



Learning By Doing 2023 Aquatic Resource Monitoring Plan



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Aquatic Resource Monitoring Plan Overview

The cooperative partners of Learning By Doing (LBD) are required through two intergovernmental agreements (IGA) to design and implement an Aquatic Resource Monitoring Plan (Plan). The purpose of the Plan as defined in the IGAs is to *“implement a monitoring plan to identify undesirable changes in, and agree upon desired modifications to, the aquatic environment, and to measure the effectiveness of actions taken to protect or improve the aquatic environment.”* Further, the Plan sets agreed-upon goals that *“rely on existing data and new data gathering under existing programs to provide the primary source of information for designing the management goals and for prioritizing those goals and reaches where the goals will be applied.”* (IGA, 2012)

The Plan is developed on an annual basis by the LBD Monitoring Subcommittee following the approved process outlined in the LBD guidance document, Aquatic Resource Monitoring Planning Process (Learning By Doing Monitoring Subcommittee, May 1, 2019). The Plan is applicable to the Cooperative Effort Area (CEA), which includes the Colorado, Fraser, and Williams Fork River Basins, upstream of the Colorado River confluence with the Blue River.

The Plan achieves the following goals:

- Fosters an understanding of aquatic resources;
- Aids in effective decision making;
- Identifies changes in the aquatic environment;
- Identifies critical stream reaches;
- Highlights desired improvements, operations, and management decisions;
- Prioritizes action steps; and
- Evaluates effectiveness of restoration or other actions taken, including application of flow enhancements.

Plan Objectives

Monitoring priorities and objectives are evaluated on an annual basis. Objectives can be broad, such as monitoring aquatic health over the entire CEA, or they can be focused on monitoring changes that result from restoration projects. Therefore, the Plan objectives are dynamic and change from year to year to meet the established goals. The objectives of the 2023 Plan are to:

- Compile and summarize existing monitoring activities;
- Maintain a comprehensive stream temperature monitoring network to identify critical areas for stream temperature and to inform environmental water releases and evaluate their effectiveness;



- Assess sediment and characterize bed particle size distribution to evaluate flushing flows, accumulation of fines, and macroinvertebrate and fish spawning habitat;
- Assess the health of macroinvertebrate communities and monitor trends and changes;
- Ensure adequate monitoring in stream segments that are currently listed on Colorado's 303(d) List of Impaired Waters and identify segments in need of more monitoring;
- Assess the population and distribution of fish;
- Document riparian vegetation monitoring in the CEA; and
- Document restorations projects within the CEA.

A detailed sampling plan for each objective follows. Unforeseen circumstances can result in changes to the sampling plans.

Summary of Existing Monitoring Efforts

A summary of all monitoring efforts conducted within the CEA is compiled every few years and is based on actual sampling that occurred during that year. LBD's monitoring is intended to complement existing monitoring efforts in the CEA; the summary is used to inform LBD's annual Plan. Appendix A – Monitoring Summary Table, is an abbreviated summary of existing monitoring efforts.

Monitoring Summary Overview

Monitoring information is requested from and provided by several entities who collect data within the CEA. Information obtained includes site location, type of monitoring and frequency of sample collection. Several entities collect data within the CEA including:

- Bureau of Land Management (BLM)
- Colorado Department of Public Health and Environment/Water Quality Control Division (CDPHE/WQCD)
- Colorado Parks and Wildlife (CPW)
- Colorado River Water Conservancy District (River District)
- Denver Water
- East Grand Water Quality Board (EGWQB)
- Grand County (GC)
- Grand County Water Information Network (GCWIN)
- Learning By Doing (LBD)
- Northern Water
- Northern Water Municipal Subdistrict (Subdistrict)
- Trout Unlimited (TU)
- US Geological Survey (USGS)

While most of the entities listed collect data in the CEA every year, some do not. For example, the CDPHE only collects data in the CEA in certain years for review of water quality standards.

Given the number of different entities that collect data, there is a large amount of monitoring that takes place each year. In an effort to normalize and streamline sampling efforts, each sampling station is assigned a river mile ID. The river mile ID is generated by mapping the geographic coordinates provided by the sampling entities and measuring how many miles away the site is from a reference point.

The river mile ID is composed of abbreviated text representing its water body (Table 1) followed by a numeric value representing the distance in miles. River mile zero is located at the most downstream portion of a waterbody, generally the confluence with a larger river. For the Colorado River, river mile zero is at the CEA boundary line,

which is the confluence with the Blue River. The river miles increase at upstream sites. For example, the river mile ID for the Colorado River 10 miles upstream of the boundary of the CEA is CR-10.

Assigning a river mile ID not only standardizes the naming convention of the sites but also allows for sites located in the same place but sampled by different entities to be grouped together as a single site. Table 1 lists the abbreviations used for the various waterbodies when assigning the River Mile IDs.

Table 1 - River Mile Abbreviations

River Name	Site Abbreviation	Group
Arapaho Creek	AC	Upper Co
Blue River	BL	Lower Co
Bobtail Creek	BC	Williams Fork
Cabin Creek	CB	Fraser
<i>Cabin Creek North Channel</i>	CBN	Fraser
<i>Cabin Creek South Channel</i>	CBS	Fraser
<i>Little Cabin Creek</i>	LCB	Fraser
Church Creek	CH	Upper Co
Colorado River	CR	Colorado
<i>North Fork of Colorado</i>	NF	Upper Co
Crooked Creek	CC	Fraser
East Inlet	EI	Upper Co
Elk Creek	EC	Fraser
Fraser River	FR	Fraser
Grand Lake	GL	Upper Co
Granby Reservoir	GR	Upper Co
<i>Granby Pump Canal</i>	GRP	Upper Co
Hurd Creek	HC	Fraser
McQuery Creek	MQC	Williams Fork
Meadow Creek	MC	Fraser
North Inlet	NI	Upper Co
Ranch Creek	RC	Fraser
<i>Ranch Creek Canal</i>	RCC	Fraser
Reeder Creek	RDC	Lower Co
Roaring Fork	RF	Upper Co
Shadow Mountain Reservoir	SM	Upper Co
Saint Louis Creek	STC	Fraser
Steelman Creek	SC	Williams Fork
Stillwater Creek	ST	Upper Co
Trail Creek	TR	Upper Co
Vasquez Creek	VC	Fraser
<i>Vasquez Creek Canal</i>	VCC	Fraser
<i>Little Vasquez Creek</i>	LVC	Fraser
Williams Fork	WF	Williams Fork
<i>Upper South Fork Williams Fork</i>	USF	Williams Fork
<i>South Fork Williams Fork</i>	SWF	Williams Fork
Willow Creek Reservoir	WC	Upper Co
<i>Willow Creek Pump Canal</i>	WCP	Upper Co
Windy Gap Reservoir	WG	Middle Co
<i>Windy Gap Pump Canal</i>	WGP	Upper Co



Duplicate Monitoring Efforts

One of the goals of the monitoring summary is to see where monitoring overlaps and try to streamline efforts. In the existing monitoring summary, there are only a few locations where there was duplicate monitoring:

- CR-22.1, CR-28.7, CR-31 – These locations are in the Colorado River downstream of and around Windy Gap Reservoir. CPW is collecting additional macroinvertebrate data at these sites prior to the start of the river habitat restoration project.
- RC-1.1 – There are two temperature monitoring locations in Ranch Creek, one maintained by the USGS and the other by GCWIN.
- FR-24 – Both the EGWQB and Denver Water collect water quality samples at this location.

2023 Stream Temperature Monitoring Plan

Stream temperature is critical to aquatic life health. The streams in the CEA support cold water fish and macroinvertebrate communities. Each cold-water fish species has a unique range of temperatures in which individuals can survive, and an even smaller range that supports optimal growth, survival, and reproduction. If frequent or sustained, above optimum temperatures can limit individual growth, and even higher temperatures can increase mortality, limit populations, and alter community structure. A robust stream temperature monitoring network in the CEA provides continuous temperature data to help assess thermal regimes and aid in aquatic life protection.

The LBD stream temperature monitoring program objectives are to:

- Complement existing stream temperature monitoring efforts;
- Provide the LBD Operations Subcommittee with timely data to make informed decisions about releases of environmental water;
- Provide continuous stream temperature data to evaluate effectiveness of environmental water releases;
- Identify critical stream reaches for water temperature;
- Assess compliance with Colorado's stream temperature standards;
- Monitor and assess impacts of restoration efforts performed by LBD.

Data collected through this program are collected in accordance with and assessed against the state of Colorado's temperature standard criteria (Colorado Department of Public Health and Environment, Water Quality Control Division, March 2019) (Colorado Department of Public Health and Environment, Water Quality Control Commission, June 2019).

This program is reviewed annually.

Existing Temperature Monitoring Network

The existing temperature monitoring network consists of 67 locations in the CEA (one location is monitored by two entities). Several entities maintain these sites: The Bureau of Land Management, Grand County Water Information Network (GCWIN), Northern Water and the U.S. Geological Survey. Many stakeholders provide financial support to maintain the existing program; these stakeholders include LBD members as well as non-LBD members. A map of the 2023 monitoring sites is shown in Figure 1 and details of the program are included in the Monitoring Summary in Appendix B.

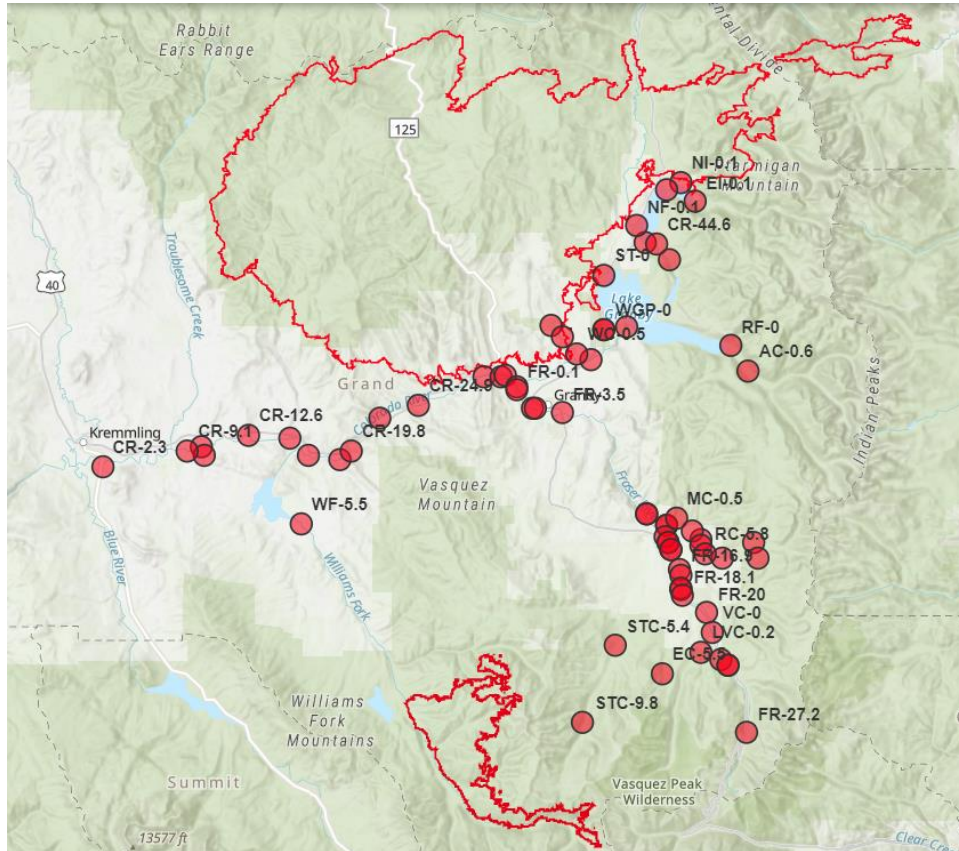


Figure 1 - Temperature Monitoring Sites in the CEA

Changes to Temperature Monitoring Plan

The existing stream temperature monitoring network was analyzed for data gaps with respect to timeliness (is the data available when it is needed), impaired waters designation, spatial coverage, diversions, historical data, and the need for baseline data. Based on this assessment, no changes were made to the 2023 temperature monitoring plan. LBD continued to monitor at 11 temperature sites and weekly data downloads at select sites (to inform the weekly LBD Operations Subcommittee calls) was maintained in 2023.

2023 LBD Temperature Monitoring

The 2023 LBD temperature monitoring program consists of 11 sites (Table 2). At two sites, data are downloaded, compiled, and distributed to the LBD Operations Subcommittee on a weekly basis from June 17 - September 15. At the remaining 9 sites, data are downloaded biweekly from April – October and the data are compiled and shared at the end of the monitoring season.

Table 2 – 2023 LBD Temperature Monitoring Plan

River Mile ID	Station Description	Latitude	Longitude	Download Frequency	Photos
STC-5.4	St Louis Creek at Fraser Experimental Forest HQ	39.907710	-105.87951	Bi-weekly	-
STC-0	St Louis Creek upstream of confluence with Fraser River	39.95175	-105.81471	Weekly (Jun - Sep)	-
RC-5.8	Ranch Creek upstream of revegetated area	39.978214	-105.79187	Bi-weekly	Y
RC-5.1	Ranch Creek downstream of revegetated area	39.984244	-105.79467	Bi-weekly	Y
FR-15	Fraser River upstream of Fraser Flats River Habitat Project	39.981338	-105.82494	Bi-weekly	-
FR-14.4	Fraser River downstream of Fraser Flats River Habitat Project	39.986438	-105.82738	Bi-weekly	Y
FR-3.5	Fraser River at Hwy 40 in Granby	40.081027	-105.93127	Weekly (Jun - Sep)	-
WC-2.3	Willow Creek upstream of Bunte Highline Ditch	40.136965	-105.92881	Bi-weekly	Y
WC-0.5	Willow Creek upstream of confluence with Colorado River	40.123601	-105.91284	Bi-weekly	-
CR-2.3	Colorado River upstream Hwy 9 Bridge in Kremmling	40.0421	-106.3714	Bi-weekly	-
WF-5.5	Williams Fork upstream of Williams Fork Reservoir	39.999510	-106.17946	Bi-weekly	-

A contingency budget was kept for additional visits that may be needed at sites impacted by the East Troublesome Fire, there is potential for heavy debris flows that would require site maintenance. Two sites, WC-0.5, and WC-2.3, include photo documentation for each visit to monitor visible changes in water quality and riparian vegetation in the burn scar.

Station Operation, Maintenance and Data Delivery

GCWIN maintains all the stations in the LBD temperature monitoring program, except for CR-2.3. CR-2.3 is maintained by the BLM.

Station Operation

Stream temperature monitoring at the sites maintained by GCWIN follows guidelines set forth in the SOP, [2023 GCWIN Stream Temperature Monitoring Protocols](#). The manual includes quality assurance and quality control (QAQC) protocols. A field logbook is filled out for each site visit.

Station Maintenance Protocol:

- GCWIN/BLM will install HOB0 Water Temp Pro v2 Data-loggers (Part # U22-001, Onset Computers, Inc., Bourne, Massachusetts) All sensors will be calibrated using the 2-point water bath method. Sensors outside of the range including +/- 0.1 o C annual drift will not be used.
- Sensors with a battery voltage below 2.4 V will not be used.
- All sensors use the same shuttle for downloading data to a computer – Onset's Hobo Optic USB Base Station U-4.
- Sensors are set to record data every 15 minutes, i.e. at 0:00, 0:15, 0:30, and 0:45 minutes on the hour. They record temperature in oC as well as recording battery voltage.
- For sensors not deployed year-round, place in river before May 1st.
- Ideally sensor is placed in the thalweg, or mid-50% of stream width, assuming these locations are in flowing water. Above all, sensor needs to be located in flowing, deep water.
- If sensor is not in the thalweg/mid 50%, it needs to be placed in a minimum of 18" of flowing water, preferably in the river "bubble line". The water needs to be sufficiently flowing so silt does not accumulate on sensor and flow is comparable to that seen in thalweg.
- Data handling includes download, QA/QC, post-processing, storage, and distribution of temperature data.

Photo Documentation Protocols:

- At stream temperature sites potentially impacted by the fire area, photos will be taken each time the site is visited (every two weeks).
- At stream temperature sites undergoing restoration, photos will be taken each time the site is visited (every two weeks).
- Each site will be analyzed for the best angle, considering the surroundings and viewpoints of interest.
- A tripod, and a non-phone camera will be used to ensure consistency in photo frame.
- Field technician will take additional written notes regarding field conditions.

Data Management

Data management includes download, QAQC, storage, and distribution of temperature data. GCWIN's Executive Director conducts final QAQC on all stream temperature data. Data from sites with weekly downloads are provided to the LBD Operations Subcommittee in an agreed upon timeframe to support operational decisions regarding environmental water releases. The final stream temperature data are provided to LBD in an Excel spreadsheet by December 1 of each year. The data are stored in GCWIN's database, which is publicly accessible.

Rig Construction

Rig considerations for potential increased debris during spring runoff.

- Field staff will add an extra rope to secure the rig to the riverbank. This gives the rig two tie down points for added security.
- Field staff have drilled larger holes into all sensor housing rigs.
- 3 fail safe attachments for rig housing.
 - U-bolt
 - Wire cable (attached to rope and sensor)
 - Zip tie



Stream temperature sensor rig and housing

Funding

Costs for the 2023 temperature monitoring are shared among some LBD partners. The partners each pay a percentage of the total cost. The cost distribution for 2023 is:

LBD Partner	Contribution %
Grand County	25%
Denver Water	25%
Northern Water/Subdistrict	25%
River District	8.3%
TU	8.3%
LBD	8.3%

2023 Sediment Monitoring Plan

Aquatic life can be impacted by human-caused deposition of excessive sediment on stream and river bottoms, resulting in the loss of critical habitat for fish and macroinvertebrates, disrupting food-web dynamics, and reducing reproductive success. Harmful impacts can include smothering of gravels and cobbles in important spawning and feeding habitats, and the filling of interstitial spaces and pool habitat with fine sediments. These conditions may result in habitat loss for macroinvertebrates, a resultant reduction in fish food sources, and smothering and loss of oxygenation in important fish spawning habitats. Other undesirable impacts of sedimentation can include population changes to more pollution tolerant macroinvertebrate species, and extirpation of sensitive species (Colorado Water Quality Control Commission, Department of Public Health and the Environment, 2014).

The following is a summary of the LBD 2023 Sediment Monitoring Plan within the CEA. The objectives of the 2023 LBD sediment monitoring program are to:

- Collect data as needed to evaluate flushing flows in key reaches within the CEA;
- Report on physical conditions in the riffles at macroinvertebrate monitoring locations;
- Assess sediment size and embeddedness in trout spawning habitat in a manner that is compliant with the [Colorado Water Quality Control Commission Narrative Sediment Policy 98-1](#);
- Monitor changes in particle distribution within the CEA, including the accumulation of fine sediment in interstitial spaces; and
- Evaluate algal conditions within the streambeds of the CEA.

Existing Sediment Monitoring

In 2010, monitoring of river substrate began "...to document the habitat quality of select trout spawning bars along the Fraser and Colorado Rivers within Grand County in response to the annual stream flow regimes" (Tetra Tech and HabiTech, 2018). In 2019, what was formerly termed "substrate" sampling was changed to "sediment" sampling to be consistent with the Colorado Water Quality Control Commission (WQCC) *Guidance for Implementation of Colorado's Narrative Sediment Standard Regulation #31, Section 31.11(1)(a)(i), Policy 98-1*. Sediment sampling has historically consisted of core sampling and pebble counts associated with fish spawning habitats, pebble counts associated with macroinvertebrate habitat, Riffle Stability Index (RSI) measurements and evaluation of algal conditions.

Core Sampling in Trout Spawning Habitat

A quantitative method used to assess fine sediment in trout spawning beds involves identifying trout spawning bars from fish redd surveys in the fall and sampling with a

McNeill-Ahneil¹ core sampler, which is 15 cm in diameter and 6 inches deep. The sampler is pushed into the gravel bed as far as it will go, and then the core is removed and sifted and sieved to identify particle size in the sample. The method is best suited for evaluating salmonid spawning sites with smaller substrate, such as pebbles and gravel. Samples can be sorted on site with sieves ranging from 75 to 0.074 mm, or sent to a lab for dry sieve analysis.

A 150 ml suspended sediment sample should also be collected from the water/fine sediment mixture remaining in the core sampler, and results should be reported in mg/L. This provides an estimate of the fine sediments, such as silt and clay that are also within the spawning bed.

Several years of core sample collections during high flow years have yielded similar results and have resulted in a recent emphasis on core sampling only during low flow years. Data collected will be compared to past data from the CEA.

Table 3 - Core Sampling Site Locations

River Mile ID	Site Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
FR-5.5	Fraser River between the Fraser Canyon and Granby (Granby Ranch)	X	X	X	X	X	X	X	X			X	X	X	X
RC-1.1	Ranch Creek below Meadow Creek (Miller Property)	X	X	X		X			X			X	X	X	X
CR-22.9	Colorado River upstream of Hot Sulphur Springs WTP (X ⁴)	X ¹	X ¹	X ²	X ²	X ³	X ³	X ³	X ³	X ³		X ⁴	X ⁴	X ⁴	X
CR-14.9	Downstream of Williams Fork confluence and Parshall	X	X	X	X	X	X	X	X	X		X	X	X	X
CR-9.1	Downstream of KB Ditch	X	X	X	X	X	X	X	X	X		X	X	X	X

No core sampling in 2019

X¹ CR4 Chimney Rock was discontinued in 2011 due to absence of spawning beds.

X² CR4 Paul Gilbert discontinued in 2014 due high flows cut off and dewatered the spawning channel site.

X³ below Hot Sulphur Springs Resort [sampled until 2018. Due to consultant changes this site has been sampled at CR-22.9\(X⁴\) since 2020.](#)

¹ McNeil, W.J. and W.H. Ahneil (1964) Success of pink salmon spawning relative to size of spawning bed materials. US Fish and Wildlife Special Scientific Report, Fisheries No. 469. US Department of Interior, Washington DC

Modified Wolman Pebble Counts^{2,3}

This widely used method samples coarse riverbed material in streams as a way of estimating cumulative distribution of grain sizes and the degree of embeddedness. It is a geomorphic measure, which is a good method for identifying median bed particle size.

Pebble counts will be conducted at all macroinvertebrate sites with the sampling grid method and a Gravelometer as required by Colorado WQCD Policy 98-1. Pebble counts are also used to assess salmonid spawning bars and macroinvertebrate habitats by utilizing the Sediment Tolerance Indicator Value (TIV_{SED}) as defined in Policy 98-1 (Colorado Water Quality Control Commission, Department of Public Health and the Environment, 2014).

Algae Presence and Embeddedness

Percent algal cover and percent embeddedness will be estimated concurrent with pebble counts in 2023. For assessment of algae, a viewing bucket (a bucket with a clear bottom and intersection markings) was employed which measures the percentage of grid intersections where algae are present. A subset of the 400 particles picked up during the pebble counts across 10 transects were measured to find the depth to which they were buried in sediment to estimate the percent embeddedness. Photographs will be taken at each site during the survey to document representative observations and to calibrate surveys over time.

² Wolman, M.G. (1954) A method of sampling coarse river-bed material. Transactions American Geophysical Union 35(6) p. 951-956

³ Bevenger, G.S. and R.M. King (1995) A Pebble Count Procedure for Assessing Watershed Cumulative Effects. USDA Forest Research Paper, RM-RP-319

Table 4 - Pebble Count and Algae Assessment Site Locations

River Mile ID	Station Description	Monitoring Frequency	Years Monitored							
			2017	2018	2019	2020	2021	2022	2023	
FR-27.2	Fraser River upstream Jim Creek/Mary Jane entrance	1x/2-3 yrs		X					X	
FR-25.1	Fraser River upstream of UP Railroad discharge	1x/2-3 yrs			X	X	X			
FR-23.4	Fraser River upstream of Winter Park San District	Annually	X	X	X	X	X	X	X	X
FR-20	Fraser River at Rendezvous Bridge	Annually	X	X	X	X	X	X	X	X
FR-15	Fraser River upstream of Fraser Flats restoration	1x/2-3 yrs	X	X	X	X	X			
FR-14	Fraser River upstream of Tabernash	Annually	X	X	X	X	X	X	X	X
FR-12.4	Fraser River upstream of Fraser Canyon	1x/2-3 yrs	X			X				X
FR-TBD	Fraser River at Kaibab Park	TBD								X*
FR-1.9	Fraser River upstream of Granby Sanitation District	1x/2-3 yrs	X		X		X			X
STC-0	Saint Louis Creek at Fraser River	1x/2-3 yrs		X	X				X	
RC-TBD	Ranch Creek upstream	TBD								X*
RC-1.1	Ranch Creek downstream of Meadow Creek	Annually	X	X	X	X	X	X	X	X
CR-31	Colorado River upstream Fraser and Windy Gap	Annually	X	X	X	X	X	X	X	X
CR-28.7	Colorado River downstream of Windy Gap	Annually	X	X	X	X	X	X	X	X
CR-24.9	Colorado River at Sheriff Ranch	1x/2-3 yrs							X*	X
CR-22.9	Colorado River upstream of Hot Sulphur Springs WTP	Annually	X	X	X	X	X	X	X	X
CR-16.7	Colorado River upstream of Williams Fork	Annually	X	X	X	X	X	X	X	X
CR-9.1	Colorado River at CR39 Bridge at KB Ditch	Annually	X	X	X	X	X	X	X	X
CR-7.4	Colorado River downstream Troublesome Creek	Annually		X	X	X	X	X	X	X
CR-1.7	Colorado River upstream of the Blue River	Discontinued		X	X	****	X			
WC-0.5	Willow Creek upstream CO River	TBD							X*	X

****Site was sampled qualitatively. Reach not wadeable due to being entirely soft, fine substrate.

X* New Sampling Site

Riffle Stability Index (RSI)

This method estimates the mobile sediment fraction in a river's riffle, that is, how the riverbed is shifting in response to flow. It is another geomorphic measure, revealing how substrate is moving in riffles, not a habitat measure that provides a metric that estimates

the quality of habitat. A river receiving excessive sediment will have smaller, finer particles accumulated in the riffle when compared to a river in dynamic equilibrium without excessive sedimentation. Riffle Stability Index values greater than 70 indicate a riffle that is somewhat loaded with sediment, and values greater than 85 indicate excess sediment. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for aquatic life.

To be able to compare historic data and move towards sampling in riffles, RSI measurements are recommended at three of the historical sediment core sample sites and six macroinvertebrate sites.

Table 5 - Riffle Stability Index Site Locations

River Mile ID	Site Description	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
FR-5.5	Fraser River between the Fraser Canyon and Granby (Granby Ranch)	X	X	X	X			X		X	
RC-1.1	Ranch Creek below Meadow Creek (Miller Property)	X	X	X	X			X		X	
CR-22.9	Colorado River upstream of Hot Sulphur Springs WTP	X	X	X	X		X	X	X	X	X
CR-14.9	Downstream of Williams Fork confluence and Parshall	X	X	X	X				X		X
CR-9.1	Downstream of KB Ditch	X	X	X	X		X	*	X		X
FR-27.2	Fraser River upstream Jim Creek/Mary Jane entrance									X	
FR-25.1	Fraser River upstream of UP Railroad discharge										
FR-23.4	Fraser River upstream of Winter Park San District						X	X		X	
FR-20	Fraser River at Rendezvous Bridge						X		X		X
FR-15	Fraser River upstream of Fraser Flats restoration						X	X		X	
FR-14	Fraser River upstream of Tabernash						X		X		
FR-12.4	Fraser River upstream of Fraser Canyon										X
FR-1.9	Fraser River upstream of Granby Sanitation District						X		*	X	X
STC-0	Saint Louis Creek at Fraser River									X	
RC-1.1	Ranch Creek downstream of Meadow Creek							X			
CR-31	Colorado River upstream Fraser and Windy Gap						X		X		X
CR-28-7	Colorado River downstream of Windy Gap						X	X	X	X	X
CR-16.7	Colorado River upstream of Williams Fork						X		X		
CR-7.4	Colorado River downstream Troublesome Creek						X			X	
CR-1.7	Colorado River upstream of the Blue River – (discontinued)						X				

No RSI sampling in 2018

*Site was supposed to be included but was erroneously omitted and was sampled in 2021 at no cost.

2023 Changes to Sediment Monitoring Plan

Generally, monitoring sites are intended to provide a long-term record. It is anticipated that only minor changes in the location of the sites would occur from one year to the next. During the annual review of the monitoring program, sites may be added or removed, especially in the short-term. As the sediment monitoring program for LBD is evolving, changes may need to take place in the list of sites to better meet the objectives of the program.

Two sampling sites were added this year. Fraser River at Kaibab Park (FR-TBD) was added to establish pre-project conditions for planned restoration in the reach. A site was added in the upper part of Ranch Creek (RC-TBD) for better spatial coverage on Ranch Creek and to monitor the effects of beavers in the area.

Historic core sampling at spawning beds will occur at all 5 sampling sites. Core sampling is our longest running dataset, and it is integral to maintain continuity.

2023 LBD Sediment Monitoring

Methods for sediment monitoring in 2023 will be the same that were used in 2022 and will build on historic monitoring efforts in the CEA. The changes outlined above are additional monitoring efforts to build upon the current monitoring program. Sediment monitoring in 2023 will be a comprehensive measure of the trout spawning and macroinvertebrate habitat.

Monitoring Sites and Sampling Frequency

The sediment monitoring plan includes:

- Sediment core sampling at all 5 of the historical core sample sites (Table 3).
- 400 count pebble counts that are compliant with Water Quality Control Commission Policy 98-1, and algae assessment at each of the 2021 macroinvertebrate sites (Table 4).
- RSI at 3 of the historical core sampling sites and at 6 riffle sites (Table 5).

In 2023, pebble counts will be collected to accompany all macroinvertebrate sampling sites, regardless of whether the macroinvertebrate site is part of a permit requirement, part of an existing monitoring program, or a new site as recommended by the LBD monitoring committee. All sampling will be conducted once in the early fall and within 2 weeks of the macroinvertebrate monitoring.



Table 6 - Summary of 2023 Sediment Monitoring

River Mile ID	Station Description	400 Pebble Count/Algae/Embeddedness	RSI	Core Sample	Entity
FR-27.2	Fraser River upstream Jim Creek/Mary Jane	X	X		LBD
FR-23.4	Fraser River upstream of Winter Park San District	X	X		LBD
FR-20	Fraser River at Rendezvous Bridge	X			LBD
FR-15	Fraser River upstream of Fraser Flats restoration	X	X		LBD
FR-14	Fraser River upstream of Tabernash	X			LBD
STC-0	Saint Louis Creek at Fraser River	X	X		LBD
RC-1.1	Ranch Creek downstream of Meadow Creek	X			LBD
CR-31	Colorado River upstream Fraser and Windy Gap	X			LBD
CR-28-7	Colorado River downstream of Windy Gap	X	X		LBD
CR-24.9	Colorado River at Sheriff Ranch	X			LBD
CR-22.9	Colorado River upstream of Hot Sulphur Springs Resort	X			LBD
CR-16.7	Colorado River upstream of Williams Fork	X			LBD
CR-9.1	Colorado River at CR39 Bridge at KB Ditch	X			LBD
CR-7.4	Colorado River downstream Troublesome Creek	X	X		LBD
CR-TBD	Colorado River TBD	X			LBD
WC-TBD	Willow Creek TBD	X			LBD
FR-5.5	Fraser River between the Fraser Canyon and Granby (Granby Ranch)		X	X	LBD
RC-1.1	Ranch Creek below Meadow Creek (Miller Property)		X	X	LBD
CR-22.9	Colorado River upstream Hot Sulphur Springs WTP		X	X	LBD
CR-14.9	Downstream of Williams Fork and Parshall			X	LBD
CR-9.1	Downstream of KB Ditch			X	LBD

Data Reporting

Data analysis will be completed by the end of 2023, and a final report will be provided to LBD in early 2024.

Funding

Costs for the 2023 sediment monitoring are shared among some LBD partners. The partners have agreed to pay a percentage of the total monitoring cost based on the following allocation:

LBD Partner	Contribution %
Grand County	25%
Denver Water	25%
Northern Water/Subdistrict	25%
River District	8.3%
TU	8.3%
LBD	8.3%

2023 Macroinvertebrate Monitoring Plan

Macroinvertebrate (aquatic organisms) communities are a good indicator of overall stream health. Macroinvertebrate communities are sensitive to a wide range of environmental disturbances and pollution. While water quality monitoring provides a snapshot of conditions at a specific time, it can fail to capture changes in water quality that may occur between sampling events. The effects of changes in water quality on macroinvertebrate communities can linger, making macroinvertebrate monitoring a good tool for detecting fluctuating environmental conditions. Changes in macroinvertebrate communities can signal impacts from urban development as well as changes in land use, the riparian habitat, or stream channel. Community diversity and presence (or absence) of certain sensitive species are indicators of the biological and ecological integrity of the rivers.

The following is a summary of the LBD 2023 macroinvertebrate monitoring plan within the CEA. The objectives of the 2023 LBD macroinvertebrate monitoring program are to:

- Complement existing monitoring efforts;
- Assess the existing state of macroinvertebrate communities in the CEA;
- Monitor trends and changes to the health of the macroinvertebrate communities;
- Assess compliance with Colorado's aquatic life standard;
- Monitor and assess impacts of restoration efforts performed by Learning by Doing.

Data collected through this program are assessed using the Colorado Water Quality Control Division's (Division's) Multi Metric Index (MMI) to determine compliance with Colorado's aquatic life standard (Colorado Department of Public Health and Environment, Water Quality Control Commission, Aug 2017). LBD has elected to compute additional standard metrics, including several key measurable indicator metrics, as a part of this program to provide a complete assessment of the macroinvertebrate community. The methods utilized are consistent with the Division's protocols for collection and analysis of macroinvertebrates.

This program is reviewed annually.

Existing Macroinvertebrate Monitoring

Existing macroinvertebrate monitoring consists of 29 sites in the CEA. Locations of the sites are included in Appendix A – Monitoring S.

Moffat Project and WGFP 401 Certification Compliance Monitoring

Denver Water and the Subdistrict are both required to conduct annual macroinvertebrate monitoring at 7 sites in the LBD CEA to comply with the conditions of

the Moffat Project and Windy Gap Firing Project 401 Certifications (Colorado Department of Public Health and Environment, Water Quality Control Division, Moffat, 2016) (Colorado Department of Public Health and Environment, Water Quality Control Division, WGFP, 2016).

Denver Water’s 401 Certification requirement includes 4 sites; 3 in the Fraser River and 1 in Vasquez Creek, upstream of Winter Park. The Subdistrict’s 401 Certification requirement includes 3 sites on the Colorado River downstream of Windy Gap Reservoir. In addition, the Subdistrict annually monitors a site that is not part of its 401 Certification requirement but was deemed important to provide contextual information for the other 3 sites. In total, eight sites are included in the monitoring programs for Denver Water and the Subdistrict as shown in Table 7.

Table 7 - Denver Water and Northern Water’s Subdistrict’s Macroinvertebrate Monitoring Sites

River Mile ID	Station Description	Entity	401 Permit
FR-23.2	Fraser River upstream of Winter Park San District	Denver Water	Yes
FR-20	Fraser River at Rendezvous Bridge	Denver Water	Yes
FR-14	Fraser River upstream of Tabernash	Denver Water	Yes
VC-0	Vasquez Creek at the Town of Winter Park	Denver Water	Yes
CR-31	Colorado River upstream of Fraser and Windy Gap	Subdistrict	Yes
CR-28.7	Colorado River downstream of Windy Gap	Subdistrict	Yes
CR-22.9	Colorado River upstream of Hot Sulfur Springs	Subdistrict	Yes
CR-16.7	Colorado River upstream of Williams Fork	Subdistrict	No

Subdistrict’s Habitat Project Macroinvertebrate Monitoring

The Windy Gap Firing Project 401 Certification requires macroinvertebrate monitoring within the Kemp Breeze Habitat Project to assess the effects of restoration. This condition requires pre-project monitoring at 2 sites. (Colorado Department of Public Health and Environment, Water Quality Control Division, WGFP, 2016). Restoration in the Kemp Breeze area downstream of Parshall, CO began in 2021. The Subdistrict collected samples at 3 sites in 2020. Sampling will occur at the same 3 sites 2 years after the project is complete.

Northern Water’s Baseline Macroinvertebrate Monitoring

In addition to the macroinvertebrate monitoring the Subdistrict does to comply with the WGFP 401 Certification, Northern Water conducts baseline macroinvertebrate monitoring for the C-BT and Windy Gap Projects every 3-5 years. The last time Northern Water conducted baseline was in 2021. No baseline monitoring occurred in 2022.

2023 Changes to Macroinvertebrate Monitoring Plan

Generally, monitoring sites are intended to provide a long-term record. It is anticipated that only minor changes in the location of the sites would occur from one year to the next. During the annual review of the monitoring program, sites may be added or removed, especially in the short-term. As the macroinvertebrate monitoring program for LBD is evolving, changes may need to take place in the list of sites to better meet the objectives of the program. Sites that are established specifically to assess the effectiveness of restoration projects might be monitored on a short-term basis and have reduced sampling frequency or be discontinued once a post project baseline is established.

Criteria for Determining Sampling Frequency

Changes in macroinvertebrate communities can occur as a result of a variety of factors, such as land-use changes, pollution, hydrology, stream restoration, agricultural diversions, highway maintenance activities, and natural events such as droughts, floods and wildfire. Knowledge and understanding of activities taking place in the watershed should therefore inform the need for and frequency of sampling at any given site. Some amount of inter-annual variability is to be expected due to varying hydrology even at sites subject to stable watershed influences.

Assessment of the macroinvertebrates present can provide a good understanding of the current health of the community. The LBD program includes several metrics that are considered key measurable indicators of macroinvertebrate health; each has a defined numeric threshold that indicates the level of health of a community. (See *Reporting and Assessment Metrics* below).

Based on knowledge of activities in the watershed and scores of the key measurable indicators, the following guidelines can be used to inform monitoring decisions:

- Sites where there are good scores for the key measurable indicators and have no known/identified stressors likely to adversely impact macroinvertebrate communities can be sampled every 2–3 years.
- When available, historical data should be reviewed to evaluate potential changes or lack thereof. Sites displaying no changes in key measurable indicator scores can be sampled every 2–3 years. Sites displaying a range of key measurable indicator scores should be sampled annually.
- Where impacts from changes in land-use, known stressors and/or restoration are expected, samples should be collected annually.

Changes to Sampling Frequency

There were no changes to sampling frequency in 2023.



New Monitoring Sites

Two sampling sites were added this year. Fraser River at Kaibab Park (FR-TBD) was added to establish pre-project conditions for planned restoration in the reach. A site was added in the upper part of Ranch Creek (RC-TBD) for better spatial coverage on Ranch Creek and to monitor the effects of beavers in the area.

2023 LBD Macroinvertebrate Monitoring

The 2023 LBD macroinvertebrate monitoring program consists of 15 sites; 4 sites in the Colorado River, 2 sites in a Colorado River tributary (Willow Creek), 4 sites in the Fraser River, 2 sites in Fraser River tributaries (Ranch Creek) and 3 sites in Williams Fork (

Table 9). The monitoring frequency is site specific and varies from annual sampling to sample collection every 2–3 years. Several of the sampling locations are sites that will be monitored long-term to provide a baseline of data to track changes. Other sites are specific to restoration or anticipated restoration projects and may be monitored only for the duration of the project. For some of the new sites (added to the program in the last few years), a baseline data set needs to be established prior to determining what frequency monitoring will occur.

For 2023, macroinvertebrate sampling will be conducted at 15 out of the 20 LBD sites. The locations of the 2023 sampling sites are shown in Table 8. In the case of an unauthorized discharge event by UPRR, an additional sample will be collected at the site downstream of the discharge, but the timing of sample collection will be different.

Table 8 - LBD Macroinvertebrate Sampling Sites and Years Monitored

River Mile ID	Station Description	Entity	Monitoring Frequency	2019	2020	2021	2022	2023	Project Specific
FR-27.2	Fraser River upstream Jim Creek	LBD	1x/2-3 yrs				X		No
FR-25.1	Fraser River upstream UP Railroad discharge	LBD	1x/2-3 yrs	X*	X	X			No
FR-TBD	Fraser River downstream UP Railroad discharge **	LBD	As needed	X*			X	X	No
FR-15	Fraser River upstream Fraser Flats restoration	LBD	1x/2-3 yrs	X	X	X			Yes
FR-12.4	Fraser River upstream Fraser Canyon	LBD	1x/2-3 yrs		X			X	No
FR-TBD	Fraser River at Kaibab Park	LBD	TBD					X*	Yes
FR-1.9	Fraser River upstream Granby San District	LBD	1x/2-3 yrs	X		X	X	X	No
STC-0	Saint Louis Creek at Fraser River	LBD	1x/2-3 yrs				X		No
RC-TBD	Ranch Creek upstream	LBD	TBD					X*	No
RC-1.1	Ranch Creek downstream Meadow Creek	LBD	Annually	X	X	X	X	X	No
CR-24.9	Colorado River at Sheriff Ranch	LBD	TBD				X*	X	Yes
CR-9.1	Colo River at CR39 Bridge at KB Ditch	LBD	Annually	X	X	X	X	X	No
CR-7.4	Colo River downstream Troublesome Crk	LBD	TBD	X	X	X	X	X	Yes
CR-1.7	Colorado River upstream the Blue River	LBD	TBD	X	X	X		X	Yes
WF-13.1	Williams Fork downstream of Henderson Mill	LBD	1x/2-3 yrs			X			No
WF-5.5	Williams Fork upstream Williams Fork Res	LBD/D W	TBD	X	X	X	X	X	Yes
WF-2	Williams Fork downstream Williams Fork Res	LBD/D W	TBD	X	X	X	X	X	Yes
WF-0.5	Williams Fork upstream Colo River at Kemp Breeze	LBD/D W	TBD	X*	X	X	X	X	Yes
WC-2.3	Willow Creek in Restoration Project Area	LBD	TBD				X*	X	Yes
WC-0.5	Willow Creek upstream of Colorado River	LBD	TBD				X*	X	Yes

**Sample collected only in the event of an unauthorized discharge from UPRR. This site was added to the program in 2019 but monitoring has not been needed to date.

Table 9 - 2023 LBD Macroinvertebrate Monitoring Sites

River Mile ID	Description	Latitude	Longitude
CR-1.7	Colorado River upstream of the Blue River	40.04650000	-106.37300000
CR-24.9	Colorado River at Sheriff Ranch	40.08736100	-106.06766700
CR-7.4	Colorado River downstream of Troublesome Creek	40.05090000	-106.31120000
CR-9.1	Colorado River downstream of KB Ditch	40.05377600	-106.28946000
FR-TBD	Fraser River downstream of UP Moffat Tunnel discharge	--	--
FR-1.9	Fraser River upstream of Granby Sanitation District	40.08452600	-105.95464000
FR-TBD	Fraser River at Kaibab Park	--	--
FR-12.4	Fraser River downstream of Crooked Creek and Tabernash	40.00689167	-105.8482722
RC-TBD	Ranch Creek upstream	--	--
RC-1.1	Ranch Creek Blw Meadow Cr Nr Tabernash Co	33.99229000	-106.17100000
WC-0.5	Willow Creek upstream of confluence with Colorado River	40.12501000	-105.91491000
WC-2.3	Willow Creek upstream of Bunte Highline Ditch	40.13703500	-105.92904000
WF-0.5	Williams Fork downstream WF Reservoir at Kemp Breeze	40.05610000	-106.18250000
WF-5.5	Williams Fork River upstream of Williams Fork Reservoir	40.00020000	-106.18036670
WF-2	Williams Fork R. below Williams Fork Reservoir	40.03592778	-106.20501390

Collection Methods and Macroinvertebrate Analysis

Results obtained by consistent sampling practices and accurate identifications provide valuable information regarding short- and long-term changes in aquatic conditions. In addition, using analytical procedures that result in quantitative data (counting all bugs in a sample) provides an accurate and dependable dataset that makes changes more apparent. Quantitative data are especially useful when evaluating the effectiveness of restoration projects and/or mitigation of known stressors.

Changes in data collection methods introduce inconsistencies in a dataset and make it difficult to perform trend analyses or compare data between sites sampled through separate programs. In order to preserve the integrity of the dataset being developed by LBD, the sampling and analytical method used in 2023 are the same as those used in previous years. These methods are consistent with those used by Denver Water and the Subdistrict, which allows for integration with and comparison to these datasets.

Timberline Aquatics performs the sampling methods as follows:

- Sampling occurs during the period from late September to early October (fall) to target macroinvertebrate communities during annual periods of high density. This sampling period is consistent with the Colorado Water Quality Control Division's

methodology for macroinvertebrate sampling (Colorado Department of Public Health and Environment, Water Quality Control Commission, Aug 2017).

- Timberline Aquatics collects the samples utilizing protocols approved by the Division's Section 303(d) Listing Methodology 2020 Listing Cycle (Colorado Department of Public Health and Environment, Water Quality Control Division, March 2019). Samples are collected with a Hess Sampler which is 13 inches in diameter and 16 inches tall with 500µm mesh. Three quantifiable Hess samples will be taken from riffle habitat at each of the sites. Each sample is taken from an area of similar size substrate and velocity (if possible) to avoid any bias from these physical parameters when making comparisons among sites.



Sample Collection with a Hess Sampler

Samples are collected with a Hess Sampler which is 13 inches in diameter and 16 inches tall with 500µm mesh. Three quantifiable Hess samples will be taken from riffle habitat at each of the sites. Each sample is taken from an area of similar size substrate and velocity (if possible) to avoid any bias from these physical parameters when making comparisons among sites.

Timberline Aquatics performs the macroinvertebrate analysis for all samples as follows:

- Identification and enumeration are done for the entire sample (i.e. all macroinvertebrates in the sample are counted).
- Macroinvertebrates are identified to the lowest practical taxonomic level consistent with the Operational Taxonomic Unit (OTU) developed by the Division, which consists of genus or species for mayflies, stoneflies, caddisflies, and many dipterans. Chironomidae will be identified to the genus level.
- As part of the quality control protocols, all sorted macroinvertebrate samples and approximately 10% of identifications are checked by another qualified taxonomist.

Assessment Metrics

The LBD macroinvertebrate data is assessed by looking at a set of 13 metrics or biological indicators. Together, these metrics provide the information needed to best meet the objectives of the program. Six of the 13 metrics are considered key measurable indicators; these have vetted thresholds that demonstrate whether the community is healthy or stressed. Table 10 provides a description of each of the metrics.

Table 11 shows the key measurable indicators and which metrics apply to each of the specific program objectives.

Reporting

Data analysis will be completed by the end of 2023, and a final report will be provided to LBD in early 2024.

Table 10 – Timberline Aquatics Reported Metrics and Description

Metric	Description
Multi-Metric Index (MMI)*	Colorado WQCD assessment tool. Provides a score from 0-100 which determines general health of aquatic community. A value for an acceptable score varies and is dependent on what ecoregion a site is located in. MMI is sensitive to a variety of pollutants and stressors.
Ephemeroptera Plecoptera Trichoptera (EPT)*	Richness of distinguishable taxa in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These are the most sensitive taxa in zones that transition from pristine to anthropogenic. Sensitive to many pollutants. EPT values below 20 can indicate stressors including nutrients.
Hilsenhoff Biotic Index (HBI)*	Indicator of nutrient enrichment as well as other stressors. A widely used indicator of organic pollution. High values of the index indicate a predominance of tolerant organisms (i.e., the sensitive species have been lost). Values range from 0-10 and increase as water quality decreases. Auxiliary MMI metric.
Shannon Diversity (SDI)*	Indicator of macroinvertebrate community structure and balance. Does not account for tolerance. Typical values range from 3-4, values less than 1 indicate poor water quality. Auxiliary MMI metric.
Tolerance Indicator Value (TIV_{sed})*	A biological indicator of impacts by excess fine sediments. The TIV _{sed} reflects both the reduction in relative abundance of sediment-sensitive taxa and the increase in relative abundance of sediment-tolerant taxa.
% Chironomidae (Midges)	Percent composition of chironomidae taxa. Chironomidae are tolerant to stress, a high score indicates a stressed environment. High percentage can indicate higher nutrients and sedimentation.
% EPT excluding Baetis	Percent composition of EPT taxa. These are the most sensitive taxa in zones that transition from pristine to anthropogenic. Baetis not included because they have a higher tolerance value and can skew results. Sensitive to many pollutants.
% Intolerant Taxa	% composition of intolerant taxa.
% Tolerant Taxa	% composition of tolerant taxa. Based on tolerance values of 7 or greater.
% Hydropsychidae of Trichoptera	% Trichoptera (caddisfly) that is of the family-level Hydropsychidae. Tolerance values range from 2-5. Fine sediment can interfere with feeding. Sensitive to ammonia. May be good fish food.
Total Taxa Richness	Total number of identifiable taxa, indicator of general community health and stability. Sensitive to metals.
Pteronarcys Californica Density	Pteronarcys Californica abundance, mean number per square meter.
Total Density	Macroinvertebrate abundance mean number per square meter. Useful when paired with other metrics.

*Key Measurable Indicator

Table 11 - Metric and Objectives

Metric	Key Measurable Indicator	Assess General Health	Monitor Trends and Changes	Restoration Assessment	Regulatory Compliance	Pollutant Specific	Support Fisheries
MMI	X	X	X	X	X	X	X
EPT	X		X	X		X	X
HBI	X	X	X	X	X	X	
Shannon Diversity	X	X	X	X	X		X
TIV	X		X	X	X	X	
% Chironomidae		X	X	X		X	
% EPT excluding Baetis		X	X	X		X	
% Intolerant Taxa		X	X	X		X	
% Tolerant Taxa		X	X	X		X	
% Hydropsychidae of Trichoptera			X			X	
Total Taxa Richness		X	X	X		X	
Pteronarcys Californica Density			X	X			X
Total Density			X	X			X

Funding

Costs for the 2023 macroinvertebrate monitoring will be shared among some LBD partners. The partners each pay a percentage of the total cost. The cost distribution for 2023 is:

LBD Partner	Contribution %
Grand County	25%
Denver Water	25%
Northern Water/Subdistrict	25%
River District	8.3%
TU	8.3%
LBD	8.3%

In addition, Denver Water will fund 50% of the monitoring costs for three sites on William Fork that are associated with their restoration projects (WF-5.5, WF-2 and WF-0.5). The remaining costs at these five sites will be covered by the LBD partners at their respective contribution percentage.

2023 303(d) Evaluation List and Monitoring Plan

The Upper Colorado River Basin was included in the 2023 listing cycle and there are changes to the 303(d) List and Monitoring Plan this year. LBD evaluates impairments identified in Regulation #93 – Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation (M&E) List (Colorado Department of Public Health and Environment, Water Quality Control Commission, Reg #93, 2023⁴) within the CEA. LBD strives to monitor segments with known impairments.

Regulation #93 consists of three components:

1. The list of Water-Quality-Limited Segments Requiring total maximum daily loads (TMDLs) fulfills section 303(d) requirements of the federal Clean Water Act. Which requires states to submit to the U.S. Environmental Protection Agency a list of those waters for which technology-based effluent limitations and other required controls are not stringent enough to implement water quality standards.
2. Colorado's Monitoring and Evaluation List identifies water bodies where there is reason to suspect water quality problems, except when there is uncertainty regarding one or more factors, such as the representative nature of the data. For example, suppose It is unclear whether the cause of impairment is attributable to pollutants instead of pollution in impaired water bodies. In that case, they go on the Monitoring and Evaluation List. The Monitoring and Evaluation (M & E) list is a state-only document not subject to EPA approval.
3. The list of Water-Quality-Limited Segments Not Requiring a TMDL identifies segments where data indicates at least one classified use is not supported, but a TMDL is not needed.

The objectives of the 303(d) Monitoring Program are to:

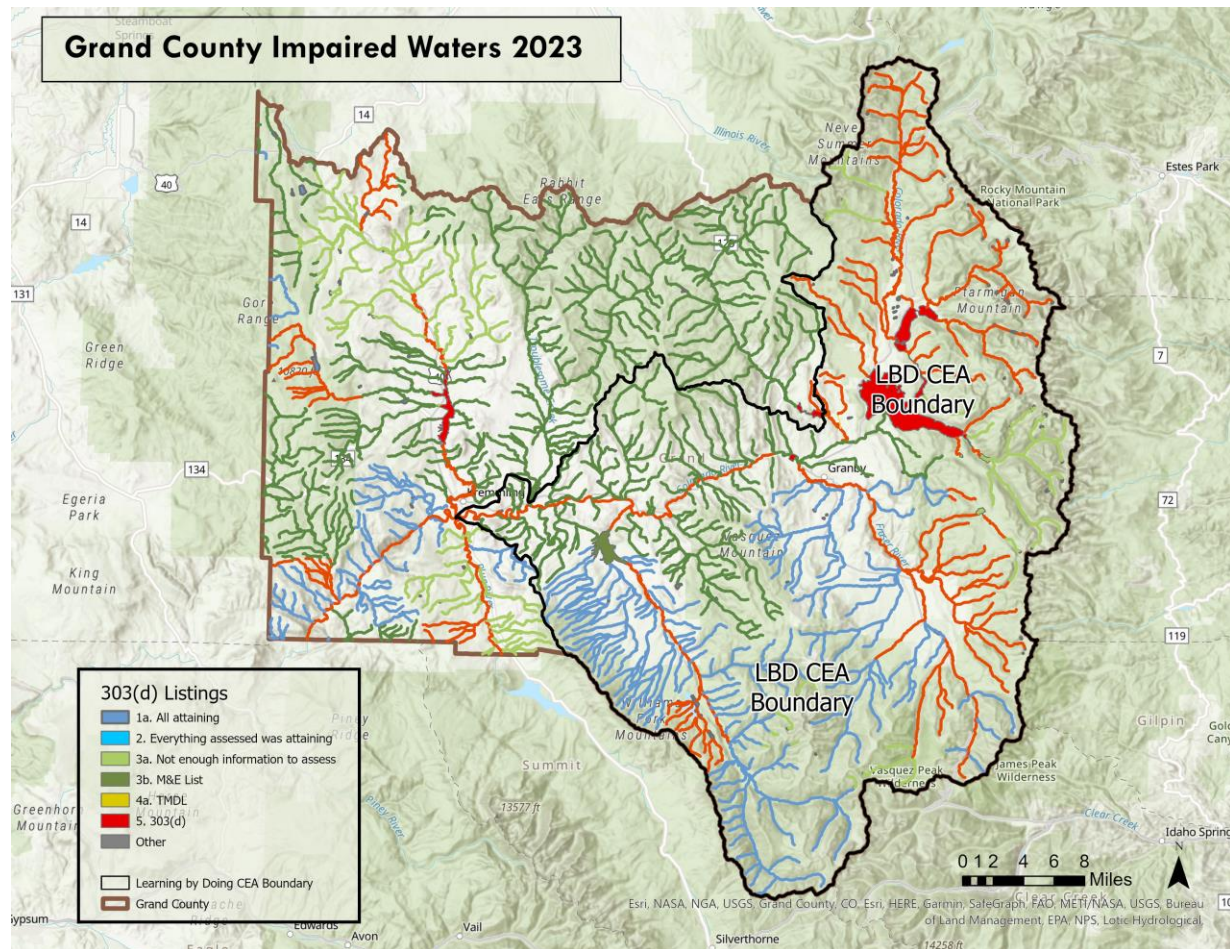
- Evaluate the current 303(d), and M&E listed water bodies within the CEA;
- Evaluate current water quality sampling programs of various agencies to determine if 303(d) listed waters are being monitored appropriately;
- Develop a monitoring plan for segments that are determined to need additional sampling.

2023 Review of Impaired Segments

In June 2023, the Water Quality Control Commission adopted the most recent version of Regulation #93, which became effective on July 24, 2023. The recently adopted 303(d) and M&E list shows seventeen stream segments listed as impaired within Grand County; Ten of these segments, COUCUC01, COUCUC02, COUCUC03, COUCUC05, COUCUC06b, COUCUC08, COUCUC10a, COUCUC10c, and six water bodies in segments COUCUC12 and COUCUC13 are located within the LBD CEA. The impaired uses of the twelve listed segments within the LBD CEA include Recreation, Water Supply

and Aquatic Life Use. The primary analytes of concern are arsenic (total), E. coli, Copper (dissolved), Iron, Manganese, Silver, Zinc, stream/lake/reservoir temperature, fish (mercury) and macroinvertebrates. In addition, there are two new listings within the CEA for lake/reservoir temperature. These changes are detailed below.

In regards to arsenic, it is worth noting arsenic is a national/statewide water quality issue. Arsenic is a naturally occurring, toxic element found in soil, bedrock, and water. Arsenic is colorless and odorless as well as a known carcinogen. Arsenic regulation at the federal level is under multiple agencies and seven different acts, including two associated with the Colorado Department of Public Health and Environment.⁵ In 2013, Colorado implemented a significant update to the arsenic water quality standards. These standards have led to some interesting and costly regulatory compliance solutions in Colorado. Unfortunately, at this time, there are no feasible treatment processes available to effectively treatment stream segments for arsenic.⁶



Grand County Impaired Waters.



Below is a detailed breakdown of the listed segment portions, analytes, and listing classifications:

Segment & Portion	LBD Monitoring Sites	Affected Use	2023 Impairments
COUCUC01_A Mainstem of the Colorado River, including all tributaries and wetlands within or flowing into Rocky Mountain National Park.		Aquatic Life Use	<u>303(d) List:</u> Zinc (Dissolved)
COUCUC02_C Colorado River from Shadow Mountain Reservoir to Granby Reservoir	CR-44.6 CR-43.5	Aquatic Life Use	<u>M&E List:</u> Copper (Dissolved) <u>303(d) List:</u> Temperature
		Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC02_D Mainstem of North Inlet from Tonahutu Creek to Grand Lake	NI-0.1	Aquatic Life Use	<u>M&E List:</u> Zinc (Dissolved), Silver (Dissolved) <u>303(d) List:</u> Copper (Dissolved)
		Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC02_E Mainstem of East Inlet	EI-0.1	Aquatic Life Use	<u>M&E List:</u> Zinc (Dissolved), Silver (Dissolved) <u>303(d) List:</u> Copper (Dissolved)
		Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC02_F Mainstem of the Colorado River, including all tributaries and wetlands within, or flowing into Arapahoe National Recreation Area. Except for Willow, Stillwater, Arapaho Creeks, East Inlet, North Inlet, Roaring Fork, and the Colorado River from Shadow Mountain Reservoir to Granby Reservoir.	NF-0.1	Aquatic Life Use	<u>M&E List:</u> Temperature
		Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC02_I Arapaho Creek downstream of Monarch Lake	AC-0.6	Aquatic Life Use	<u>M&E List:</u> Silver (Dissolved) <u>303(d) List:</u> Temperature
		Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC02_K Willow Creek, including all tributaries and wetlands, from the National Forest boundary to a point immediately upstream of Willow Creek Reservoir.	CLU-0.7 CLU-0 WC-6.3	Aquatic Life Use	<u>M&E List:</u> Temperature
COUCUC02_L Stillwater Creek, including its tributaries and wetlands, within or flowing into Arapahoe Recreation Area.	ST-0	Aquatic Life Use	<u>303(d) List:</u> Temperature
		Water Supply Use	<u>M&E List:</u> Iron (Dissolved) <u>303(d) List:</u> Arsenic (Total), Manganese (Dissolved)
COUCUC02_M Roaring Fork Arapaho Creek from Indian Peaks Wilderness to Lake Granby	RF-0	Aquatic Life Use	<u>M&E List:</u> Copper (Dissolved) <u>303(d) List:</u> Macroinvertebrates
		Water Supply Use	<u>M&E List:</u> Arsenic (Total)

Segment & Portion	LBD Monitoring Sites	Affected Use	2023 Impairments
COUCUC03_A Colorado River from outlet of Lake Granby to Windy Gap Reservoir	CR-38.3 CR-35.8 CR-34.7 CR-32.1 CR-31 CR-30.8	Water Supply Use	<u>M&E List:</u> Arsenic (Total)
COUCUC03_B Colorado River from Windy Gap Reservoir to 578 Road Bridge	CR-29.8	Water Supply Use	<u>M&E List:</u> Arsenic (Total)
COUCUC03_C Colorado River from 578 Road Bridge to Gore Canyon	CR-28.7 CR-27.5 CR-24.9 CR-23.5 CR-22.9 CR-22.7 CR-22.1 CR-21.9 CR-19.8 CR-18.4 CR-16.7 CR-14.9 CR-13.7 CR-12.6 CR-9.1 CR-7.4 CR-2.3 CR-1.7	Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
		Aquatic Life Use	<u>303(d) List:</u> Temperature
COUCUC05_B Mainstem of Willow Creek from the outlet of Willow Creek Reservoir to the confluence with the Colorado River	WC-3.8 WC-2.3 WC-0.9 WC-0.5	Water Supply Use	<u>M&E List:</u> Arsenic (Total) <u>303(d) List:</u> Manganese (Dissolved)
COUCUC06b_A Mainstem of un-named tributary to Willow Creek from the headwaters to Willow Creek Reservoir Road		Aquatic Life Use	<u>303(d) List:</u> Nitrite
COUCUC06b_B Mainstem of un-named tributary to Willow Creek from the Willow Creek Reservoir Road to the confluence with Willow Creek	CH-0.5	Aquatic Life Use	<u>TMDL:</u> Ammonia
COUCUC08_B Mainstem of Williams Fork River below Kinney Creek	WF-19 WF-13.1 WF-5.5 WF-2 WF-0.5	Water Supply Use	<u>M&E List:</u> Arsenic (Total)
		Aquatic Life Use	<u>303(d) List:</u> Temperature
COUCUC08_C Ute Creek and its tributaries		Water Supply Use	<u>M&E List:</u> Arsenic (Total)
COUCUC10a_B Ranch Creek and its tributaries	RC-9 LCB-2.2 CB-0.6 RC-5.8 RC-5.1 RC-4.7 HC-0.5	Water Supply Use	<u>M&E List:</u> Iron (Dissolved)
		Aquatic Life Use	<u>303(d) List:</u> Temperature

Segment & Portion	LBD Monitoring Sites	Affected Use	2023 Impairments
	RC-1.1 MC-0.5		
COUCUC10a_D Vasquez Creek and its tributaries	VT-0 VC-4.3 VC-8 LVC-0.2 VC-0	Aquatic Life Use	<u>303(d) List:</u> Macroinvertebrates (Provisional)
COUCUC10a_G Saint Louis Creek below King Creek	STC-0	Aquatic Life Use	<u>303(d) List:</u> Temperature
COUCUC10c_A Fraser River from below the Hammond No 1 Ditch in Town of Fraser to Fraser Canyon near Tabernash.	FR-17.7 FR-16.9 FR-16.6 FR-15 FR-14	Recreational Use	<u>M&E List:</u> E.coli
		Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC10c_B Fraser River from Fraser Canyon near Tabernash to the Town of Granby	FR-12.4 FR-4.5 FR-5.5 FR-3.5	Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC10c_C From the Town of Granby to confluence with Colorado River	FR-1.9 FR-1.6 FR-0.1	Recreational Use	<u>M&E List:</u> E.coli
		Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC12_B Shadow Mountain Reservoir	SM-CHL SM-NOR2 SM-NW1 SM-MID SM-DAM	Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC12_C Lake Granby	GR-WES GR-DAM GR-EAS	Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
		Aquatic Life Use	<u>303(d) List:</u> Fish (Mercury)
COUCUC12_E Grand Lake	GL-WES GL-ATW GL-MID	Aquatic Life Use	<u>M&E List:</u> Fish (Mercury)
		Water Supply Use	<u>303(d) List:</u> Arsenic (Total)
COUCUC13_D Williams Fork Reservoir		Water Supply Use	<u>M&E List:</u> Arsenic (Total)
COUCUC13_E Windy Gap Reservoir	WG-DAM	Water Supply Use	<u>303(d) List:</u> Arsenic (Total)



2023 CPW Fish Monitoring Plan

In cooperation with LBD monitoring efforts, CPW plans to survey fish populations at the following locations in 2023. All fish survey activities are dependent upon flow and temperature conditions, as well as staff and volunteer availability.

Fraser River

Safeway – this site is surveyed annually and is the longest continuous data set on the Fraser River. Sampling will be conducted August 31st.

Fraser River Ranch. Sampling will be conducted September 5.

Kaibab Park, Town of Granby. Sampling will be conducted September 6.

Colorado River

Town of Granby property behind River Run RV Park on the Colorado River. Sampling will be conducted on two sites on October 3rd.

Willow Creek

One site will be surveyed in the East Troublesome burn area to monitor ongoing fire recovery.



2023 Riparian Area Monitoring Plans

Northern Water's Municipal Subdistrict Riparian Vegetation Monitoring

Condition 30 of the WGFP 1041 Permit requires the Subdistrict to prepare a monitoring plan to establish baseline conditions of riparian and wetland vegetation along the Colorado River from Windy Gap Reservoir downstream to the lower terminus of the Kemp-Breeze Wildlife Area, and on Willow Creek below Willow Creek Reservoir (Grand County, 2012).

The monitoring is being conducted by ERO. The primary objectives of the Riparian Vegetation Monitoring Plan are to:

- Obtain baseline data that describes the existing conditions of riparian vegetation and communities within the study area;
- Document the conditions of riparian vegetation and communities within the study area following the WGFP Project implementation.

The data generated as part of this monitoring plan can also be used to develop more specific management objectives to determine if conditions are being maintained, improved, or are declining. Based on the baseline and future monitoring data, management actions can be designed to meet management objectives. Monitoring for this study did occur in 2023.

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Appendix A – Monitoring Summary Table



Appendix B – List of Projects in the CEA
