A Comprehensive Study to Ensure Longevity and Health of the Capitol Creek Watershed

From native cutthroat and rainbow trout, to ranchers and rural residents, the Capitol Creek watershed is an essential resource for all who reside in the Capitol Creek basin. But, the watershed needs care to keep it healthy and thriving, especially in the face of regular use and climate change.

In order to determine water management solutions that preserve our way of life in the Capitol Creek Watershed, honor the basin's biodiversity, ranching heritage and shifting water needs, the Snowmass Capitol Creek Caucus conducted an investigation to examine the following questions:

How does water use in the basin alter stream hydrology?

How do those alterations impact the stream ecosystem?

How can we best manage basin water use to simultaneously support agricultural water demands and promote functional stream ecosystems?

These questions are being asked against a backdrop of urgent and accelerating calls for exploration of new ways to use and manage water, not only in the state of Colorado but across the entire Colorado River basin. The attention water use and management in the western U.S. is now regularly receiving in the national press illustrates the rapid ascent of the issue in popular discourse. Opportunity exists for stakeholders and water users in the Capitol Creek watershed to implement local solutions for meeting multiple use objectives of water. The list of potential solutions are not without hazard and their successful implementation will require close coordination among neighbors and water users. The exploration of potential projects and programs and the manner in which barriers to their implementation are addressed (and hopefully overcome) may, in turn, be instructive to stakeholders in other watersheds grappling with similar issues.

Areas of focus

The Snowmass and Capitol Creek watersheds drain a portion of the Elk Mountains in the south-central part of the Roaring Fork Watershed. Capitol Creek originates at Capitol Lake (11,560 feet). Capitol Creek has three tributaries. Nickelson Creek rises outside the Caucus boundary and is a perennial stream (flows year around). Lime Creek enters Capitol Creek downstream of Nickelson Creek. It is an intermittent stream (flows intermittently) and is dry most of the year. Little Elk Creek starts close to the Capitol Creek trailhead. It closely parallels Capitol Creek and enters Capitol Creek just below East Sopris Creek Road (Figure ES-1).

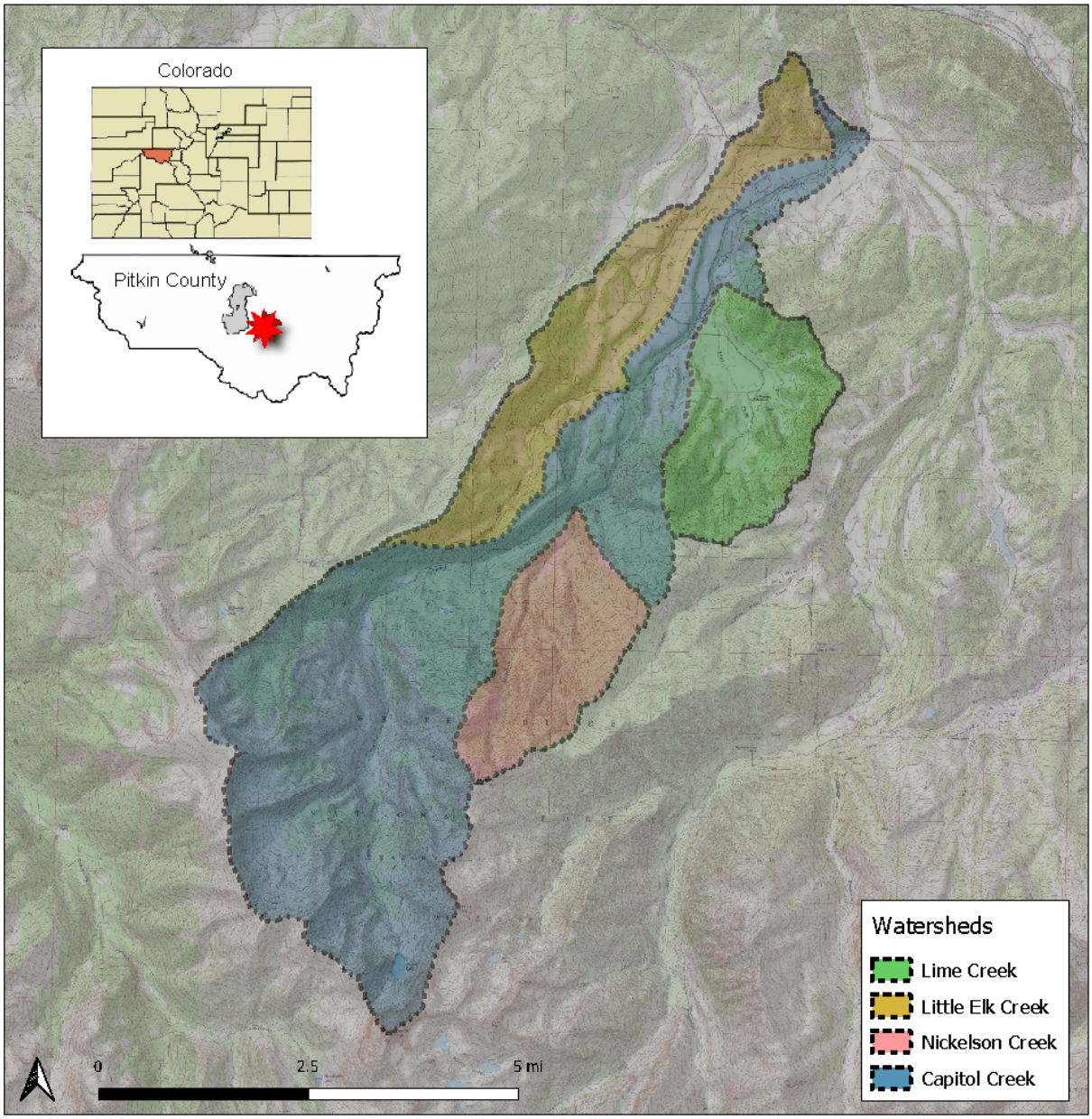
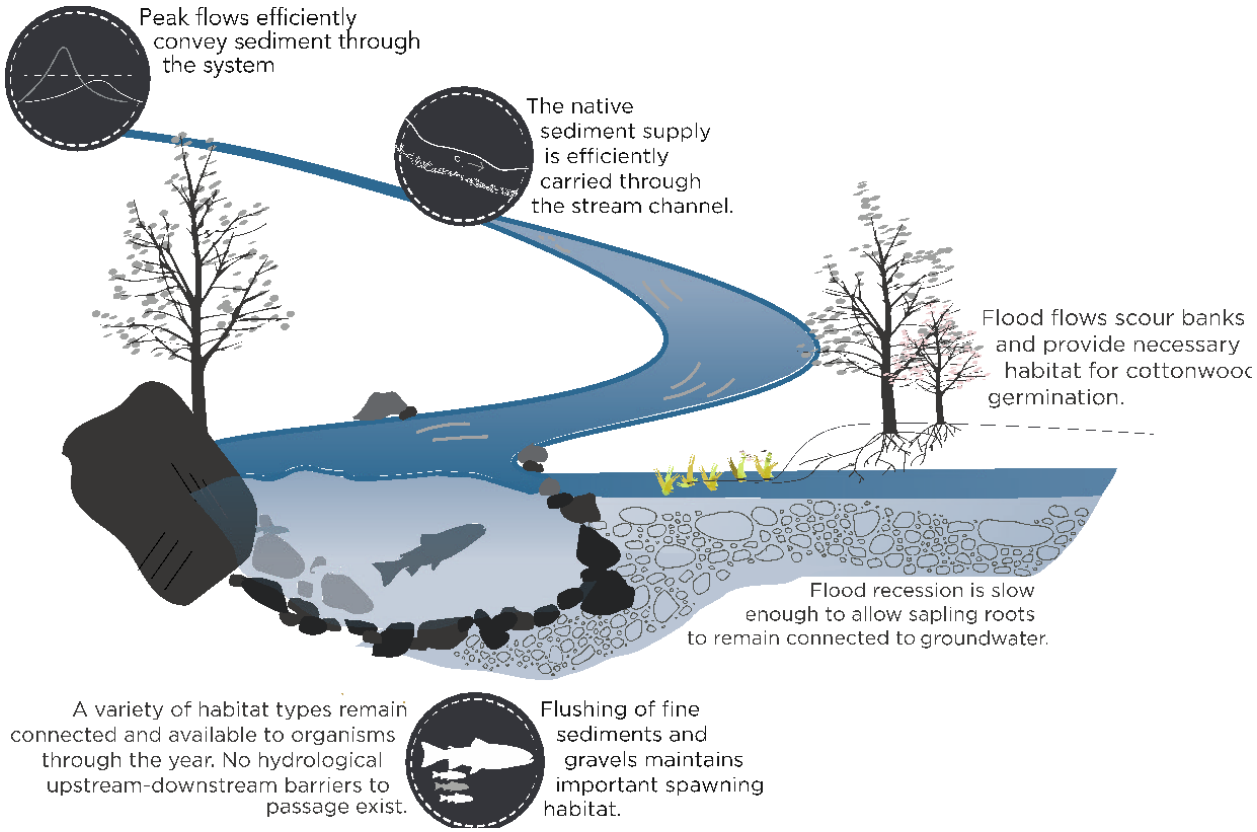


Figure ES-1. Location map of the project area.

Most of Capitol Creek's 12- mile length is upstream and outside of the Caucus boundary. This area is comprised of public land, most of which is designated as part of the Snowmass Maroon Bells wilderness. The lower third of Capitol Creek is within the Caucus area, flowing through modestly steep terrain and eventually to the valley floor which is subdivided into rural residential and agricultural use. Little Elk Creek and part of Gateway subdivisions are located in the lower watershed of Capitol Creek.

What makes a healthy watershed?

We look to patterns of streamflow, stream network connectivity, and water quality as important indicators of an ecosystem's ability to support fish and other species that rely on the waterways and riparian areas. Healthy watersheds in high elevation settings like Capitol Creek tend to exhibit relatively unaltered patterns of streamflow, vigorous riparian forests, and tend to be free of invasive species. Highly connected stream networks allow fish to find adequate habitat for feeding, spawning and other behaviors at different times of year or during drought periods. Riparian vegetation provides cover and shading for fish and other species—leaf litter falling into the stream is an important food source for aquatic insects. High spring peak flows flush fine sediment from the streambed and refresh spawning gravels for fish. Low flows are sufficient to support movement of animals throughout the stream network in the late summer through winter period. Many, but not all, of these characteristics are present on streams in the Capitol Creek watershed.



Primary challenges to ecosystem health in the Capitol Creek Watershed include aquatic habitat degradation, diminished stream network connectivity during some periods of the year, and competition/hybridization between native and non-native species. Conservation opportunities for native fishes in the Capitol Creek Watershed arise from addressing limitations: increasing or protecting flood and summer streamflows; protecting and restoring off-channel habitat; installing fish screens in diversions and providing for fish passage around diversions and low-head dams; managing non-native species; improving water quality; controlling or eliminating invasive fish species, and supporting native fish stocking efforts. Protections for riparian areas may be an important tool for limiting the potential for climate-change induced increases in stream temperature in the future that degrade habitat quality for native trout. Clearly, much can be done. The current focus of the Caucus is the impact of altered streamflow on ecosystem health.

Data for Supporting Local Decisions

The Caucus recently commissioned a study of existing and potential future streamflows along Capitol Creek and its tributaries. That effort entailed on-the-ground measurements and simulation modeling of natural inflows, administration of water rights, and human uses of water. Information generated by those assessment activities includes likely impacts to streamflow due to changing climatological conditions, changes in irrigated acreage, population growth, changes in land use, and potential future water conservation efforts. This approach aligns with the view of potential water futures articulated by the Technical Update to the Colorado Water Plan[1]. Specifically, the assessment yielded information on streamflows in Capitol Creek and its tributaries under the following scenarios:

Baseline – Current Conditions

Current irrigated acreages and irrigation practices
Historical IWR
Historical hydrology

Scenario A – Business as Usual

Slight reduction of irrigated acreage
Broad application of modest irrigation efficiency measures
Climate is similar to conditions in the 20th century

Scenario C – Cooperative Growth

Reduction of irrigated acreage
20% increase to Irrigation Water Requirement (IWR)
Population growth consistent with current forecasts
Increased water and energy conservation measures
Emergence of water saving technology
Moderate warming of the climate increasing water demands in all sectors

Scenario E – Hot Growth

Much warmer climate with significantly increased population

[1] https://cwcb.colorado.gov/colorado-water-plan/technical-update-to-the-plan

Rapid transition of agricultural lands to residential development
Reduction of irrigated acreage
Decline in streamflow and water supply in headwaters
31% increase to IWR climate factor

The modeling tools produced by the assessment can also be employed to simulate future streamflow conditions, both with and without implementation of local water conservation actions.

How do current water uses impact the watershed?

About a dozen irrigation ditches remove water from Capitol Creek between Capitol Falls ditch near the Capitol Creek trailhead and its confluence with Snowmass Creek (Figure ES-2). Water from area streams is applied to fields using sprinklers and flood irrigation. The water that is not used by corps returns to the creek as surface flow or percolates down along the soil column and flows underground to return to a stream some distance away. Many ditches along Capitol Creek export water out of the Capitol Creek watershed and into the Little Elk Creek watershed. Associated irrigation return flows do not return to Capitol Creek. Instead, they accrue to Little Elk Creek and/or Snowmass Creek. As a result, the full diversion amount in these ditches is lost to Capitol Creek along most of its length.

The impact of water uses on streamflows and the knock-on effects for ecosystem condition were considered through several lenses. Specific evaluations were provided, relating minimum streamflow needs to available streamflows under existing conditions and a range of potential future scenarios. Network connectivity was assessed in a similar manner. A review of historical water quality data helped identify potential connections between water use, stream temperature, and concentrations of constituents like selenium. These topics are discussed briefly below:

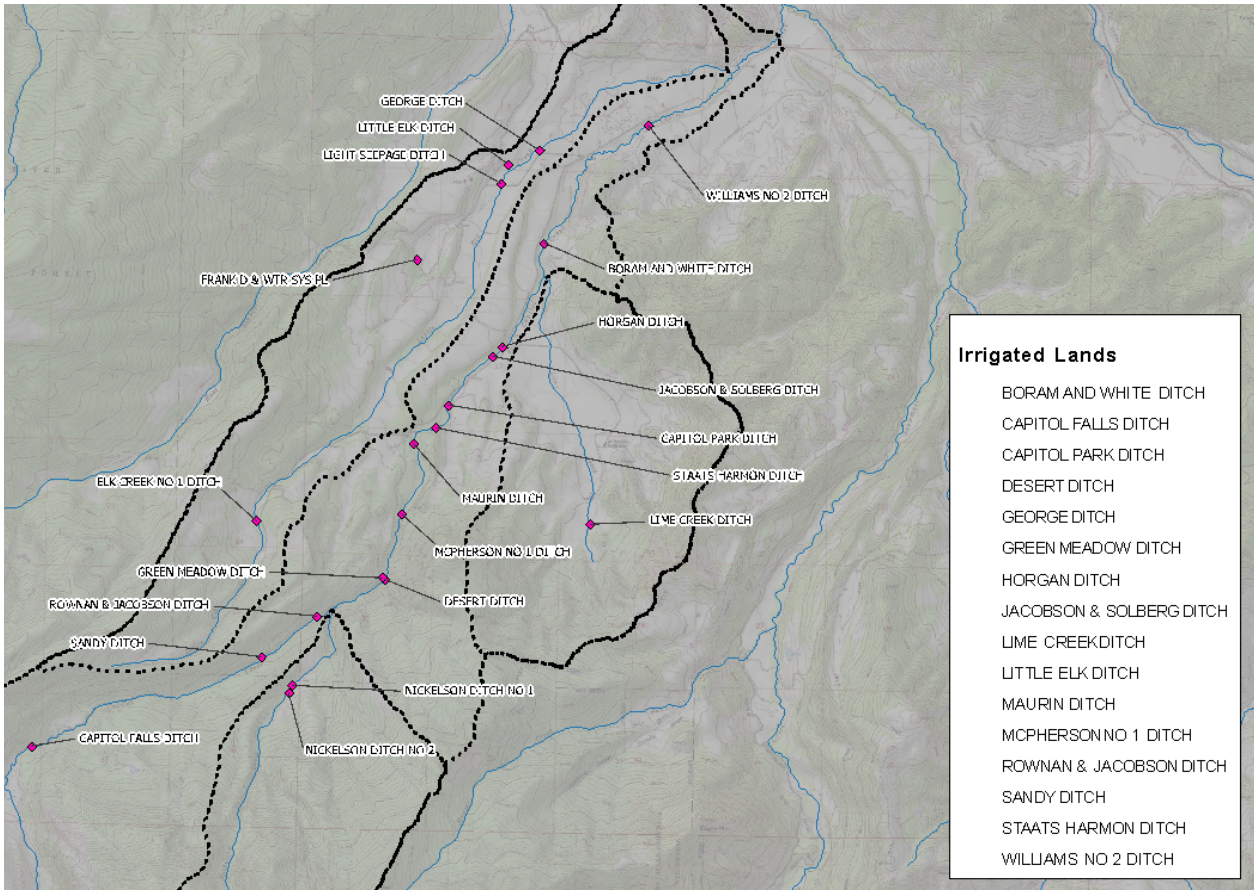


Figure ES-2. Map of irrigated parcels and associated diversion structures in the Capitol Creek watershed.

Minimum Streamflow

Perhaps you've noticed dry or trickling creeks between rain events in mid-late summer and early fall. In order to maintain a healthy aquatic ecosystem, Colorado Parks and Wildlife and the Colorado Water Conservation Board indicate that stream flows should stay at or above 10 cfs (cubic feet per second) during the late summer and fall months. This threshold defines the lower bound of acceptable habitat quality for fish and other aquatic species.

What we found:

The most notable impacts on low stream flows occur at the Capitol Park Ditch, Jacobson & Solberg Ditch and the Horgan Ditch, which divert water at an important section of Capitol Creek. Additionally, the Maurin Ditch depletes creek flows by up to 50% during the late summer months of typical years. Instream flow thresholds are met between 56% and 78% of the time on Capitol Creek under current conditions, depending on the location along the stream corridor. The greatest streamflow deficits for aquatic life protection are expected to occur on the section of Capitol Creek below the Capitol Park Ditch (Table 1).

Table 1. Monthly streamflow percentiles for the month of August computed for each of the four modeled scenarios. 25th percentile flows reflect dry year types and 75th percentile flows reflect modestly wet year types. Heatmap colors indicate departures from the 10 cfs instream flow threshold with warmer colors indicating flows lower than 10 cfs and cooler colors indicating higher flows.

		Monthly Median Discharge (cfs)				
	Scenario	Minimum	25th Percentile	50th Percentile	75th Percentile	Maximum
Upstream of Capitol Creek and Nickelson Creek confluence	Baseline	14.01	23.25	29.98	43.74	124.28
	Scenario A	0.00	4.25	8.31	24.30	107.77
	Scenario C	0.00	0.00	0.67	3.08	31.72
	Scenario E	0.00	0.00	0.00	1.67	21.44
Upstream of Capitol Park Ditch	Baseline	4.63	6.30	11.05	26.31	108.31
	Scenario A	3.54	13.11	16.49	33.84	120.24
	Scenario C	3.20	5.87	8.01	11.27	39.64
	Scenario E	2.81	4.37	6.31	9.26	28.69
Downstream of Capitol Park Ditch	Baseline	0.00	1.52	5.85	22.49	101.69
	Scenario A	0.77	3.69	6.14	21.05	101.24
	Scenario C	3.00	4.89	5.95	7.01	29.25
	Scenario E	0.00	0.00	0.84	1.35	16.88
Downstream of Boram and White Ditch	Baseline	0.00	1.42	7.23	23.78	106.81
	Scenario A	3.42	12.48	15.89	33.07	119.48
	Scenario C	3.11	5.53	7.70	10.69	39.07
	Scenario E	2.74	4.23	6.05	8.76	28.10
Downstream of Capitol Creek and Little Elk Creek confluence	Baseline	4.29	11.23	15.77	33.22	119.35
	Scenario A	14.01	24.57	29.98	44.05	124.28
	Scenario C	10.82	17.12	21.83	26.85	51.90
	Scenario E	9.67	14.14	18.81	23.00	34.07
Upstream of Capitol Creek and Snowmass Creek confluence	Baseline	4.28	11.25	15.78	33.23	119.36
	Scenario A	4.60	8.80	10.31	24.99	107.86
	Scenario C	3.02	4.91	5.96	7.03	29.27
	Scenario E	4.62	5.38	6.15	6.33	20.03

Under climate change scenarios C and E, modeling indicates that the frequency of instream flows falling below 10 cfs increases at most locations above Little Elk Creek. For example, above the Capitol Park Ditch, a warming climate depletes flows in Capitol Creek so that the 10 cfs minimum flow threshold shifts from being met in average years to being met in only in the wettest 25% of years under both climate change scenarios. This pattern is reflected at most locations except below the Little Elk Creek confluence where the influence of irrigation return flows prop up late season flows.

What this means:
Managing flows for the benefit of aquatic ecosystems will likely require a consistent focus on the reaches of Capitol Creek below the Capitol Park Ditch, Boram and White Ditch, and Williams No. 2 Ditch under a range of existing and potential future hydrological scenarios.

Network Connectivity

The fractal-like structure of many streams in the Capitol Creek watershed is not just beautiful, it's important. A connected stream network refers not only to the streams themselves, but also the links

between streams and the landscapes surrounding them. Connectivity is often used as a proxy for resilience when thinking about ecosystem condition. While no scientifically-defined thresholds exist for describing minimum acceptable levels of stream network connectivity, maintaining or achieving a highly-connected stream corridor structure is often a worthwhile goal. Some notable exceptions do exist, however. Such is the case in Colorado waterways where a disconnected stream network may afford some protection for native fish populations against invasion from introduced sport fish or unmanaged invasive species.

Barriers to connectivity include both large and small channel spanning structures, push-up dams or other water delivery infrastructure, and culverts. Flow-depleted stream reaches too shallow for fish and other organisms to traverse, and natural features such as waterfalls or extended steep cascades as present barriers to longitudinal travel. The significance of different features varies by species. Some fish, such as brook and cutthroat trout, can ascend very steep and powerful headwaters reaches. Other species endemic to the larger rivers and tributaries may experience greater difficulty navigating around or through such obstacles.

What we found:
A field reconnaissance of potential barriers to passage along the Capitol Creek mainstem indicated that most structures probably do not entirely prohibit fish passage. Upstream pools created by existing diversions do provide some local habitat during low water periods and throughout the winter but the high number of structures on Capitol Creek probably does to limit the ability of aquatic organisms to easily transit through a reach. Generally, large channel-spanning structures create the largest impediment to passage.

What this means:
Fish passage projects should be pursued opportunistically in the watershed and any future upgrades to diversion structures should consider and incorporate aquatic organism passage design elements. Increasing connectivity along the mainstem of Capitol Creek in the fall months is expected to provide a modest benefit to spawning activities of the cold-water fish that traverse between Snowmass Creek and Capitol Creek.Protecting network connectivity on the smaller order streams high in the watershed will benefit cutthroat trout. It is important to note that increased connectivity between habitats within a stream network is not always desirable. Ensuring the long-term health and genetic purity of the existing cutthroat trout populations may require establishing or maintaining downstream barriers to passage (e.g. Capitol Falls) for other species like rainbow trout.

<u>Water Quality</u>
Much like humans, the fish, flora and other fauna who depend on the watershed need a certain standard of water quality to survive and thrive. Water temperature, dissolved oxygen concentrations, and impacts from selenium can all impact water quality on Capitol Creek. Data in the Capitol Creek watershed for the past 20 years provides a view of historical water quality conditions and helps identify potential linkages to water use and management.

What we found:
Historical dissolved oxygen (DO) levels observed on Capitol Creek at the confluence with Snowmass Creek fall within the water quality standard thresholds for aquatic life protection. One water temperature observation in July 2002 (a notably low flow year) fell above the chronic water

quality standard for aquatic life. Otherwise, water temperatures are generally within acceptable ranges for protection of fish.

Capitol Creek is on the 2018 Colorado 303(d) List and Monitoring and Evaluation List (M&E List) for selenium levels which likely degrade the health of the local fishery and/or limit use of the stream by resident fish in Snowmass Creek. Selenium exceedances were observed in several years in the March through October period and are likely related to groundwater irrigation return flows through the underlying Mancos Shale.

What this means:
Elevated selenium concentrations on lower Capitol Creek and, presumably, on Little Elk Creek likely degrade the health of the local fishery and/or limit use of the stream by resident fish in Snowmass Creek. Anticipated elevated selenium levels on Little Elk Creek make it of little value to aquatic species and, thus, maintaining streamflow levels in that creek should not be a management priority. The assumptions about selenium in Little Elk Creek can be verified through additional water quality monitoring. Use of more efficient irrigation water application methods may help reduce selenium concentrations in local streams in the future.

Opportunities for Local Action

Numerous project opportunities were identified throughout the Capitol Creek watershed that can help the Caucus advance its goal of promoting water management strategies that simultaneously meet diverse human and ecosystem needs. These opportunities primarily address the streamflow "pinch-points" identified by the assessment activities discussed above. All project ideas are intended to be voluntary, may be compensated, and can be designed to be responsive to the needs of the stream and the needs of the water user. They do not necessarily require state approval or oversight. Three project types are considered relevant to ongoing discussions about water use and management in the Capitol Creek watershed:

- New instream flow water right appropriations: Newer ISFs tend to be more nuanced, better representing seasonal and water availability variation. However, many users may not wish to invite additional state administration and oversight to Capitol Creek.

- Changes in points of diversion: combining points of diversions for several ditches, or moving points of diversion downstream to provide streamflow benefits without requiring a water user to reduce demand.

- Irrigation scheduling agreements: voluntary agreements to coordinate a water user's diversions with stream needs.

- Instream flow water transfers a willing seller or lessor may convert their water and priority into ISF water through an agreement with the State. Unlike less formal irrigation scheduling agreements, an ISF water transfer will shepherd water through a designated reach according to priority. These agreements too can be tailored to fit the creek and water user's needs.

Assessment activities also identified potential opportunities to restore streamflows below specific ditches. These opportunities are described to assist the community in understanding how alternative streamflow management might occur. Critically, these illustrative examples do not reflect an expressed willingness of

any party to move forward with any idea. Indeed, the first question in any further discussion of these opportunities is whether the water right holder is amenable to further study. Legal and technical due diligence also are critical for on any such projects. Example streamflow restoration projects that may be instructive in guiding ongoing discussions between local stakeholders include:

Monastery Reach

Water Right/ Diversion Structures: Capitol Park Ditch (mile 4.7), Jacobson & Solberg Ditch (mile 4.1), and
Horgan Ditch (mile 4.07)
Dry-up Point in Scenarios: Baseline, reduced flow in C
Return Flows: Accrue to Capitol Creek

Operations & Opportunities: The upstream three consecutive diversions may provide streamflow restoration opportunities. If operated in a coordinated manner, streamflow available, but not diverted, at Capitol Park Ditch could be bypassed at Jacobson & Solberg and Horgan, for benefits extending 1.5 miles to the Boram and White (mile 3.14). Moreover, an infrastructure and water rights evaluation could determine the efficacy, streamflow restoration benefit, expense, and cost-savings of combining two or more of these diversion into a single diversion system.

Maurin Ditch

Dry-up Point in Scenarios: None observed, but halves streamflow in Baseline Scenario.
Local Priorities: 160A, 204A
Senior Decreed Amount: 1.90 cfs
Return flows: Accrue to Capitol Creek

Operations & Opportunities: The Maurin Ditch's significant length means that return flows do not return to Capitol Creek for several miles. In the Baseline Scenario, Maurin Ditch's return flows return only above Williams No. 1 Ditch, creating a long, dewatered reach. Based on a preliminary site visit, it appears the Maurin Ditch could redirect return flows from its upper fields to Capitol Creek sooner, creating a restorative benefit to Capitol Creek between the new and historical point of return flows. One possible restoration opportunity would be to fully irrigate the property in the spring and early summer, and when streamflows begin to drop, cease irrigating the lower fields, and redirect upper field return flows back to the river at below the Horgan Ditch diversion.

Williams No. 2

Dry-up Point in Scenarios: Baseline, C, and E
Local Priorities: O1
Senior Decreed Amount: 6 cfs

Return Flows: Exported to Snowmass Creek

Operations & Opportunities: A mile and a half above Capitol Creek's confluence with Little Elk Creek, modeling shows that in August Williams No. 2 can divert all the streamflow remaining in Capitol Creek into the Snowmass Creek drainage. The Williams No. 2 is, therefore, a candidate for further study of streamflow restoration options. For instance, an irrigation scheduling agreement could be used to ensure a minimum flow is bypassed at Williams No. 2's headgate at critical times. Or, the ditch might be a candidate for an ISF water transfer, converting its senior priority (or a portion thereof) for instream flow use. Considerations to be further studied are:

- Although return flows might not be legally owed to Snowmass Creek because Williams No. 2 water is 'exported' under a formal transfer, what impacts would the reduction in irrigation and return flows have on Snowmass Creek?
- If Williams No. 2 reduced use without a transfer, would a junior upstream user increase diversions, exacerbating streamflow issues?
- Would upstream users agree to a Shoshone-style arrangement to honor the Williams No. 2's priority even at times when Williams No. 2 is bypassing water?

Boram and White

Dry-up Point in Scenarios: Baseline and C
Local Priorities: 9, 57
Senior Decreed Amount: 2.5 cfs
Return Flows: Exported to Little Elk. Very little use in Little Elk downstream of return flows.

Operations & Opportunities: The Boram and White Ditch holds the most senior water right on Capitol Creek, and a portion of its water has already been changed for augmentation uses. Modeling shows the ditch can divert all the physically available streamflow at certain streamflow levels, making the ditch a candidate for streamflow restoration projects, either a formal transfer or an irrigation scheduling agreement. The same considerations for the Williams Ditch No. 2 apply to the Boram and White as well. Opportunity may exist to partially satisfy the Boram and White demand with flows from Little Elk Creek at some times of the year. If an equal amount of water could be bypassed at the Capitol Creek headgate, some gains for aquatic ecosystems would accrue to the most impacted section of the stream.

- Although return flows might not be legally owed to Little Elk Creek because Boram and White water is 'exported', what impacts would the reduction in irrigation and return flows have on Little Elk Creek? The model shows very little water use in the Little Elk Creek below the Boram and White point of return flow. A review of the previous water court change cases may answer these questions.
- If Boram and White reduced use without a transfer, would a junior upstream user increase diversions, exacerbating streamflow issues?
- Would upstream users agree to a Shoshone-style arrangement to honor the Boram and White priority even at times when Williams No. 2 is bypassing water?