/17/2024	6.87	17.3	NA	10.89	101.2	12.1	12.2
CC02	9/23/2024	6.28	15.0	NA	11.23	102.9	11.5	12.0
CC02	10/15/2024	6.46	18.5	2.42	11.99	103.6	9.0	NA
CC02	11/4/2024	6.72	18.2	0.70	12.88	104.4	6.3	6.7
HC01	5/9/2023	NA	15.8	0.33	11.65	NA	7.0	NA
HC01	5/31/2023	6.63	18.0	1.72	12.15	101.9	7.6	10.0
HC01	6/21/2023	6.73	27.9	2.19	10.98	98.9	10.9	17.7
HC01	7/10/2023	6.68	46.0	1.99	10.57	100.5	12.9	14.0
HC01	11/14/2023	6.56	19.6	1.87	12.77	98.1	4.3	4.4
HC01	4/2/2024	6.61	15.6	1.08	13.02	97.8	3.4	4.5
HC01	5/15/2024	6.53	15.6	0.84	11.94	97.9	6.9	7.2
HC01	8/19/2024	7.18	54.2	0.97	10.74	101.4	12.8	17.7
HC01	9/17/2024	6.35	16.4	NA	10.98	99.5	10.9	11.2
HC01	10/15/2024	6.20	15.2	5.19	12.18	102.3	7.8	8.1
HC01	11/4/2024	6.11	20.3	0.44	12.86	101.5	5.4	5.7
HC02	5/9/2023	6.93	28.5	0.40	12.33	NA	8.2	NA
HC02	5/31/2023	7.01	36.0	2.39	12.16	101.0	7.7	8.9
HC02	6/21/2023	7.00	60.0	1.75	11.13	100.8	11.5	16.6
HC02	7/10/2023	6.65	77.8	3.76	10.52	100.7	13.7	14.0
HC02	7/13/2023	6.63	81.9	1.17	10.58	100.2	13.5	18.2
HC02	7/17/2023	6.88	76.4	1.95	10.48	100.8	13.6	17.3
HC02	7/19/2023	6.19	26.9	3.18	11.04	103.0	12.8	14.2
HC02	7/31/2023	6.75	39.2	4.78	10.66	101.9	13.8	14.0
HC02	8/8/2023	6.58	33.6	1.51	10.48	101.1	13.7	15.0
HC02	10/2/2023	6.55	39.2	1.66	11.42	101.3	10.2	10.5
HC02	10/10/2023	6.66	51.6	1.36	11.21	100.9	10.0	13.1
HC02	10/19/2023	6.18	50.2	NA	11.37	101.3	10.1	12.2
HC02	10/24/2023	6.54	88.6	NA	13.03	99.8	4.0	7.1
HC02	10/26/2023	6.67	93.5	0.82	13.28	101.2	3.9	4.2
HC02	10/31/2023	6.39	71.4	0.79	12.68	100.3	5.3	5.7
HC02	11/14/2023	6.75	39.4	1.65	12.48	98.5	5.3	5.8
HC02	4/2/2024	6.95	33.0	2.18	12.91	99.2	4.3	5.8
HC02	5/14/2024	6.59	29.5	NA	12.34	102.7	7.4	8.1
HC02	5/15/2024	6.77	28.9	0.56	12.28	100.1	6.6	6.7
HC02	5/21/2024	6.45	43.1	0.64	12.31	101.6	7.0	7.1
HC02	5/23/2024	6.61	48.4	6.22	11.41	99.6	9.3	9.9
HC02	5/29/2024	6.57	42.6	0.95	11.97	101.5	8.1	8.6
HC02	5/30/2024	6.69	50.8	1.52	12.00	101.2	7.9	8.3
HC02	7/29/2024	6.78	50.2	1.76	10.64	101.6	13.1	14.2
HC02	8/5/2024	6.75	62.0	2.21	10.22	99.3	13.8	15.0
HC02	8/8/2024	7.01	70.8	0.85	10.18	105.7	16.9	18.3
HC02	8/19/2024	6.82	84.6	0.89	10.43	102.2	14.4	14.7
HC02	8/27/2024	6.72	47.4	1.35	10.75	98.8	11.7	11.7

Site	Date	pH	Specific conductivity (µS/cm)	Turbidity (NTU)	Dissolved oxygen (mg/l)	Dissolved oxygen (%)	Water Temperature (°C)	Air Temperature (°C)
HC02	9/17/2024	7.06	32.1	NA	11.00	100.3	11.2	11.2
HC02	9/23/2024	6.34	17.2	NA	11.01	101.5	11.8	13.1
HC02	10/15/2024	6.44	34.4	3.14	12.10	103.8	8.7	NA
HC02	11/4/2024	6.62	36.1	0.47	12.80	104.4	6.6	6.7
KC01	5/9/2023	6.89	41.6	0.38	11.93	NA	9.4	NA
KC01	5/31/2023	6.90	33.0	1.43	11.70	101.2	9.2	10.0
KC01	6/21/2023	7.09	41.9	1.62	11.09	100.2	11.4	15.6
KC01	7/10/2023	6.96	56.4	1.72	10.54	100.9	13.6	15.0
KC01	11/14/2023	6.58	18.0	0.79	12.50	100.1	5.9	5.5
KC01	4/2/2024	6.91	28.7	0.57	12.88	99.7	4.6	4.3
KC01	5/15/2024	6.73	32.6	0.68	11.87	99.8	7.9	10.0
KC01	8/19/2024	7.28	42.2	0.93	10.61	104.5	14.7	15.6
KC01	9/17/2024	6.52	20.6	NA	10.99	101.1	11.6	12.3
KC01	9/23/2024	6.17	13.2	NA	11.33	103.7	11.4	12.3
KC01	10/15/2024	6.19	18.1	0.91	12.20	104.1	8.4	8.6
KC01	11/4/2024	6.27	17.8	1.63	12.78	103.1	6.2	6.2
KC01B	8/19/2024	7.15	13.9	0.66	10.28	105.3	16.5	15.3
KC01B	9/17/2024	6.71	20.0	NA	10.99	101.0	11.6	12.0
KC01B	9/23/2024	6.40	12.2	NA	11.42	104.3	11.3	12.5
KC01B	10/15/2024	6.38	15.8	1.24	12.19	104.6	8.6	8.7
KC01B	11/4/2024	6.45	13.6	0.46	12.60	104.1	7.1	6.8
KC02	5/9/2023	7.50	14.0	0.30	11.18	NA	10.8	NA
KC02	5/31/2023	6.82	20.0	1.24	11.76	102.0	9.4	10.0
KC02	6/21/2023	6.28	11.3	1.39	11.19	100.9	11.3	14.2
KC02	7/10/2023	6.94	11.0	1.85	10.11	100.9	15.6	15.0
KC02	11/14/2023	6.54	16.7	0.97	12.19	99.6	6.7	6.1
KC02	4/2/2024	6.93	20.7	1.03	12.89	98.7	4.1	5.8
KC02	5/15/2024	6.81	21.8	0.56	12.14	100.5	7.2	8.0
KC02	8/19/2024	6.84	16.3	1.02	9.72	99.7	16.6	15.1
KC02	9/17/2024	6.75	25.1	NA	10.31	97.2	12.4	12.6
KC02	9/23/2024	6.40	18.8	NA	11.17	101.8	11.2	12.0
KC02	10/15/2024	6.59	18.3	1.86	12.03	103.8	8.9	NA
KC02	11/4/2024	6.69	14.7	0.35	12.50	104.1	7.4	6.9
KC03	5/9/2023	7.23	19.4	0.48	NA	103.7	7.1	NA
KC03	5/31/2023	7.01	33.0	1.83	11.87	101.8	8.9	7.8
KC03	6/21/2023	6.66	13.9	1.97	10.94	102.1	11.4	12.4
KC03	7/10/2023	6.77	14.1	1.85	10.17	101.9	15.8	14.0
KC03	7/13/2023	5.93	15.0	1.20	10.00	102.0	16.4	19.9
KC03	7/17/2023	6.74	15.4	1.80	9.92	101.6	16.7	20.0
KC03	7/19/2023	6.72	20.9	3.79	11.16	104.3	12.9	13.5
KC03	7/31/2023	6.52	103.0	2.18	9.95	99.9	16.0	14.0
KC03	8/8/2023	6.66	32.9	1.64	9.86	96.5	14.4	15.0
KC03	10/2/2023	6.72	24.3	1.73	11.18	101.3	11.0	11.1
KC03	10/10/2023	7.12	25.1	1.21	11.05	101.1	10.6	14.7
KC03	10/19/2023	6.60	30.2	NA	11.44	101.5	10.1	16.4

Site	Date	pH	Specific conductivity (µS/cm)	Turbidity (NTU)	Dissolved oxygen (mg/l)	Dissolved oxygen (%)	Water Temperature (°C)	Air Temperature (°C)
KC03	10/24/2023	6.99	26.9	NA	11.72	100.1	8.4	11.8
KC03	10/26/2023	6.33	24.3	1.06	11.46	96.3	7.8	13.4
KC03	10/31/2023	7.15	16.5	1.01	11.78	100.1	8.3	6.4
KC03	11/14/2023	6.89	22.4	1.70	11.91	98.7	7.3	7.0
KC03	4/2/2024	6.78	23.5	0.91	13.05	99.7	4.1	4.1
KC03	5/14/2024	6.66	30.5	NA	12.38	103.2	7.4	7.7
KC03	5/15/2024	6.66	23.7	0.51	12.09	98.9	6.6	7.6
KC03	5/21/2024	6.44	21.4	0.53	12.16	101.2	7.5	7.1
KC03	5/23/2024	6.87	24.5	3.28	11.31	99.6	9.8	10.1
KC03	5/29/2024	6.37	26.8	0.81	12.11	103.9	8.5	9.5
KC03	5/30/2024	6.89	26.0	1.03	12.03	101.5	8.0	8.3
KC03	7/29/2024	6.68	17.6	4.33	10.09	101.8	15.8	15.6
KC03	8/5/2024	6.78	18.7	5.08	9.52	99.4	17.4	18.2
KC03	8/8/2024	6.64	16.9	1.10	9.54	102.0	18.6	19.7
KC03	8/19/2024	6.48	16.8	0.91	9.42	98.3	17.4	17.0
KC03	8/27/2024	6.56	22.9	1.43	9.51	94.0	14.8	14.4
KC03	9/17/2024	7.03	29.7	NA	10.82	99.5	11.6	12.1
KC03	9/23/2024	6.08	25.6	NA	10.99	101.8	11.9	13.0
KC03	10/15/2024	6.25	19.8	0.82	11.50	102.2	10.1	NA
KC03	11/4/2024	6.32	17.1	0.45	12.35	104.6	8.0	7.2
Schoenbar	8/19/2024	6.97	141.5	3.59	10.25	100.4	14.4	15.3
Schoenbar	9/17/2024	6.67	55.8	NA	10.91	99.9	11.4	11.7
Schoenbar	9/23/2024	6.15	30.1	NA	11.16	102.2	11.5	12.1
Schoenbar	10/15/2024	6.25	43.0	8.65	12.00	103.2	8.8	8.9
Schoenbar	11/4/2024	6.45	62.0	0.89	12.61	102.7	6.6	6.0

Bacteria Data

Table 2. Bacteria data. Values that exceed acute criteria (40 CFU/100 ml for drinking water/raw fish consumption for fecal coliform) and 410 CFU/100 ml for contact recreation for E. coli are in bold.

Site	Sample Type	Date	Fecal coliform (CFU/100 ml)	E. coli (CFU/100 ml)
CC02	Routine	10/10/2023	13	21
CC02	Routine	10/19/2023	155	166
CC02	Routine	10/2/2023	7	5
CC02	Routine	10/24/2023	10	11
CC02	Routine	10/31/2023	2	<1
CC02	Routine	5/14/2024	37	29
CC02	Routine	5/21/2024	8	6
CC02	Routine	5/23/2024	162	98
CC02	Routine	5/29/2024	3	3
CC02	Routine	5/30/2024	2	2
CC02	Routine	7/10/2023	4	4
CC02	Routine	7/13/2023	<1	4
CC02	Routine	7/17/2023	18	14
CC02	Routine	7/19/2023	>400; diluted samples 10x but it wasn't sufficient; all plates had TNTC.	>400; diluted samples 10x but it wasn't sufficient; all plates had TNTC.
CC02	Routine	7/29/2024	2	3
CC02	Routine	7/31/2023	162	160
CC02	Routine	8/19/2024	45	51
CC02	Routine	8/27/2024	252	209
CC02	Routine	8/5/2024	14	15
CC02	Routine	8/8/2023	672	614
CC02	Routine	8/8/2024	8	10
HC02	Routine	10/10/2023	15	26
HC02	Routine	10/19/2023	52	65
HC02	Routine	10/2/2023	26	19
HC02	Routine	10/24/2023	2	5
HC02	Routine	10/26/2023	4	3
HC02	Routine	10/31/2023	2	<1
HC02	Routine	5/14/2024	52	39
HC02	Routine	5/21/2024	6	2
HC02	Routine	5/23/2024	127	101
HC02	Routine	5/29/2024	3	2
HC02	Routine	5/30/2024	34	48
HC02	Routine	7/10/2023	23	16
HC02	Routine	7/13/2023	15	17
HC02	Routine	7/17/2023	61	46
HC02	Routine	7/19/2023	>400; diluted samples 10x but it wasn't sufficient; all plates had TNTC.	>400; diluted samples 10x but it wasn't sufficient; all plates had TNTC.
HC02	Routine	7/29/2024	62	39
HC02	Routine	7/31/2023	630	510
HC02	Routine	8/19/2024	9	8
HC02	Routine	8/27/2024	21	16

Site	Sample Type	Date	Fecal coliform (CFU/100 ml)	E. coli (CFU/100 ml)
HC02	Routine	8/5/2024	10	15
HC02	Routine	8/8/2023	212	258
HC02	Routine	8/8/2024	8	10
KC03	Routine	10/10/2023	15	10
KC03	Routine	10/19/2023	76	98
KC03	Routine	10/2/2023	21	18
KC03	Routine	10/24/2023	29	10* result invalid per SOP: total coliform growth >200 cfu/100ml, potentially inhibited growth of e. coli
KC03	Routine	10/26/2023	16	11
KC03	Routine	10/31/2023	3	2* result invalid per SOP: total coliform growth >200 cfu/100ml, potentially inhibited growth of e. coli
KC03	Routine	5/14/2024	183	144
KC03	Routine	5/21/2024	111	124
KC03	Routine	5/23/2024	376	278
KC03	Routine	5/29/2024	36	19
KC03	Routine	5/30/2024	50	53
KC03	Routine	7/10/2023	6	4
KC03	Routine	7/13/2023	59	44
KC03	Routine	7/17/2023	10	9
KC03	Routine	7/19/2023	>400; diluted samples 10x but it wasn't sufficient; all plates had TNTC.	>400; diluted samples 10x but it wasn't sufficient; all plates had TNTC.
KC03	Routine	7/29/2024	145	159
KC03	Routine	7/31/2023	196	220
KC03	Routine	8/19/2024	111	80
KC03	Routine	8/27/2024	81	77
KC03	Routine	8/5/2024	53	68
KC03	Routine	8/8/2023	306	284
KC03	Routine	8/8/2024	85	103
CC02	Field Replicate	10/2/2023	13	3
CC02	Field Replicate	10/24/2023	8	3
CC02	Field Replicate	5/14/2024	37	28
CC02	Field Replicate	5/29/2024	6	1
CC02	Field Replicate	7/13/2023	5	3
CC02	Field Replicate	7/19/2023	>400; diluted samples 10x but it wasn't sufficient; all plates had TNTC.	>400; diluted samples 10x but it wasn't sufficient; all plates had TNTC.
CC02	Field Replicate	8/5/2024	11	18
HC02	Field Replicate	10/26/2023	2	<1
HC02	Field Replicate	5/21/2024	6	11
HC02	Field Replicate	7/10/2023	25	13
HC02	Field Replicate	7/17/2023	36	39
HC02	Field Replicate	7/31/2023	580	480
HC02	Field Replicate	8/27/2024	15	16
HC02	Field Replicate	8/8/2024	7	12
KC03	Field Replicate	10/10/2023	19	9

Site	Sample Type	Date	Fecal coliform (CFU/100 ml)	E. coli (CFU/100 ml)
KC03	Field Replicate	10/19/2023	69	74
KC03	Field Replicate	10/31/2023	5	7* result invalid per SOP: total coliform growth >200 cfu/100ml, potentially inhibited growth of e. coli
KC03	Field Replicate	5/23/2024	440	262
KC03	Field Replicate	5/30/2024	39	30
KC03	Field Replicate	7/29/2024	133	146
KC03	Field Replicate	8/19/2024	97	72
KC03	Field Replicate	8/8/2023	288	342

Metals and Hardness

Table X. Cadmium, chromium, copper, lead, zinc and hardness data. Routine samples with concentrations that exceed hardness-based chronic criteria are in bold.

Site	Sample Type	Date	Hardness (mg/l)	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Lead (µg/l)	Zinc (µg/l)
CC01	Sample-Routine	5/9/2023	1.4	<0.05	<0.2	0.26	<0.2	1.91
CC01	Sample-Routine	5/31/2023	1.5	<0.05	<0.2	0.27	<0.2	0.86
CC01	Sample-Routine	6/21/2023	2.6	<0.05	<0.2	0.20	<0.2	1.22
CC01	Sample-Routine	7/10/2023	2.7	<0.05	<0.2	0.57	0.370	1.21
CC01	Sample-Routine	11/14/2023	2.6	<0.05	<0.2	<0.2	<0.2	<0.5
CC01	Sample-Routine	4/2/2024	2.3	<0.05	<0.2	0.25	<0.2	1.31
CC01	Sample-Routine	5/15/2024	2.55	<0.05	<0.2	<0.2	<0.2	<0.5
CC01	Sample-Routine	8/19/2024	3.16	<0.05	<0.2	0.236	<0.2	<0.5
CC01	Sample-Routine	9/17/2024	4.82	<0.05	<0.2	0.515	<0.2	0.657
CC01	Sample-Routine	9/23/2024	2.75	<0.05	<0.2	0.286	<0.2	<0.5
CC01	Sample-Routine	10/15/2024	2.33	<0.05	<0.2	<0.2	<0.2	1.741
CC01	Sample-Routine	11/4/2024	2.82	<0.05	<0.2	<0.2	<0.2	<0.5
CC02	Sample-Routine	5/9/2023	3.0	<0.05	<0.2	0.33	<0.2	1.66
CC02	Sample-Routine	5/31/2023	3.6	<0.05	<0.2	0.50	<0.2	2.84
CC02	Sample-Routine	6/21/2023	5.6	<0.05	<0.2	0.45	<0.2	0.63
CC02	Sample-Routine	7/10/2023	6.4	<0.05	<0.2	0.76	0.203	9.79
CC02	Sample-Routine	11/14/2023	4.7	<0.05	<0.2	<0.2	<0.2	<0.5
CC02	Sample-Routine	4/2/2024	3.5	<0.05	<0.2	0.40	<0.2	0.68
CC02	Sample-Routine	5/15/2024	3.96	<0.05	<0.2	0.229	<0.2	0.869
CC02	Sample-Routine	8/19/2024	8.64	<0.05	<0.2	0.655	<0.2	1.003
CC02	Sample-Routine	9/17/2024	2.91	<0.05	<0.2	<0.2	<0.2	<0.5
CC02	Sample-Routine	9/23/2024	4.10	<0.05	<0.2	0.520	<0.2	0.739
CC02	Sample-Routine	10/15/2024	4.52	<0.05	<0.2	0.449	<0.2	3.869
CC02	Sample-Routine	11/4/2024	4.72	<0.05	<0.2	0.374	<0.2	<0.5
HC01	Sample-Routine	5/9/2023	3.6	<0.05	<0.2	0.30	<0.2	1.78
HC01	Sample-Routine	5/31/2023	3.8	<0.05	<0.2	0.35	<0.2	0.66
HC01	Sample-Routine	6/21/2023	9.9	<0.05	<0.2	0.22	<0.2	0.76
HC01	Sample-Routine	7/10/2023	12	<0.05	<0.2	0.24	<0.2	1.27
HC01	Sample-Routine	11/14/2023	5.0	<0.05	<0.2	<0.2	<0.2	<0.5
HC01	Sample-Routine	4/2/2024	4.1	<0.05	<0.2	0.25	<0.2	0.52
HC01	Sample-Routine	5/15/2024	4.34	<0.05	<0.2	<0.2	<0.2	0.701
HC01	Sample-Routine	8/19/2024	18.2	<0.05	<0.2	0.265	<0.2	0.502
HC01	Sample-Routine	9/17/2024	4.65	<0.05	<0.2	0.316	<0.2	<0.5
HC01	Sample-Routine	10/15/2024	3.58	<0.05	<0.2	0.240	<0.2	3.232
HC01	Sample-Routine	11/4/2024	5.94	<0.05	<0.2	<0.2	<0.2	<0.5
HC02	Sample-Routine	5/9/2023	6.8	<0.05	<0.2	0.47	<0.2	1.33
HC02	Sample-Routine	5/31/2023	8.1	<0.05	<0.2	0.83	<0.2	2.12
HC02	Sample-Routine	6/21/2023	19	<0.05	<0.2	1.29	<0.2	2.98
HC02	Sample-Routine	7/10/2023	22	<0.05	<0.2	0.97	0.217	2.87
HC02	Sample-Routine	11/14/2023	11	<0.05	<0.2	0.74	<0.2	1.58
HC02	Sample-Routine	4/2/2024	8.7	<0.05	<0.2	1.20	<0.2	3.01
HC02	Sample-Routine	5/15/2024	8.60	<0.05	<0.2	0.688	<0.2	1.301

Site	Sample Type	Date	Hardness (mg/l)	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Lead (µg/l)	Zinc (µg/l)
HC02	Sample-Routine	8/19/2024	25.8	<0.05	<0.2	0.845	<0.2	1.607
HC02	Sample-Routine	9/17/2024	10.4	<0.05	<0.2	1.584	<0.2	1.955
HC02	Sample-Routine	9/23/2024	8.21	<0.05	<0.2	3.020	<0.2	2.747
HC02	Sample-Routine	10/15/2024	10.3	<0.05	<0.2	1.593	<0.2	3.777
HC02	Sample-Routine	11/4/2024	11.2	<0.05	<0.2	0.930	<0.2	1.405
KC01	Sample-Routine	5/9/2023	13	<0.05	<0.2	0.50	<0.2	2.18
KC01	Sample-Routine	5/31/2023	9.3	<0.05	<0.2	0.92	<0.2	1.42
KC01	Sample-Routine	6/21/2023	13	<0.05	<0.2	0.61	<0.2	2.38
KC01	Sample-Routine	7/10/2023	19	<0.05	<0.2	0.45	<0.2	1.41
KC01	Sample-Routine	11/14/2023	5.4	<0.05	<0.2	<0.2	<0.2	<0.5
KC01	Sample-Routine	4/2/2024	10	<0.05	<0.2	0.89	<0.2	1.70
KC01	Sample-Routine	5/15/2024	12.1	<0.05	<0.2	0.681	<0.2	1.184
KC01	Sample-Routine	8/19/2024	15.0	<0.05	<0.2	0.402	<0.2	0.726
KC01	Sample-Routine	9/17/2024	7.08	<0.05	<0.2	0.780	<0.2	1.099
KC01	Sample-Routine	9/23/2024	4.65	<0.05	<0.2	0.536	<0.2	1.316
KC01	Sample-Routine	10/15/2024	5.52	<0.05	<0.2	0.384	<0.2	1.892
KC01	Sample-Routine	11/4/2024	5.64	<0.05	<0.2	0.457	<0.2	0.527
KC01B	Sample-Routine	8/19/2024	3.87	<0.05	<0.2	<0.2	<0.2	<0.5
KC01B	Sample-Routine	9/17/2024	6.70	<0.05	<0.2	0.724	<0.2	1.154
KC01B	Sample-Routine	9/23/2024	4.44	<0.05	<0.2	0.568	<0.2	1.351
KC01B	Sample-Routine	10/15/2024	4.51	<0.05	<0.2	0.312	<0.2	2.606
KC01B	Sample-Routine	11/4/2024	3.92	<0.05	<0.2	0.282	<0.2	<0.5
KC02	Sample-Routine	5/9/2023	3.1	<0.05	<0.2	0.22	<0.2	0.68
KC02	Sample-Routine	5/31/2023	4.5	<0.05	<0.2	0.66	<0.2	1.07
KC02	Sample-Routine	6/21/2023	3.1	<0.05	<0.2	<0.2	<0.2	0.69
KC02	Sample-Routine	7/10/2023	3.1	<0.05	<0.2	0.27	<0.2	2.07
KC02	Sample-Routine	11/14/2023	4.6	<0.05	<0.2	<0.2	<0.2	<0.5
KC02	Sample-Routine	4/2/2024	6.1	<0.05	<0.2	0.62	<0.2	2.29
KC02	Sample-Routine	5/15/2024	7.23	<0.05	<0.2	0.312	<0.2	1.206
KC02	Sample-Routine	8/19/2024	4.58	<0.05	<0.2	0.397	<0.2	0.702
KC02	Sample-Routine	9/17/2024	8.97	<0.05	<0.2	0.643	<0.2	1.133
KC02	Sample-Routine	9/23/2024	6.85	<0.05	<0.2	0.752	<0.2	1.499
KC02	Sample-Routine	10/15/2024	5.60	<0.05	<0.2	0.450	<0.2	2.514
KC02	Sample-Routine	11/4/2024	4.22	<0.05	<0.2	0.296	<0.2	<0.5
KC03	Sample-Routine	5/9/2023	4.0	<0.05	<0.2	0.50	<0.2	0.95
KC03	Sample-Routine	5/31/2023	6.4	<0.05	<0.2	1.63	<0.2	3.01
KC03	Sample-Routine	6/21/2023	3.9	<0.05	<0.2	0.45	<0.2	1.55
KC03	Sample-Routine	7/10/2023	3.4	<0.05	<0.2	0.45	0.202	1.59
KC03	Sample-Routine	11/14/2023	6.5	<0.05	<0.2	2.24	<0.2	1.56
KC03	Sample-Routine	4/2/2024	6.6	<0.05	<0.2	2.62	<0.2	3.50
KC03	Sample-Routine	5/15/2024	7.65	<0.05	<0.2	3.606	<0.2	1.252
KC03	Sample-Routine	8/19/2024	4.57	<0.05	<0.2	0.476	<0.2	0.573
KC03	Sample-Routine	9/17/2024	10.1	<0.05	<0.2	5.259	<0.2	2.268
KC03	Sample-Routine	9/23/2024	8.64	<0.05	<0.2	5.773	<0.2	2.618
KC03	Sample-Routine	10/15/2024	5.64	<0.05	<0.2	1.797	<0.2	2.350
KC03	Sample-Routine	11/4/2024	4.74	<0.05	<0.2	1.134	<0.2	0.816

Site	Sample Type	Date	Hardness (mg/l)	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Lead (µg/l)	Zinc (µg/l)
Schoenbar	Sample-Routine	8/19/2024	50.4	<0.05	<0.2	11.34	<0.2	2.666
Schoenbar	Sample-Routine	9/17/2024	18.6	<0.05	<0.2	19.68	<0.2	3.034
Schoenbar	Sample-Routine	9/23/2024	10.6	<0.05	<0.2	19.50	<0.2	2.972
Schoenbar	Sample-Routine	10/15/2024	15.2	<0.05	<0.2	24.12	<0.2	4.156
Schoenbar	Sample-Routine	11/4/2024	21.4	<0.05	<0.2	19.48	<0.2	3.192
CC01	Quality Control Sample-Field Replicate	5/9/2023	2.0	<0.05	<0.2	<0.2	<0.2	0.68
HC01	Quality Control Sample-Field Replicate	5/31/2023	3.6	<0.05	<0.2	0.33	<0.2	<0.5
KC02	Quality Control Sample-Field Replicate	6/21/2023	3.2	<0.05	<0.2	<0.2	<0.2	<0.5
HC01	Quality Control Sample-Field Replicate	7/10/2023	12	<0.05	<0.2	0.26	<0.2	3.47
CC02	Quality Control Sample-Field Replicate	11/14/2023	4.7	<0.05	<0.2	<0.2	<0.2	<0.5
HC01	Quality Control Sample-Field Replicate	4/2/2024	3.9	<0.05	<0.2	0.28	<0.2	0.61
CC01	Quality Control Sample-Field Replicate	5/15/2024	2.54	<0.05	<0.2	<0.2	<0.2	<0.5
HC01	Quality Control Sample-Field Replicate	8/19/2024	17.9	<0.05	<0.2	1.627	<0.2	1.580
KC03	Quality Control Sample-Field Replicate	9/17/2024	9.63	<0.05	<0.2	5.110	<0.2	3.160
CC01	Quality Control Sample-Field Replicate	9/23/2024	2.64	<0.05	<0.2	0.213	<0.2	0.781
KC02	Quality Control Sample-Field Replicate	10/15/2024	5.62	<0.05	<0.2	0.532	<0.2	2.628
KC02	Quality Control Sample-Field Replicate	11/4/2024	4.23	<0.05	<0.2	0.274	<0.2	<0.5

Alkalinity, minerals and ions

Site	Sample Type	Date	Alkalinity (mg/l)	Settleable Solids (ml/l)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Sulfate (mg/l)
CC01	Sample-Routine	5/9/2023	4.8	<0.1	0.46	0.19	1.08	NA	NA
CC01	Sample-Routine	5/31/2023	4.0	<0.1	0.51	0.18	0.87	NA	NA
CC01	Sample-Routine	6/21/2023	6.6	<0.1	0.66	0.23	1.07	NA	NA
CC01	Sample-Routine	7/10/2023	16	<0.1	0.66	0.25	1.24	NA	NA
CC01	Sample-Routine	11/14/2023	4.4	<0.1	0.63	0.25	1.21	NA	NA
CC01	Sample-Routine	4/2/2024	3.0	<0.1	0.54	0.22	1.23	NA	NA
CC01	Sample-Routine	5/15/2024	2.8	<0.1	0.615	0.247	1.35	NA	NA
CC01	Sample-Routine	8/19/2024	2.8	<0.1	0.8	0.284	1.45	1.45	0.54
CC01	Sample-Routine	9/17/2024	2.8	<0.1	1.37	0.340	1.63	NA	NA
CC01	Sample-Routine	9/23/2024	<2.0	<0.1	0.685	0.254	1.41	NA	NA
CC01	Sample-Routine	10/15/2024	2.8	<0.1	0.549	0.233	1.27	NA	NA
CC01	Sample-Routine	11/4/2024	<2.00	<0.1	0.691	0.266	1.31	NA	NA
CC02	Sample-Routine	5/9/2023	4.0	<0.1	0.82	0.23	1.26	NA	NA
CC02	Sample-Routine	5/31/2023	3.2	<0.1	1	0.26	1.19	NA	NA
CC02	Sample-Routine	6/21/2023	11	<0.1	1.6	0.38	1.60	NA	NA
CC02	Sample-Routine	7/10/2023	8.2	<0.1	1.8	0.46	1.94	NA	NA
CC02	Sample-Routine	11/14/2023	4.0	<0.1	1.3	0.35	1.48	NA	NA
CC02	Sample-Routine	4/2/2024	4.2	<0.1	0.95	0.27	1.38	NA	NA
CC02	Sample-Routine	5/15/2024	4.0	<0.1	1.09	0.302	1.52	NA	NA
CC02	Sample-Routine	8/19/2024	4.8	<0.1	2.43	0.625	2.64	3.12	3.56
CC02	Sample-Routine	9/17/2024	2.2	<0.1	0.728	0.266	1.37	NA	NA
CC02	Sample-Routine	9/23/2024	2.0	<0.1	1.15	0.300	1.52	NA	NA
CC02	Sample-Routine	10/15/2024	4.8	<0.1	1.26	0.334	1.49	NA	NA
CC02	Sample-Routine	11/4/2024	3.4	<0.1	1.34	0.334	1.50	NA	NA
HC01	Sample-Routine	5/9/2023	6.8	<0.1	0.96	0.28	1.18	NA	NA
HC01	Sample-Routine	5/31/2023	4.2	<0.1	1	0.31	1.28	NA	NA
HC01	Sample-Routine	6/21/2023	8.4	<0.1	3	0.59	1.87	NA	NA
HC01	Sample-Routine	7/10/2023	11	<0.1	3.8	0.72	2.32	NA	NA
HC01	Sample-Routine	11/14/2023	8.2	<0.1	1.3	0.42	1.50	NA	NA
HC01	Sample-Routine	4/2/2024	4.0	<0.1	1.1	0.33	1.37	NA	NA
HC01	Sample-Routine	5/15/2024	5.6	<0.1	1.14	0.364	1.55	NA	NA
HC01	Sample-Routine	8/19/2024	16.8	<0.1	5.56	1.04	2.96	2.89	4.86
HC01	Sample-Routine	9/17/2024	2.4	<0.1	1.25	0.371	1.55	NA	NA
HC01	Sample-Routine	10/15/2024	2.0	<0.1	0.87	0.343	1.34	NA	NA
HC01	Sample-Routine	11/4/2024	5.0	<0.1	1.63	0.456	1.58	NA	NA
HC02	Sample-Routine	5/9/2023	5.2	<0.1	2.1	0.39	1.83	NA	NA
HC02	Sample-Routine	5/31/2023	6.0	<0.1	2.5	0.45	2.02	NA	NA
HC02	Sample-Routine	6/21/2023	13	<0.1	6.1	0.89	3.89	NA	NA
HC02	Sample-Routine	7/10/2023	15	<0.1	6.8	1.1	4.69	NA	NA
HC02	Sample-Routine	11/14/2023	11	<0.1	3.5	0.58	2.38	NA	NA
HC02	Sample-Routine	4/2/2024	6.0	<0.1	2.7	0.47	2.49	NA	NA
HC02	Sample-Routine	5/15/2024	5.8	<0.1	2.65	0.481	2.29	NA	NA
HC02	Sample-Routine	8/19/2024	19.0	<0.1	8.12	1.33	5.39	7.36	8.32

Site	Sample Type	Date	Alkalinity (mg/l)	Settleable	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Sulfate (mg/l)
				Solids (ml/l)					
HC02	Sample-Routine	9/17/2024	6.2	<0.1	3.32	0.504	2.24	NA	NA
HC02	Sample-Routine	9/23/2024	3.8	<0.1	2.65	0.387	1.82	NA	NA
HC02	Sample-Routine	10/15/2024	6.8	<0.1	3.27	0.518	2.09	NA	NA
HC02	Sample-Routine	11/4/2024	7.0	<0.1	3.53	0.579	2.18	NA	NA
KC01	Sample-Routine	5/9/2023	12	<0.1	4.6	0.45	1.54	NA	NA
KC01	Sample-Routine	5/31/2023	7.0	<0.1	3.1	0.37	1.41	NA	NA
KC01	Sample-Routine	6/21/2023	11	<0.1	4.5	0.41	1.66	NA	NA
KC01	Sample-Routine	7/10/2023	17	<0.1	6.6	0.61	1.94	NA	NA
KC01	Sample-Routine	11/14/2023	6.6	<0.1	1.7	0.27	1.03	NA	NA
KC01	Sample-Routine	4/2/2024	6.8	<0.1	3.4	0.38	1.43	NA	NA
KC01	Sample-Routine	5/15/2024	9.4	<0.1	4.13	0.436	1.57	NA	NA
KC01	Sample-Routine	8/19/2024	12.8	<0.1	5.1	0.548	1.71	1.71	4.66
KC01	Sample-Routine	9/17/2024	4.4	<0.1	2.34	0.301	1.24	NA	NA
KC01	Sample-Routine	9/23/2024	3.2	<0.1	1.48	0.231	0.941	NA	NA
KC01	Sample-Routine	10/15/2024	4.0	<0.1	1.81	0.242	1.03	NA	NA
KC01	Sample-Routine	11/4/2024	4.6	<0.1	1.81	0.271	1.05	NA	NA
KC01B	Sample-Routine	8/19/2024	3.8	<0.1	1.11	0.268	0.968	1.26	0.96
KC01B	Sample-Routine	9/17/2024	5.0	<0.1	2.2	0.292	1.2	NA	NA
KC01B	Sample-Routine	9/23/2024	3.8	<0.1	1.4	0.229	0.914	NA	NA
KC01B	Sample-Routine	10/15/2024	3.6	<0.1	1.4	0.247	1.01	NA	NA
KC01B	Sample-Routine	11/4/2024	3.2	<0.1	1.16	0.249	1.00	NA	NA
KC02	Sample-Routine	5/9/2023	7.0	<0.1	0.88	0.22	0.89	NA	NA
KC02	Sample-Routine	5/31/2023	5.8	<0.1	1.4	0.25	0.99	NA	NA
KC02	Sample-Routine	6/21/2023	2.6	<0.1	0.91	0.21	0.82	NA	NA
KC02	Sample-Routine	7/10/2023	5.2	<0.1	0.86	0.22	0.86	NA	NA
KC02	Sample-Routine	11/14/2023	8.8	<0.1	1.4	0.26	0.97	NA	NA
KC02	Sample-Routine	4/2/2024	5.4	<0.1	2	0.26	1.19	NA	NA
KC02	Sample-Routine	5/15/2024	7.0	<0.1	2.46	0.264	1.16	NA	NA
KC02	Sample-Routine	8/19/2024	4.6	<0.1	1.37	0.281	1.22	1.41	1.58
KC02	Sample-Routine	9/17/2024	5.4	<0.1	3.02	0.346	1.23	NA	NA
KC02	Sample-Routine	9/23/2024	3.8	<0.1	2.33	0.249	1.04	NA	NA
KC02	Sample-Routine	10/15/2024	3.6	<0.1	1.82	0.255	1.02	NA	NA
KC02	Sample-Routine	11/4/2024	3.8	<0.1	1.27	0.256	0.969	NA	NA
KC03	Sample-Routine	5/9/2023	6.2	<0.1	1.2	0.25	1.02	NA	NA
KC03	Sample-Routine	5/31/2023	5.2	<0.1	2.1	0.28	1.41	NA	NA
KC03	Sample-Routine	6/21/2023	5.2	<0.1	1.2	0.23	0.88	NA	NA
KC03	Sample-Routine	7/10/2023	5.4	<0.1	1	0.23	0.92	NA	NA
KC03	Sample-Routine	11/14/2023	9.4	<0.1	2.1	0.31	1.14	NA	NA
KC03	Sample-Routine	4/2/2024	4.6	<0.1	2.2	0.28	1.48	NA	NA
KC03	Sample-Routine	5/15/2024	5.2	<0.1	2.56	0.306	1.41	NA	NA
KC03	Sample-Routine	8/19/2024	3.6	<0.1	1.36	0.285	1.18	1.39	1.53
KC03	Sample-Routine	9/17/2024	6.4	<0.1	3.45	0.365	1.57	NA	NA
KC03	Sample-Routine	9/23/2024	3.8	<0.1	2.94	0.314	1.42	NA	NA
KC03	Sample-Routine	10/15/2024	4.6	<0.1	1.81	0.272	1.21	NA	NA
KC03	Sample-Routine	11/4/2024	3.2	<0.1	1.44	0.279	1.08	NA	NA

Site	Sample Type	Date	Alkalinity (mg/l)	Settleable Solids (ml/l)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Sulfate (mg/l)
Schoenbar	Sample-Routine	8/19/2024	23.2	<0.1	18.2	1.19	5.47	6.16	31.5
Schoenbar	Sample-Routine	9/17/2024	5.6	<0.1	6.49	0.587	2.61	NA	NA
Schoenbar	Sample-Routine	9/23/2024	2.8	<0.1	3.45	0.481	1.86	NA	NA
Schoenbar	Sample-Routine	10/15/2024	5.2	<0.1	5.12	0.593	1.89	NA	NA
Schoenbar	Sample-Routine	11/4/2024	8.2	<0.1	7.55	0.625	2.64	NA	NA

Nutrients and dissolved organic carbon

Table X. Ammonium-N, nitrate+nitrite-N, dissolved organic carbon, and total and dissolved phosphorus.

Site	Sample Type	Date	Ammonia-nitrogen (mg/l)	Nitrate-Nitrite-N (mg/l)	Dissolved organic carbon (mg/l)	Phosphorus -Dissolved (mg/l)	Phosphorus -Total (mg/l)
CC01	Sample-Routine	5/9/2023	<0.02	<0.02	2.2	<0.001	<0.005
CC01	Sample-Routine	5/31/2023	<0.02	<0.02	2.6	0.0023	<0.005
CC01	Sample-Routine	6/21/2023	<0.02	<0.02	4.2	0.0051	0.006
CC01	Sample-Routine	7/10/2023	<0.02	<0.02	4.6	0.0044	0.011
CC01	Sample-Routine	11/14/2023	<0.02	0.030	4.4	0.0026	0.007
CC01	Sample-Routine	4/2/2024	<0.02	<0.02	2.7	0.0024	0.0037
CC01	Sample-Routine	5/15/2024	<0.02	<0.02	3.9	0.004	0.006
CC01	Sample-Routine	8/19/2024	<0.02	<0.02	4.9	0.004	0.008
CC01	Sample-Routine	9/17/2024	<0.02	0.053	7.4	0.004	<0.005
CC01	Sample-Routine	9/23/2024	<0.02	0.031	7.2	0.004	0.009
CC01	Sample-Routine	10/15/2024	<0.02	0.023	4.3	0.002	0.008
CC01	Sample-Routine	11/4/2024	<0.02	0.029	3.6	0.002	0.007
CC02	Sample-Routine	5/9/2023	0.028	<0.02	2.5	<0.001	0.031
CC02	Sample-Routine	5/31/2023	<0.02	0.026	4.1	<0.001	<0.005
CC02	Sample-Routine	6/21/2023	0.028	0.105	3.1	0.0055	0.006
CC02	Sample-Routine	7/10/2023	<0.02	0.229	2.6	0.0047	0.006
CC02	Sample-Routine	11/14/2023	<0.02	0.049	4.2	0.0028	0.007
CC02	Sample-Routine	4/2/2024	<0.02	0.024	3.5	0.0023	0.0035
CC02	Sample-Routine	5/15/2024	<0.02	0.030	4.2	0.005	0.004
CC02	Sample-Routine	8/19/2024	<0.02	0.340	2.4	0.004	0.006
CC02	Sample-Routine	9/17/2024	<0.02	0.033	6.6	0.006	<0.005
CC02	Sample-Routine	9/23/2024	<0.02	0.043	6.9	0.005	0.009
CC02	Sample-Routine	10/15/2024	<0.02	0.043	4.0	0.003	0.009
CC02	Sample-Routine	11/4/2024	<0.02	0.040	4.4	0.002	0.007
HC01	Sample-Routine	5/9/2023	0.026	<0.02	2.2	<0.001	<0.005
HC01	Sample-Routine	5/31/2023	<0.02	<0.02	5.9	0.0022	<0.005
HC01	Sample-Routine	6/21/2023	<0.02	0.055	2.8	0.0054	0.005
HC01	Sample-Routine	7/10/2023	<0.02	0.102	2.2	0.0037	<0.005
HC01	Sample-Routine	11/14/2023	<0.02	0.027	4.8	0.0016	<0.005
HC01	Sample-Routine	4/2/2024	<0.02	<0.02	4.9	0.0017	0.0021
HC01	Sample-Routine	5/15/2024	0.020	<0.02	4.9	0.003	0.005
HC01	Sample-Routine	8/19/2024	<0.02	0.115	2.1	0.003	0.005
HC01	Sample-Routine	9/17/2024	<0.02	<0.02	8.5	0.003	<0.005
HC01	Sample-Routine	10/15/2024	<0.02	<0.02	4.4	0.005	0.011
HC01	Sample-Routine	11/4/2024	<0.02	<0.02	4.4	0.001	0.006
HC02	Sample-Routine	5/9/2023	<0.02	<0.02	2.3	<0.001	<0.005
HC02	Sample-Routine	5/31/2023	<0.02	0.034	4.5	0.0049	0.008
HC02	Sample-Routine	6/21/2023	0.028	0.094	3.8	0.0050	0.006
HC02	Sample-Routine	7/10/2023	<0.02	0.155	2.3	0.0085	0.013
HC02	Sample-Routine	11/14/2023	<0.02	0.056	4.2	0.0037	0.006
HC02	Sample-Routine	4/2/2024	<0.02	0.036	5.1	0.0035	0.0059

HC02	Sample-Routine	5/15/2024	<0.02	0.030	5.2	0.004	0.006
HC02	Sample-Routine	8/19/2024	0.021	0.135	3.1	0.007	0.005
HC02	Sample-Routine	9/17/2024	<0.02	0.037	8.6	0.004	<0.005
HC02	Sample-Routine	9/23/2024	<0.02	0.027	7.1	0.005	0.011
HC02	Sample-Routine	10/15/2024	<0.02	0.030	5.1	0.003	0.011
HC02	Sample-Routine	11/4/2024	<0.02	0.031	4.4	0.001	0.007
KC01	Sample-Routine	5/9/2023	0.052	0.057	1.1	<0.001	<0.005
KC01	Sample-Routine	5/31/2023	<0.02	0.063	6.2	<0.001	<0.005
KC01	Sample-Routine	6/21/2023	<0.02	0.080	1.7	0.0034	<0.005
KC01	Sample-Routine	7/10/2023	<0.02	0.102	1.2	0.0027	<0.005
KC01	Sample-Routine	11/14/2023	<0.02	0.079	2.5	0.0015	<0.005
KC01	Sample-Routine	4/2/2024	<0.02	0.085	4.8	0.0015	0.0016
KC01	Sample-Routine	5/15/2024	0.030	0.070	4.6	0.002	<0.005
KC01	Sample-Routine	8/19/2024	<0.02	0.122	1.6	<0.001	<0.005
KC01	Sample-Routine	9/17/2024	<0.02	0.073	4.7	0.002	<0.005
KC01	Sample-Routine	9/23/2024	<0.02	0.044	4.0	0.003	0.007
KC01	Sample-Routine	10/15/2024	<0.02	0.062	2.2	<0.001	0.005
KC01	Sample-Routine	11/4/2024	<0.02	0.068	1.8	<0.001	<0.005
KC01B	Sample-Routine	8/19/2024	<0.02	0.052	1.6	<0.001	<0.005
KC01B	Sample-Routine	9/17/2024	<0.02	0.073	5.1	0.004	<0.005
KC01B	Sample-Routine	9/23/2024	<0.02	0.043	3.5	0.004	0.006
KC01B	Sample-Routine	10/15/2024	<0.02	0.067	2.2	<0.001	0.005
KC01B	Sample-Routine	11/4/2024	<0.02	0.071	2.2	0.005	
KC02	Sample-Routine	5/9/2023	0.030	0.072	0.97	<0.001	<0.005
KC02	Sample-Routine	5/31/2023	<0.02	0.069	2.0	<0.001	<0.005
KC02	Sample-Routine	6/21/2023	<0.02	0.069	1.0	0.0037	<0.005
KC02	Sample-Routine	7/10/2023	<0.02	0.060	1.1	0.0028	<0.005
KC02	Sample-Routine	11/14/2023	0.021	0.086	2.3	0.0034	0.006
KC02	Sample-Routine	4/2/2024	<0.02	0.085	2.4	0.0018	0.0024
KC02	Sample-Routine	5/15/2024	0.030	0.060	1.3	0.003	<0.005
KC02	Sample-Routine	8/19/2024	0.037	0.055	2.0	0.003	0.007
KC02	Sample-Routine	9/17/2024	0.075	0.079	4.4	0.008	<0.005
KC02	Sample-Routine	9/23/2024	0.034	0.055	3.5	0.004	0.007
KC02	Sample-Routine	10/15/2024	0.020	0.067	2.5	0.001	0.006
KC02	Sample-Routine	11/4/2024	<0.02	0.077	1.8	<0.001	<0.005
KC03	Sample-Routine	5/9/2023	0.024	0.073	0.99	<0.001	0.016
KC03	Sample-Routine	5/31/2023	<0.02	0.088	2.2	0.0014	<0.005
KC03	Sample-Routine	6/21/2023	<0.02	0.067	1.2	0.0027	<0.005
KC03	Sample-Routine	7/10/2023	<0.02	0.058	1.2	0.0022	<0.005
KC03	Sample-Routine	11/14/2023	0.040	0.087	2.3	0.0035	0.014
KC03	Sample-Routine	4/2/2024	<0.02	0.076	3.1	0.0024	0.0037
KC03	Sample-Routine	5/15/2024	<0.02	0.060	2.1	0.003	0.005
KC03	Sample-Routine	8/19/2024	0.105	0.056	1.9	0.008	0.012
KC03	Sample-Routine	9/17/2024	0.117	0.085	4.6	<0.001	0.008
KC03	Sample-Routine	9/23/2024	<0.02	0.074	3.4	0.004	0.009
KC03	Sample-Routine	10/15/2024	<0.02	0.080	2.1	0.001	0.006
KC03	Sample-Routine	11/4/2024	<0.02	0.074	2.1	<0.001	0.006
Schoenbar	Sample-Routine	8/19/2024	NA	NA	4.0	0.010	NA

Schoenbar	Sample-Routine	9/17/2024	NA	NA	9.2	0.003	NA
Schoenbar	Sample-Routine	9/23/2024	NA	NA	8.0	0.017	NA
Schoenbar	Sample-Routine	10/15/2024	NA	NA	4.8	0.011	NA
Schoenbar	Sample-Routine	11/4/2024	NA	NA	5.5	0.002	NA