Consulting
Engineers and
Scientists

Substrate and Algae Assessment in the Colorado River and Fraser River Basins 2025

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Sediment and Algae Assessment in the Colorado River and Fraser River Basins 2025

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Consulting Engineers and Scientists

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1. Introduction

At the request of Grand County's Learning by Doing (LBD), GEI Consultants, Inc. (GEI) conducted assessments of the substrate and algae at multiple sampling locations in the Colorado River and Fraser River basins in Grand County in the fall of 2025. A total of 16 sites were assessed from September 10, 2025, through September 12, 2025. Eight sites were located on the Colorado River, five were located on the Fraser River, one was located on Ranch Creek, one was located on Willow Creek, and one was located on Williams Fork River (Williams Fork).

All sixteen sites sampled by GEI for substrate and algae characteristics in 2025 were established in previous years by LBD at various locations throughout their Cooperative Effort Area (CEA), and 15 were sampled at least once between 2019 and 2025. Site WF-5.5 was sampled in 2025 but had not been included in sediment surveys since 2019.

GEI performed pebble counts and measured percent fines, percent embeddedness, and algal cover. The data collected at each site location may be used to assess potential sediment transport issues in the basin, and to assess aquatic habitat metrics such as the Sediment Tolerance Indicator Value (TIV_{SED}).

2. Cooperative Effort Area

All sampling sites were located within LBD's CEA in Grand County (Figure 2-1; Table 2-1). The sampling area in 2025 included eight sites on the Colorado River that extend from the town of Granby, CO to the town of Kremmling, CO. Site CRCC-0.5 was established on the Colorado River in the new connectivity channel. This engineered channel was constructed to reconnect the Colorado River around Windy Gap Reservoir; construction was completed in fall of 2024 and water was first introduced into the channel on October 25, 2023.

The five sites sampled on the Fraser River extended from Winter Park, CO to Granby, CO (Figure 2–1). One site on Ranch Creek was sampled in 2025 in Tabernash, CO, upstream from the confluence with the Fraser River.

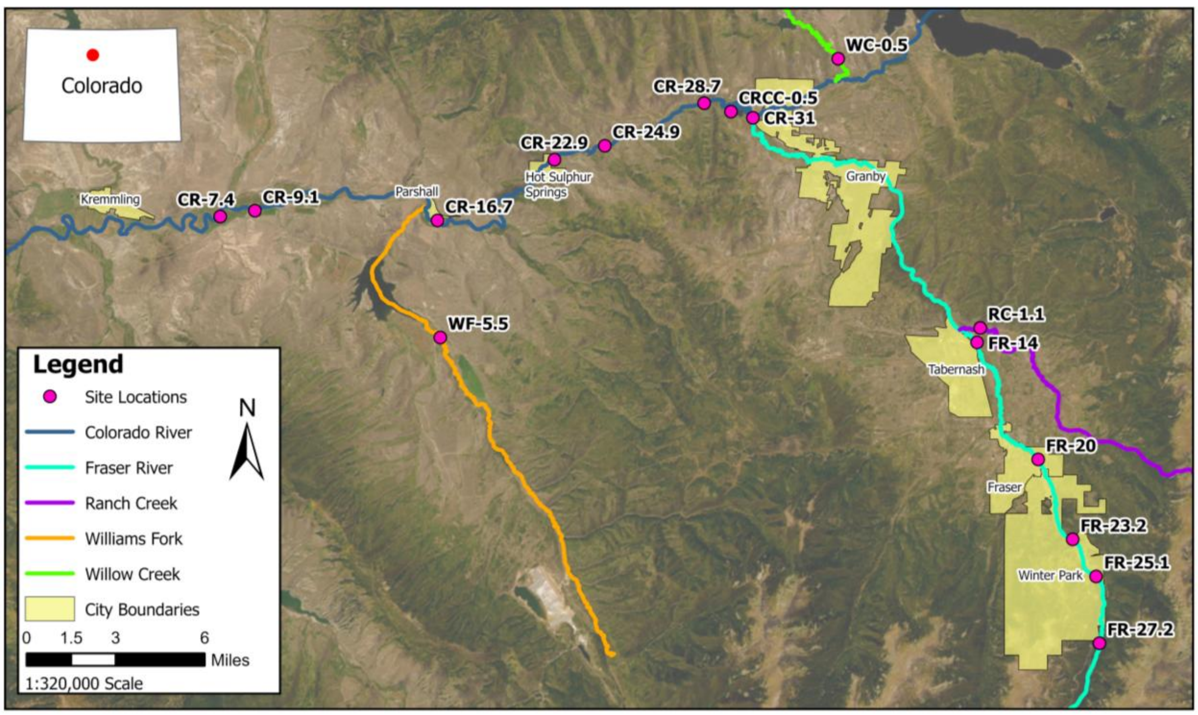

Figure 2-1: All sites on the Colorado River, Fraser River, Ranch Creek, Willow Creek, and Williams Fork sampled in 2025.

Table 2-1: Names and locations for all sites sampled in 2025. *Site CR-28.7 was moved upstream due to property access issues.

Site Name	Station Description	Latitude/Longitude
CR-31	Colorado River upstream of Fraser and Windy Gap	40.101/-105.973
CRCC-0.5	Colorado River Connectivity Channel	40.104/-105.987
CR-28.7*	Colorado River just downstream of Windy Gap	40.108/-106.004
CR-24.9	Colorado River at Sheriff Ranch	40.087/-106.067
CR-22.9	Colorado River at Hot Sulphur Springs	40.080/-106.099
CR-16.7	Colorado River upstream of Williams Fork	40.050/-106.173
CR-9.1	Colorado River at CR39 Bridge at KB Ditch	40.054/-106.289
CR-7.4	Colorado River downstream of Troublesome Creek	40.051/-106.311
FR-27.2	Fraser River above Jim Creek	39.845/-105.752
FR-25.1	Fraser River upstream of UP Moffat Tunnel discharge	39.878/-105.754
FR-23.2	Fraser River upstream of Winter Park Sanitation	39.896/-105.769
FR-20	Fraser River at Rendezvous Bridge	39.935/-105.791
FR-14	Fraser River upstream of Tabernash	39.992/-105.830
RC-1.1	Ranch Creek downstream of Meadow Creek	39.999/-105.828
WC-0.5	Willow Creek upstream of bridge/downstream of future restoration site	40.130/-105.919
WF-5.5	Williams Fork Upstream of Reservoir	39.993/-106.171

3. Methods

3.1 Pebble Counts and Embeddedness

At all 16 sites where pebble counts were performed, substrate was sampled with the Modified Wolman Pebble Count Method outlined by Colorado Water Quality Control Division (WQCD) Policy 98-1 (Colorado Department of Public Health and Environment [CDPHE] 2024). Ten evenly spaced transects were established along a length of stream approximately twenty times the average bankfull width. At each of these ten transects, a 60 by 60-centimeter (cm) sampling frame was used to designate four substrate particles for measurement at ten evenly spaced points across the transect (Photos 3-1 and 3-2). This accounted for a total of 40 substrate particle measurements per transect, and a total of 400 measurements per sampling location. The sampling frame consisted of 4 aluminum bars connected to form a square, with an inside width of 60 cm, and 4 elastic bands placed forming four cross sections with a width of 50 cm. The intermediate axis of each particle designated by the elastic band cross sections on the sampling frame was measured using a gravelometer (a ruler was used if the particle was too large to fit through the apertures in the gravelometer). Ocular estimates were used for substrate particles that could not be removed from the bed (i.e., due to size or water depth). The measurements of the individual particles were used to calculate the D_{50} and the D_{84} of the sample. The notation D represents the particle diameter in millimeters (mm), and the subscript denotes the percentile; the D_{50} and D_{84} are the diameters (in mm) that are larger than 50 percent and 84 percent of the particles in the sample, respectively. The percentage of fine substrate (i.e., < 2 mm) was also calculated to determine the availability of clean substrate and interstitial spaces (i.e., the spaces between gravel and cobble particles used by macroinvertebrates and juvenile fishes).

Photo 3-1: Algae being observed with a viewing bucket on the Colorado River.

Photo 3-2: Sampling frame with four intersections for randomized substrate selection.

A subset of the particles measured at each of the transects at each site were used to determine percent embeddedness, or the extent to which larger particles are surrounded by or buried in fine substrate (i.e., sand and silt). Five large gravel or cobble-sized particles at each transect were measured for percent embeddedness, for a total of 50 embeddedness measurements per sampling location. Embeddedness percentages were determined by measuring the height that each representative particle was buried in fine substrate and dividing by the total particle height (Burns and Edwards 1985). This method allowed for a quantitative estimate of the total percent embeddedness at each site.

Ten transects were established at all sites, but some transects contained deep water that prevented wading/data collection at some locations. On the Colorado River, portions of one transect at sites CRCC-0.5 and CR-7.4 were not wadeable, and pebble count data were collected from as many stations as possible along the transects. On the Fraser River, Ranch Creek, Willow Creek, and Williams Fork all transects were wadeable, and algae and pebble sampling efforts were completed at all transects. Inaccessible portions of sites were assessed visually when possible. If visual assessment of sediment particles, embeddedness, or algae cover was not feasible, no data were collected for that portion of a transect.

Table 3--1: List of the 16 sites where 400-rock pebble counts, embeddedness estimates, and algae coverage estimates were conducted. High water depth prevented complete sampling at two sites.

Site Name	Station Description	Completed Pebble Count Transects	Notes
CR-31	Colorado River upstream of Fraser and Windy Gap	10	
CRCC-0.5	Colorado River Connectivity Channel	9	396/400 pebbles counted
CR-28.7	Colorado River just downstream of Windy Gap	10	
CR-24.9	Colorado River at Sheriff Ranch	10	
CR-22.9	Colorado River at Hot Sulphur Springs	10	
CR-16.7	Colorado River upstream of Williams Fork	10	
CR-9.1	Colorado River at CR39 Bridge at KB Ditch	10	
CR-7.4	Colorado River downstream of Troublesome Creek	9	389/400 pebbles counted
FR-27.2	Fraser River above Jim Creek	10	
FR-25.1	Fraser River upstream of UP Moffat Tunnel discharge	10	
FR-23.2	Fraser River upstream of Winter Park Sanitation	10	
FR-20	Fraser River at Rendezvous Bridge	10	
FR-14	Fraser River upstream of Tabernash	10	
RC-1.1	Ranch Creek downstream of Meadow Creek	10	
WC-0.5	Willow Creek downstream of restoration site	10	
WF-5.5	Williams Fork above Reservoir	10	

3.2 Algae Presence, Percent Cover, and Thickness

Algae presence (filamentous algae and diatoms), percent filamentous algae cover, and diatom thickness data were recorded using a combined method that included protocols taken from the WQCD Standard Operating Procedures for the Collection of Stream Periphyton Samples (CDPHE, no year) combined with the grid-based pebble count method. Along each transect established for pebble counts, presence of filamentous algae, presence of diatoms, percent filamentous algae cover, and diatom thickness were measured or visually estimated.

The algal communities were observed at three distances per transect: 25 percent, 50 percent, and 75 percent from the streambank, for a total of 30 points evaluated at each site. The algae viewing bucket consisted of a 5-gallon bucket with its bottom replaced with transparent plexiglass with 50 evenly spaced points marked with permanent marker (Photo 3–5). At each of the three transect positions, the presence of filamentous algae and/or diatoms was recorded. This metric provides information on whether algae and/or diatoms were found at most viewing locations or were patchy or rare in distribution at a site. Filamentous algae are defined as algae that are green in color and form strands or filaments. Diatoms are microscopic algae and tend not to form tall-growing colonies, with one exception. *Didymosphenia geminata* (Didymo) sometimes forms dense, brown or gray blooms that can cover much of the stream substrate. Low-growing algae and the readily identifiable Didymo were considered diatoms. For filamentous algae cover data, the viewing bucket was used twice at each of the three locations along each transect, to allow viewing at a total of 100 evenly spaced points at each location. The total number of points where filamentous algae was growing was divided by 100 to calculate the percent filamentous algae cover at each of the three viewing locations per transect (see Appendix D for example photos of algal coverage). At each of the three distances the thickness of diatom growth was visually estimated in millimeters (mm) and categorized in accordance with Stevenson and Bahls 1999 (Table 3–2). Example photos of algae cover are presented in Appendix D.

Table 3-2: Diatom thickness categories as defined by Stevenson and Bahls 1999.

Category	Categorical Description
0	Substrate rough with no visual evidence of microalgae
0.5	Substrate slimy, but no visual accumulation of microalgae evident
1	A thin layer of microalgae is visually evident
2	Accumulation of microalgal layer from 0.5 to 1 mm thick is evident
3	Accumulation of microalgal layer from 1 to 5 mm thick is evident
4	Accumulation of microalgal layer from 5 mm to 2 cm thick is evident
5	Accumulation of microalgal layer greater than 2 cm thick is evident

4. 2025 Results

4.1 Pebble Counts and Embeddedness

Pebble counts were performed at eight sites on the Colorado River, five sites on the Fraser River, one site on Ranch Creek, one site on Willow Creek, and one site on Williams Fork from September 9, 2025, through September 12, 2025.

In total, gravel, small cobble, and cobble were the most abundant substrate classes, averaging 26 percent, 22 percent, and 23 percent respectively among all sites (Table 4-1, Figure 4.1). Sites FR-20, FR-25.1, and WC-0.5 were the only sites where the most common substrate was not gravel, small cobble, or cobble. Fines were the most abundant substrate at sites FR-20 and WC-0.5 with percentages of 39 and 51, respectively, and boulder substrate was most abundant at Site FR-25.1 at 35 percent.

Table 4-1: Percent average substrate size classes at all sites sampled in 2025.

Sites	Substrate Size Categories							
	Fines	Small Gravel	Gravel	Small Cobble	Cobble	Small Boulder	Boulder	Bedrock
	<2 mm	2-8 mm	8-64 mm	64-128 mm	128-256 mm	256-512 mm	>512mm	
CR-31	1.3	6.0	25.8	20.8	45.3	1.0	0	0
CRCC-0.5	5.6	6.8	14.4	23.2	46.5	3.5	0	0
CR-28.7	5.3	1.3	29.8	30.3	29.5	3.5	0.5	0
CR-24.9	13.0	6.0	21.4	20.8	31.4	3.7	1.0	0
CR-22.9	11.0	4.8	23.3	29.8	27.8	3.3	0	0
CR-16.7	10.8	8.0	35.3	25.0	19.0	1.8	0.3	0
CR-9.1	16.0	5.7	23.7	34.2	18.5	1.0	1.0	0
CR-7.4	15.4	8.7	46.5	21.3	6.7	0.8	0.5	0
FR-27.2	5.7	26.2	51.6	12.5	4.0	0	0	0
FR-25.1	4.5	5.7	12.7	12.2	19.4	10.7	35.0	0
FR-23.2	8.4	11.6	31.4	15.1	28.5	3.5	1.5	0
FR-20	39.0	3.0	13.8	16.3	18.3	8.8	1.0	0
FR-14	5.0	4.8	13.3	21.8	29.8	24	1.5	0
RC-1.1	12.9	4.7	35.1	28.6	11.7	3.5	3.5	0
WF-5.5	11.7	1.0	22.8	24.8	31.3	6.9	1.5	0
WC-0.5	51.4	1.5	12.3	14.1	15.6	3.7	1.5	0

Bedrock was not observed at any site in 2025. On the Colorado River, cobble and small cobble were the most abundant substrate at all sites except CR-16.7 and CR-7.4, where gravel was the dominate substrate (Table 4-1, Figure 4-1). Small boulders were observed at all Colorado River sites, and boulders were observed at four out of the eight sites. (Figure 4-1). The most downstream site, Site CR-7.4, had a greater proportion of fines and gravel substrate than all other sites on the Colorado River in 2025.

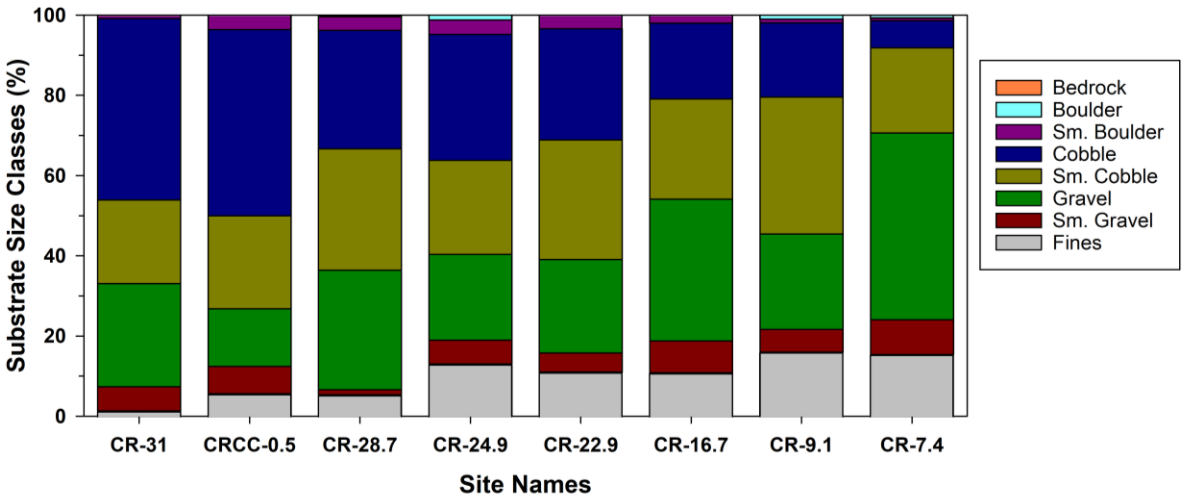

Figure 4-1: Percentage of substrate size classes for all sites on the Colorado River in 2025. Sites are ordered from left to right from upstream to downstream.

On average, the most abundant substrate classes on the Fraser River in 2025 were gravel, small cobble, and cobble. Gravel was the most abundant substrate at sites FR-27.2 and FR-23.2. Site FR-25.1 had 35 percent boulders and 10.7 percent small boulders, the highest amount for both substrate types among all Fraser River sites (Table 4-1; Figure 4-2). Fines were most abundant at Site FR-20; this site had the highest concentration of fines out of all Fraser River sites at 39 percent. At Site RC-1.1 on Ranch Creek, the most abundant substrate was gravel, followed by small cobble. This site had the second highest concentration of fines (12.9 percent) among the Ranch Creek and Fraser River sites in 2025 (Table 4-1).

The Colorado River tributaries had variable proportions of substrate. All substrate classes besides bedrock were observed at both Willow Creek sites. Cobble was the most common substrate at Site WF-5.5 (31 percent), whereas fines were the most common substrate at Site WC-0.5 (51.4 percent, Figure 4-3). Site WC-0.5 had the highest percentage of fines among all sites sampled in 2025.

Of the 16 sites surveyed with the 400-rock modified Wolman count in 2025, only sites FR-20 and WC-0.5 had a percentage of fine sediment (i.e., < 2 mm) greater than 27.7 percent, which is the threshold set in CDPHE Policy 98-1 for the protection of macroinvertebrates for sites in the CEA.

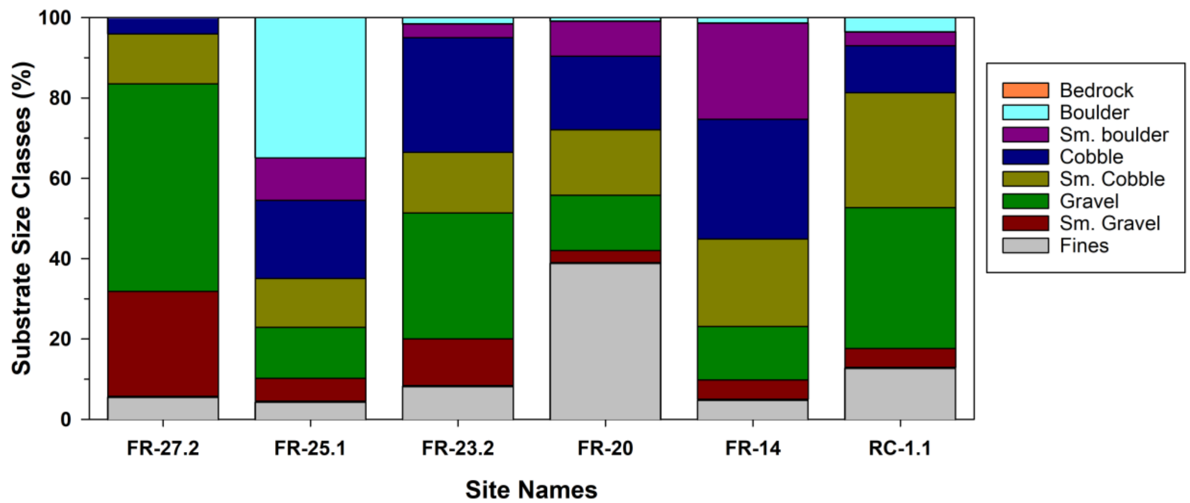

Figure 4-2: Percentage of substrate size classes for all sites on the Fraser River and Ranch Creek in 2025. Sites are ordered for the Fraser River left to right from upstream to downstream.

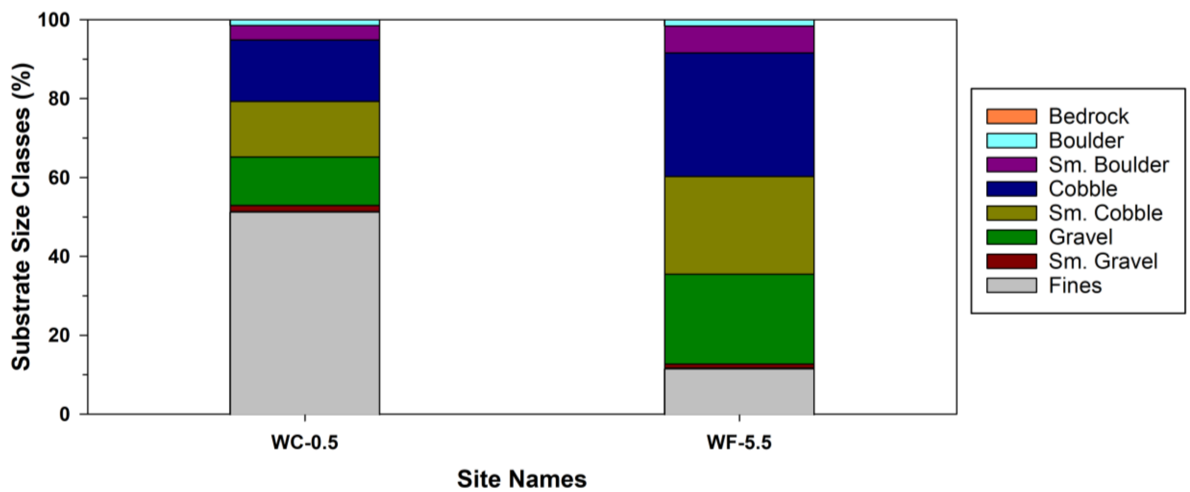

Figure 4-3: Percentage of substrate size classes for all sites on Willow Creek and Williams Fork in 2025.

Average percent embeddedness was greater than or equal to 27.9 percent across all 16 sites (Table 4-2). The highest embeddedness on the Fraser River was 65.1 percent at Site FR-20, and the lowest embeddedness was 32.7 percent at the most upstream site, FR-27.2 (Table 4-2). Site WC-0.5 had the highest average embeddedness among all sites with 76 percent. The lowest average embeddedness among all sites was at Site CRCC-0.5 with 27.9 percent.

Table 4-2: Average embeddedness at all sites sampled in 2025.

Sites	Waterbody	Average Percent Embeddedness
CR-31	Colorado River	29.8
CRCC-0.5	Colorado River	27.9
CR-28.7	Colorado River	40.6
CR-24.9	Colorado River	45.7
CR-22.9	Colorado River	41.7
CR-16.7	Colorado River	46.7
CR-9.1	Colorado River	41.7
CR-7.4	Colorado River	47.7
FR-27.2	Fraser River	32.7
FR-25.1	Fraser River	52.1
FR-23.4	Fraser River	39.8
FR-20	Fraser River	65.1
FR-14	Fraser River	45.6
RC-1.1	Ranch Creek	54.5
WF-5.5	Williams Fork	48.4
WC-0.5	Willow Creek	76.0

4.2 Algae Presence, Percent Cover, and Thickness

The algae community was assessed at a total of 30 points within each site reach in conjunction with pebble count surveys in September 2025. As with the pebble counts, portions of transects at some sites were too deep and/or turbid for algae community measurements. The percent average presence of filamentous algae ranged from 0 to 90 on the Colorado River and ranged from 23 to 43 on the Fraser River. Site WF-5.5 on the Williams Fork had 100 percent filamentous algae presence, whereas Site WC-0.5 on Willow Creek had 50 percent presence (Table 4-3). Site RC-1.1 on Ranch Creek had zero percent filamentous presence. The average values of filamentous algae presence on the Colorado River and Fraser River were 43 and 38 percent, respectively.

The average percent filamentous algae cover varied between sites, but average cover at all sites was less than 35 percent among all sites except for Site WF-5.5. Within-site variability (i.e., between transects at a given site) was also high, indicating that the distribution and coverage of algae was patchy in 2025. Percent filamentous algae cover on the Colorado River ranged from 0 percent at Site CR-24.9 to 28.7 percent at Site CR-16.7. On the Fraser River, percent filamentous algae cover ranged from 3.1 percent at Site FR-27.2 to 25.8 percent at Site FR-14. The site on Ranch Creek had zero percent filamentous algae cover and Site WF-5.5 on the Williams Fork had the highest percent filamentous algae cover among all sites sampled in 2025 with a percentage of 68.9.

Table 4-3: Filamentous algae and diatom data by site in 2025.

Sites	Waterbody	Percent Average Filamentous Presence	Percent Average Filamentous Algae Cover	Percent Average Diatom Presence	Average Categorical Diatom Thickness
CR-31	Colorado River	60	4.4	100	4.03
CRCC-0.5	Colorado River	77	9.2	87	2.52
CR-28.7	Colorado River	7	3.3	100	0.88
CR-24.9	Colorado River	0	0	100	2.93
CR-22.9	Colorado River	7	0.3	93	1.32
CR-16.7	Colorado River	87	28.7	97	3.25
CR-9.1	Colorado River	13	8.7	100	2.58
CR-7.4	Colorado River	90	25.1	97	3.17
FR-27.2	Fraser River	43	3.1	97	0.83
FR-25.1	Fraser River	23	3.3	100	0.67
FR-23.2	Fraser River	37	7.6	43	2.10
FR-20	Fraser River	43	7.5	100	1.45
FR-14	Fraser River	43	25.8	97	0.88
RC-1.1	Ranch Creek	0	0	87	0.77
WF-5.5	Williams Fork	100	68.9	93	2.62
WC-0.5	Willow Creek	50	24.3	33	0.22

Diatoms were observed at all sites sampled in 2025, and most sites had a high percentage of diatom presence. All sites besides WC-0.5 and FR-23.2 had an average diatom presence between 87 and 100 percent (Table 4–4). Site WC-0.5 had an average diatom presence of 33 percent and Site FR-23.2 had an average diatom presence of 43 percent. Average diatom thickness varied by site, but average thickness was only indicative of extensive Didymo blooms at sites CR-31 and CR-16.7.

5. Discussion

The substrate and algae community data gathered in the fall of 2025 at multiple sites along representative stretches of the Colorado River, Fraser River, Ranch Creek, Willow Creek, and Williams Fork have enabled a basin-wide assessment of substrate size, substrate mobility, substrate deposition, and algae coverage data. Spatial and temporal trends in the last seven years of data were identified by visual analysis, in an effort to identify patterns in the data. Preliminary findings are summarized below, along with inference about the effects of current conditions and trends on fish and macroinvertebrate habitat quality.

5.1 Pebble Counts and Embeddedness

5.1.1 Colorado River, Willow Creek, and Williams Fork

In 2025, fine substrate was highest at site CR-7.4, which is the most downstream site. The percentage of fines at Site CR-7.4 was over twice as high in 2024 compared to 2025. The percentage fines at sites CR-28.7 and CR-24.9 increased from 2024 to 2025, whereas fines decreased at sites CR-31, CRCC-0.5, CR-22.9 and CR-16.7. Site WC-0.5 had 51.4 percent fines, which was the highest abundance of fines among all sites sampled in 2025. This high percentage of fines is due to the presence of beaver ponds within the Willow Creek site reach. Beavers began constructing ponds at this site in 2024, but effects on sediment dynamics were less apparent than in 2025, when the ponds were storing notable amounts of fine sediment.

The proportion of small gravel was consistently less than 10 percent among all sites on the Colorado River in 2025. The percentage of small gravel was greater at sites lower in the CEA, at sites CR-9.1 and CR-7.4. In 2025, the percentage of gravel at the Colorado River sites ranged from 14.4 percent at site CRCC-0.5 to 46.5 percent at site CR-7.4. Site CR-7.4 has had the highest percentage of gravel in all years sampled.

Average embeddedness values on the Colorado River in 2025 ranged from 27.9 percent at Site CRCC-0.5 to 47.7 percent at Site CR-7.4. Site CR-31 had the second lowest embeddedness with 29.8 percent. Embeddedness values at the remaining sites on the Colorado River were between 41.7 percent and 47.7 percent in 2025.

A complex mosaic of channel morphology, both regulated and unregulated tributary inputs, reservoirs, diversions, monsoon season rains, and spring runoff affect sediment proportions on the Colorado River, both spatially and temporally. The East Troublesome Fire burned over 190,000 acres in fall of 2020[1]; the severity of the burn varied with location, but the fire

[1] https://storymaps.arcgis.com/stories/d8ef7c5f041d46e8931fc4498b3cad40

affected multiple Colorado River tributaries including Willow Creek, Drowsy Water Creek, and Troublesome Creek. All of the sampling sites on the Colorado River within the CEA had the potential to be affected by post-fire sedimentation. While the amount of fine sediment, small gravel, and gravel increased at most of the Colorado River sites since 2020, and the effects of the fire were most apparent at CR-7.4. This site is located downstream of Troublesome Creek, an unregulated tributary to the Colorado River. Similarly, the proportion of fine sediment at Site CR-24.9 approached 50 percent in 2022. This was a direct result of a post-fire flood in Drowsy Water Creek that deposited large amounts of sediment into the Colorado River. Site CR-24.9 is located in a steeper and less sinuous reach of the Colorado River than Site CR-7.4, so it experiences increased sediment transport rates and faster removal of fine sediment. However, in 2025 the proportion of fine sediments decreased at Site CR-7.4 and increased at Site CR-24.9, indicating that flows were sufficient to move fine sediment through much of the system and that sediment is still entering the Colorado River, either through tributaries, overland flow, or both.

Spring runoff flows and reservoir releases were above average in both 2023 and 2024 then returned to normal in 2025. The lower flows in 2025 may have caused less sediment to be transported, which is why fines decreased since 2024 at all sites except Site CR-24.9. Site CR-28.7 was temporarily relocated in 2025 due to property access issues, but the differing sediment characteristics at the temporary site compared to the annual monitoring site showed the influence of local characteristics on river function. The Colorado River immediately downstream of Windy Gap Reservoir has a mobile channel and can recruit new sediment from its floodplains. Conversely, CR-28.7 is steeper and more laterally constrained, which limits its ability to both retain smaller substrate such as gravel and recruit it from local sources.

In 2025, embeddedness decreased at all but two sites after having decreased at multiple sites between 2023 and 2024. The 2023 and 2024 flushing flows from Granby Reservoir could have had persistent effects on embeddedness. It is also possible that sediment inputs from fire-affected areas have begun to decrease.

The Colorado River Connectivity Channel reconnects the Colorado River around Windy Gap Reservoir and was designed in part to sediment continuity to the Colorado River. Conditions were as expected for a newly constructed stream reach; sediment gradations were still typical of a new constructed channel (i.e., gravel, small gravel, and fines were rare), and but green algae and diatoms have colonized the substrate at this site. Changes may occur in the following years downstream of the Connectivity Channel and Windy Gap Reservoir, but substantial changes have yet to occur. Reconnecting the Colorado River may increase sediment continuity, or the similarity of sediment characteristics between Site CR-31 and sites downstream of Windy Gap, but this predicted outcome may take several years to be measurable.

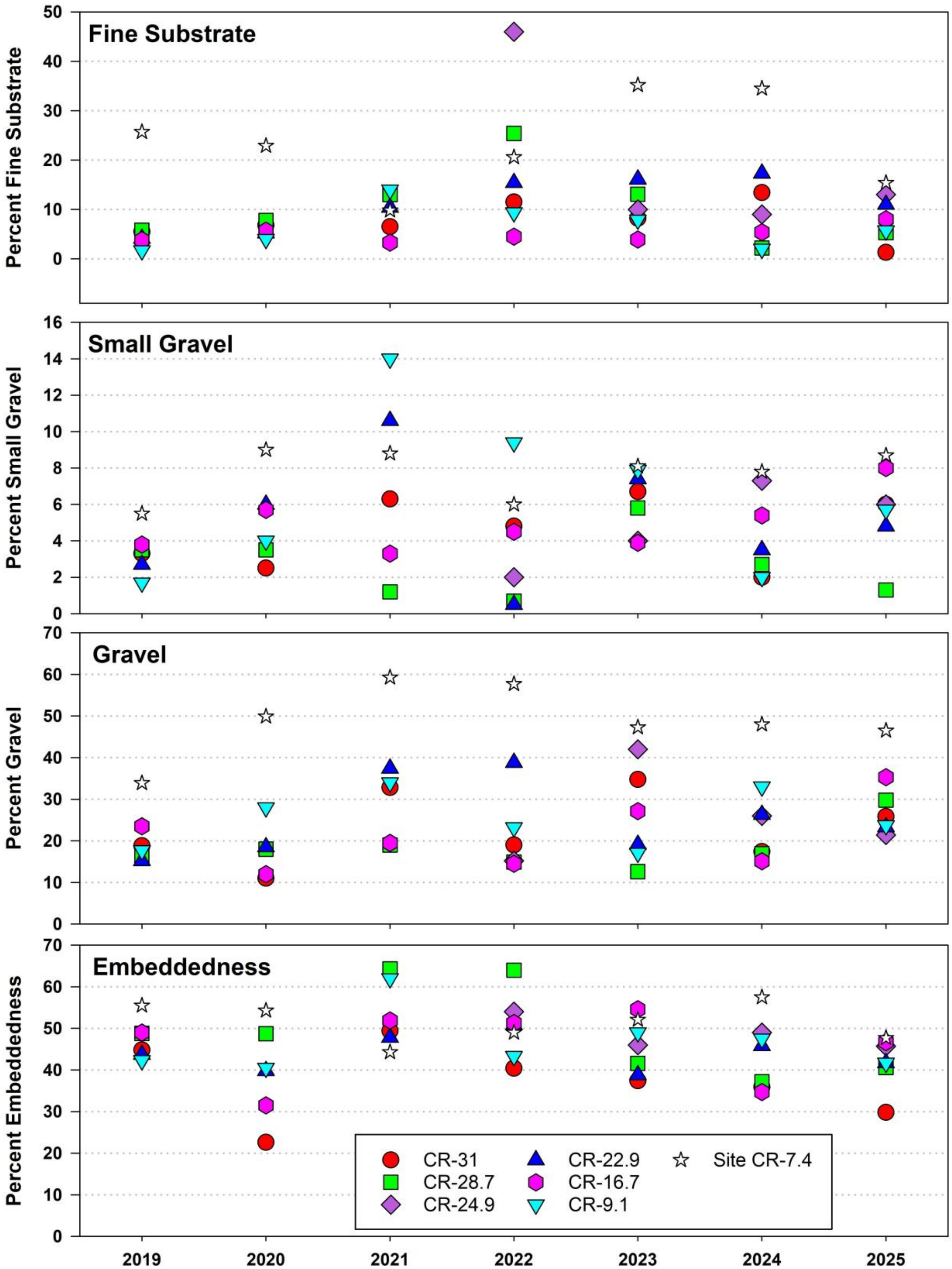

Figure 5-1: **Percentages of fine substrate, small gravel and gravel, and percent embeddedness on long-term Colorado River monitoring sites from 2019-2025. Note difference in y-axis scales.**

5.1.2 Fraser River and Ranch Creek

On average, the most abundant substrate classes on the five sites sampled on the Fraser River in 2025 were small cobble and cobble substrate. However, the single highest substrate class varied by site. For example, Site FR-20 had the highest percentage of fines among the Fraser River sites with 39 percent, whereas Site FR-25.1 had the highest percentage of boulder substrate with 35 percent. Gravel was the most abundant substrate class at Site FR-27.2 and FR-23.2, and cobble was the most abundant at Site FR-14. The proportions of fines increased from 2024 to 2025 at all Fraser River sites, but the increases were not substantial at any site except Site FR-20, where fines increased by 32 percent. Over time, the percentage of fine substrates has been consistently low at Site FR-14 and consistently high at Site RC-1.1, a trend that continued in 2025. Embeddedness values ranged from 32 percent at Site FR-25.1 to 65.1 percent at Site FR-20 in 2025. The large proportion of fines at Site FR-20 contributed to the high embeddedness at this site.

The differences in long-term sediment characteristics at the Fraser River sites can be partially explained by local conditions. Site FR-14 is a straight and relatively steep site that transports sediment efficiently, but Site RC-1.1 continues to be affected by beaver activity. Although there are currently no dams in the sampling site, periodic breaches of upstream dams deliver fine sediment and gravel to Site RC-1.1. Similarly, the interannual variability in sediment characteristics at Site FR-23.2 can be attributed to its location downstream of a large beaver complex. The increase in fine sediment at Site FR-20 is also attributable to a new beaver dam that was built within the site. While long-term data are not available for Site FR-27.2, this site has had a higher proportion of gravel than the remaining Fraser River sites both times it was surveyed between 2019 and 2025. This site is upstream of all diversions, so the increased proportion of gravel is not surprising. Further, the Fraser River upstream of this site flows parallel to Highway 40. Winter road operations include the use of traction sand, much of which enters the Fraser River. Beaver complexes likely trap a substantial amount of the traction sand that enters the river, but large amounts of sand are also removed annually from the sand retention facility immediately west of the highway and downstream of the Mary Jane entrance. The fact that Site FR-27.2 did not contain a high proportion of sand in 2025 suggests that lack of diversions allow efficient transport of sand through the site.

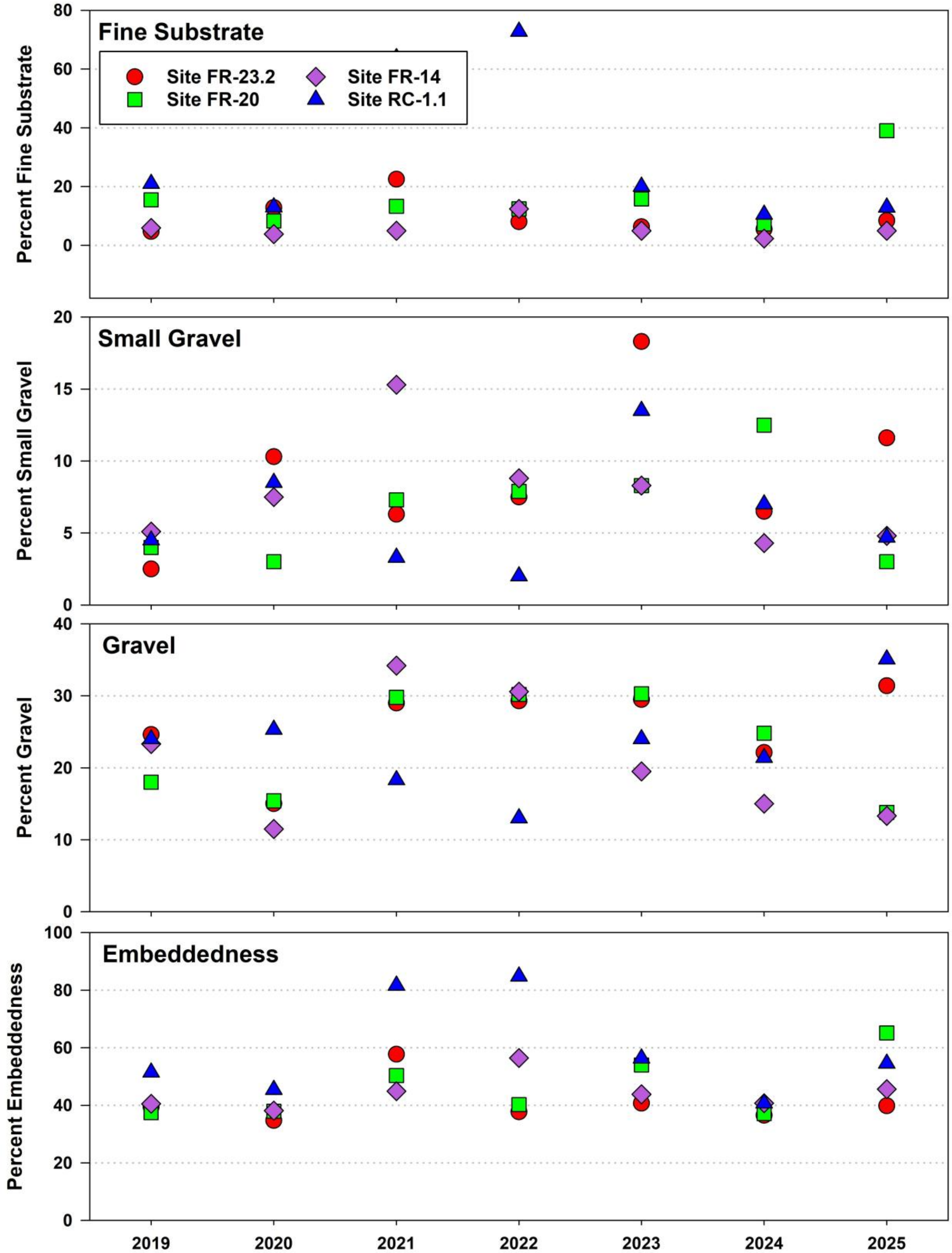

Figure 5-2: Percentages of fine substrate, small gravel and gravel, and percent embeddedness on long-term Fraser River monitoring sites 2019-2025. Note difference in y-axis scales.

5.2 Algae Presence, Percent Cover, and Thickness

Green filamentous algae were present at all sites sampled in 2025, except for sites CR-24.9 and RC-1.1. Algae was common (i.e., > 50 percent average presence) at half the sites on the Colorado River, Ranch Creek, Willow Creek, and Williams Fork, but not common at the Fraser River sites. Algae was sparse (less than 50 percent coverage when present) at all sites sampled, except for Site WF-5.5, where the average percent algae cover was 68.9 percent. There was no notably progressive longitudinal trend in algal presence or cover, but the five upstream sites on the Colorado River had less filamentous algae presence and cover than the three downstream sites. On the Fraser River, sites FR-14 and FR-20 had the greatest presence of algae. These sites are downstream of the towns of Winter Park and Fraser.

Diatoms were observed at all sites sampled in 2025. Most sites had a moderate to high occurrence (mean 89 percent over all sites) but low coverage/thickness (mean 1.9 over all sites). On the Colorado River, diatom thickness ranged from Category 0 to 5 (no evidence of microalgae to and accumulation of microalgal layer greater than 2 cm thick), with the highest average thickness category value of 4.03 at Site CR-31. The Fraser River contained overall high diatom presence (mean 87 percent presence) with the maximum presence of 100 occurring at sites FR-20 and FR-25.1. The highest average thickness category value of 1.45 for the Fraser River occurred at Site FR-20.

The greater thickness values of diatoms on the Colorado River and Fraser River in 2025 are due to the presence of Didymo. Where Didymo was absent, diatom thickness values ranged from being absent to a thin layer that was visually evident but less than 0.5 mm in thickness. In 2025, Didymo was present in the CEA and formed extensive blooms at sites CR-24.9 and CR-9.1. This species tends to create blooms in stable, low velocity flow regimes (Kirkwood et al. 2007; Miller at al. 2009). Sustained low flow periods in spring, summer, or fall can facilitate didymo blooms intermittently throughout the CEA. The presence of Didymo often coincided with zero filamentous algae presence, but the reasons for this are not clear or indicate the Didymo was smothering the filamentous algae.

Algae coverage on the Colorado River increased from 2019 through 2021, decreased through 2024, and was variable in 2025. The increase in algal cover was likely a response to nutrient inputs from fire-affected runoff after the East Troublesome Fire, as this same pattern was not observed for all Fraser River sites. Over this time period, no sites consistently had higher coverage relative to other sites. Diatom presence approached 100 percent at most sites in all years except 2021 and 2022; lower diatom presence in these two years may have occurred because of higher algae coverage and increased competition for nutrients and light. Diatom presence at all sites remained above 50 percent in both 2024 and 2025.

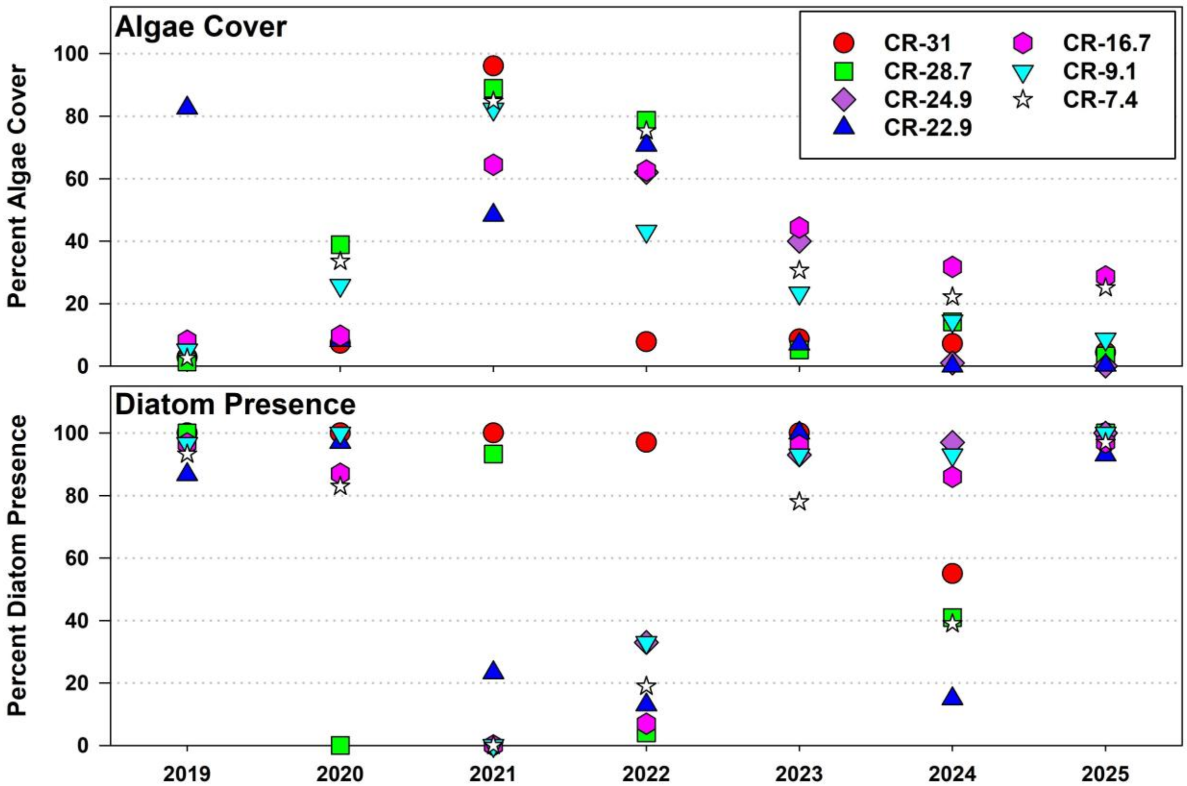

Figure 5-3: Percentages of algae coverage and diatom presence on long-term Colorado River monitoring sites 2019-2025.

On the Fraser River, algae coverage was higher in 2021 and 2022, but the temporal pattern was not as clear as on the Colorado River. In the Fraser River, peaks in algal coverage may be more of a function of local influences, such as the presence of beaver ponds, municipal land use, or both. Diatom coverage at the Fraser River monitoring sites approached 100 percent at most sites in all years except for Site FR-23.2 in 2025 (43 percent) and in 2021 and 2022, when between-site variability was high. Increased algae coverage in these years may have reduced available light and nutrients for diatoms at certain sites.

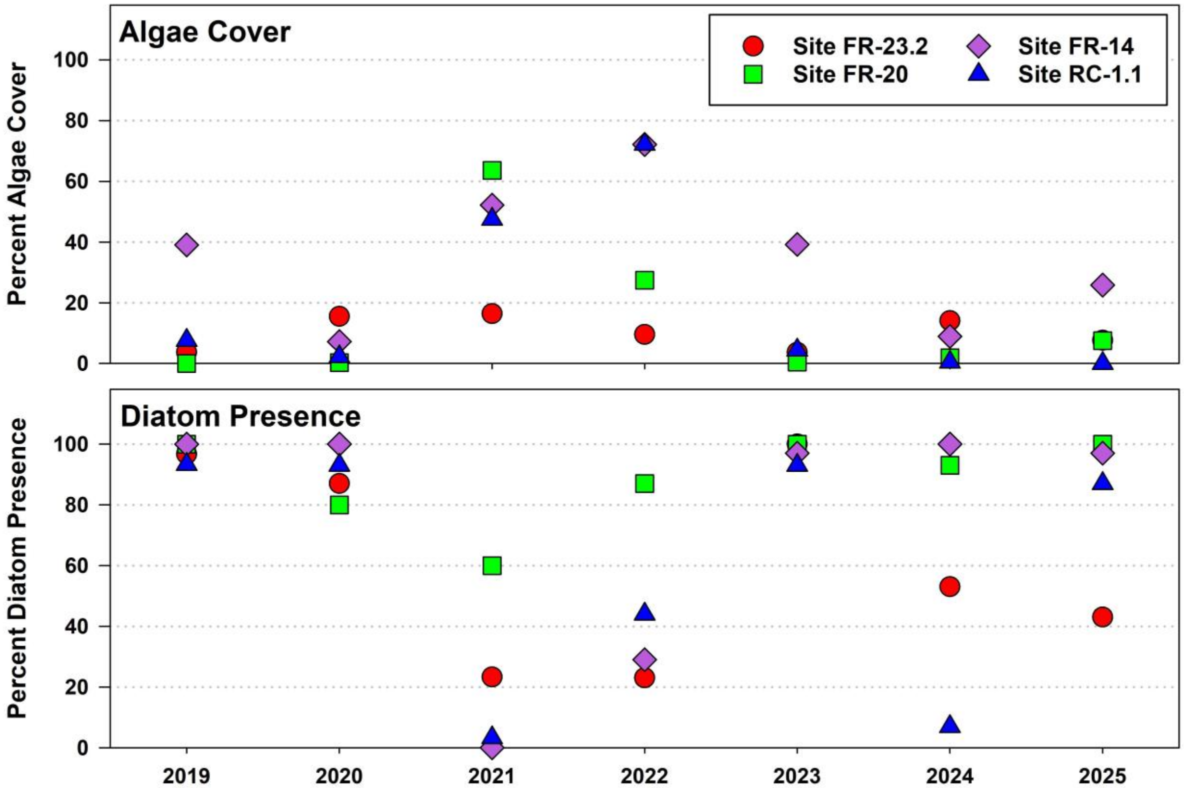

Figure 5-4: Percentages of algae coverage and diatom presence on long-term Fraser River monitoring sites 2019-2025.

6. Conclusion

The sediment and algae conditions in the CEA in the Colorado and Fraser River drainages are typical of managed systems, but long-term data indicate that there is some variability in the system with respect to sediment characteristics and algae populations. The 2025 annual daily flows observed in Grand County, CO were lower than the previous two years at each gage location (Appendix B). The following flushing flow recommendations were developed as part of the Grand County Stream Management Plan: 600 cfs for 50 hours every third year and 1,200 cfs for 72 hours every sixth year. Both of these requirements were met in 2024; flows of this magnitude were not released downstream of Windy Gap Reservoir in 2025. However, lower flows in 2025 did not lead to an obvious accumulation of fine sediment in the Colorado River below Windy Gap between 2024 and 2025.

Ditches/dams and beaver ponds trap gravel. Unpaved roads, unregulated tributaries, and erodible hillslopes provide sources of sand and gravel. The proportion of sand and silt was low enough to meet CDPHE criteria for the protection of aquatic life at all sampled sites except at sites WC-0.5 and FR-20, and though the proportion of gravel has increased modestly at some sites since 2019, gravel was still limited throughout the CEA. Embeddedness was between 29.8 and 76 percent at all sampled sites in 2025, with high embeddedness values occurring in sites with active beaver dams. Aquatic life response to embeddedness is species-specific. While a limited number of studies suggest that embeddedness reduces diversity of aquatic life and/or fish body condition when values exceed 25 to 35 percent (Boillet et al. 2005, Hamid and Rawi 2011, McGinley et al. 2013). Defining embeddedness goals for each site in the CEA would be difficult. The amount of fine sediment at a given site is a complex result of tributary inputs, transport from upstream areas, and inputs/storage on floodplains (Wohl et al. 2015). For example, Site CR-7.4 is located in a low-gradient area downstream of Troublesome Creek, which is unregulated. Thus, a high percentage of fines and high embeddedness is not surprising at this site, and while sediment conditions at this site are not particularly conducive to spawning, Site CR-9.1 has lower amounts of fine sediment and adequate spawning gravels. Thus, the connectivity of Site CR-7.4 with other sites prevents its largely natural sediment conditions from being detrimental to aquatic life.

Changes in substrate composition from 2019 through 2025 varied, with more consistent temporal patterns in the Colorado River drainage. Average fine substrate increased between 2019 and 2022 and decreased from 2022 to 2025. The average percentages of small gravel and gravel increased at the Colorado River sites between 2024 and 2025, but the general ranges remained consistent. The highest between-site variability in sediment characteristics in the Colorado River occurred in 2021, after the East Troublesome Fire.

Sediment characteristics in the Fraser River did not exhibit significant temporal patterns, but between-site differences appear to be a result of local conditions. Site FR-14 appears to efficiently transport sediment, and both gravel size classes decreased in 2025. Conditions remain variable at sites FR-23.2 and RC-1.1 because they are typically flanked by beaver pond complexes.

Didymo was present and extensive at selected sites within the CEA, but generally absent or in low densities at the remaining sites in the CEA in 2025. Green filamentous algae was found in all but two sites in the CEA, but algal coverage tended to be low; no nuisance filamentous algae blooms were observed. Algae data at long-term monitoring sites showed that most sites were characterized by low occurrence and low coverage of green algae and low diatom thickness, and that metrics consistent with algae blooms were not associated with any site across multiple years. This suggests that nuisance blooms of algae and/or diatoms are not tied to specific locations in the CEA.

The availability of clean substrate and interstitial spaces is limited at many sites within the CEA due to high embeddedness by fine sediment. A low proportion of gravels and embeddedness of cobbles limit habitat for macroinvertebrates and small fishes (Waters 1995). A limited number of studies indicate that the effects of Didymo and green algae on macroinvertebrate communities are variable (Patrick 1983; Dodds and Gudder 1992; Ellsworth 2000; Spaulding and Elwell 2007; Tonkin et al. 2014), but reduction of sensitive taxa like mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) have been documented in some studies (Kilroy et al. 2009). Historic spring runoff flows in the CEA were greater in magnitude and duration than current spring runoff flows, multiple instream structures disrupt sediment transport, and natural processes and human land use have altered the nutrient dynamics of the Colorado and Fraser rivers. Unsurprisingly, aquatic habitat conditions in the CEA have characteristics that are typical of working rivers. Conversely, long-term data for substrate and algae indicate that sediment processes and algal populations in the CEA are still dynamic. Thus, habitat limitations caused by sediment or algal conditions are not static in space or time. While large-scale disturbances such as permanent reservoirs and wildfires have affected sediment dynamics in the CEA, it also appears that a combination of management actions such as sediment trapping/removal, stream restoration, and use of flushing flows have helped maintain sediment conditions that are conducive to supporting aquatic life.

7. References

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Appendix A Sediment and Algae Data

Site: CR-31
Date: 9/9/2025
Notes:

Transect Substrate Count

Transect	Fines <2mm	Sm. Gravel 2-8mm	Gravel 8-64mm	Sm. Cobble 64-128mm	Cobble 128-256mm	Sm. Boulder 256-512mm	Boulder >512mm	Bedrock Bedrock
1	0	4	13	9	14	0	0	0
2	0	1	13	12	14	0	0	0
3	0	5	11	11	13	0	0	0
4	0	0	4	7	28	1	0	0
5	0	1	8	6	25	0	0	0
6	2	4	11	9	12	2	0	0
7	0	3	10	11	16	0	0	0
8	1	4	16	6	13	0	0	0
9	2	0	5	5	27	1	0	0
10	0	2	12	7	19	0	0	0
Total	5	24	103	83	181	4	0	0
% of Total	**1.3**	**6**	**25.8**	**20.8**	**45.3**	**1**	**0**	**0**
	1.3	7.3	33.1	53.9	99.2	100.2	100.2	100.2
	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble 128-**	**Sm. Boulder 256-**	**Boulder**	**Bedrock**
	<2mm	**2-8mm**	**8-64mm**	**64-128mm**	**256mm**	**512mm**	**>512mm**	**Bedrock**

Embeddedness

Transect	Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Avg.	
1	30	40	40	40	30	36.0	
2	40	30	40	40	40	38.0	
3	50	25	30	20	30	31.0	
4	30	25	40	25	25	29.0	
5	30	15	30	20	10	21.0	
6	15	25	30	50	50	34.0	
7	15	20	15	10	15	15.0	
8	40	15	20	50	60	37.0	
9	30	15	40	30	20	27.0	
10	40	30	25	25	30	30.0	
						29.8	**Total Avg.**

Site: CR-28.7
Date: 9/10/2025
Notes:

Transect Substrate Count

Transect	**Fines <2mm**	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**
1	0	1	14	12	13	0	0	0
2	6	0	5	12	12	3	2	0
3	4	0	11	10	12	3	0	0
4	5	1	13	14	6	1	0	0
5	1	0	21	12	6	0	0	0
6	0	0	8	15	16	1	0	0
7	2	0	13	12	11	2	0	0
8	0	1	14	8	17	0	0	0
9	3	0	7	13	14	3	0	0
10	0	2	13	13	11	1	0	0
Total	21	5	119	121	118	14	2	0
% of Total	**5.3**	**1.3**	**29.8**	**30.3**	**29.5**	**3.5**	**0.5**	**0**
	5.3	6.6	36.4	66.7	96.2	99.7	100.2	100.2
	Fines <2mm	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**

Embeddedness

Transect	**Emb. 1**	**Emb. 2**	**Emb. 3**	**Emb. 4**	**Emb. 5**	Avg.	
1	50	40	50	40	50	46.0	
2	55	30	40	60	40	45.0	
3	65	45	40	40	30	44.0	
4	40	50	100	40	30	52.0	
5	30	30	50	55	50	43.0	
6	30	25	50	25	40	34.0	
7	15	30	20	25	25	23.0	
8	25	50	25	30	10	28.0	
9	5	35	40	60	60	40.0	
10	40	60	50	75	30	51.0	
						40.6	**Total Avg.**

Site: CR-24.9
Date: 9/9/2025
Notes:

Transect Substrate Count

Transect	**Fines** **<2mm**	**Sm. Gravel** **2-8mm**	**Gravel** **8-64mm**	**Sm. Cobble** **64-128mm**	**Cobble** **128-256mm**	**Sm. Boulder** **256-512mm**	**Boulder** **>512mm**	**Bedrock** **Bedrock**
1	7	3	8	10	11	1	0	0
2	6	1	6	13	9	1	4	0
3	3	1	8	10	18	1	0	0
4	5	2	13	8	12	0	0	0
5	2	5	11	4	15	3	0	0
6	10	1	3	7	16	3	0	0
7	8	1	7	11	12	1	0	0
8	4	2	6	17	10	1	0	0
9	2	0	13	8	15	2	0	0
10	5	8	11	6	8	2	0	0
Total	52	24	86	94	126	15	4	0
% of Total	**13**	**6**	**21.4**	**23.4**	**31.4**	**3.7**	**1**	**0**
	13	19	40.4	63.8	95.2	98.9	99.9	99.9
	Fines **<2mm**	**Sm. Gravel** **2-8mm**	**Gravel** **8-64mm**	**Sm. Cobble** **64-128mm**	**Cobble** **128-256mm**	**Sm. Boulder** **256-512mm**	**Boulder** **>512mm**	**Bedrock** **Bedrock**

Embeddedness

Transect	**Emb. 1**	**Emb. 2**	**Emb. 3**	**Emb. 4**	**Emb. 5**	Avg.	
1	40	50	70	30	50	48.0	
2	50	30	30	40	15	33.0	
3	50	25	15	60	30	36.0	
4	30	40	30	90	75	53.0	
5	40	20	75	50	60	49.0	
6	40	30	26	50	60	41.2	
7	30	50	100	60	25	53.0	
8	30	45	60	30	60	45.0	
9	45	20	45	30	30	34.0	
10	80	60	50	60	75	65.0	
						45.7	**Total Avg.**

Site: CR-22.9
Date: 9/9/2025
Notes:

Transect Substrate Count

Transect	**Fines <2mm**	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**
1	4		5	13	14	3	0	0
2	4	1	5	13	16	1	0	0
3	4	2	7	16	11	0	0	0
4	4	1	13	10	10	2	0	0
5	5	3	9	11	12	0	0	0
6	4	1	11	14	7	3	0	0
7	0	2	13	13	10	2	0	0
8	7	5	6	12	10	0	0	0
9	4	3	9	8	15	1	0	0
10	8	1	15	9	6	1	0	0
Total	44	19	93	119	111	13	0	0
% of Total	**11**	**4.8**	**23.3**	**29.8**	**27.8**	**3.3**	**0**	**0**
	11	15.8	39.1	68.9	96.7	100	100	100
	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble**	**Sm. Boulder**	**Boulder**	**Bedrock**
	<2mm	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**

Embeddedness

Transect	**Emb. 1**	**Emb. 2**	**Emb. 3**	**Emb. 4**	**Emb. 5**	Avg.	
1	40	30	40	30	40	36.0	
2	30	40	20	30	45	33.0	
3	50	30	40	30	30	36.0	
4	30	20	40	30	30	30.0	
5	45	40	40	40	40	41.0	
6	15	55	15	5	25	23.0	
7	35	60	15	25	30	33.0	
8	10	95	80	25	60	54.0	
9	95	75	15	50	15	50.0	
10	75	80	50	100	100	81.0	
						41.7	**Total Avg.**

Site: CR-16.7
Date: 9/9/2025
Notes:

Transect Substrate Count

Transect	**Fines <2mm**	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**
1	2	3	10	12	12	0	1	0
2	2	2	18	10	7	1	0	0
3	2	6	15	14	3	0	0	0
4	26	3	8	2	1	0	0	0
5	3	3	11	7	13	3	0	0
6	1	3	19	7	8	2	0	0
7	0	2	11	12	14	1	0	0
8	0	1	16	17	6	0	0	0
9	7	6	12	6	9	0	0	0
10	0	3	21	13	3	0	0	0
Total	43	32	141	100	76	7	1	0
% of Total	**10.8**	**8**	**35.3**	**25**	**19**	**1.8**	**0.3**	**0**
	10.8	18.8	54.1	79.1	98.1	99.9	100.2	100.2
	Fines <2mm	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**

Embeddedness

Transect	**Emb. 1**	**Emb. 2**	**Emb. 3**	**Emb. 4**	**Emb. 5**	Avg.	
1	30	50	50	70	60	52.0	
2	40	30	25	40	50	37.0	
3	40	50	20	50	60	44.0	
4	100	100	30	60	60	70.0	
5	70	50	60	40	30	50.0	
6	50	50	50	40	60	50.0	
7	30	30	25	20	40	29.0	
8	40	30	50	50	10	36.0	
9	70	90	60	50	50	64.0	
10	20	25	30	60	40	35.0	
						46.7	**Total Avg.**

Site: CR-9.1
Date: 9/9/2025
Notes:

Transect Substrate Count

	Fines	Sm. Gravel	Gravel	Sm. Cobble	Cobble	Sm. Boulder	Boulder	Bedrock
Transect	**<2mm**	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**
1	10	2	9	15	6	0	0	0
2	14	0	5	17	4	0	0	0
3	9	0	4	10	17	0	0	0
4	4	0	10	15	10	1	0	0
5	0	1	11	20	7	0	0	0
6	10	2	13	8	6	1	0	0
7	5	6	9	14	6	0	0	0
8	5	4	12	15	4	0	0	0
9	7	4	13	6	4	2	4	0
10	0	4	9	17	10	0	0	0
Total	64	23	95	137	74	4	4	0
% of Total	**16**	**5.7**	**23.7**	**34.2**	**18.5**	**1**	**1**	**0**
	16	21.7	45.4	79.6	98.1	99.1	100.1	100.1
	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble**	**Sm. Boulder**	**Boulder**	**Bedrock**
	<2mm	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**

Embeddedness

Transect	Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Avg.	
1	20	20	40	60	60	40.0	
2	100	80	50	50		70.0	
3	70	95	20	40	60	57.0	
4	40	60	60	30	20	42.0	
5	20	40	30	40	40	34.0	
6	50	40	20	10	40	32.0	
7	50	20	20	30	45	33.0	
8	70	15	25	50	15	35.0	
9	60	30	50	50	30	44.0	
10	40	10	25	60		33.8	
						41.7	**Total Avg.**

Site: CR-7.4
Date: 9/9/2025
Notes:

Transect Substrate Count

Transect	**Fines <2mm**	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**
1	0	3	17	10	8	0	2	0
2	9	2	19	7	3	0	0	0
3	6	2	18	2	0	0	0	0
4	3	4	24	8	1	0	0	0
5	5	3	21	9	2	0	0	0
6	10	4	20	6	0	0	0	0
7	13	4	14	9	1	0	0	0
8	13	5	9	11	2	0	0	0
9	1	6	14	10	6	3	0	0
10	0	1	25	11	3	0	0	0
Total	60	34	181	83	26	3	2	0
% of Total	**15.4**	**8.7**	**46.5**	**21.3**	**6.7**	**0.8**	**0.5**	**0**
	15.4	24.1	70.6	91.9	98.6	99.4	99.9	99.9
	Fines <2mm	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**

Embeddedness

Transect	**Emb. 1**	**Emb. 2**	**Emb. 3**	**Emb. 4**	**Emb. 5**	Avg.	
1	40	40	20	50	50	40.0	
2	60	50	40	50	80	56.0	
3	40	50	40			43.3	
4	20	30	30	50	40	34.0	
5	40	50	80	70	40	56.0	
6	20	50	40	50	80	48.0	
7	30	30	50	40	90	48.0	
8	70	80	60	30	40	56.0	
9	60	20	60	60	50	40.0	
10	10	50	60	50	50	44.0	
						47.7	**Total Avg.**

Site: FR-27.2
Date: 9/10/2025
Notes:

Transect Substrate Count

Transect	Fines <2mm	Sm. Gravel 2-8mm	Gravel 8-64mm	Sm. Cobble 64-128mm	Cobble 128-256mm	Sm. Boulder 256-512mm	Boulder >512mm	Bedrock Bedrock
1	1	2	31	6	0	0	0	0
2	5	12	22	1	0	0	0	0
3	0	3	26	9	2	0	0	0
4	5	12	18	4	1	0	0	0
5	1	16	17	5	1	0	0	0
6	2	16	17	4	2	0	0	0
7	0	12	22	4	2	0	0	0
8	6	14	19	1	0	0	0	0
9	1	6	20	10	3	0	0	0
10	2	12	15	6	5	0	0	0
Total	23	105	207	50	16	0	0	0
% of Total	**5.7**	**26.2**	**51.6**	**12.5**	**4**	**0**	**0**	**0**
	5.7	31.9	83.5	96	100	100	100	100
	Fines <2mm	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**

Embeddedness

Transect	Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Avg.	
1	20	10	20	10	30	18.0	
2	30	20	10	50	30	42.0	
3	20	10	30	50	100	38.0	
4	100	20	40	10	20	34.0	
5	40	50	20	40	20	34.0	
6	20	40	40	50	30	36.0	
7	40	50	20	20	60	38.0	
8	15	50	30	20	50	33.0	
9	30	20	30	30	56	50.0	
10	10	15	40	50	20	27.0	
						32.7	**Total Avg.**

Site: FR-25.1
Date: 9/10/2025
Notes:

Transect Substrate Count

	Fines	Sm. Gravel	Gravel	Sm. Cobble	Cobble	Sm. Boulder	Boulder	Bedrock
Transect	**<2mm**	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**
1	5	2	8	8	9	6	5	0
2	2	0	4	4	4	3	23	0
3	1	0	3	4	14	9	9	0
4	0	1	3	5	5	4	22	0
5	0	4	3	5	6	2	20	0
6	1	1	6	7	12	2	11	0
7	1	3	9	3	8	4	12	0
8	6	6	6	4	4	3	11	0
9	1	2	4	5	10		18	0
10	1	4	5	4	6	10	10	0
Total	18	23	51	49	78	43	141	0
% of Total	**4.5**	**5.7**	**12.7**	**12.2**	**19.4**	**10.7**	**35**	**0**
	4.5	10.2	22.9	35.1	54.5	65.2	100.2	100.2
	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble**	**Sm. Boulder**	**Boulder**	**Bedrock**
	<2mm	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**

Embeddedness

Transect	Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Avg.	
1	50	50	60	30	40	46.0	
2	40	60	50	70	40	52.0	
3	50	50	50	60	60	54.0	
4	40	25	30	40	50	37.0	
5	70	50	20	50	60	50.0	
6	30	40	80	10	40	40.0	
7	80	60	60	70	50	64.0	
8	50	60	50	40	70	54.0	
9	60	70	60	60	50	50.0	
10	50	70	80	80	40	64.0	
						52.1	**Total Avg.**

Site: FR-23.2
Date: 9/10/2025
Notes:
No beaver dam at U.S. end of reach. A small beaver dam was present in the middle of the reach.

Transect Substrate Count

	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble**	**Sm. Boulder**	**Boulder**	**Bedrock**
Transect	**<2mm**	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**
1	2	6	16	9	7	0	0	0
2	0	7	17	3	13	0	0	0
3	0	6	7	5	19	3	0	0
4	4	1	6	7	19	3	0	0
5	0	5	17	3	11	3	1	0
6	0	3	17	12	10	2	0	0
7	11	1	10	7	7	2	2	0
8	9	4	9	3	11	1	3	0
9	6	8	15	4	7	0	0	0
10	2	6	13	8	11	0	0	0
Total	34	47	127	61	115	14	6	0
% of Total	**8.4**	**11.6**	**31.4**	**15.1**	**28.5**	**3.5**	**1.5**	**0**
	8.4	20	51.4	66.5	95	98.5	100	100
	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble**	**Sm. Boulder**	**Boulder**	**Bedrock**
	<2mm	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**

Embeddedness

Transect	**Emb. 1**	**Emb. 2**	**Emb. 3**	**Emb. 4**	**Emb. 5**	Avg.	
1	50	50	60	40	40	48.0	
2	10	20	20	10	40	20.0	
3	50	20	10	50	25	31.0	
4	25	30	50	30	50	37.0	
5	10	40	30	20	40	28.0	
6	30	25	50	50	30	37.0	
7	100	70	20	70	90	70.0	
8	30	25	60	80	60	51.0	
9	30	50	40	20	40	36.0	
10	50	30	50	50	20	40.0	
						39.8	**Total Avg.**

Site: FR-20
Date: 9/10/2025
Notes:

Transect Substrate Count

Transect	Fines <2mm	Sm. Gravel 2-8mm	Gravel 8-64mm	Sm. Cobble 64-128mm	Cobble 128-256mm	Sm. Boulder 256-512mm	Boulder >512mm	Bedrock Bedrock
1	22	0	1	5	4	6	2	0
2	40	0	0	0	0	0	0	0
3	40	0	0	0	0	0	0	0
4	2	2	9	13	9	5	0	0
5	1	1	7	17	8	4	2	0
6	6	0	12	7	11	4	0	0
7	19	4	5	2	8	2	0	0
8	2	2	10	12	7	7	0	0
9	8	1	7	4	16	4	0	0
10	16	2	4	5	10	3	0	0
Total	156	12	55	65	73	35	4	0
% of Total	**39**	**3**	**13.8**	**16.3**	**18.3**	**8.8**	**1**	**0**
	39	42	55.8	72.1	90.4	99.2	100.2	100.2
	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble**	**Sm. Boulder**	**Boulder**	**Bedrock**
	<2mm	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**

Embeddedness

Transect	Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Avg.	
1	70	40	70	90	100	74.0	
2	100	100	100	100	100	100.0	
3	100	100	100	100	100	100.0	
4	15	35	45	35	30	32.0	
5	30	40	15	40	60	37.0	
6	40	40	25	40	30	35.0	
7	95	100	100	90	80	93.0	
8	100	50	10	20	15	39.0	
9	80	60	75	40	25	56.0	
10	95	100	80	75	75	85.0	
						65.1	**Total Avg.**

Site: FR-14
Date: 9/10/2025
Notes:

Transect Substrate Count

	Fines	Sm. Gravel	Gravel	Sm. Cobble	Cobble	Sm. Boulder	Boulder	Bedrock
Transect	**<2mm**	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**
1	2	1	4	8	11	14	0	0
2	1	1	4	9	15	8	2	0
3	5	3	3	13	5	10	1	0
4	2	1	10	8	8	11	0	0
5	2	1	7	5	9	16	0	0
6	2	1	7	5	14	11	0	0
7	1	3	6	8	14	8	0	0
8	0	2	7	10	11	7	3	0
9	0	3	3	11	18	5	0	0
10	5	3	2	10	14	6	0	0
Total	20	19	53	87	119	96	6	0
% of Total	**5**	**4.8**	**13.3**	**21.8**	**29.8**	**24**	**1.5**	**0**
	5	9.8	23.1	44.9	74.7	98.7	100.2	100.2
	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble**	**Sm. Boulder**	**Boulder**	**Bedrock**
	<2mm	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**

Embeddedness

Transect	Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Avg.	
1	60	50	40	30	15	39.0	
2	50	60	30	50	40	46.0	
3	50	40	45	35	25	39.0	
4	50	40	35	40	50	43.0	
5	35	45	45	30	50	41.0	
6	60	35	60	75	50	56.0	
7	75	25	15	60	10	37.0	
8	50	25	40	70	60	49.0	
9	30	60	80	50	60	56.0	
10	100	25	25	50	50	50.0	
						45.6	**Total Avg.**

Site: RC-1.1
Date: 9/10/2025
Notes: Still no beaver dams at site. Substrate compacted at first 2-3 transects but loosened up, especially in vicinity of former ponds.

Transect Substrate Count

Transect	**Fines <2mm**	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**
1	2	2	15	16	4	1	1	0
2	5	1	13	10	6	3	2	0
3	7	2	18	6	6	1	0	0
4	7	4	6	14	5	4	0	0
5	4	4	8	17	3	2	2	0
6	5	1	9	14	4	0	7	0
7	6	0	12	10	7	3	2	0
8	8	0	20	8	4	0	0	0
9	1	3	22	12	3	0	0	0
10	7	2	18	8	5	0	0	0
Total	52	19	141	115	47	14	14	0
% of Total	**12.9**	**4.7**	**35.1**	**28.6**	**11.7**	**3.5**	**3.5**	**0**
	12.9	17.6	52.7	81.3	93	96.5	100	100
	Fines <2mm	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**

Embeddedness

Transect	Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Avg.	
1	50	50	50	60	40	50	
2	40	50	60	50	50	50	
3	**70**	45	60	50	65	58	
4	65	50	65	75	85	68	
5	50	50	70	45	60	55	
6	25	50	60	90	90	63	
7	100	50	75	50	30	61	
8	**50**	**70**	**50**	100	40	62	
9	50	25	75	20	25	39.0	
10	40	15	15	50	75	39.0	
						54.5	**Total Avg.**

Site: WF-5.5

Date: 9/9/2025

Notes: Lots of dead organic matter in depositional zones-dead didymo. Water receded recently about 6-8in. Similar conditions to last habitat survey for WF. Water appears lower than usual.

Transect Substrate Count

	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble**	**Sm. Boulder**	**Boulder**	**Bedrock**
Transect	**<2mm**	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**
1	0	0	8	11	17	3	1	0
2	15	0	2	10	11	2	1	0
3	1	0	6	12	14	7	0	0
4	2	1	8	11	15	3	0	0
5	9	0	8	5	15	3	0	0
6	4	0	15	10	9	2	0	0
7	10	0	7	9	9	5	2	0
8	0	0	20	8	11	1	0	0
9	2	2	8	10	14	2	2	0
10	4	1	10	14	11	0	0	0
Total	47	4	92	100	126	28	6	0
% of Total	**11.7**	**1**	**22.8**	**24.8**	**31.3**	**6.9**	**1.5**	**0**
	11.7	12.7	35.5	60.3	91.6	98.5	100	100
	Fines	**Sm. Gravel**	**Gravel**	**Sm. Cobble**	**Cobble**	**Sm. Boulder**	**Boulder**	**Bedrock**
	<2mm	**2-8mm**	**8-64mm**	**64-128mm**	**128-256mm**	**256-512mm**	**>512mm**	**Bedrock**

Embeddedness

Transect	**Emb. 1**	**Emb. 2**	**Emb. 3**	**Emb. 4**	**Emb. 5**	Avg.	
1	30	50	50	40	30	40.0	
2	20	60	100	60	30	54.0	
3	40	60	50	70	60	56.0	
4	50	50	60	60	40	52.0	
5	30	50	70	80	60	58.0	
6	50	60	40	30	40	44.0	
7	20	50	40	50	40	40.0	
8	60	20	50	40	40	42.0	
9	30	50	40	40	60	44.0	
10	60	60	50	40	60	54.0	
						48.4	**Total Avg.**

Site: WC-0.5
Date: 9/9/2025
Notes:
Beaver activity has dramatically affected top half of site. Turbidity low this year, can see bottom.

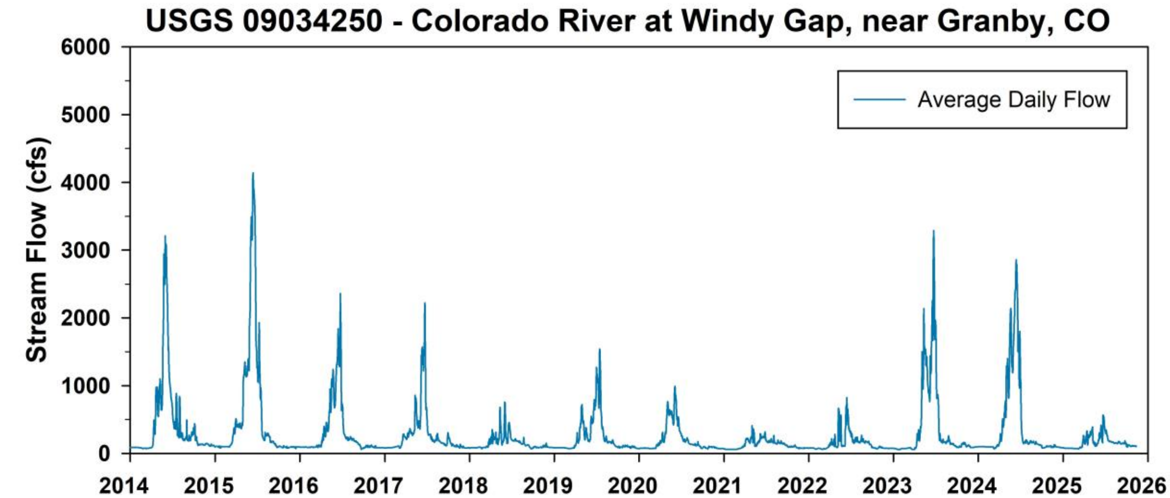
Transect Substrate Count

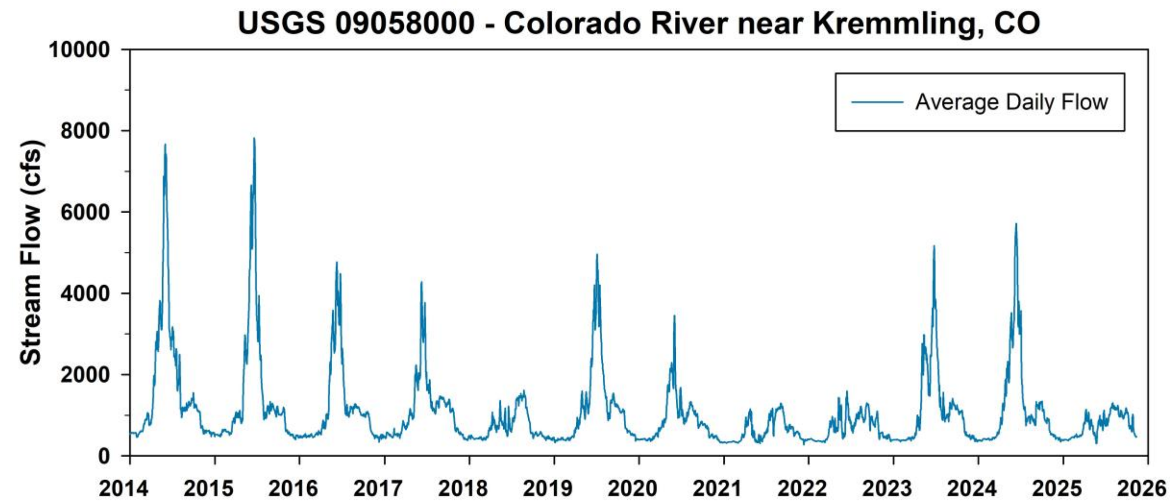
Transect	Fines <2mm	Sm. Gravel 2-8mm	Gravel 8-64mm	Sm. Cobble 64-128mm	Cobble 128-256mm	Sm. Boulder 256-512mm	Boulder >512mm	Bedrock Bedrock
1	40	0	0	0	0	0	0	0
2	1	2	5	13	18	1	0	0
3	22	0	4	4	9	1	0	0
4	29	0	6	3	2	0	0	0
5	40	0	0	0	0	0	0	0
6	10	0	15	13	6	1	0	0
7	11	0	6	12	11	0	0	0
8	12	2	3	6	8	7	2	0
9	28	0	0	0	3	5	4	0
10	15	2	11	6	6	0	0	0
Total	208	6	50	57	63	15	6	0
% of Total	**51.4**	**1.5**	**12.3**	**14.1**	**15.6**	**3.7**	**1.5**	**0**
	51.4	52.9	65.2	79.3	94.9	98.6	100.1	100.1
	Fines <2mm	**Sm. Gravel 2-8mm**	**Gravel 8-64mm**	**Sm. Cobble 64-128mm**	**Cobble 128-256mm**	**Sm. Boulder 256-512mm**	**Boulder >512mm**	**Bedrock Bedrock**

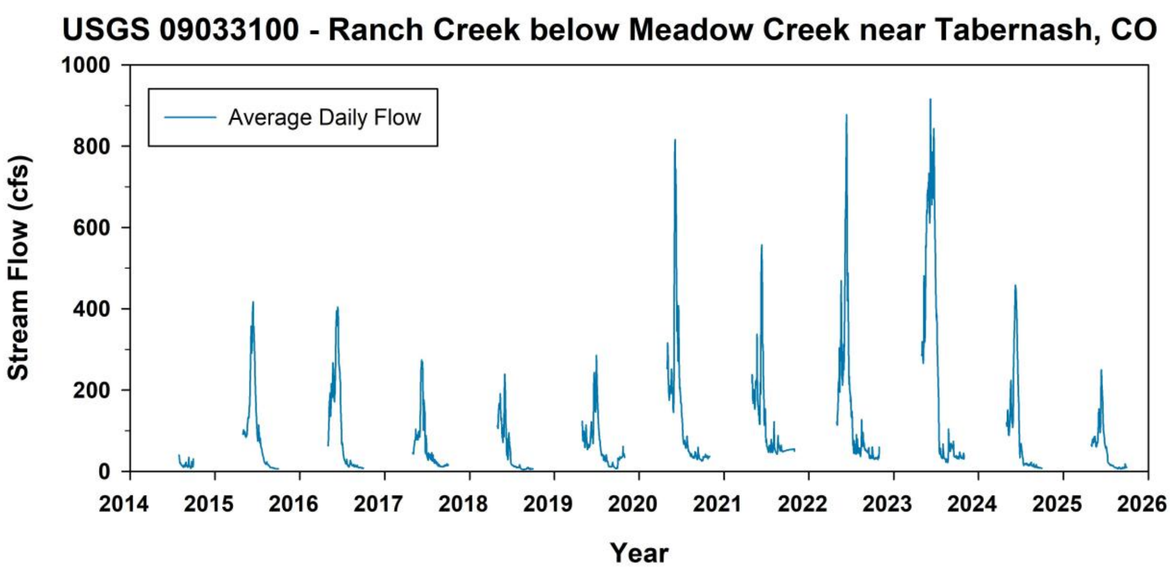
Embeddedness

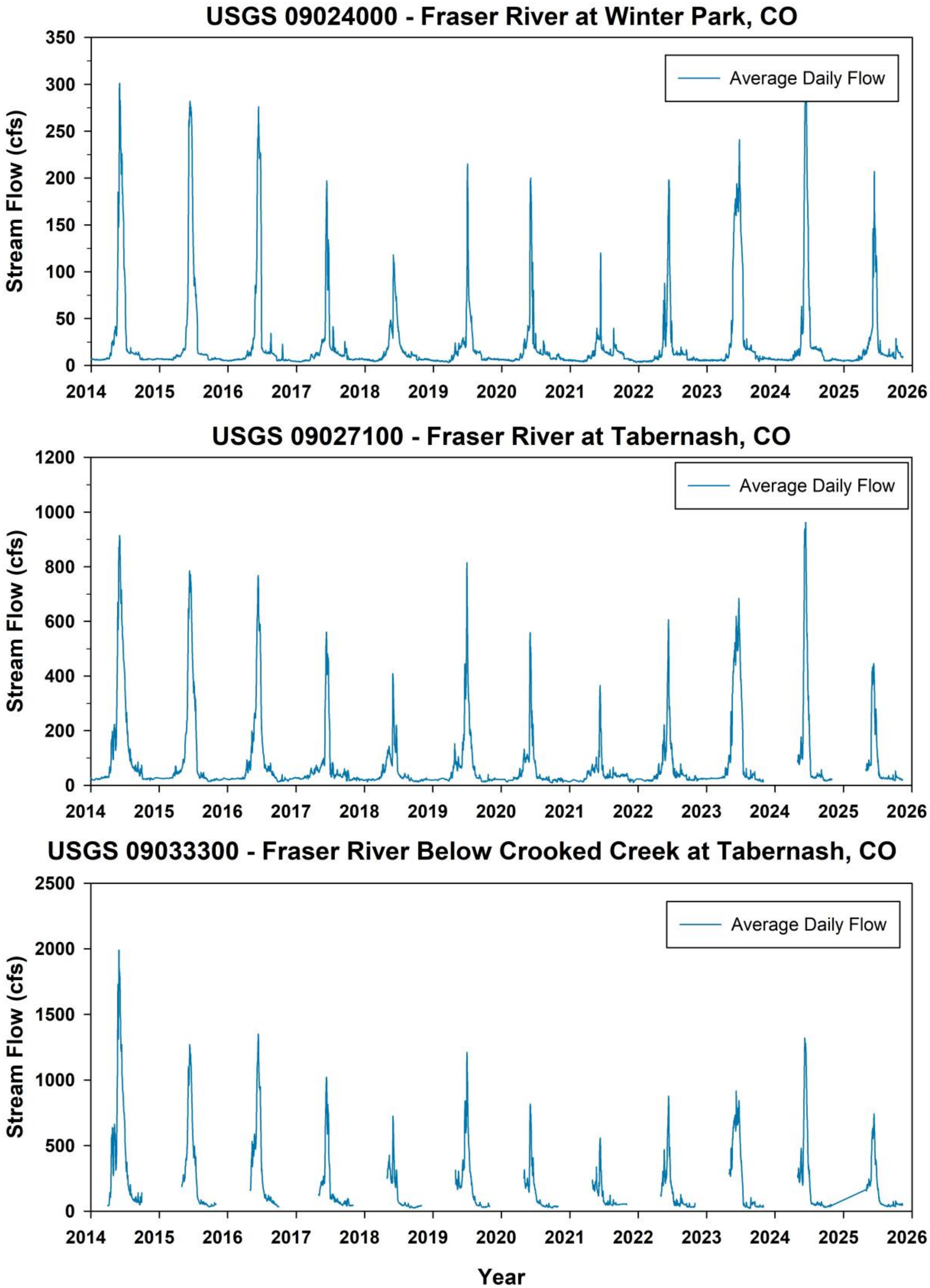
Transect	Emb. 1	Emb. 2	Emb. 3	Emb. 4	Emb. 5	Avg.	
1	100	100	100	100	100	100.0	
2	15	30	50	60	10	33.0	
3	80	80	90	100	100	90.0	
4	85	60	80	100	100	85.0	
5	100	100	100	100	100	100.0	
6	40	30	60	70	40	48.0	
7	80	60	70	70	50	66.0	
8	85	90	75	75	80	81.0	
9							
10	75	95	75	95	65	81.0	
						76.0	**Total Avg.**

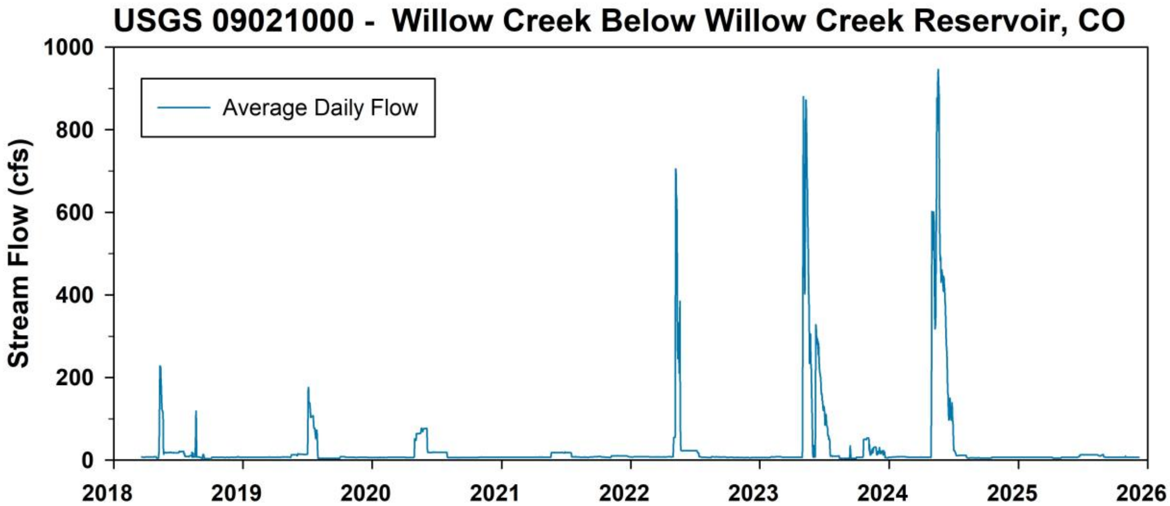
Appendix B Long-term Flow Data

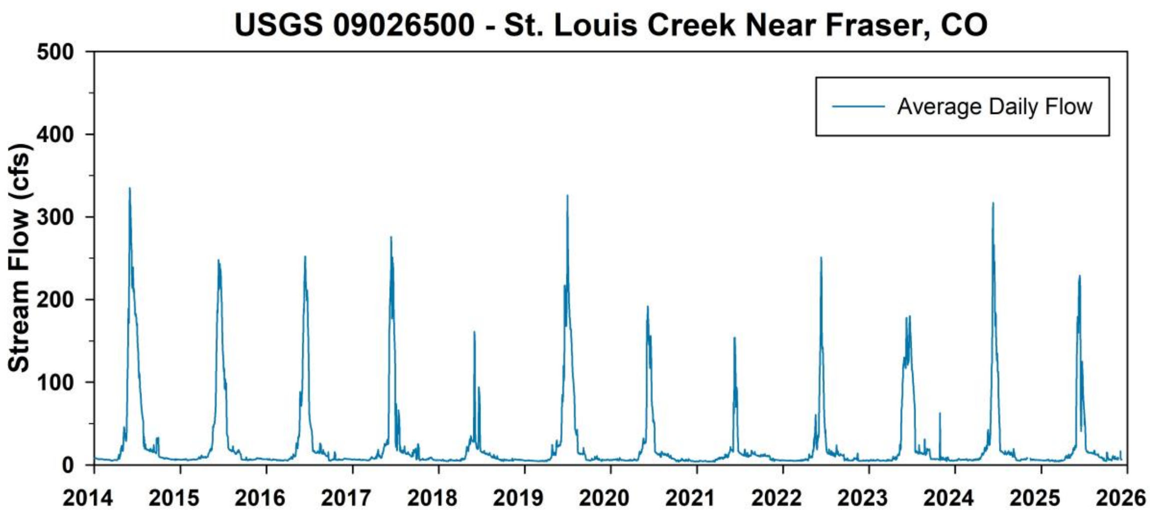

USGS 09034250 - Colorado River at Windy Gap, near Granby, CO
Average Daily Flow
Stream Flow (cfs)
0
1000
2000
3000
4000
5000
6000
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026


USGS 09058000 - Colorado River near Kremmling, CO
Average Daily Flow
Stream Flow (cfs)
0
2000
4000
6000
8000
10000
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026


USGS 09033100 - Ranch Creek below Meadow Creek near Tabernash, CO
Average Daily Flow
Stream Flow (cfs)
0
200
400
600
800
1000
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
Year


USGS 09024000 - Fraser River at Winter Park, CO
Average Daily Flow
Stream Flow (cfs)
0
50
100
150
200
250
300
350
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
USGS 09027100 - Fraser River at Tabernash, CO
Average Daily Flow
Stream Flow (cfs)
0
200
400
600
800
1000
1200
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
USGS 09033300 - Fraser River Below Crooked Creek at Tabernash, CO
Average Daily Flow
Stream Flow (cfs)
0
500
1000
1500
2000
2500
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
Year


USGS 09021000 - Willow Creek Below Willow Creek Reservoir, CO
Average Daily Flow
Stream Flow (cfs)
0
200
400
600
800
1000
2018
2019
2020
2021
2022
2023
2024
2025
2026


USGS 09026500 - St. Louis Creek Near Fraser, CO
Average Daily Flow
Stream Flow (cfs)
0
100
200
300
400
500
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026

Appendix C 2019 to 2025 Pebble Count Data

Table C-1: Percent average substrate size classes at all sites sampled in 2019.

Sites	Substrate Size Categories							
	Fines	Small Gravel	Gravel	Small Cobble	Cobble	Small Boulder	Boulder	Bedrock
	<2 mm	2-8 mm	8-64 mm	64-128 mm	128-256 mm	256-512 mm	>512mm	
CR-31	5.5	3.3	18.8	32.0	29.0	11.5	0	0
CR-28.7	5.8	3.5	16.1	27.9	36.4	10.3	0	0
CR-22.9	4.1	2.7	15.2	20.7	46.0	10.6	0.7	0
CR-16.7	12.3	3.8	23.5	27.0	26.0	4.0	2	1.5
CR-9.1	12.0	1.7	17.7	27.2	38.7	2.7	0	0
CR-7.4	25.7	5.5	33.9	27.7	7.2	0	0	0
CR-1.7	65.8	13.8	6.5	5.8	7.0	1.3	0	0
FR-25.1	8.5	3.0	7.2	8.2	8.0	14.7	50.4	0
FR-23.2	4.7	2.5	24.6	35.2	28.3	3.5	1.2	0
FR-20	15.5	4.0	18.0	28.8	17.3	11.8	4.8	0
FR-15	13.4	2.5	21.3	24.3	22.3	13.6	2.5	0
FR-14	5.9	5.1	23.3	26.2	30.9	8.1	0.5	0
FR-1.9	8.8	3.8	22.8	35.8	22.3	6.5	0	0
RC-1.1	21.0	4.5	24.0	27.0	17.5	2.5	3.5	0

Table C-2: Percent average substrate size classes at all sites sampled in 2020.

Sites	Substrate Size Categories							
	Fines	Small Gravel	Gravel	Small Cobble	Cobble	Small Boulder	Boulder	Bedrock
	<2 mm	2-8 mm	8-64 mm	64-128 mm	128-256 mm	256-512 mm	>512mm	
CR-31	6.8	2.5	11	18.8	47.9	13	0	0
CR-28.7	7.8	3.5	18	12	46.8	12	0	0
CR-22.9	5.2	6	18.5	20.4	36.2	12.7	1	0
CR-16.7	11.2	5.7	12	19	32.9	15.5	3.5	0.2
CR-9.1	8.5	4	28	35.3	19.8	4.3	0.3	0
CR-7.4	22.9	9	49.9	15	3	0.2	0	0
FR-25.1	10.3	3	6.5	5.3	10	22.3	42.8	0
FR-23.2	12.8	10.3	15	16.3	23.3	12.8	9.8	0
FR-20	8.3	3	15.4	25	28	18.7	1.5	0
FR-15	7.8	6	15	21.8	33.3	15.5	0.5	0
FR-14	3.8	7.5	11.5	20.3	34.3	22.5	0.3	0
FR-12.4	8.8	10.3	18.5	26.5	24.5	11.3	0.3	0
FR-5.5	5	9	20	37	27	2	0	0
RC-1.1	13	8.5	25.3	27.5	19.3	2.8	3.8	0
FRC-2	5	32.7	45.5	13.9	3	0	0	0

Table C-3: Percent average substrate size classes at all sites sampled in 2021.

Sites	Substrate Size Categories							
	Fines	Small Gravel	Gravel	Small Cobble	Cobble	Small Boulder	Boulder	Bedrock
	<2 mm	2-8 mm	8-64 mm	64-128 mm	128-256 mm	256-512 mm	>512mm	
CR-31	6.5	6.3	32.8	21.5	22.5	10	0.5	0
CR-28.7	13	1.2	19	20.7	36.2	6.7	3.2	0
CR-22.9	10.4	10.6	37.4	18.6	16.3	4.5	2.2	0
CR-16.7	18.8	3.3	19.5	17	31	7.8	2.8	0
CR-9.1	24	14	34	18.3	8.5	1	0.3	0
CR-7.4	9.8	8.8	59.3	17.5	4.5	0.3	0	0
CR-1.7	86	4.8	4.8	2.5	0	1.3	0.8	0
FR-25.1	5	14.3	17.5	5	12.3	6	40	0
FR-23.2	22.5	6.3	29	10.3	20.8	5.5	5.8	0
FR-20	13.3	7.3	29.8	14.5	22	9.5	3.8	0
FR-15	7.6	7.1	44.1	17.2	15.9	7.1	1	0
FR-14	5	15.3	34.2	17.1	19.3	7.2	2	0
FR-1.9	6.3	11.3	33.8	22.3	24.8	1.8	0	0
RC-1.1	63.8	3.3	18.3	4	6.8	1.8	2.3	0

Table C-4: Percent average substrate size classes at all sites sampled in 2022.

Sites	Substrate Size Categories							
	Fines	Small Gravel	Gravel	Small Cobble	Cobble	Small Boulder	Boulder	Bedrock
	<2 mm	2-8 mm	8-64 mm	64-128 mm	128-256 mm	256-512 mm	>512mm	
CR-31	11.5	4.8	19.0	24.3	35.5	5.0	0	0
CR-28.7	25.4	0.7	14.9	31.5	22.5	4.6	0.2	0
CR-24.9	46.1	1.7	15.2	14.2	17.0	4.7	0	1.0
CR-22.9	15.4	0.5	38.8	31.6	7.0	3.2	1.5	2.0
CR-16.7	22.9	4.5	14.5	23.9	20.9	2.7	7.0	3.5
CR-9.1	16.1	9.4	23.2	22.9	21.9	6.3	0.3	0
CR-7.4	20.6	6.0	57.7	12.8	2.6	0.3	0	0
CR-TBD	21.3	8.8	38.8	17.5	12.5	1.3	0	0
FR-27.2	22.9	11.7	33.9	21.9	8.2	0.7	0.5	0
FR-23.2	8.0	7.5	29.3	25.3	17.3	6.3	6.5	0
FR-20	12.4	7.9	30.2	19.1	21.8	7.2	1.5	0
FR-14	12.4	8.8	30.6	19.7	23.0	4.5	0.9	0
RC-1.1	72.8	2.0	13.0	5.8	4.3	1.0	1.3	0
STC-0	9.3	8.0	21.8	21.5	29.0	9.3	1.3	0
WC-TBD	26.8	5.5	20.3	30.3	15.5	0.8	1.0	0

Table C-5: Percent average substrate size classes at all sites sampled in 2023.

Sites	Substrate Size Categories							
	Fines	Small Gravel	Gravel	Small Cobble	Cobble	Small Boulder	Boulder	Bedrock
	<2 mm	2-8 mm	8-64 mm	64-128 mm	128-256 mm	256-512 mm	>512mm	
CR-31	8.2	6.7	34.7	29.7	18.3	2.5	0	0
CR-28.7	13.1	5.8	12.6	22.2	33.1	12.6	0.5	0
CR-24.9	10.3	4	41.8	23.8	19	1.3	0	0
CR-22.9	16.1	7.4	19.1	22.2	25.5	9.4	0.3	0
CR-16.7	23.5	3.9	27.1	17.5	20.1	7.5	0.5	0
CR-9.1	21.2	7.9	17.1	25.5	23.4	4.6	0.3	0
CR-7.4	35.2	8.1	47.3	5.6	2.7	0.5	0.5	0
FR-23.2	6.3	18.3	29.5	21	17.1	7.1	0.7	0
FR-20	15.8	8.3	30.3	20	17	6	2.8	0
FR-14	5	8.3	19.5	22	26	16	3.3	0
FR-12.4	7	10	31.8	23.3	25	3	0	0
FR-TBD	14.8	9.3	35	18.3	18.3	2.8	1.8	0
FR-1.9	13	8	18.3	25	32	3.5	0.3	0
RC-TBD	12	15.3	36.8	21.8	10.5	1.5	2.3	0
RC-1.1	20	13.5	24	25	12.3	1	4.3	0
WC-0.5	20.3	6.8	15.5	23.5	24.8	6	3.3	0

Table C-6: Percent average substrate size classes at all sites sampled in 2024.

Sites	Substrate Size Categories							
	Fines	Small Gravel	Gravel	Small Cobble	Cobble	Small Boulder	Boulder	Bedrock
	<2 mm	2-8 mm	8-64 mm	64-128 mm	128-256 mm	256-512 mm	>512mm	
CR-31	13.4	2	17.4	30.8	29.5	5.8	1	0
CR-C	14.3	7	24	23.8	24.5	6.5	0	0
CR-28.7	2.2	2.7	16.9	28.6	34.3	9.2	6	0
CR-24.9	9.1	7.3	26	34	21.3	1.3	0	1
CR-22.9	17.3	3.5	26.3	36	13.3	3.5	0.3	0
CR-16.7	12.8	5.4	15.1	17.8	26.4	13.1	7.4	2
CR-9.1	16.3	2	33	30.3	14	2.3	2.3	0
CR-7.4	34.5	7.8	48	6	2	0	1.8	0
FR-25.1	2.5	7.2	11.9	5	22	22.8	28.7	0
FR-23.2	5.5	6.5	22.1	26.4	24.6	9	6	0
FR-20	7.3	12.5	24.8	13.5	32.3	9.5	0.3	0
FR-15	9.1	11.6	33.9	26.9	12	2.5	2.9	1.2
FR-14	2.3	4.3	15	24.3	44.5	9.8	0	0
FR-3.5	10.2	6.9	18.4	27.5	30.5	4.2	2.2	0
RC-1.1	10.5	7	21.4	26.4	18	7.5	9.2	0
WC-0.5	19.8	6	26.5	26.5	20.5	0.8	0	0
WC-TBD	13.3	6.2	40.7	27.4	11.6	0.5	0.2	0
WF-13.1	7.7	2.5	21.2	15.7	19	17.3	16.8	0

Table C-7: Percent average substrate size classes at all sites sampled in 2025.

Sites	Substrate Size Categories							
	Fines	Small Gravel	Gravel	Small Cobble	Cobble	Small Boulder	Boulder	Bedrock
	<2 mm	2-8 mm	8-64 mm	64-128 mm	128-256 mm	256-512 mm	>512mm	
CR-31	1.3	6	25.8	20.8	45.3	1	0	0
CR-C	5.6	6.8	14.4	23.2	46.5	3.5	0	0
CR-28.7	5.3	1.3	29.8	30.3	29.5	3.5	0.5	0
CR-24.9	13	6	21.4	23.4	31.4	3.7	1	0
CR-22.9	11	4.8	23.3	29.8	27.8	3.3	0	0
CR-16.7	10.8	8	35.3	25	19	1.8	0.3	0
CR-9.1	16	5.7	23.7	34.2	18.5	1	1	0
CR-7.4	15.4	8.7	46.5	21.3	6.7	0.8	0.5	0
FR-27.2	5.7	26.2	51.6	12.5	4	0	0	0
FR-25.1	4.5	5.7	12.7	12.2	19.4	10.7	35	0
FR-23.2	8.4	11.6	31.4	15.1	28.5	3.5	1.5	0
FR-20	39	3	13.8	16.3	18.3	8.8	1	0
FR-14	5	4.8	13.3	21.8	29.8	24	1.5	0
RC-1.1	12.9	4.7	35.1	28.6	11.7	3.5	3.5	0
WF-5.5	11.7	1	22.8	24.8	31.3	6.9	1.5	0
WC-0.5	51.4	1.5	12.3	14.1	15.6	3.7	1.5	0

Appendix D Algae Cover Photos

Photo D-1: Examples of approximately 25 percent (left) and 50 percent (right) algae cover.

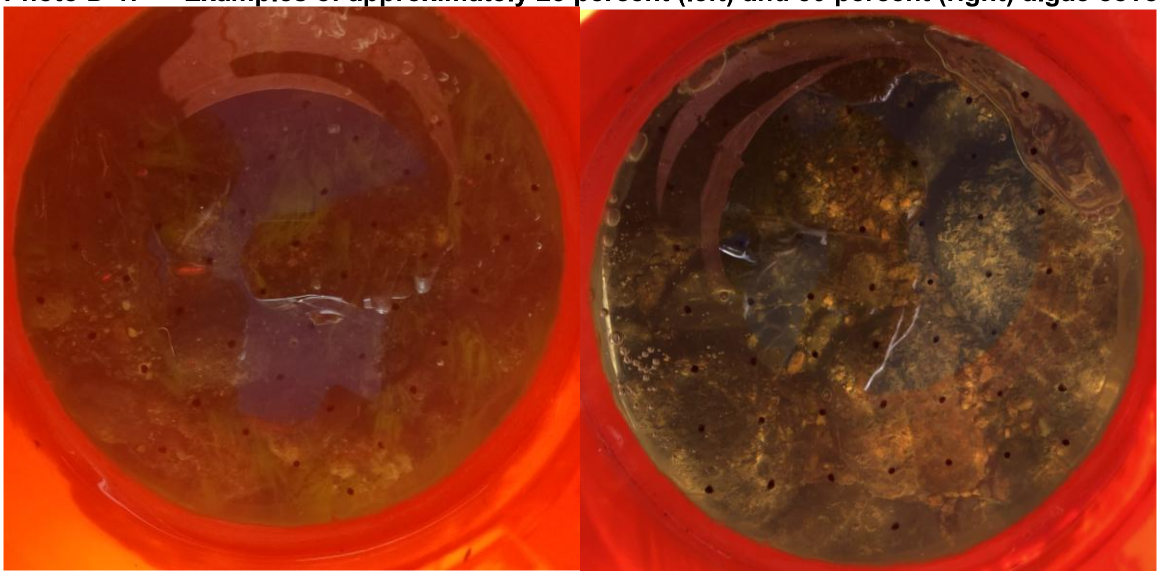
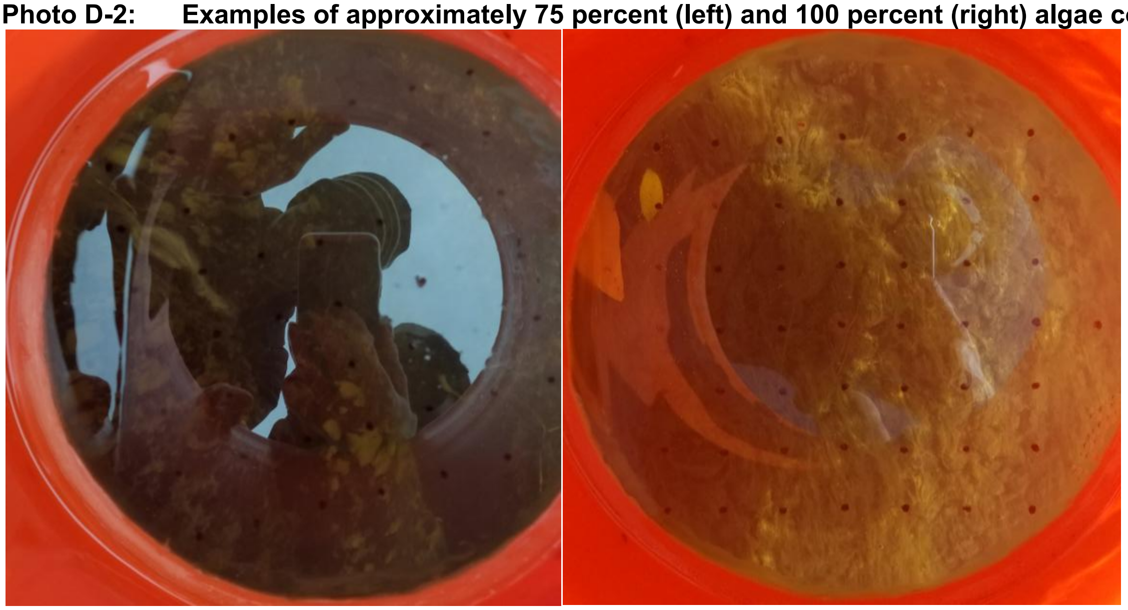


Photo D-2: Examples of approximately 75 percent (left) and 100 percent (right) algae cover.



Appendix E Long-term Embeddedness Data

Table E-1: Long-term embeddedness data from 2019 - 2025. NS = Not Sampled.

Sites	Waterbody	Average Percent Embeddedness						
		2019	2020	2021	2022	2023	2024	2025
CR-31	Colorado River	44.8	22.6	49.4	40.4	37.4	35.9	29.8
CRCC-0.5	Colorado River	NS	NS	NS	NS	NS	NS	27.9
CR-C	Colorado River	NS	NS	NS	NS	NS	39	NS
CR-28.7	Colorado River	48.8	48.7	64.3	64.0	41.6	37.2	40.6
CR-24.9	Colorado River	NS	NS	NS	53.7	45.9	48.9	45.7
CR-22.9	Colorado River	43.7	39.8	47.8	50.8	38.8	45.8	41.7
CR-16.7	Colorado River	49.0	31.5	51.9	51.3	54.6	34.7	46.7
CR-14.9	Colorado River	NS	NS	NS	NS	NS	NS	NS
CR-9.1	Colorado River	42.3	40.5	62.0	43.3	49.0	47.5	41.7
CR-7.4	Colorado River	55.5	54.3	44.3	49.0	52.1	57.5	47.7
CR-TBD	Colorado River	NS	NS	NS	80.5	NS	NS	NS
CR-1.7	Colorado River	65.5	NS	90.1	NS	NS	NS	NS
FR-27.2	Fraser River	NS	NS	NS	56.7	NS	NS	32.7
FR-25.1	Fraser River	51.8	37.3	59.4	NS	NS	32	52.1
FR-23.2	Fraser River	39.4	34.7	57.7	37.7	40.7	36.5	39.8
FR-20	Fraser River	37.4	37.9	50.3	40.2	54.0	37.1	65.1
FR-15	Fraser River	46.9	35.4	48.0	NS	NS	38.8	NS
FR-14	Fraser River	40.5	38.1	44.9	56.4	43.8	40.7	45.6
FR-12.4	Fraser River	NS	35.9	NS	NS	45.9	NS	NS
FR-TBD	Fraser River	NS	NS	NS	NS	52.4	NS	NS
FR-5.5	Fraser River	NS	NS	NS	NS	NS	NS	NS
FR-3.5	Fraser River	NS	NS	NS	NS	NS	38.4	NS
FR-1.9	Fraser River	40.0	NS	44.5	NS	42.4	NS	NS
RC-TBD	Ranch Creek	NS	NS	NS	NS	52.1	NS	NS
RC-1.1	Ranch Creek	51.4	45.4	81.6	84.8	56.3	40.7	54.5
STC-0	St. Louis Creek	NS	NS	NS	39.0	NS	NS	NS
WC-TBD	Willow Creek	NS	NS	NS	65.1	NS	49.5	NS
WC-0.5	Willow Creek	NS	NS	NS	NS	51.6	47.7	76
WF-5.5	Willow Creek	NS	NS	NS	NS	NS	NS	48.4
WF-13.1	Williams Fork	NS	NS	NS	NS	NS	29.6	NS