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Colorado Water Conservation Board
Department of Natural Resources

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TO: Colorado Water Conservation Board Members

FROM: Rob Viehl, Chief
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Stream and Lake Protection Section

DATE: May 21-22, 2025

SUBJECT: 10.d Proposed Acquisition of an Interest in the Shoshone Water Rights for Instream Flow Use on the Colorado River

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I. Staff Recommendation

Pursuant to instream flow Rule 6b, the Board's consideration of this proposal at this meeting will initiate the 120-day period for Board review. **No formal action is required at this time.** Staff believe that this proposal for instream flow use is a valuable additional beneficial use of the historical Shoshone Power Plant water rights to preserve and improve the natural environment by restoring flows in the depleted reach of stream and improving river connectivity and habitat. This initial presentation of this proposal provides an opportunity for the Board and the public to identify questions or concerns that Staff and project partners can address at this or a subsequent meeting. Ultimately, the Board will be required to evaluate the appropriateness of the acquisition and, if accepted, to determine how best to utilize the acquired water to preserve and improve the natural environment, which will be subject to any terms and conditions imposed by the final change of water right decree.

II. Background

The proposed acquisition represents a rare opportunity for an important public-private partnership regarding operation of a large water right that has been, and will continue to be, important to most of the major water providers and water users in both the west slope and east slope of Colorado. This opportunity has come to CWCB after several decades of discussions and considerations of various options (both temporary and permanent) for managing the situation if the Shoshone Power Plant ceases to generate hydropower, and thus ceases use of the water rights. The Shoshone Water Rights, although physically impacting a relatively short reach of stream, because of its magnitude and location of operation can have an effect on a large part of the entire state of Colorado. Because of the magnitude of potential impacts, project partners are dedicated to maintaining river operations upon which water users statewide have historically relied and planned. Project partners will continue to

coordinate with the many other statewide water users during the water court process to ensure non-injury to other water rights, as is required by Colorado water law.

(1) Key Drivers of Colorado River Administration

A number of features drive the complex administration of the Colorado River within the state of Colorado. Multiple transmountain water diversions (TMDs) divert an average of nearly 500,000 acre-feet from the Colorado River and its tributaries on the "west slope" for front-range uses on the "east slope". The large **upstream** TMDs include: Adams Tunnel (Colorado-Big Thompson and Windy Gap projects managed by USBR and Northern Water); Robert's Tunnel (Denver Water); Moffat Tunnel (Denver Water); and Homestake Tunnel (Aurora and Colorado Springs). The large **downstream** TMDs include: Boustead Tunnel (Fry-Ark Project managed by SEWCD, CPW, and USFS); and Twin Lakes Tunnel (Twin Lakes Canal Company). In addition to the large TMDs, several large reservoirs are used to store water for east slope use, to replace east slope uses on the west slope, or as compensatory water for west slope use. The large **upstream** reservoirs include: the four reservoirs of the Colorado Big Thompson project (Lake Granby, Shadow Mountain Reservoir, Grand Lake, and Willow Creek Reservoir); Windy Gap Reservoir; Dillon Reservoir; Green Mountain Reservoir; Williams Fork Reservoir; Wolford Mountain Reservoir; and Homestake Reservoir. The main **downstream** reservoir is: Ruedi Reservoir. See the maps at **Enclosure A**. The large and dominant calling water rights are the Shoshone Water Rights (described below in **Section II (2))**, and the Cameo water rights demand for Grand Valley irrigators.

(2) State-based Planning and Management Efforts

State-funded planning efforts and processes have identified permanent protection of the Shoshone water rights as critical to the Colorado River. The Colorado Basin Roundtable's Basin Implementation Plan[1] states that, "Protecting the Shoshone Hydroelectric Plant [water rights], Grand Valley irrigators' water rights (Cameo Call), and the 15-Mile Reach are vital to both consumptive and nonconsumptive needs." It encourages all entities to "work together to ensure the Shoshone Hydroelectric Plant water rights are maintained in perpetuity to ensure downstream water deliveries are made." The Upper Colorado Wild and Scenic Alternative Management Plan[2] (W&S Plan) is a state-supported effort to develop an alternative to a Wild and Scenic designation to protect the Outstandingly Remarkable Values (ORVs) in the Colorado River from the confluence with the Blue River downstream to a location near No Name Creek, just downstream of Shoshone. This stakeholder-led plan, formally federally adopted in 2015, identifies the Shoshone and Cameo Water Rights as long-term protective measures that are "expected to provide significant protection of the ORVs." ORVs include

[1] Colorado Basin Implementation Plan, Volume 1, January 2022, https://dnrweblink.state.co.us/cwcbsearch/0/edoc/216707/Colorado_BIP_Volume1_2022.pdf

[2] Amended and Restated Upper Colorado River Wild and Scenic Stakeholder Group Management Plan, Adopted January 2012, Amended and Restated June 2020 Last revised July 2024 https://www.upcowildandscenic.com/uploads/1/3/5/3/135388668/amended_and_restated_sg_plan_july_2024.pdf

scenic, recreational fishing, recreational float-boating, geological, wildlife, historical, and paleontological values. According to the W&S Plan, the administrative call from these water rights "generally results in stream flow through the subject stream segments in amounts greater than would exist in the absence of the administrative call." Lastly, the Middle Colorado River Integrated Water Management Plan[3] (2021), which evaluated the Colorado River from Glenwood Canyon to De Beque Canyon, identified securing the permanent acquisition of the Shoshone Water Rights with the addition of an instream flow use as an important action that can benefit irrigation, municipal, recreational, and environmental interests.

III. The Proposal

The Colorado River Water Conservation District ("River District") and Public Service Company of Colorado ("PSCo") have offered to the Colorado Water Conservation Board ("CWCB") an interest in the Shoshone Water Rights for instream flow ("ISF") purposes on the mainstem of the Colorado River in Glenwood Canyon. See the maps at **Enclosure A,** the offer letter at **Enclosure B**. The Shoshone Water Rights are decreed for non-consumptive hydropower generation use at the Shoshone Hydroelectric Power Plant, currently owned by PSCo, a subsidiary of Xcel Energy. Through a December 2023 Purchase and Sale Agreement ("PSA), the River District agreed to purchase, and PSCo agreed to sell, the Shoshone Water Rights, so long as the water rights will be used for instream flow purposes to the extent they are not being used for power generation, contingent on a number of conditions including a PSCo lease for continued hydroelectric power generation while the power plant remains operable.

Under this proposal, the River District would purchase and maintain ownership of the water rights, while CWCB would hold perpetual ISF use rights, and PSCo would hold a lease for hydropower use. See draft ISF Agreement as **Enclosure C**. The Shoshone Water Rights offered to CWCB total 1,408 cfs, comprised of the Senior Shoshone Water Right in the amount of 1,250 cfs, and the Junior Shoshone Water Right in the amount of 158 cfs, (together, the "Shoshone Water Rights"), as further described below in **Section VI**. The CWCB would use these water rights, pursuant to their individual priorities, in the combined amount of up to 1,408 cfs, as recommended by Colorado Parks and Wildlife (see CPW recommendation as **Enclosure D**), to preserve and improve the natural environment to a reasonable degree in a 2.4 mile reach of the Colorado River between the Shoshone Power Diversion Dam and Tunnel and the Shoshone Power Plant Discharge Outlets ("Shoshone Reach"), as shown on the maps at **Enclosure A**.

To effectuate the proposal, a joint water court application will be required, in which CWCB, PSCo, and the River District will be co-applicants. In the water court application, the co-applicants will request a change of the beneficial use of the water rights to add instream flow use by the CWCB when the rights are not being used, or only partially being used, to generate hydropower. See draft water court application, as **Enclosure E.** The River District's proposed

[3] Middle Colorado River Integrated Water Management Plan, 2021
https://www.midcowatershed.org/iwmp

dedication of the exclusive right to use the Shoshone Water Rights for instream flow purposes to the CWCB is in accordance with section 37-92-102(3), C.R.S., and the Rules Concerning the Colorado Instream Flow and Natural Lake Level Program, 2 CCR 408-2 ("ISF Rules").

IV. The Board's ISF Acquisition Procedures

ISF Rule 6 governs the Board's procedures to acquire water for ISF use. ISF Rule 6b gives the Board 120 days from the Board's first consideration of the proposed acquisition to determine what terms and conditions it will accept in an acquisition agreement for an interest in water to preserve and improve the natural environment. ISF Rule 6 requires a minimum of two Board meetings to allow for public input prior to taking final action on a proposed acquisition. The Board's initial consideration of this proposal at its May 2025 meeting initiates the 120-day time period for the Board to consider the proposed acquisition. ISF Rule 6e requires the Board to evaluate the appropriateness of the acquisition and, if accepted, to determine how best to utilize the acquired water to preserve or improve the natural environment. ISF Rule 6e lists several factors the Board shall consider in its evaluation of the acquisition, which are addressed in **Section VIII** of this memo.

The Board can take final action on the proposal at the following Board meeting in July 2025. However, ISF Rule 6m(4) provides that any person may request the Board to hold a hearing on the proposed acquisition, so long as such request is filed within 20 days after the first consideration, which is this May 2025 Board meeting. In the event a hearing is requested, the Board will need to take action to consider the request, and if granted, to appoint a Hearing Officer and schedule a hearing to occur within 120 days of this first consideration. Such hearing and final decision on the proposal could occur at the Board meeting in September 2025.

The Board can accept several types of ISF acquisitions for water, water rights, or interests in water, for various durations including temporary, long-term, and permanent acquisitions. Two different statutes govern the required processes after CWCB approval: (a) permanent acquisitions fall under 37-92-102(3) C.R.S., which operate under the jurisdiction of the Water Court; and (b) temporary loan acquisitions fall under 37-83-105 C.R.S., which operate under the jurisdiction of the Division of Water Resources. This proposal is for a permanent acquisition of an interest in water under 37-92-102(3) that requires judicial action by the water court to allow a new beneficial use under Colorado water rights law. The Board can accept the interest in the water right, but the water right must be changed in water court to allow the additional ISF use under a final decree before the ISF use can occur. Acceptance of the full decreed amount by the CWCB Board is essential so that the full decreed water right may be changed in water court; however, the future use of the Shoshone Water Right shall be subject to any terms and conditions imposed by the change of water right final water court decree. See generally 37-92-305(3) C.R.S. (regarding changes of water rights by the water courts). The water court process is required, as a standard procedure under the Water Rights and Determination Act of 1969, 37-92-101 C.R.S. ("the 1969 Act"), and so long as proper

notice is given, the water court shall have jurisdiction over all parties affected thereby, whether or not they chose to appear.

As required by statutes and regulations, CWCB staff has provided proper notice and requests for recommendations regarding this proposal. CWCB staff has requested recommendations from the Colorado Division of Parks and Wildlife (CPW), the U.S. Department of Agriculture, and the U.S. Department of Interior. Pursuant to ISF Rule 6m(1), CWCB staff has provided notice of the proposed acquisition to all persons on the appropriate ISF Subscription Mailing Lists and provided notice to the State Engineer's Substitute Supply Plan Notification List for Water Division 5.

V. The Board Actions to Date

In response to the River District's September 2023 application to the CWCB for a Non-Reimbursable Investment Project seeking funding toward the purchase of the water rights associated with the Shoshone Power Plant, on January 25, 2024, the CWCB held a virtual workshop. At the workshop, presentations and discussions on the Shoshone Water Right Permanency Project included reviews of agreements and the ISF acquisition process with a general timeline. Board action followed during the January 29, 2024 CWCB Board meeting, in which the CWCB Board unanimously approved the request to partially fund the River District's purchase of the Shoshone Hydro Plant water rights. The 2024 Project's Bill (HB 24-1435) Section 14(2), states:

> (2) (a) For the 2024-25 state fiscal year, $20,000,000 is appropriated to the department of natural resources for use by the Colorado water conservation board. This appropriation is from the Colorado water conservation board construction fund created in section 37-60-121, C.R.S. To implement this subsection (2)(a), the Colorado water conservation board may use this appropriation to partner with the Colorado river water conservation district in the purchase of the water rights owned by the public service company of Colorado and currently used for the operation of the Shoshone power plant. The Colorado water conservation board shall vote to release the money to the Colorado river water conservation district after confirming that the closing conditions of the purchase and sale agreement between the Colorado river water conservation district and the public service company of Colorado have been met.
>
> (b) The money appropriated in subsection (2)(a) of this section remains available for the designated purposes until June 30, 2031.

VI. The Shoshone Water Rights

The Shoshone Water Rights are currently used as decreed, for power generation by PSCo at the hydroelectric power plant (the "Shoshone Power Plant") located on the mainstem of the Colorado River in Glenwood Canyon, approximately six miles upstream of the City of

Glenwood Springs. The Shoshone Power Plant produces hydroelectric energy by means of PSCo's diversion of the Shoshone Water Rights (consisting of the 1905 senior priority water right in the amount of 1,250 cfs, and a 1940 junior priority water right in the amount of 158 cfs), further described as follows:

(i) The Glenwood Power Canal and Pipeline water right, decreed on December 9, 1907, in Civil Action No. 466, Eagle County District Court, in the amount of 1,250 cfs with an appropriation date of January 7, 1902, for power, mining, milling, manufacturing, lighting, heating, and traction purposes; and as decreed absolute by the Eagle County District Court on February 27, 1911, in Civil Action No. 553 (the "Senior Shoshone Water Right"); and

(ii) The Shoshone Hydro Plant Diversion No. 2 water right, decreed absolute on February 7, 1956, in Civil Action No. 1123, Eagle County District Court, in the amount of 158 cfs, with an appropriation date of May 15, 1929, for manufacturing and generation of electrical energy (the "Junior Shoshone Water Right").

See Shoshone decrees as **Attachment 2 to Enclosure F.** The water diverted by PSCo for hydropower generation use is returned to the Colorado River after such water is conveyed through the Shoshone Power Plant's penstocks and turbines to the river at the plant's discharge outlets, approximately 2.4 miles downstream of the point of diversion at the Shoshone Diversion Dam and Tunnel, as depicted on the maps attached as **Enclosure A**.

Administration and measurement of the Shoshone Water Rights has historically occurred using the streamflow gauge (USGS 09070500) located on the Colorado River near Dotsero, Colorado ("Dotsero Gage"). Consistent with historical administration, the "Natural Flow" is the amount of water in the Colorado River measured at the Dotsero Gage, including the amount of water usable under by the Shoshone Water Rights when those water rights are in priority, except that the Natural Flow does not include any water released from storage and conducted into the Colorado River upstream of the Dotsero Gage (accounting for evaporation and transit loss), which water is intended for delivery for use downstream of the discharge outlets for the Shoshone Power Plant.

VII. Summary of Proposed ISF Use

Under this proposal, CWCB would enter into a Water Right Dedication and ISF Agreement ("ISF Agreement") with the River District and PSCo, which dedicates to CWCB a perpetual ISF use of the Shoshone Water Rights. See draft ISF Agreement as **Enclosure C**. Pursuant to the PSA between the River District and PSCo, with an effective date of January 1, 2024, the River District is the contract purchaser of the Shoshone Water Rights. The PSA provides that PSCo, and its successors and assigns, is entitled to a leasehold interest in the Shoshone Water Rights for continued use of the Shoshone Water Rights for hydropower generation at the Shoshone Power Plant. See the "Lease," the form of which is attached to the PSA at **Attachment 3 to Enclosure F**.

CWCB would apply its acquired exclusive right for ISF use in the Shoshone Reach through approximately 2.4 miles on the Colorado River. The ISF use serves to preserve and improve the natural environment to a reasonable degree using the acquired interest in the Shoshone Water Rights for a combined rate of ***up to*** 1,408 cfs (under the 1902 senior right of 1250 cfs, and the 1929 junior right of 158 cfs), as further described above in **Section VI**. The water rights would retain their original individual priority dates with respect to water rights administration. Downstream of the Shoshone Reach, the return flows from use of the Shoshone Water Rights become part of the natural stream flow in the Colorado River and are available for appropriation and use by water rights holders. The CWCB would accept the proposed interest in the full decreed amount of the Shoshone Water Rights, which ISF use will then be subsequently limited by any terms and conditions imposed by the change of water right final water court decree, as required to prevent injury to other water users, both upstream and downstream of the Shoshone Reach. CPW analysis indicates that the best use of the acquired water rights is to preserve and improve the natural environment in the Shoshone Reach of the Colorado River at any rate up to full decreed amount of 1,408 cfs, and that fish habitat will also be improved in the Shoshone Reach at streamflows up to at least 3,000 cfs. See CPW's recommendation letter and report as **Enclosure D**. CPW evaluated the higher flow rates partly because, at times, there has been, and will continue to be, other water in the stream, including shepherded reservoir releases flowing through this stream reach for delivery to downstream uses. These higher flow rates consist of Natural Flow available to the Shoshone Water Rights combined with the shepherded water.

Because this acquisition is for non-consumptive water rights, and has no associated historical consumptive use, the provisions of sections 37-92-102(3) and 305(3)(b), C.R.S. (requiring that all contracts or agreements for interests in water, and the water court decree implementing the contracts or agreements, to state that the board or the lessor, lender, or donor may bring about beneficial use of the historical consumptive use of the leased, loaned, or donated water right downstream of the instream flow reach as fully consumable water) are not relevant and do not apply to this acquisition.

The Shoshone Water Rights influence flow in the Colorado River and its tributaries both upstream and downstream of the Shoshone Reach. Administration and use of the Shoshone Water Rights for ISF use in the Shoshone Reach is intended to replicate the historical administration and use of the Shoshone Water Rights. Administration and use of the water rights for ISF purposes in the Shoshone Reach will allow for the continuance of administrative practices and water availability scenarios upon which water users have relied, and for the continuance of water supply plans for many entities both upstream and downstream of the Shoshone Reach. **Upstream,** this will help maintain the historical stream flow conditions in the Colorado River mainstem and its tributaries upon which upstream water users have relied, including conditions for CWCB's many upstream ISF water rights. **Downstream**, because administration and use of the Shoshone Water Rights for ISF use in the Shoshone Reach should not change, this use will maintain required historical return flows in the Colorado River mainstem upon which downstream water users have relied, including downstream ISF water rights. Maintaining such downstream return flow conditions is a standard requirement in

water court for water rights change cases. Factors the Board is required to consider are discussed below in **Section VIII**.

VIII. Factors Required for CWCB to Consider

Pursuant to ISF Rule 6e, the Board shall evaluate the appropriateness of any acquisition of water, water rights, or interests in water to preserve or improve the natural environment. Such evaluation shall include, but need not be limited to consideration of the following factors, as discussed under each of the enumerated factors:

> ***(1) The reach of stream or lake level for which the use of the acquired water is proposed, which may be based upon any one or a combination of the following: the historical location of return flow; the length of the existing instream flow reach, where applicable; whether an existing instream flow water right relies on return flows from the water right proposed for acquisition; the environment to be preserved or improved by the proposed acquisition; or such other factors the Board may identify;***

The proposed reach for ISF use of the Shoshone Water Rights, the Shoshone Reach, is an approximately 2.4-mile reach of the Colorado River in Glenwood Canyon between the Shoshone Power Diversion Dam and Tunnel ("Upstream Terminus"), and the Shoshone Power Plant Discharge Outlets ("Downstream Terminus"). See maps in **Enclosure A**. The Shoshone Reach is defined by the Shoshone Water Rights decrees and historical operations. The Shoshone Power Plant takes water from the Colorado River via the Shoshone Diversion Dam and Tunnel, which is located upstream of the Shoshone Power Plant. This historical use of the Shoshone Water Rights for power generation depletes the Shoshone Reach by the full diversion amount during plant operation. Once water is diverted from the river at the Shoshone Diversion Dam, it is conveyed through a tunnel in the canyon walls, before dropping through two turbines and returning to the Colorado River via discharge outlets located just beneath the Shoshone Power Plant, which is the historical location of return flows. There is not an existing ISF water right in this reach, and no existing ISF relies on the return flows except to the extent that return flows may flow, if not consumed, to the 15-Mile Reach ISF water rights decreed in Case Nos. 92CW286 and 94CW330. The natural environment to be preserved and improved is within this 2.4-mile reach of the Colorado River in Glenwood Canyon, as further discussed in **Section VIII (5)** below.

Upstream of the Shoshone Reach, the CWCB holds over 300 decreed ISF water rights that protect nearly 1,500 miles of streams and rivers. See maps in **Enclosure A.** These ISFs, held on behalf of the people of Colorado, preserve headwater streams tributary to the mainstems, as well as mainstem reaches of the Colorado, Blue, and Eagle Rivers. These ISF water rights protect values that range from conserving native Colorado Cutthroat Trout to recreationally important Gold Medal sport fisheries throughout the upper basin. The ISFs above the Shoshone Reach were appropriated based on the stream conditions that existed at the time of the appropriation. When calling, the Shoshone Water Rights have historically curtailed junior diverting water rights on the tributaries, effectively bringing streamflow through these

upstream ISF reaches, particularly during low-flow conditions when calls are necessarily placed. For example, in 2023, Fraser River streamflow dropped significantly, and upon investigation, it was found that when the Shoshone call was abruptly turned off, diverters were able to take an additional 9-10 cfs from two different tributaries to the Fraser River. DWR could not curtail the water rights without a senior call in effect. This dried up Vasquez Creek and reduced streamflow below the decreed ISF rates on the Fraser River. This is just one example to demonstrate that without maintenance of the historical flow regime, there is potential for stream conditions to change significantly in the upper portion of the basin, both on the mainstem and on the tributaries, resulting in less streamflow for existing ISF water rights.

Downstream from the Shoshone Reach, the CWCB holds numerous decreed ISF water rights in the headwater streams tributary to the mainstems, as well as in mainstem reaches of the Roaring Fork, Crystal, and Colorado Rivers that are indirectly impacted by operations of the Shoshone Water Rights. See maps in **Enclosure A.** Potential impacts to these downstream ISF water rights by Shoshone operations are complex and depend on operations of both large and small individual water rights, which is difficult to parse, demonstrating the degree of entanglement of ISF water rights with other operations over several different river basins.

(2) The natural flow regime;

The headwaters of the Colorado River originate in the State of Colorado in Rocky Mountain National Park along the continental divide at about ~14,300 feet in elevation. The Colorado River flows for about 166 miles through Grand Lake, Kremmling, and Glenwood Canyon before reaching the Shoshone Powerplant Diversion Dam. Flows in the Shoshone Reach are the result of a natural snowmelt runoff flow regime, together with significant flow alteration due to water uses throughout the 4,470 square mile basin.

Streamflow in the Colorado River is highly variable year to year and seasonally due to natural differences in snowpack, rain events, and baseflow processes. There are also many sources of flow alteration in the upstream basin including multiple TMDs, large reservoirs, smaller reservoirs, in-basin diversions, and other releases to the 15-Mile Reach. These different water uses have a variety of effects from reducing the total flow volume to changing the magnitude or timing of water reaching the Shoshone Reach.

The USGS measures streamflow at the Colorado River Dotsero Gage, USGS 09070500), approximately 8.5 miles upstream from the Shoshone Reach. The Dotsero Gage, which includes effects from upstream water uses, indicates that for the full gage period of record from 1940 to 2024, monthly mean flows are between 4,600 and 6,100 cfs during runoff and between 850 cfs and 1,200 cfs during winter months. Peak streamflow during snowmelt runoff can be as low as 2,000 cfs in drought years such as 2002 and over 22,000 cfs in extreme runoff years like in 1984.

(3) Any potential material injury to existing decreed water rights;

Within the Shoshone Reach, there are no other water rights or diversions. However, a number of augmentation plans and exchanges extend through this reach. By maintaining the non-consumptive nature of the water rights, along with continuing operation of the water rights in their historical manner, the exchanges and augmentation plans should be unaffected by the new ISF use. This proposed acquisition is intended to maintain historical use and replicate historical return flows.

There are many existing decreed junior and senior water rights located both upstream and downstream of the Shoshone Water Rights and the associated Shoshone Reach. Many junior upstream users can continue to divert during a Shoshone call because they operate under either individual augmentation plans or are covered by the Green Mountain Reservoir historic user pool releases ("HUP"). Downstream users rely on the return flows from the Shoshone operation. Because the historical operation is to be maintained with the proposed ISF use, both the upstream and downstream water rights will be protected against injury. The upstream water rights should experience the same operation of their water rights, which will continue to rely on the existing augmentation plans and HUP protections. The downstream users can continue to rely on maintenance of historical return flows from this new non-consumptive ISF use. The details of the historical use that is to be replicated will appropriately be analyzed during the required water court process, is designed to investigate such details. Use of the Shoshone Water Rights for ISF and hydropower purposes shall be subject to any terms and conditions imposed by the change of water right decree to be entered by the water court.

(4) The historical consumptive use and historical return flows of the water right proposed for acquisition that may be available for instream flow use;

The Shoshone Water Rights have been used throughout most of the 20th century and are still in operation today. This long period of hydropower plant operation provides a robust historical use period that will result in acquired water rights that can be used for ISF beneficial use upon completion of a change case. The exact amount and timing of water that can be put to ISF use will be determined during the water court change case. It is the intent of the proposed acquisition to replicate the historical use and historical return flows while applying this non-consumptive water right to ISF use within the historically depleted stream reach. Because the historical use is for non-consumptive power generation, the measure of the water right is its historical use, rather than a historical consumptive use. Pursuant to any restrictive terms and conditions in the final water court decree, so long as the return flows are maintained to the stream downstream of the Shoshone Reach, the full historical diversion amount will become available for ISF use within the Shoshone Reach, to the extent the water rights are not being used to generate hydropower. As with any change of water rights, determining the historical use amount can be a complicated, time-consuming, and potentially controversial endeavor. During the water court process, parties to the change case will present and discuss their engineering analyses and legal positions regarding the historical use

of the Shoshone Water Rights using various types of measures, models, and operations regarding historical stream flow, diversions, administration, reservoir releases, water rights analysis, and power generation. Several numerical and conceptual models will likely be discussed as part of the water court process, which will rely on water rights experts and will be a multi-year process to develop decree terms and conditions regarding the amount of water that will be available for ISF use under the Shoshone Water Rights. Interested parties to date have expressed support for this proposal in general but have expressed hesitation on the historical use analysis and resulting amount of water that will be available for ISF use. Details regarding limits on timing and amounts will be evaluated during the water court process and will be imposed by the final water court decree.

> ***(5) The natural environment that may be preserved or improved by the proposed acquisition, and whether the natural environment will be preserved or improved to a reasonable degree by the water available from the proposed acquisition;***

The Shoshone Reach of the Colorado River runs through the central portion of Glenwood Canyon, a confined canyon where the river over time carved a deep gorge that runs nearly 15 miles between 2,500 feet high walls of sedimentary rock. The canyon is a heavily trafficked corridor, the river and its floodplain are confined by Interstate 70, a streamside recreational path, and railroad. The Shoshone Reach of the Colorado River in Glenwood Canyon supports a high-quality fishery, even in its dewatered state with limited available habitat. The legal diversion by the Shoshone Water Rights of the entirety of the Colorado River when flows are less than 1,408 cfs leaves the Shoshone Reach in a dewatered state. Under seasonally low flows with diminished conditions, aquatic habitat persists, specifically in deep pools and glides isolated by steep boulder drops or shallow riffles. Despite the anthropogenic alteration of the Colorado River through Glenwood Canyon, the Shoshone Reach continues to support a variety of native and sport fisheries and some limited riparian areas. Wildlife commonly encountered include bighorn sheep, river otters, beaver, Mule Deer, elk, Peregrine Falcons, and eagles. Riparian and upland plant communities generally consist of cottonwood and alder in the riparian areas, and oak, pine, spruce, fir, and aspen trees in the uplands. The unique canyon geology includes caves, springs, and geothermal outputs. Consistent base flows and periodic high flows would provide major benefits in the Shoshone Reach that include maintenance of food webs and sediment dynamics, dampening of temperature extremes, and increased aquatic habitat. See GEI's report as **Enclosure G**.

Given the demonstrated biological benefits within the Shoshone Reach, to the Colorado River headwaters and tributaries, and to the mainstem Colorado River below the power plant, CPW staff believe this is an appropriate acquisition and recommends the CWCB accept the interest in the acquired water. CPW's analysis indicates that the best use of the acquired water rights is to preserve and improve the natural environment in the Shoshone Reach of the Colorado River at any rate up to the full decreed amount of 1,408 cfs, and that fish habitat will also be improved in the Shoshone Reach at streamflows up to at least 3,000 cfs. See CPW's recommendation letter and report as **Enclosure D**. CPW evaluated the higher flow rates because, at times, there has been, and will continue to be, other water in the stream,

including shepherded reservoir releases flowing through this stream reach for delivery to downstream uses. These higher flow rates consist of Natural Flow available to the Shoshone Water Rights combined with the shepherded water.

(6) The location of other water rights on the subject stream(s);

Within the Shoshone Reach, there are no other water rights or diversions. However, a number of augmentation plans, exchanges, and water deliveries extend through the Shoshone Reach. There are many decreed junior and senior water rights located both upstream and downstream of the Shoshone Reach. See **Section II (1)** above, for a list of the main structures. See the discussion regarding protection from injury above, in **Section VIII (3)**.

(7) The effect of the proposed acquisition on any relevant interstate compact issue, including whether the acquisition would assist in meeting or result in the delivery of more water than required under compact obligations;

CWCB will ensure that the change of the Shoshone Water Rights to allow ISF uses will not expand the historical use of the water right and will not reduce the return flows that were maintained by the historical diversions. Use of the Shoshone Water Rights for ISF and hydropower purposes shall be subject to terms and conditions imposed by the change of water right decree to be entered by the water court, which will restrict the future use. Downstream of the Shoshone Reach, the return flows from use of the Shoshone Water Rights will become part of the natural stream flow in the Colorado River and will be available for other uses as it was historically. CWCB will ensure that this acquisition will not have an effect on interstate compact issues.

(8) The effect of the proposed acquisition on the maximum utilization of the waters of the state;

The beneficial use of the Shoshone Water Right under this acquisition will be for non-consumptive ISF use in the Shoshone Reach. Because the water right is non-consumptive, any other use of this water right must also be non-consumptive, which includes very few types of other water uses. CWCB will ensure that changing these water rights to include ISF use will allow the same level of utilization of the non-consumptive Shoshone Water Rights, which will not alter water available for other uses. Therefore, CWCB will ensure that use of the Shoshone Water Rights for instream flow to preserve and improve the Colorado River in the Shoshone Reach will continue to allow maximum utilization of the waters of the State of Colorado. At the lower terminus of the Shoshone Reach, the historical return flow will be maintained and will become part of the natural stream flow available for downstream water uses, both consumptive and nonconsumptive. There are several large diversions downstream of the Shoshone Reach which rely on the historical return flows. Furthermore, for any return flows that remain in the river, that are not diverted and consumed between Shoshone and the 15-Mile Reach, have been used, and may continue to be used, by the ISF water right held by CWCB in 15-Mile Reach as another non-consumptive use. Consequently, by not expanding the

historical use, and by continuing the utilization of the Shoshone Water Rights, CWCB will ensure that this acquisition will not have a negative effect on the maximum utilization of the waters of the state.

(9) Whether the water acquired will be available for subsequent use or reuse downstream;

The River District and PSCo will not claim any right of use of the Shoshone Water Rights downstream of the Shoshone Reach in the change case filed for this acquisition. CWCB will not claim any such right, but rather any right of use in the Shoshone Water Rights ends at the Lower Terminus of the Shoshone Reach. Downstream of the Shoshone Reach, the return flows from use of the Shoshone Water Rights will become part of the natural stream flow in the Colorado River and will be available for appropriation and use by water rights holders.

Because this acquisition is for non-consumptive water rights, for which the return flow from use of these water rights will become part of the natural stream flow downstream of the Shoshone Reach, the provisions of §§37-92-102(3) and 305(3)(b), C.R.S. (requiring that all contracts or agreements for interests in water, and the water court decree implementing the contracts or agreements, to state the board or the lessor, lender, or donor may bring about beneficial use of the historical consumptive use of the leased, loaned, or donated water right downstream of the instream flow reach as fully consumable water) are not relevant and do not apply to this acquisition.

(10) The cost to complete the transaction or any other associated costs;

The River District has applied for a non-reimbursable grant in the amount of $20 million from CWCB, which CWCB has approved to help pay for a portion of their $99 million purchase of this water right from PSCo. This acquisition for ISF use is part of the grant process and does not require additional payments from the funds specifically allocated for ISF acquisitions from the construction fund. Other funds for the purchase include $20 million committed by River District's Board of Directors, over $16 million committed by west slope supporters, and $40 million awarded but not yet contracted by the U.S. Bureau of Reclamation as part of the Inflation Reduction Act's Upper Basin Environmental Drought Mitigation, Bucket 2 Ecosystem ("B2E") Financial Assistance Program. CWCB's other associated costs to complete the transaction include time commitments by staff and the Attorney General's Office for the Board process and water court processes, followed by operational needs with record keeping, which are all part of CWCB's normal operating budget.

(11) The administrability of the acquired water right when used for instream flow purposes;

The Colorado Division of Water Resources ("DWR") administers calls for the Shoshone Water Rights which have resulted in the curtailment of junior water rights upstream of the Shoshone Power Plant. The administration of the water rights, whether for hydropower use or for ISF

use, should remain the same as the historical practice and should be unaffected by this additional ISF use. The Senior Shoshone Water Right is one of the most senior water rights on the Colorado River. During significant periods of the year, there is not sufficient water to satisfy all water rights decreed on the Colorado River and its tributaries within the State of Colorado, thus administration of calls against junior water rights have been placed, by both the senior and the junior Shoshone Water Rights. Administration and measurement of the Shoshone Water Rights has historically occurred using the Dotsero Gage. Consistent with historical administration, the Natural Flow is the amount of water in the Colorado River measured at the Dotsero Gage, including the amount of water usable by the Shoshone Water Rights when those water rights are in priority, except that the Natural Flow does not include any water released from storage and conducted into the Colorado River upstream of the Dotsero Gage (accounting for evaporation and transit loss), which water is intended for delivery for use downstream of the discharge outlets for the Shoshone Power Plant.

IX. Conclusion

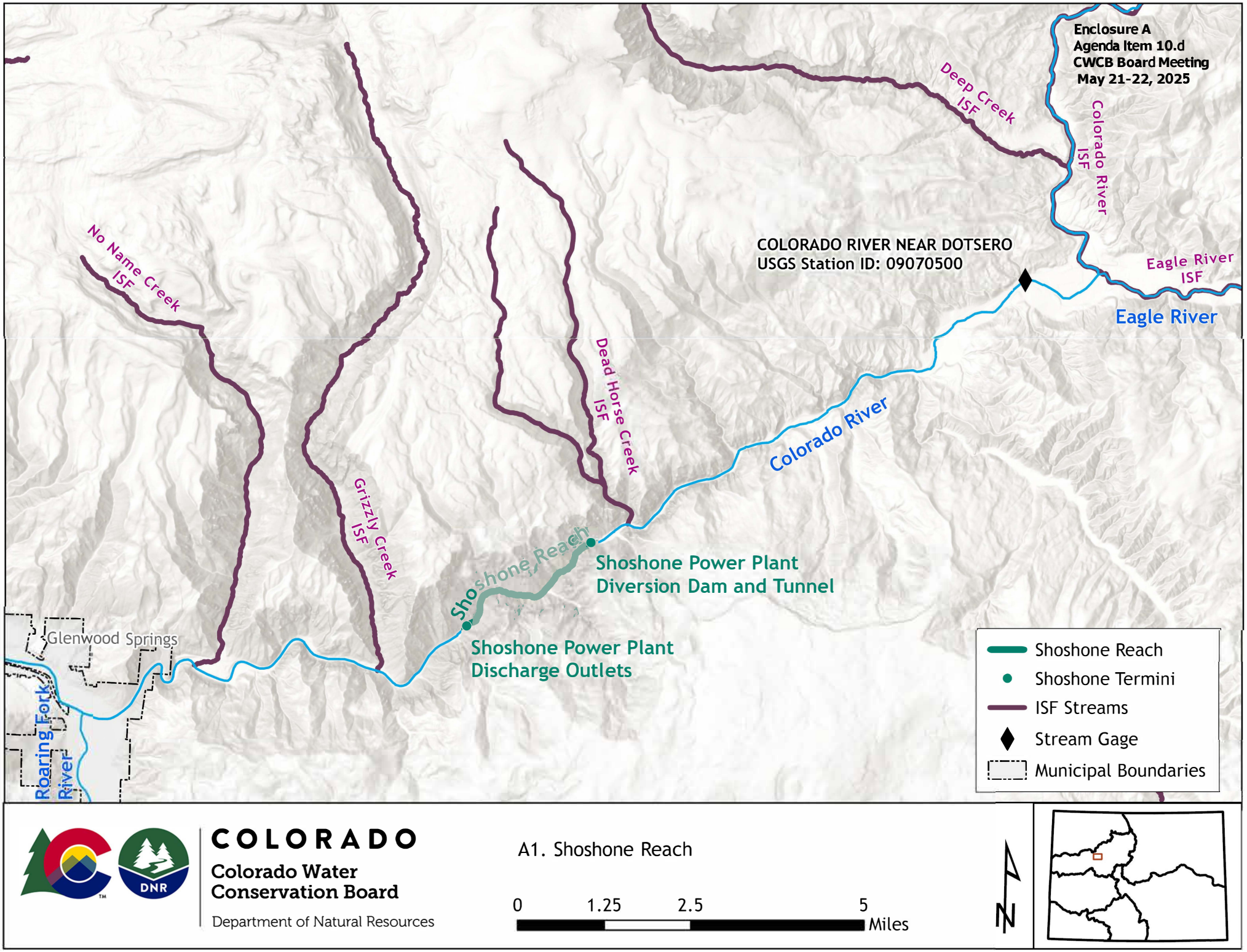
At a future Board meeting in which the Board will be asked to take final action, it is anticipated that Staff will recommend that the Board take the following actions:

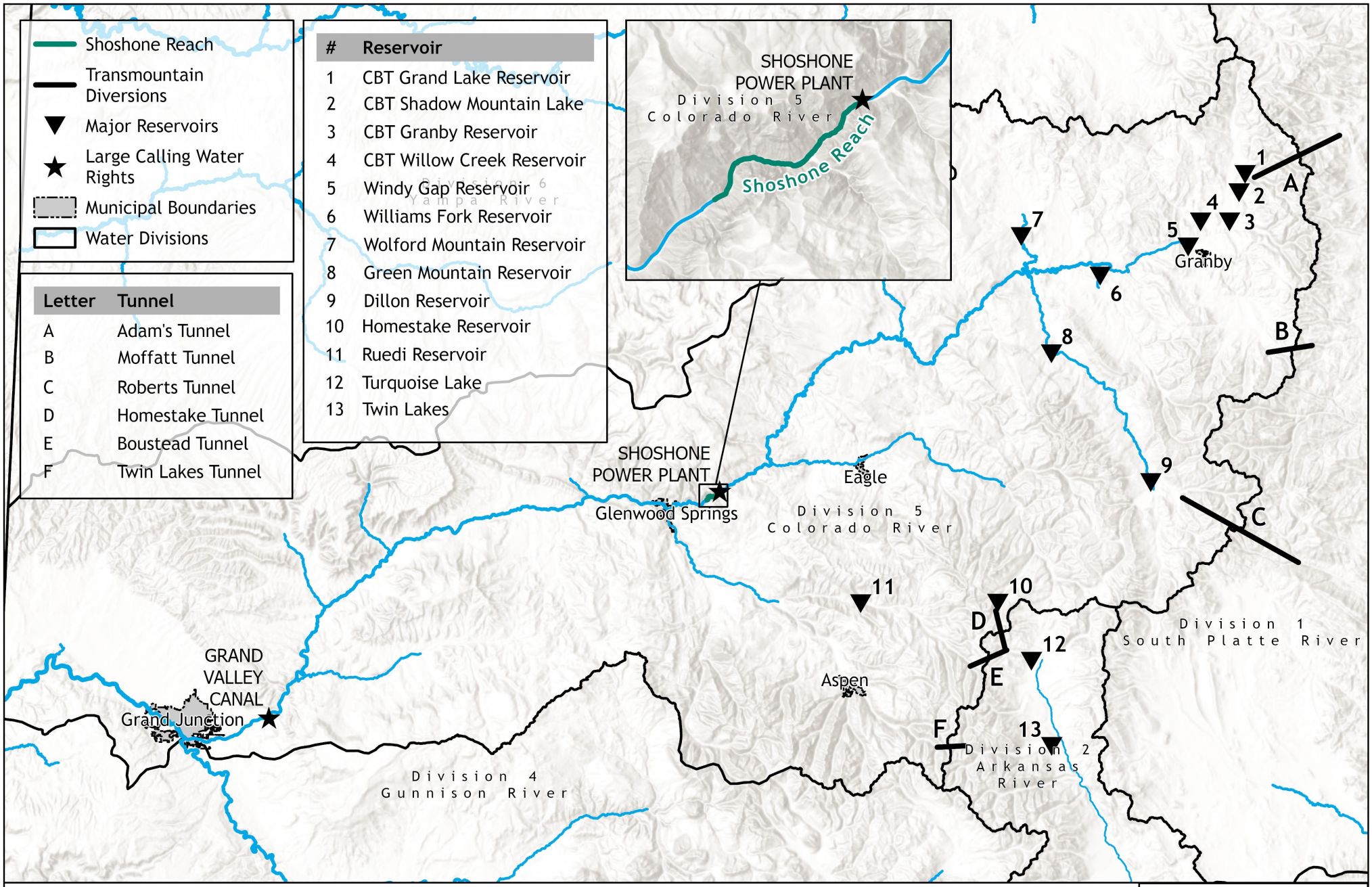
- Determine that the CWCB accepts a perpetual interest in the Shoshone Water Rights for instream flow use up to the full decreed amounts to preserve and improve the natural environment to a reasonable degree;
- Direct the CWCB Director to sign the ISF Agreement, so long as it is substantially similar to the draft ISF Agreement attached to the Board memo;
- Determine that the best use of the acquired interest in the Shoshone Water Rights is to preserve and improve the natural environment to a reasonable degree within the Shoshone Reach of the Colorado River, up to the flow rates recommended by CPW, which will be included in the water court application; and
- Direct Staff to work with the Attorney General's Office and the Co-Applicants to file a water court application requesting to add an instream flow use to the Shoshone Water Rights in accordance with 37-92-102(3).

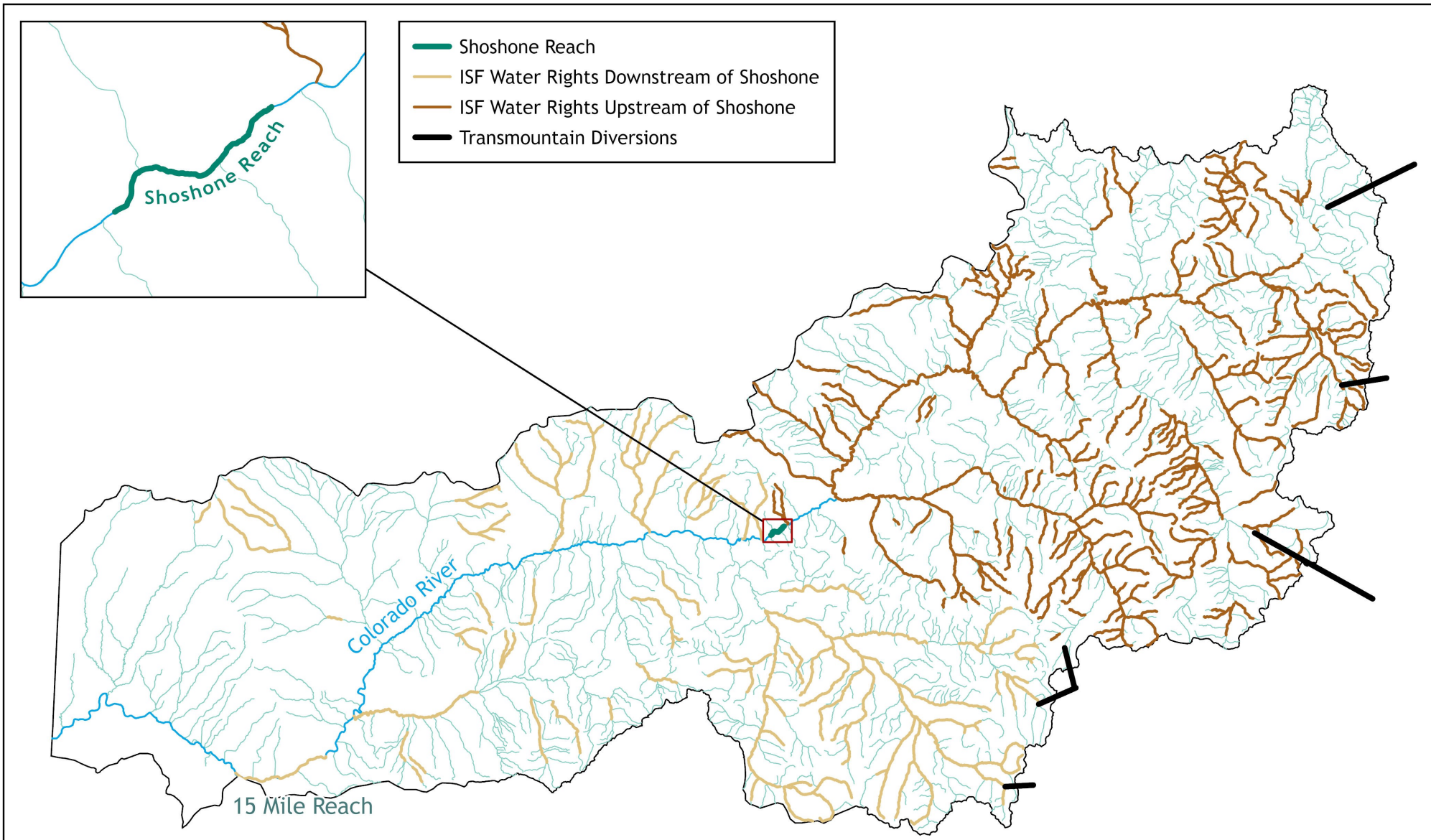
The Board can take final action on this proposal at the following Board meeting in July 2025 if no hearing is requested. However, if a hearing is requested within 20 days of the day the Board hears the proposal, and the Board grants the request, the hearing must be held within 120 days of May 21, 2025. The hearing and final action could occur at the September 2025 Board meeting. If the Board accepts the acquisition, a water court application would be filed, and the multi-year water court process could begin.

Enclosures:

A. Maps
    A1. Shoshone Reach
    A2. Colorado River Basin Transbasin Diversions and Reservoirs
    A3. Colorado River Basin ISF Water Rights
B. River District & PSCo's Offer Letter
C. Draft ISF Agreement
D. CPW's Recommendation Letter and Report
    D1. CPW's Letter of Recommendation
    D2. CPW's Biological Evaluation Report
E. Draft Water Court Application
F. River District's Technical Memorandum - with Attachments
    Attachment 1. Shoshone Water Rights Decrees
    Attachment 2. Maps
    Attachment 3. 2016 Shoshone Outage Protocol Agreement
    Attachment 4. Draft Instream Flow Agreement
    Attachment 5. 2024 Miller Report
    Attachment 6. 2025 Ecosystem Report
    Attachment 7. USFS-BLM Report
    Attachment 8. HU Assessment
    Attachment 9. Check Case Memo
    Attachment 10. Purchase and Sale Agreement
    Attachment 11. Hydros Yield Assessment
    Attachment 12. Hydros Yield Addendum
    Attachment 13. ISF Benefits Memorandum
    Attachment 14. Draft Water Court Application
G. GEI Report - GEI Consultants, Inc., April 2025 "Review of the Effects of Flow on Biology and Stream Processes, Glenwood Canyon"
H. Public Comment Letters (Aurora & Colorado Springs Utilities)


Enclosure A
Agenda Item 10.d
CWCB Board Meeting
May 21-22, 2025
Deep Creek ISF
Colorado River ISF
No Name Creek ISF
COLORADO RIVER NEAR DOTSERO
USGS Station ID: 09070500
Eagle River ISF
Eagle River
Dead Horse Creek ISF
Colorado River
Grizzly Creek ISF
Shoshone Reach
Shoshone Power Plant
Diversion Dam and Tunnel
Shoshone Power Plant
Discharge Outlets
Glenwood Springs
Roaring Fork River
Shoshone Reach
Shoshone Termini
ISF Streams
Stream Gage
Municipal Boundaries
COLORADO
Colorado Water
Conservation Board
Department of Natural Resources
A1. Shoshone Reach
0
1.25
2.5
5
Miles
N


Shoshone Reach
Transmountain Diversions
Major Reservoirs
Large Calling Water Rights
Municipal Boundaries
Water Divisions
Reservoir
1 CBT Grand Lake Reservoir
2 CBT Shadow Mountain Lake
3 CBT Granby Reservoir
4 CBT Willow Creek Reservoir
5 Windy Gap Reservoir
6 Williams Fork Reservoir
7 Wolford Mountain Reservoir
8 Green Mountain Reservoir
9 Dillon Reservoir
10 Homestake Reservoir
11 Ruedi Reservoir
12 Turquoise Lake
13 Twin Lakes
Letter Tunnel
A Adam's Tunnel
B Moffatt Tunnel
C Roberts Tunnel
D Homestake Tunnel
E Boustead Tunnel
F Twin Lakes Tunnel
SHOSHONE POWER PLANT
Division 5 Colorado River
Shoshone Reach
Granby
Eagle
Glenwood Springs
Aspen
GRAND VALLEY CANAL
Grand Junction
Division 4 Gunnison River
Division 1 South Platte River
Division 2 Arkansas River
COLORADO
Colorado Water Conservation Board
Department of Natural Resources
A2. Colorado River Basin
Transbasin Diversions and Reservoirs
0 12.5 25 50 Miles
N



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

A3. Colorado River Basin ISF Water Rights

0 12.5 25 50 Miles

N

COLORADO RIVER DISTRICT
PROTECTING WESTERN COLORADO WATER SINCE 1937

Xcel Energy®

May 6, 2025

Via electronic mail
Colorado Water Conservation Board
Attn: Director Lauren Ris
1313 Sherman Street, Room 721
Denver, Colorado 80203

RE: Proposed Acquisition of an Interest in the Shoshone Water Rights for Instream Flow Use

Dear Members of the Board:

The Colorado River Water Conservation District (the "River District"), on behalf of a large coalition of West Slope governments and water user organizations, and Public Service Company of Colorado ("PSCo"), are pleased to offer to the Colorado Water Conservation Board ("CWCB") a proposal for the permanent dedication to the CWCB of the exclusive right to use the Shoshone Water Rights for instream flow purposes through an acquisition agreement with the River District and PSCo.

The Shoshone Water Rights.

For over a century, the Shoshone Power Plant, a "run-of-river" hydroelectric power plant located in Glenwood Canyon, Colorado, has commanded the waters of the Colorado River to generate hydroelectric power by means of two direct flow non-consumptive water rights: a 1905 senior priority water right in the amount of 1,250 cubic feet per second ("cfs"), and a 1940 junior priority water right in the amount of 158 cfs (together, the "Shoshone Water Rights"). PSCo owns and operates the Shoshone Power Plant and exercises the Shoshone Water Rights to generate hydroelectricity by diverting up to 1,408 cfs (the sum of the 1,250 cfs senior priority and the 158 cfs junior priority). PSCo diverts water from the Colorado River via the "Shoshone Diversion Dam," which is located upstream of the Shoshone Power Plant near the Hanging Lake Tunnel. After such water is diverted, it is conveyed approximately 2.4 miles through a tunnel in the canyon walls, before dropping 167 feet through two turbines and returning to the Colorado River via discharge outlets located just below the Shoshone Power Plant.

Summary of the Proposed Instream Flow Agreement.

The River District and PSCo, in consultation with the CWCB's Stream and Lake Protection Section and the Colorado Attorney General's Office, developed the proposed "Shoshone Water

Rights Dedication and ISF Agreement" (the "ISF Agreement"), which is enclosed hereto for your reference. As described in the ISF Agreement, the proposed instream flow use of the Shoshone Water Rights will preserve and improve the natural environment within the defined "Shoshone Reach" (a distance of approximately 2.4 miles of the Colorado River) between the Shoshone Diversion Dam and the outfall of the Shoshone Power Plant.

The ISF Agreement does not contemplate any new instream flow appropriation by the CWCB nor is such an appropriation necessary. Instead, the ISF Agreement provides that the CWCB will acquire the exclusive right to use the Shoshone Water Rights for instream flow purposes within the Shoshone Reach to the extent that the rights are not being used by PSCo to generate hydropower. The Shoshone Water Rights will be used for instream flow purposes at the decreed 1,408 cfs rate of natural flow, subject of course to the availability of natural flow in priority and consistent with the terms and conditions to be contained in the change of water rights decree.

The ISF Agreement is consistent with the CWCB's legal authority to acquire interests in water pursuant to C.R.S. § 37-92-102(3). Under the ISF Agreement, the CWCB will acquire the exclusive right to use the Shoshone Water Rights for instream flow purposes and the River District will retain fee title to the water rights. This type of acquisition is not unusual nor without precedent, and is specifically recognized as a lawful acquisition pursuant to section 37-92-102(3), C.R.S. Among other examples, this acquisition concept has been utilized by the CWCB several times in acquisition agreements with multiple parties, including the Colorado Water Trust, Denver Water, the City and County of Boulder, and Pitkin County. Most importantly, the use of the Shoshone Water Rights for instream flow purposes will result in the preservation and improvement of the natural environment within the Shoshone Reach of the Colorado River.

Additional Benefits of the Proposed Instream Flow Use of the Shoshone Water Rights.

The operation of the Shoshone Power Plant for over a century has resulted in a historical flow regime that provides numerous and diverse benefits to water users and the natural environment. Given the seniority of the Shoshone Water Rights, their non-consumptive use, and the physical location of the Shoshone Power Plant upstream of the Grand Valley, the Shoshone Water Rights are the primary basis upon which the Colorado River and its tributaries in Water Division No. 5 are administered. These incidental benefits, however, are not limited to agricultural, recreational, municipal, and economic factors. The historical exercise and administration of the Shoshone Water Rights has also resulted in direct ecological benefits on the Colorado River from its headwaters to the location of the Shoshone Reach by sustaining vital aquatic habitat, improving stream temperatures, and benefitting fish habitat during seasonal low-flow periods. Additionally, the exercise of the Shoshone Water Rights moderates the impacts of upstream diversions in a way that preserves the health of our state's namesake river.

In recent years, the Shoshone Water Rights and their associated benefits have been threatened by a series of natural hazards prompting unplanned outages at the Shoshone Power Plant. To ensure the permanent protection of the historical flow regime created by the Shoshone Water Rights, the

River District signed a Purchase and Sale Agreement ("PSA") with PSCo in December 2023 to acquire the Shoshone Water Rights. The guiding principle of the PSA and of the proposed ISF Agreement is that the Shoshone Water Rights will be used for instream flow purposes by the CWCB to the extent they are not used by PSCo for hydropower generation. Once the beneficial use of instream flow is added to the existing decreed uses, the water rights will be used in perpetuity in a manner that mimics the historical use of the water rights for hydropower generation, thereby continuing to protect critical resources for future generations across the state while simultaneously preserving and improving the natural environment.

Supporting Memorandum and Request for CWCB Approval of the Proposed ISF Agreement.

We have included a supporting memorandum and technical reports with this letter providing additional explanation and support of the proposed instream flow use of the Shoshone Water Rights. We believe the memorandum and technical reports provide ample support for the CWCB to determine that the CWCB's acquisition of the exclusive right to use the Shoshone Water Rights for instream flow purposes in the Shoshone Reach is appropriate to preserve and improve the natural environment to a reasonable degree and that the proposed ISF Agreement should be approved.

The River District and PSCo respectfully request that the CWCB initiate its consideration of the proposed ISF Agreement at its regular meeting on May 21, 2025. Representatives from PSCo and the River District will attend the May 21 meeting to provide more information regarding the proposed ISF Agreement and to answer any questions the CWCB may have. The River District and PSCo enthusiastically look forward to continuing to work with the CWCB, its staff, and the Office of the Attorney General on this important project.

Sincerely,

COLORADO RIVER WATER CONSERVATION DISTRICT

By: _____
Andrew A. Mueller
General Manager

PUBLIC SERVICE COMPANY OF COLORADO

By: _____
Robert S. Kenney
President

Enclosures: Shoshone Water Rights Dedication and ISF Agreement [draft]
Technical Memorandum and Attachments

DRAFT
SHOSHONE WATER RIGHTS DEDICATION AND ISF AGREEMENT

(Shoshone Water Rights)

This WATER RIGHT DEDICATION and ISF AGREEMENT ("Agreement"), is made as of this ____ day of _____, 2025, by and between the Colorado Water Conservation Board ("CWCB"), an agency of the State of Colorado, the Colorado River Water Conservation District ("River District"), a political subdivision of the State of Colorado, and Public Service Company of Colorado, a Colorado corporation ("PSCo"). The CWCB, the River District, and PSCo may be hereinafter referred to individually as a "party," and together as the "parties."

RECITALS

A. The CWCB is an agency of the State of Colorado created to aid in the protection and development of the waters of the state for the benefit of its present and future inhabitants. In 1973, the General Assembly vested the CWCB with the exclusive authority to appropriate waters of the natural stream for minimum stream flows between specific points on a stream to preserve the natural environment to a reasonable degree.

B. Pursuant to section 37-92-102(3), C.R.S., the General Assembly has also vested the CWCB with the ability to acquire, by grant, purchase, donation, lease, or other contractual agreement, such water, water rights, and interests in water that are not on the division engineer's abandonment list in such amount as the CWCB determines is appropriate for stream flows to preserve and/or improve the natural environment to a reasonable degree.

C. The River District was created by the provisions of sections 37-46-101, C.R.S., *et seq*., to promote the health and general welfare of the State of Colorado by the conservation, use, and development of the water resources of the Colorado River and its principal tributaries. The River District constituents include West Slope governmental entities and water interests that desire to maintain in perpetuity the flow regime within Water Division 5 created by the historical exercise of the water rights that are the subject of this Agreement.

D. PSCo is a Colorado corporation and is the owner and operator of the hydroelectric power plant (the "Shoshone Power Plant") located on the mainstem of the Colorado River in Glenwood Canyon, approximately six miles upstream of Glenwood Springs, Colorado. The Shoshone Power Plant produces hydroelectric energy by means of PSCo's diversion of the following water rights:

(i) The Glenwood Power Canal and Pipeline water right, decreed on December 9, 1907, in Civil Action No. 466, Eagle County District Court, in the amount of 1,250 cubic feet per second of time ("c.f.s.") with an appropriation date

of January 7, 1902, for power, mining, milling, manufacturing, lighting and heating and traction purposes, and as decreed absolute by the Eagle County District Court on February 27, 1911, in Civil Action No. 553 (the "Senior Shoshone Water Right"); and

(ii) The Shoshone Hydro Plant Diversion No. 2 water right, decreed absolute on February 7, 1956, in Civil Action No. 1123, Eagle County District Court, in the amount of 158 c.f.s. with an appropriation date of May 15, 1929, for manufacturing and generation of electrical energy (the "Junior Shoshone Water Right").

Together, these two water rights are referred-to as the "Shoshone Water Rights".

E. The Senior Shoshone Water Right is one of the most senior water rights on the Colorado River. During significant periods of the year, there is not sufficient water to satisfy all water rights decreed on the Colorado River and its tributaries within the State of Colorado. At such times, when the measurable Natural Flow of the Colorado River drops below 1,408 c.f.s. (the sum of 1,250 c.f.s. attributable to the Senior Shoshone Water Right and 158 c.f.s. attributable to the Junior Shoshone Water Right) at the streamflow gauge (USGS 09070500) located on the Colorado River near Dotsero, Colorado ("Dotsero Gage"), the Colorado Division of Water Resources ("DWR") administers a call for the Shoshone Water Rights which results in the curtailment of junior water rights upstream of the Shoshone Power Plant. The Dotsero Gage is the location where the administration and measurement of the Shoshone Water Rights has historically occurred. The "Natural Flow" is the amount of water in the Colorado River measured at the Dotsero Gage, including the amount of water usable by the Shoshone Water Rights when those water rights are in priority, except that the "Natural Flow" does not include any water released from storage and conducted into the Colorado River upstream of the Dotsero Gage (accounting for evaporation and transit loss), which water is intended for delivery for use downstream of the discharge outlets for the Shoshone Power Plant.

F. The Shoshone Water Rights are decreed for non-consumptive hydropower generation use at the Shoshone Power Plant. All of the water diverted by PSCo for hydropower generation use is returned to the Colorado River after such water is conveyed through the Shoshone Power Plant's penstocks and turbines, to a point of return at the plant's discharge outlets that is approximately 2.4 miles downstream of the point of diversion at the Shoshone Diversion Dam and Tunnel, as depicted on the map attached as **Exhibit A**. The approximate locations of the "Shoshone Diversion Dam and Tunnel" and the outfall for the "Shoshone Power Plant Discharge Outlets" are as follows:

i. **Shoshone Power Plant Diversion Dam and Tunnel:** on the right bank, being the northerly bank, of the Colorado River whence the North quarter corner of Section Thirty (30), Township Five (5) South, Range Eighty-Seven (87) West of the 6th Principal Meridian bears North 23° 48'20" East 2,414.64 feet, in Garfield County, Colorado.

ii. **Shoshone Power Plant Discharge Outlets:** on the right bank, being the northerly bank, of the Colorado River whence the Southeast corner of Section Thirty-five (35), Township Five (5) South, Range Eighty-Eight (88) West of the 6th Principal Meridian bears South 29° 24' 14" East, 1,771 feet, in Garfield County, Colorado.[1]

The reach of stream between the Shoshone Power Diversion Dam and Tunnel and the Shoshone Power Plant Discharge Outlets is referred to herein as the "Shoshone Reach." Through this Agreement, the parties seek to preserve and improve the natural environment of the Colorado River within the Shoshone Reach to a reasonable degree.

G. Pursuant to the Purchase and Sale Agreement between the River District and PSCo, with an effective date of January 1, 2024 (the "PSA"), the River District is the contract purchaser of the Shoshone Water Rights. The PSA provides that PSCo, and its successors and assigns, is entitled to a perpetual leasehold interest in the Shoshone Water Rights for continued use of the Shoshone Water Rights for hydropower generation at the Shoshone Power Plant (the "Lease," the form of which is attached to the PSA as "Exhibit D"). The PSA (including all its Exhibits and Attachments) is attached and incorporated hereto as **Exhibit B**.

H. PSCo's historical exercise of the Shoshone Water Rights has resulted in a streamflow regime that has benefitted the natural environment of the Colorado River basin both upstream and downstream of the Shoshone Power Plant. In addition, the historical exercise of the Shoshone Water Rights has provided benefits to water users throughout the Colorado River basin by providing a relatively predictable water rights administration regime both upstream and downstream of the Shoshone Power Plant.

I. The parties wish to continue the general historical call operations and maintain the flow regime of the Colorado River, both upstream and downstream of the Shoshone Power Plant. In furtherance of that effort, and subject to the terms of this Agreement, the River District wishes to dedicate to the CWCB, at no additional cost to the CWCB, the exclusive right to use the Shoshone Water Rights for instream flow purposes within the proposed Shoshone Reach to the extent the water rights are not being used for hydropower generation purposes at the Shoshone Power Plant, subject to the requirements of this Agreement. To that end, and subject to the terms set forth herein, the River District, PSCo, and the CWCB agree to jointly file an application to adjudicate a change of the Shoshone Water Rights in Garfield County District Court, Water Division No. 5, (the "Water Court") to add instream flow use to preserve and improve the natural environment of the Shoshone Reach of the Colorado River to a reasonable degree as an additional beneficial use of the Shoshone Water Rights. Use of the Shoshone Water Rights for instream flow and hydropower purposes shall be subject to any terms and conditions imposed by the change of water right decree to be entered by the Water Court, further described in Paragraphs XX and XX below (the "Decree").

[1] The legal description set forth above for the Downstream Terminus (Shoshone Power Plant Discharge Outlets) is an approximate location developed by River District staff and may be supplemented or modified at the time a water court application is filed in Water Division No. 5.

J. At two regularly scheduled public meetings of the CWCB held on [date], and [date], the CWCB considered the River District's proposed dedication of the exclusive right to use the Shoshone Water Rights for instream flow purposes to the CWCB in accordance with section 37-92-102(3), C.R.S., and the Rules Concerning the Colorado Instream Flow and Natural Lake Level Program ("ISF Rule(s)"), 2 CCR 408-2. At its regularly scheduled meeting on [date], the CWCB determined that it is appropriate to enter this Agreement and that the best use of the acquired interest in the Shoshone Water Rights is use up to the full decreed amount of 1,408 c.f.s., for instream flow use to preserve and improve the natural environment to a reasonable degree within the Shoshone Reach. Such use of the Shoshone Water Rights for instream flow purposes can occur within the Shoshone Reach to the extent the Shoshone Water Rights are not being exercised for hydropower generation purposes at the Shoshone Power Plant, up to the full amount of 1,408 c.f.s. of Natural Flow (hereinafter, the "ISF Rate"), subject to the limitations described in Paragraphs 7 and 9 below.

K. The CWCB, the River District, and PSCo wish to cooperate to implement such legal mechanisms and to obtain such court decree and approvals as are necessary to change the Shoshone Water Rights to include instream flow use for the purpose of preserving and improving the natural environment within the Shoshone Reach, and to protect the Natural Flow ISF Rate through the Shoshone Reach to the extent it is not being exercised for hydropower generation purposes at the Shoshone Power Plant.

AGREEMENT

NOW THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the parties agree as follows:

DEDICATION

1. The Recitals to this Agreement are incorporated by this reference and shall constitute part of this Agreement.

2. The River District hereby dedicates to the CWCB, effective as of the date of closing of the PSA, at no additional cost to the CWCB, the exclusive right to use the Shoshone Water Rights for instream flow use within the Shoshone Reach, to the extent such water rights are not being used for hydropower generation purposes at the Shoshone Power Plant pursuant to the Lease, and subject to the requirements of Paragraph 9 below. The River District shall retain title to the Shoshone Water Rights.

3. This Agreement acknowledges the CWCB's consideration of the Colorado Parks and Wildlife analysis showing a biological need to preserve and improve the natural environment of the Shoshone Reach of the Colorado River to a reasonable degree.

4. The parties intend that the Decree, as further described in Paragraphs XX and XX below, shall confirm that the water attributable to the Shoshone Water Rights up to the available ISF Rate will remain in the stream to preserve and improve the environment to a reasonable

degree within the Shoshone Reach where the CWCB does not presently have a decreed instream flow right, to the extent the Shoshone Water Rights are not being used for hydropower generation purposes.

5. The parties intend that the Decree shall confirm that the Shoshone Water Rights shall be administered by the State Engineer and the Division Engineer for Water Division No. 5 ("Engineers") based on the Natural Flow at the Dotsero Gage. Instream flow use of the Shoshone Water Rights will be administered through the Shoshone Reach where the intended instream flow use will occur with the goal of utilizing the Shoshone Water Rights up to the available ISF Rate without diversion or exchange by intervening water users. The parties intend that the Decree shall also contain an affirmative finding which confirms that the change of the Shoshone Water Rights for the additional instream flow use is administrable by the Engineers and is capable of meeting all applicable statutory requirements.

6. In the event any new infrastructure or stream gaging stations are either necessary or desirable for the implementation of this Agreement, or in the event that any new infrastructure—including measuring devices—are deemed necessary by the Engineers with respect to the Shoshone Water Rights, the parties agree to work cooperatively with each other in good faith to accommodate the installation of any such infrastructure or gaging stations, which are necessary to make water available for use under this Agreement, in an efficient and economical manner.

CONDITIONS ON THE ADMINISTRATION AND EXERCISE OF THE SHOSHONE WATER RIGHTS FOR INSTREAM FLOW USE

7. It is the intent of the parties that the Shoshone Water Rights will be protected for instream flow use to the maximum extent possible as allowed under the Water Court Decree, to the extent the Shoshone Water Rights are not being used for power generation. To implement this mutual intent, the CWCB agrees that it will request administration of the Shoshone Water Rights for instream flow use in the Shoshone Reach of the Colorado River to preserve and improve the natural environment to a reasonable degree at all times when the Natural Flow of the Colorado River as measured at the Dotsero Gage is less than 1,408 c.f.s., subject only to the limitations set forth below:

   a. Any terms, conditions, and limits set forth in the Decree;

   b. Any reduction in instream flow use made pursuant to the terms and conditions of Paragraph 9, below, due to use or planned use of the Shoshone Water Right for power generation; and

   c. During any period wherein the CWCB and the River District jointly agree in writing to reduce the flow rate requested for administration of the Shoshone Water Rights for instream flow purposes.

8. Pursuant to ISF Rule 10, 2 CCR 408-2, the parties shall cooperate in the administration and monitoring of the instream flow use of the Shoshone Water Rights dedicated to the CWCB under this Agreement so that, subject to the terms of this Agreement and the Decree, the CWCB will maximize the use of the Shoshone Water Rights for instream flow purposes to the extent the rights are not being used for hydropower generation purposes at the Shoshone Power Plant. PSCo, the CWCB and the River District shall coordinate with DWR to monitor the flow and calculate the Natural Flow of the Colorado River at the Dotsero Gage as the point of administration for the Shoshone Water Rights for hydropower generation and instream flow use.

9. The CWCB and the River District shall notify PSCo of any request for administration required by the provisions of this Agreement. PSCo shall provide advance written notice to the River District and the CWCB at least thirty (30) days prior to any scheduled operations or maintenance activities that result in a full or partial shutdown of the Shoshone Power Plant, and shall provide notice as soon as reasonably possible of any unscheduled shutdown or reduction of Shoshone Power Plant operations. During the term of the Lease, the parties will coordinate on at least an annual basis to determine how the Shoshone Water Rights will be allocated between hydropower generation and instream flow use in a manner consistent with the terms and conditions of the Decree that (1) maximizes PSCo's ability to exercise the Shoshone Water Rights for hydropower generation purposes; and (2) maximizes the ability to use the Shoshone Water Rights for instream flow purposes to the extent the water rights are not being used for hydropower generation purposes at the Shoshone Power Plant, in a manner that does not reduce the availability of the Shoshone Water Rights for subsequent hydropower use. Upon termination of the Lease, this paragraph, and any other restrictions on the Shoshone Water Rights throughout this Agreement due to hydropower use, shall no longer be in effect, and, subsequent to any permanent decommissioning of the Shoshone Power Plant, instream flow shall be the only use of the Shoshone Water Rights.

10. Each party to this Agreement shall also immediately report, in writing, to the other parties the nature of any communications with the Engineers concerning the administration of the Shoshone Water Rights as contemplated by this Agreement. Following the closing of the PSA, the parties shall identify those persons and provide such contact information (including email and telephone number) to the other parties necessary to effectuate the purposes hereof.

11. Any rights created by this Agreement are contractual rights. Use by the CWCB for instream flow purposes in accordance with this Agreement does not provide the CWCB an ownership right in the Shoshone Water Rights or in any of the River District or PSCo's facilities or water rights as they exist now or may exist in the future.

12. The CWCB's contractual rights to and interest in the Shoshone Water Rights dedicated to the CWCB for use in the Shoshone Reach under this Agreement extends to and terminates at the downstream termination point of the Shoshone Reach, which is the stream accrual point for the current Shoshone Power Plant Discharge Outlets.

NO CREATION OF RIGHT OF SUCCESSIVE USE OF THE SHOSHONE WATER RIGHTS DOWNSTREAM OF THE SHOSHONE REACH

13. This Agreement does not recognize any use or create any right of use by the River District of the Shoshone Water Rights downstream of the Shoshone Reach. Notwithstanding the foregoing, this Paragraph 13 does not prevent any use by the River District or its constituents of the natural stream flow downstream of the Shoshone Reach within the priority system and in accordance with Colorado law and the Decree.

WATER COURT PROCEEDINGS

14. The parties shall file and diligently pursue a Water Court application and any necessary appeals to obtain the Decree in a final, unappealable form confirming a change of water right for the Shoshone Water Rights to include the additional use for instream flow purposes by the CWCB and confirming that the water attributable to the Shoshone Water Rights will be used for instream flow to preserve and improve the natural environment in the Shoshone Reach of the Colorado River to a reasonable degree up to the full amount of the ISF Rate , subject to the terms and conditions of the Decree and this Agreement. In such water court application, the CWCB, the River District, and PSCo shall be co-applicants for the purpose of advancing and protecting their contractual rights under this Agreement, including adjudicating a decreed right to use of the Shoshone Water Rights by the CWCB to preserve and improve the natural environment to a reasonable degree within the Shoshone Reach. Except as otherwise provided in the PSA, to which the CWCB is not subject, each party shall bear its own attorney fees and costs related to its participation in any water court adjudication contemplated under this Paragraph 14. Except for its own attorney fees and court filing fees, the CWCB is not responsible for paying costs of prosecuting the water court application, including the costs of hiring a consulting engineer or other witnesses in furtherance of such application, or attorney fees of any other party incurred in relation thereto.

15. The parties intend that the Decree shall confirm that to the extent the water dedicated under this Agreement is not being used for hydropower generation at the Shoshone Power Plant, such water shall be beneficially used by the CWCB for instream flow purposes to preserve and improve the natural environment of the Colorado River within the Shoshone Reach to a reasonable degree, subject to the terms and conditions of the Decree and this Agreement.

16. The parties agree that the Decree shall not confirm any new appropriation of water. N or shall any claim be included in the Water Court application except as expressly described in this Agreement. The parties further agree that, upon the successful prosecution of the Water Court application described in Paragraph 14, above, and upon the issuance of the Decree by the Water Court, no further claim for approval of any change of water right with respect to the Shoshone Water Rights shall be sought by any of the parties to this Agreement in the future without first obtaining the prior written consent of all the parties hereto. The River District agrees it will not transfer or otherwise encumber the rights to any other person or entity without the express written consent of the CWCB, with the exception of the right to enter into a promissory note and deed of trust to the benefit of

PSCo as provided by paragraph 3.1.d.2 of the PSA. The parties agree to request that the Water Court include an express statement in the Decree setting forth the limitations described in this Paragraph 16, to wit:

a. the decree does not confirm any new appropriation or change except to add instream flow;
b. no further claim for approval of any change of the Shoshone Water Rights will be sought by any of the applicants without written consent of the other applicants hereto; and
c. the River District will not transfer or otherwise encumber the Shoshone Water Rights to any other person or entity without the express written consent of the CWCB.

RECORDS AND ACCOUNTING

17. The River District shall be responsible for maintaining all records and accounting necessary for the implementation of this Agreement, using forms mutually agreeable to the parties, and all records required by the Engineers for the administration of the changed Shoshone Water Rights.

18. The River District will provide accounting related to the operation of this Agreement to the CWCB and PSCo.

MISCELLANEOUS PROVISIONS

19. The term of this Agreement is perpetual unless terminated in accordance with the terms of this Agreement.

20. This Agreement will automatically terminate and be of no further effect in the event that (i) the sale of the Shoshone Water Rights from PSCo to the River District does not close or occur, or (ii) the PSA is terminated or otherwise expires. Except as otherwise provided in the immediately preceding sentence in this Paragraph 20, this Agreement may be amended or terminated by the written agreement of the parties, and any such termination or amendment shall take effect only when signed by all of the parties to this Agreement or their successors in interest.

21. Neither the CWCB nor PSCo is responsible for construction or modification of any structures that may be necessary for use of the Shoshone Water Rights for instream flow purposes.

22. This Agreement shall not be assignable by any party without the written consent of all the parties hereto. Notwithstanding the foregoing, an assignment by PSCo of this Agreement to any successor or assign of its rights under the Lease is approved by the CWCB and River District without separate written consent, however thirty (30) days advanced written notice of the assignment to the River District and the CWCB is required, and PSCo may assign the Lease only to a successive owner or operator of the Shoshone Power Plant for power generation purposes. Notice and contact information shall be provided to all parties concurrent with any assignment. In the event of the termination of the Lease by PSCo or

its successors or assigns pursuant to Paragraph 26, below, the River District and CWCB will not be required to obtain the written consent of PSCo or its successors or assigns to assign this Agreement.

23. Pursuant to section 37-92-102(3), C.R.S., this Agreement shall be enforceable by each of the parties hereto as a water matter according to the terms and conditions of this Agreement. The parties further agree that the exclusive venue for and jurisdiction of any dispute pertaining to the interpretation or enforcement of this Agreement shall be the Water Court (as defined herein); *provided, however*, that before commencing any action for enforcement of this Agreement, the party alleging the violation shall notify the other parties in writing of the alleged violation and the parties shall make a good faith effort to resolve their differences through informal consultation.

24. The parties hereto acknowledge and agree that specific performance of this Agreement shall be the exclusive remedy for failure of any party to comply with any provision of this Agreement. The parties hereby waive any right to seek or collect damages for any breach or violation of this Agreement.

25. Enforcement of this Agreement and all rights and obligations hereunder are reserved solely to the CWCB, the River District, and PSCo, and not to any third party. Any services or benefits which third parties may receive or provide as a result of this Agreement are incidental to the Agreement and do not create any rights for such third parties.

26. The parties anticipate that at some point in the future, PSCo may permanently decommission the Shoshone Power Plant, and the Lease will terminate. In the event that the Lease terminates, then PSCo shall provide written notice to the parties of the termination of the Lease and PSCo's rights and obligations under this Agreement will also be deemed to be terminated; however, all rights and responsibilities between the CWCB and the River District will remain in effect. Upon termination of the Lease, all restrictions on the Shoshone Water Rights throughout this Agreement due to hydropower use shall no longer be in effect, and, subsequent to any permanent decommissioning of the Shoshone Power Plant, instream flow shall be the only use of the Shoshone Water Rights.

27. The provisions of §§37-92-102(3) and 305(3)(b), C.R.S. that require that all contracts or agreements for interests in water, and the water court decree implementing the contracts or agreements, to state the board or the lessor, lender, or donor may bring about beneficial use of the historical consumptive use of the leased, loaned, or donated water right downstream of the instream flow reach as fully consumable water are not relevant and do not apply to this acquisition.

28. In the event the Decree and this Agreement are inconsistent, the Decree shall control.

29. This Agreement shall be construed in accordance with the laws of the State of Colorado and shall be interpreted broadly to give effect to its purposes.

30. Any failure or delay by a party in exercising any of its rights, power, and remedies hereunder or in accordance with laws shall not lead to a waiver of such rights, and the waiver of any single or partial exercise of a party's rights shall not preclude such party from exercising such rights in any other way and exercising the remaining part of the party's rights.

31. Any notice, consent, waiver, request or other communication required or provided to be given under this Agreement shall be in writing and shall be sufficiently given and shall be deemed delivered when: (a) delivered personally; (b) transmitted by email to the then-designated address of the party, provided that a delivery receipt sent by the recipient is received by the sender, provided if the delivery receipt is sent on a non-business day, or after 5:00 p.m. local time at the physical address of the recipient, then the notice will be deemed received on the next business day; (c) two (2) business days after deposit with the United States Postal Service by certified or registered mail, return receipt requested, postage prepaid; or (d) one (1) business day following deposit with a nationally recognized overnight delivery service, in any event, addressed to the applicable party as set forth below, or at such address as either party may from time-to-time specify in writing to the other:

If to the CWCB:

Section Chief
Colorado Water Conservation Board
Stream and Lake Protection Section
1313 Sherman Street, Room 721
Denver, CO 80203
DNR_CWCBISF@state.co.us

and

Jen Mele
First Assistant Attorney General
Natural Resources and Environment Section
1300 Broadway, 7th Floor
Denver, CO 80203
jen.mele@coag.gov

If to PSCo:

Public Service Company of Colorado
Attn: Environmental Services
1800 Larimer Street, Suite 1300
Denver, CO 80202

and

Public Service Company of Colorado
Attn: Legal Dept. – Real Estate
1800 Larimer Street, Suite 1400
Denver, CO 80202

(303) 294-2222
Frances.A.Folin@xcelenergy.com

and

Welborn Sullivan Meck & Tooley, P.C.
Carolyn F. Burr, Esq.
James M. Noble, Esq.
1401 Lawrence Street, Suite 1800
Denver, CO 80202
(303) 830-2500
cburr@wsmtlaw.com
jnoble@wsmtlaw.com

If to the River District:

Colorado River Water Conservation District
General Manager
Andrew Mueller
201 Centennial St., Suite 200
Glenwood Springs, CO 81601
edinfo@crwcd.org

and

General Counsel,
Peter Fleming, Esq.
201 Centennial St., Suite 200
Glenwood Springs, CO 81601
(970) 945-8522
pfleming@crwcd.org

32. Each provision contained herein shall be severable and independent from each of the other provisions such that if at any time any one or more provisions herein are found to be invalid, illegal, or unenforceable, the validity, legality, or enforceability of the remaining provisions herein shall not be affected as a result thereof.

33. The effective date of this Agreement shall be the last date shown on the signature page or pages of this Agreement, provided however that parties' rights and obligations under this Agreement with specific regard to the exercise of the Shoshone Water Rights for instream flow purposes shall not commence until the closing date of the PSA. If the PSA is terminated according to its terms, then this Agreement shall also automatically terminate. This Agreement may be executed in two or more counterparts, each of which when so executed shall be deemed to be an original and all of which when taken together shall constitute one and the same instrument. The counterparts of this Agreement may be executed and delivered by electronic means (including portable document format) by either of the parties and the receiving party may rely on the receipt of such document so executed and delivered electronically as if the original had been received.

[remainder of page intentionally blank]

[signature page(s) follow]

IN WITNESS WHEREOF, the CWCB, the River District, and PSCo have executed this Agreement as of the last date of execution.

COLORADO WATER CONSERVATION BOARD

By: _____
Lauren Ris, Director

Date: _____

[signatures continue on next page]

[signature page to Water Right Dedication Agreement (Shoshone Water Rights)]

COLORADO RIVER WATER CONSERVATION DISTRICT

ATTEST:

By: _____
Andy Mueller, General Manager

BY: _____

Date: _____

[signatures continue on next page]

[signature page to Water Right Dedication Agreement (Shoshone Water Rights)]

PUBLIC SERVICE COMPANY OF COLORADO

By:_____
Robert Kenney, President

Date:_____

[signature page to Water Right Dedication Agreement (Shoshone Water Rights)]

Exhibit A
(Shoshone Diversion Dam and Tunnel)

Exhibit B
(Purchase and Sale Agreement)

COLORADO
Parks and Wildlife
Department of Natural Resources

Enclosure D1
Agenda Item 10.d
CWCB Board Meeting
May 21-22, 2025

May 6, 2025

Director Lauren Ris
Colorado Water Conservation Board
1313 Sherman Street, 7th Floor
Denver, CO 80203

Subject: Colorado Parks and Wildlife Recommendation on the Proposed Acquisition of an Interest in the Shoshone Hydroelectric Power Plant Water Rights

Dear Ms. Ris,

Colorado Parks and Wildlife (CPW) offers the following evaluation of the proposed instream flow (ISF) acquisition of water rights associated with the Shoshone Hydroelectric Power Plant, which are currently owned and operated by Public Service Company (PSCo), a subsidiary of Xcel Energy. The Colorado River District (CRD) is in the process of acquiring the Shoshone water rights and has proposed adding ISF as a beneficial use and making that water available to the Colorado Water Conservation Board (CWCB or Board) for the benefit of the aquatic ecosystem in the Colorado River. The CWCB will review this proposal and may accept an interest in the water rights through a two-board meeting administrative approval process, currently scheduled to commence in May. As required under CWCB's Instream Flow and Natural Lake Level Program Rules, CWCB has requested that CPW evaluate the aquatic benefits and provide recommendations on the proposed acquisition. CPW's perspective is offered under the mandate of our mission to perpetuate the wildlife resources of the state and provide enjoyable and sustainable outdoor recreation opportunities that educate and inspire current and future generations to serve as active stewards of Colorado's natural resources.

The Shoshone water rights include a 1250 cfs senior right with a 1905 priority date and a 158 cfs junior right with a 1940 priority date for a total decreed flow rate of 1408 cfs. The CRD is in the process of acquiring the Shoshone water rights from PSCo under procedures described in their Purchase and Sales Agreement executed in December 2023. If the CWCB votes to approve the acquisition by accepting an interest in the water rights, PSCo, CRD, and the CWCB will file a joint water court application to add ISF as a decreed beneficial use to the Shoshone water rights. Once a decree is obtained, the Shoshone water rights can be dedicated to CWCB to exercise ISF use

Jeff Davis, Director, Colorado Parks and Wildlife
Parks and Wildlife Commission: Dallas May, Chair · Richard Reading, Vice-Chair · Karen Bailey, Secretary · Jessica Beaulieu
Marie Haskett · Tai Jacober · Jack Murphy · Gabriel Otero · Murphy Robinson · James Jay Tutchton · Eden Vardy

when the rights are not used to generate hydropower. Furthermore, should the power plant be decommissioned, ISF use will become the sole beneficial use for the water rights. The reach defined for ISF use extends from the point of diversion for the hydroelectric plant at the Shoshone Dam approximately 2.4 miles downstream to the outfall of the power plant discharge outlets. This reach, referred to as the Shoshone Reach, will benefit from a donation of the full water right (up to 1408 cfs) when in priority and as dictated by the water court change case.

The Shoshone water rights have a significant influence on administration of the Colorado River due to their seniority, magnitude, and location. An administrative call of the Shoshone water rights has historically served as an important legal mechanism for water right curtailment on the upper Colorado River mainstem and its tributaries, with broad implications for flow management throughout the Upper Colorado River watershed. Given the age of the power plant and operational challenges, permanent preservation of the Shoshone water rights has been contemplated for decades and prioritized in numerous planning efforts. As entirely non-consumptive water rights, partnering with the CWCB to utilize the state's ISF acquisition tool and dedicating the rights to ISF use was identified as an appropriate legal mechanism to protect the rights in perpetuity.

In response to CWCB's request, CPW's offers the attached report which details our assessment, professional opinions, and recommendations on the proposal. The report includes details about several factors the Board must consider in evaluating the appropriateness of the acquisition, specifically the natural environment and whether that natural environment will be preserved and/or improved to a reasonable degree by the water available from the proposed acquisition. The Shoshone Reach of the Colorado River is a high-gradient, dangerous segment of river, so no fishery and habitat studies existed in the reach prior to 2023. CPW staff conducted fishery surveys to fill this data gap and coordinated with CRD and CWCB staff to assess flow-habitat relationships using two-dimensional hydraulic habitat modeling.

Based on these assessments, CPW concludes there is a flow-dependent natural environment that can be preserved and improved by the proposed acquisition. The water right preserves the historical flow regime in the Colorado River upstream while improving flows in the Shoshone Reach by adding additional wetted area and suitable fish habitat to a historically dewatered section of the Colorado River. The best use of this water is to preserve and improve the natural environment at any flow rate up to 1408 cfs, the amount decreed for the subject water rights. Additionally, hydraulic-habitat modeling shows that fish habitat improves in the Shoshone Reach at flows up to at least 3000 cfs. However, this upper threshold of 3000 cfs is based on the upper limit of the hydraulic-habitat model. It is also our professional opinion that flows

greater than 3000 cfs provide improvements to fish habitat, specifically by supporting important geomorphic functions and habitat maintenance. Based on professional expertise, flows greater than 3000 cfs maintain an aquatic food base, provide additional thermal refuge areas, and support fish passage. Given the anticipated biological benefits, CPW staff believes this acquisition will preserve and improve the natural environment to a reasonable degree and recommends the CWCB accept the interest in the acquired water. CPW staff will be available at the May CWCB meeting to address the benefits provided by the proposal and to answer any questions about the fishery and associated flow benefits of dedicating the Shoshone water rights to ISF use.

Sincerely,



Jeff Davis

Director of Colorado Parks and Wildlife

Biological Evaluation of the Shoshone Water Rights Instream Flow Acquisition



Colorado Parks and Wildlife

May 6, 2025

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1. Introduction

Built in the early 1900s, the Shoshone Hydroelectric Power Plant sits on the north bank of the Colorado River in the middle of Glenwood Canyon. Currently owned and operated by Public Service Company (PSCo), a subsidiary of Xcel Energy, the power plant and associated direct flow water rights are used to generate hydroelectric power by diverting flow from the Colorado River through two hydropower turbines. The water rights consist of a relatively senior water right with a 1905 priority date for 1250 cfs and a junior right with a 1940 priority date for 158 cfs. The combined total of 1408 cfs is decreed for non-consumptive beneficial use of power generation.

The seniority, magnitude and decreed use of these water rights, when combined with a call on the water right(s), have historically commanded water administration on the Colorado River. When a valid call is placed and administered at the Shoshone power plant, junior appropriators upstream are directed to curtail surface diversions or provide augmentation water to replace out of priority depletions to the calling right. Additionally, a Shoshone call dictates reservoir releases that supplement baseflows in the Upper Colorado River. During periods of low flows in the river, which can extend from the conclusion of spring runoff through the winter, the diversion is legally required to sweep, or divert the entirety of the river to place a call on the hydropower right. This administrative requirement results in the river channel being significantly dewatered for 2.4-miles between the Shoshone Dam and power plant outfall. Without the Shoshone call in place, junior appropriators are entitled to exercise their water rights, depleting streamflows throughout the Upper Colorado Basin and impacting many water rights, including instream flow (ISF) water rights held by the Colorado Water Conservation Board (CWCB).

The Colorado River District (CRD) is in the process of acquiring the Shoshone water rights from PSCo. In partnership with the CWCB, the CRD has proposed adding an ISF beneficial use to the water rights by filing a joint water court change case application. Once a decree is obtained, the Shoshone water rights can be dedicated to CWCB to exercise ISF use when the rights are not used or only partially used to generate hydropower. Furthermore, should the power plant be decommissioned, ISF use will become the sole beneficial use for the water rights. The reach defined for ISF use extends from the point of diversion for the hydropower plant at Shoshone Dam approximately 2.4 miles downstream to the power plant outfall (Map 1). This reach is referred to as the Shoshone Reach and is described in detail below.

CPW supports CWCB's ISF Program by providing biological and technical expertise and assists CWCB staff in making a determination of whether the natural environment will be preserved and/or improved to a reasonable degree by the water made available under the proposed acquisition. CPW staff use professional judgement and best available data to make that determination and in some instances collect additional biological data where little exists. The

Shoshone Reach of the Colorado River is a high-gradient, dangerous segment of river, so limited biological information existed in the reach prior to 2023. CPW reviewed existing data, collected additional data, and worked with CWCB, CRD, and consultants to develop additional studies for the proposed acquisition. The following report is CPW's evaluation of the proposed acquisition and CPW's recommendations to the Board pursuant to C.R.S.37-92-102(3).

2. Natural Environment & Biological Data

2.1 Natural Environment Overview

The Shoshone Reach of the Colorado River runs through the central portion of Glenwood Canyon, a confined canyon where the river over time carved a deep gorge that runs nearly 15-miles between 2,500 feet high walls of sedimentary rock. The canyon is a heavily trafficked corridor and the river and its floodplain are confined by Interstate 70, a streamside recreational path, and railroad. The river is heavily used by whitewater enthusiasts and floatboaters. In the Shoshone Reach, steep riverbed drops create renowned rapids for expert whitewater kayakers. Downstream of the outlet of Shoshone Power Plant, the Shoshone Rapids are targeted by private and commercial whitewater boaters spring through fall as flows allow. Immediately below the rapids, year-round casual and angler floatboating occurs from Grizzly Creek to Glenwood Springs. Throughout Glenwood Canyon, there are diverse outdoor recreational opportunities beyond river whitewater and floatboating including coldwater sportfishing, hiking, rock climbing, streamside bike and pedestrian trail use, vapor caves, and hot springs. These recreational opportunities provide the foundation of the local tourism-based economy.

The infrastructure and operation of the Shoshone water rights creates significant hydrological alteration to the Colorado River. The dam was constructed to impound and divert water for hydropower generation and creates a barrier to downstream sediment transport and upstream river connectivity for aquatic organisms, especially fish. For a Shoshone call to be administered the structure much divert the called priority water. This can result in the legal diversion of the entirety of the Colorado River when flows are less than 1408 cfs, which leaves the Shoshone Reach in a dewatered state. During seasonally low flows, the Colorado River flows are comprised of seepage from the dam (Photo 1), groundwater, and tributary inputs. Under these diminished flow conditions, aquatic habitat persists mainly in deep pools and glides that are isolated by steep boulder drops or shallow riffles that present passage challenges for fish. Aquatic organisms are impacted by habitat fragmentation and limited occupiable wetted habitat. Through the reach, there are many insurmountable drops created by the river gradient and large boulder constrictions. While the Shoshone water rights call may have specific localized impacts to the Shoshone Reach, there are broad benefits provided by the call in the form of flow supplementation to the Colorado River mainstem and its tributaries.

Despite the anthropogenic alteration of the Colorado River through Glenwood Canyon, the Shoshone Reach continues to support a variety of native and sport fisheries and some limited

riparian areas. Wildlife commonly encountered include bighorn sheep, river otters, beaver, Mule Deer, elk, Peregrine Falcons, and eagles. Riparian and upland plant communities generally consist of cottonwood and alder in the riparian areas, and oak, pine, spruce, fir, and aspen trees in the uplands. The unique canyon geology includes caves, springs, and geothermal outputs. The discrete and diffuse geothermal springs occur at the eastern and western ends of Glenwood Canyon, including one of the largest hot springs in the state of Colorado, Glenwood Hot Springs and in the popular Yampah Vapor Caves. These and other extraordinary values of the Colorado River between Gore Canyon and Glenwood Canyon qualify it as eligible for a federal Wild and Scenic Rivers designation.

2.2 Colorado River Fish Community

2.2.1 Fish Community Overview

The Colorado River hosts a diversity of native river fishes and abundant coldwater sportfishes. The native fish community inhabiting the Colorado River in proximity to and through the Shoshone Reach includes multiple cold and cool water species, including small-bodied sculpin and dace, and larger-bodied Bluehead Suckers, Flannelmouth Suckers, and Roundtail Chub, which are naturally adapted to a wide range of mainstem river habitats and water quality conditions. A variety of coldwater salmonid species, both native and introduced, comprise the sportfish community, including (in order of abundance): Brown Trout, Rainbow Trout, Mountain Whitefish, and Cutthroat Trout. The coldwater sportfish thrive in colder temperatures and clearer waters than Colorado River mainstem native fish, but are able to withstand some seasonal perturbations including warmer summer water temperatures and occasional sediment flows from monsoonal rains. CPW manages the Colorado River from its headwaters downstream to Rifle for coldwater sportfish, including the Shoshone Reach. Near Rifle, warmer river temperatures develop as well as increased turbidity. Critical Habitat begins at the Highway 13 bridge in Rifle for the federally listed Threatened and Endangered river fishes, Colorado Pikeminnow and Razorback Sucker, and farther downstream near the Utah Border for Bonytail Chub and Humpback Chub. The diversity of Colorado River fishes and their life history characteristics are sustained by the variety of habitats and dramatic landscapes that characterize the river corridor in Western Colorado.

The current State Wildlife Action Plan (SWAP) identifies wildlife conservation priorities of CPW and recognizes the Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub (collectively known as the “Three Species”) as Tier 1 Species of Greatest Conservation Need. In the Colorado River and its tributaries, the Three Species persist from higher elevation waters around 8,000 feet downstream to the western desert and canyon reaches where they overlap with the Colorado River Threatened and Endangered fishes. As documented in the 2019 Rangewide Three Species Conservation Agreement and Strategy (“2019 Conservation Strategy”), the Three Species have become increasingly rare with significantly reduced occupancy in less than 50 percent of their historic range. The dramatic decline of the Three Species in mainstem rivers is attributed to habitat degradation due to hydrologic alterations and reduced water availability because of water diversions, fragmentation and passage

impediments from dams and diversions, and the widespread invasion of nonnative fishes that either hybridize with (in the case of native suckers), compete with, or predate upon native fishes. The ability of the Three Species to exploit ephemeral and intermittent tributary habitats and the seasonal movements (some greater than 100 miles) performed by native suckers, allows for their long-term persistence in the Colorado River.

The Upper Colorado River is well suited to coldwater fishes in its cooler high-elevation climate sustained by winter snowpack that provides cold waters that surge seasonally as runoff or upwells through springs. The widespread introduction of several trout species, Brown Trout, Rainbow Trout, and Brook Trout, and their salmonid relative, Mountain Whitefish, began in the late 1800s in the Colorado River basin. In the 1940s, Colorado wildlife officials introduced the Mountain Whitefish, another Colorado native fish, from its indigenous waters in the Yampa River to the Roaring Fork River to increase diversity in angling opportunities. Expansion of whitefish into the Colorado River above Glenwood Canyon is limited by Shoshone Dam, as it provides a substantial barrier to upstream fish passage. Once the only trout in the Colorado River, native Colorado River Cutthroat Trout continue to use the Colorado River mainstem periodically, but primarily sustain their populations in cold tributary streams where they are better suited to high elevation and isolated habitats than the introduced trout species. Coldwater sportfish and sculpin are best suited to the coldwater reaches of the Colorado River where high seasonal flows and higher stream gradients maintain hydraulic conditions for the maintenance of preferred habitats for reproduction, growth, and forage.

Rainbow Trout and Brown Trout are the two most popular sportfish targeted by anglers in Colorado (2020 Colorado Angler Survey Summary Report). Prioritized for Wild Sportfish Management, CPW categorizes the Colorado River as “302 - Salmonid Recreation Stream” which specifies that the fishery consists of mostly wild-produced trout, with some stocking of Whirling Disease (WD) resistant Rainbow Trout fingerlings to overcome losses from the WD parasite. Increasingly successful, the current fishery management strategy allows CPW to designate the Colorado River in Glenwood Canyon as a Quality Trout Water, as it is considered a productive, quality fishery where anglers are likely to catch quality-sized trout (greater than 14 inches). Fishing the Colorado River is an enticing recreational opportunity that attracts visitors and residents to the area and generates millions of dollars for local economies annually. Small native fish (sculpin and dace) serve as a nutritious food source along with a healthy macroinvertebrate community to support the sport fishery, and the rare native fishes occasionally encountered by anglers while fishing for sportfish add unexpected and unique encounters.

2.2.2 Fish Survey Results

Recent CPW fish surveys in the Shoshone Reach of the Colorado River (November 2023 and October 2024) revealed a notably high abundance of desirable fish species. These efforts were the first documented fish surveys by CPW in this section of river. The sampling included both opportunistic capture surveys for presence detection (spot electrofishing) and a population

survey to estimate relative fish abundance and biomass. The November 2023 survey occurred during an extended period of time when the Shoshone power plant was inoperable (February 2023-August 2024), allowing more natural flow conditions. Due to flow conditions, the 2023 survey was limited to electrofishing along the banks and wadeable river margins. Spot electrofishing in 2023 detected the presence of Brown Trout and Rainbow Trout, confirming trout will migrate into and use the Shoshone Reach following a period of restored flows.

In October 2024, extensive spot surveys were conducted in the dewatered river channel after the power plant came back online. The 2024 spot electrofishing surveys demonstrated the extent of Brown Trout, Rainbow Trout, dace, sculpin, Mountain Whitefish, and Longnose Sucker (in order of relative abundance) and confirmed their presence throughout the 2.4-mile Shoshone Reach. In October 2024, CPW staff also conducted a depletion estimate to survey the population for the first time in order to assess fish abundance, biomass, and size class structure of the fishery (Photo 2). Fish captured during the survey include in descending order of abundance: dace, Brown Trout (Photo 3), Rainbow Trout (Photo 4), Mountain Whitefish, Longnose Sucker, Bluehead Sucker (Photo 5), and sculpin. Table 1 summarizes the Abundance (fish/acre), Biomass (pounds/acre), and Total Fish Length from tip of nose to tip of tail in inches calculated for each fish species encountered.

Table 1: Summary of Abundance (fish per acre), Biomass (pounds per acre), and the average and range of Fish Total Lengths (inches) for an October 23, 2024 survey in a dewatered Colorado River reach between Shoshone Dam and Shoshone Hydropower Plant near Flag Buttress.

Fish Species	**Abundance** fish/acre	**Biomass** pounds/acre	**Fish Total Length Mean (Min-Max)** inches
Brown Trout	205	205.1	11.3 (3.9 – 21.9)
Rainbow Trout	157	125.6	13.0 (8.2 – 15.6)
Mountain Whitefish	20	10.2	10.6 (5.6 – 12.3)
Sculpin *spp*.	6	--	3.4 (3.2 – 3.6)
Dace *spp*.	260	--	3.8 (1.9 – 5.2)
Bluehead Sucker	8	2.3	8.3 (7.7 – 8.9)
Longnose Sucker	14	7.1	10.7 (10.0 – 11.3)

2.2.3 Fishery Discussion & Conclusion

Low flows in October 2024 in the Shoshone Reach provided CPW an opportunity to thoroughly evaluate the fishery in the high-gradient, boulder-lined river channel that would otherwise be

inaccessible. Though significantly depleted from its natural flow condition, the residual stream was sustained by a minimal flow of water bypassing the dam, perennial tributary flow, and spring flows that maintained pools, riffles, and runs to harbor a notable abundance of fishes. The presence of sub-adult Bluehead Suckers and a variety of age-classes of trout suggests that some spawning occurs in this reach in either mainstem or proximal tributary habitats. Juvenile and adult fish are able to find refuge from aquatic and terrestrial predators in the channel's limited wetted area, specifically in small habitat features created by large boulders and in runs and pools that hold residual depth. Furthermore, the persistence of large trout supports quality angling opportunities in the canyon-bound river that benefits local communities that are sustained by tourism-based economies.

The adaptability of the Three Species to intermittent and seasonally dynamic river conditions allows for their persistence in an altered river system. CPW researchers have documented the use of small tributary habitat in the Colorado River basin (Thompson and Hooley-Underwood 2019), where naturally ephemeral and intermittent stream conditions are similar to those in the Shoshone Reach under current hydropower diversion operations. Within proximity to Glenwood Canyon, fishery monitoring reaches at Lyons Gulch (6 miles upstream), No Name (lower Glenwood Canyon), South Canyon (6 miles downstream), and New Castle (13 miles downstream) have detected the presence of at least one of the Three Species during each sampling occasion between 2008 and 2024, and CPW considers the Colorado River to be occupied Three Species habitat throughout Glenwood Canyon.

The recent population survey of the Shoshone Reach in October 2024 documented the presence of juvenile Bluehead Suckers. Bluehead Sucker are more likely to exploit the local canyon reaches, as they are more often found in higher gradient, swifter velocity habitats compared to the Flannelmouth Sucker and Roundtail Chub (Thompson and Hooley-Underwood 2019). In particular, juvenile Bluehead Sucker primarily consume macroinvertebrates as a food source (2019 Conservation Strategy), thus they are likely to exploit the Shoshone Reach year-round based on the 2024 CPW macroinvertebrate and fish surveys. Flannelmouth Sucker are confirmed to use the Shoshone Reach, as a CPW PIT-tagged fish from the Eagle River was detected by a PIT-tag antenna in Debeque Canyon approximately 90 miles downstream, requiring the fish to migrate downstream through the Shoshone Reach, including the power plant diversion infrastructure. Despite their rarity, Roundtail Chub are regularly detected in approximately 50 percent of surveys at three locations surrounding Glenwood Canyon – Lyons Gulch, South Canyon, and New Castle – all of which exhibit habitat characteristics (low gradient, more turbid water) preferable to Roundtail compared to high-gradient canyon reaches (2019 Conservation Strategy). All Three Species use Glenwood Canyon at least briefly to access or find refuge given the dynamic conditions that offer seasonally and spatially variable resources. Ensuring the permanency of historical flows available through the Shoshone water right and restoring instream flow to dewatered Shoshone Reach will support the continued persistence of the Three Species in the Upper Colorado River.

The Shoshone Reach of the Colorado River in Glenwood Canyon supports a high-quality fishery, even in its seasonally dewatered state with limited wetted habitat. During the

October 2024 survey, the Shoshone Reach had very low flow, as the majority of the natural river flow above Shoshone Dam was diverted into the hydropower plant. The reduced channel, despite appearing from a distance to be flowing at a mere trickle, provides enough holding habitat in deep pools and glides and offers large cover features to harbor both small and large river fishes produced in the full spectrum of waters and resources lower in Glenwood Canyon. As the water recedes from the Shoshone Reach with declining seasonal flows, smaller fish find habitats with favorable velocities and small pools to occupy between large boulders. Microhabitats that support small-bodied fish like dace persist between small substrates and also support macroinvertebrate and algae food sources. Large predatory trout will find desirable slower velocities in deep, boulder-lined runs and pools where they successfully use these habitats to make a living through the winter – finding cover from their predators and hunting for their own prey. As encountered in the fish survey, an abundance of small-bodied prey, including sculpin, dace, and juvenile trout and suckers will sustain larger predatory trout. Rainbow Trout can subsist on the abundance of macroinvertebrates, a preferred prey item, that concentrate into the reduced wetted channel. Few competitors will invade their occupied habitat, especially for the adult fishes, as large drops in the river channel once connected by water become insurmountable (Photo 6). The presence of a variety of age classes of fish indicate that some supplemental reproduction for Colorado River native and sportfish populations occurs in the Shoshone Reach, particularly following a period of restored flows.

2.3 Biocriteria & the Macroinvertebrate Community

2.3.1 Biocriteria Overview

Macroinvertebrate data can be used to evaluate the overall health of a waterbody and to analyze stressors to an aquatic ecosystem using “biocriteria” or aquatic life metrics. Water quality samples only represent a singular moment in time and provide limited information on the combination of pollutants and stressors affecting a biological community. In contrast, macroinvertebrates are the best single assemblage for bioassessment due to their generally short life spans of approximately a year, limited migration patterns, representation in most Colorado habitats, and ease of collection. Although the Colorado Department of Health and Environment (CDPHE) has macroinvertebrate data for the COUCUC03 segment of the Colorado River from the outlet of Lake Granby to below the confluence with the Roaring Fork River, no sampling stations exist in Glenwood Canyon. To fill this data gap and assess biocriteria for the Shoshone Reach, CPW staff collected macroinvertebrate samples in the Colorado River at a location below Devils Hole Creek (CRblwDH) on November 5, 2024. During the sampling event, flows were very low (approximately 50 cfs) as the Shoshone power plant was operating (Photo 8). LRE Water performed laboratory identification of the samples and ran a standard 300-count sub-sample of the macroinvertebrate data through Colorado’s Ecological Data Application System (EDAS) program. Based on the analysis, CRblwDH meets the state thresholds for macroinvertebrate health and biodiversity.

2.3.2 Macroinvertebrate Survey Results

The summary tables below reports the macroinvertebrate community metrics that the state considers when assessing a stream's macroinvertebrate community and potential impairment. Macroinvertebrate metrics and thresholds are described in CDPHE Policy 10-1. Colorado's multi-metric index (MMI) is a combination of macroinvertebrate metrics used to score sites from 0 to 100. The MMI score for CRblwDH is 64.3 which exceeds the state's threshold (greater than 45) and meets the threshold for a "High Scoring Water" (greater than 56). The two auxiliary metrics used by CDPHE are the Hilsenhoff Biotic Index (HBI) and Shannon Diversity Index (SDI). HBI is an indicator of how many pollution-tolerant insects occupy the site where higher scores indicate a pollutant-tolerant community. The HBI score for CRblwDH, 4.44, is below the state threshold of 5.8 and considered typical. The SDI metric quantifies community biodiversity, with high scores indicating a greater variety of species present in a range from 0 to 5. The SDI score for this site is 2.17, narrowly meeting the state's threshold of greater than 2.1.

Table 2: Macroinvertebrate metrics (MMI, HBI and SDI) for CPW's macroinvertebrate survey site (CRblwDH) in the Shoshone Reach

Station ID	Waterbody Name	Location	Latitude	Longitude	Collection Date	Biotype	MMI	Hilsenhoff Biotic Index (HBI)	Shannon Diversity Index
WQCC Policy 10-1						1 (Transition)	> 45	< 5.8	> 2.1
CRblwDH	Colorado River	Below Devil's Hole	39.57608	-107.20968	05-Nov-24	1	64.3	4.44	2.17

Additional metrics analyzed by CPW staff evaluate the presence of sensitive macroinvertebrate species belonging to the mayfly (*Ephemeroptera*), stonefly (*Plecoptera*), or caddisfly (*Trichoptera*) orders, also known as "EPT" taxa. The metric "% EPT non-*Baetidae*" indicates how many insects belong to the EPT orders excluding the *Baetidae* family. *Baetidae* are mayfly species that are pollution-tolerant, so they are intentionally excluded from this metric. At the CRblwDH site, approximately 90% of the individuals collected in the sample belong to EPT orders while only 25% of those species belong to the EPT category which excludes *Baetidae*, indicating that a vast majority of EPT individuals at this site were pollution-tolerant *Baetidae* species. The "% Intolerant taxa" category assesses the percentage of the sample with pollution-intolerant species. At the CRblwDH site, despite a high presence of *Baetidae* species, there is a strong presence of pollution-intolerant taxa with 39.1% of the sample belonging to that category. This sample had 23 total taxa present, which demonstrates the macroinvertebrate community is species-rich, thus considered to have relatively high biodiversity. Of the 23 taxa present, 11 taxa were EPT species. The final metric assessed by CPW is sediment Tolerance Index Value (TIV) to characterize the sediment tolerance of the macroinvertebrate community on a ranking of 1 to 10. The sediment TIV score for this site is 5.62, meeting the threshold of less than 7.2 for this region. The relatively high abundance of sediment-sensitive macroinvertebrate species indicates that fine sediments are relatively low in the Shoshone Reach, which is expected in a high-gradient transport reach with an upstream on-channel dam.

Table 3: Additional macroinvertebrate metrics assessed for CPW's macroinvertebrate survey site (CRblwDH) in the Shoshone Reach

Station ID	Waterbody Name	Location	EPT % non Baetidae	% EPT	% Intolerant Taxa	Total Taxa	EPT Taxa	Sediment TIV
CRblwDH	Colorado River	Below Devil's Hole	24.7	90.5	39.1	23	11	5.62

2.3.3 Macroinvertebrate Community Discussion & Conclusion

All indices demonstrate Aquatic Life Use attainment at this site for the macroinvertebrate community despite dewatered conditions leading up to and during the sampling event. Approximately three months of extended dewatering occurred prior to sample collection. The sample was collected in a portion of a riffle where perennial water in a low-flow channel likely persists year-round despite the diversions into the power plant (Photo 9). Even under these low flow conditions, CRblwDH is meeting and even surpassing select thresholds for macroinvertebrate health and biodiversity in the low-flow channel. This indicates both good habitat and water quality are maintained in the consistently wetted portions of the channel. When Shoshone is operational and diverting, insects entrained in the river bed outside of the low-flow channel may perish as the channel dries. Several macroinvertebrate families within the orders of stonefly (6 families) and caddisfly (5 families) are present in the Colorado River upstream of Shoshone at a survey site sampled by Timberline Aquatics near Sweetwater, but are missing in the river below Shoshone Dam (GEI, 2025). Both stoneflies and caddisflies make limited movements and live attached to or under rocks. As the waters recede, they will become stranded. This is one explanation for the low SDI score and low percentage of EPT non-*Baetidae*. The missing families would likely occupy this segment of the Colorado River if there were consistent flow throughout the channel, and they may recolonize if consistent flows return.

With an overall diverse population of macroinvertebrates in the low-flow channel, the macroinvertebrate community in the Shoshone Reach has potential to improve. The current resident community of insects serves as a population center that would expand as the wetted channel area increases with additional flow. Particularly during the winter, additional flows will result in less anchor ice within the canyon, which will likely improve the macroinvertebrate community diversity. With fluctuating river flows, fish can move in to the Shoshone Reach when flow increases, but food may be limited in rewetted habitat if the majority of insects persist in the perennial low-flow channel. A healthy and diverse macroinvertebrate community is a crucial component of the ecosystem and indicates potential for healthy fish populations.

3. Instream Flow Evaluation & Flow-Habitat Relationships

3.1 Instream Flow Evaluation Overview

CPW supports CWCB's ISF Program by providing biological and technical expertise and assists the CWCB in making a determination of whether the natural environment will be preserved and/or improved to a reasonable degree by the water made available under the proposed acquisition. CPW staff use professional judgement and best available data to make that determination and in some instances may collect additional biological data to fill data gaps. No fishery or habitat studies existed in the Shoshone Reach prior to 2023 because its gradient and occasional high flows often make it inaccessible and dangerous. In addition to fisheries sampling conducted in 2023 and 2024, CPW staff recommended collecting data necessary for an instream flow evaluation using the Instream Flow Incremental Methodology (IFIM). IFIM is a widely accepted method used to quantify how hydraulic habitat attributes relevant to fish vary with flow over a representative reach. The two-part modeling approach uses habitat suitability criteria (HSC) indices and hydraulic modeling to evaluate habitat suitability as a function of discharge for specific aquatic species. IFIM has been widely used in Colorado for instream flow evaluations on large and complex rivers, namely the Dolores River, San Miguel River, Cache La Poudre River, Blue River, and Colorado River between Kremmling and Dotsero. The IFIM methodology uses a hydraulic model, paired with HSC for fish species and life stages of interest. Habitat suitability for hydraulic variables of depth and velocity, and sometimes substrate and cover, are combined into a composite score which can be summed over the representative study reach to calculate the area of suitable habitat, also known as weighted usable area (WUA). WUA is a measure of suitable fish habitat that varies as depth and velocity change with discharge.

3.1.1 Overview Freshwater Consulting Habitat Modeling – 2023-24

In November 2023, CRD contracted with two consulting firms, River Restoration and Freshwater Consulting, to evaluate hydraulic habitat-flow relationships in the Shoshone Reach using IFIM.

Two-dimensional (2D) hydraulic modeling was performed by River Restoration using SRH-2D on a representative reach of the Colorado River. The study reach, referred to as Site 1, measured 1850 feet long with an upper terminus approximately 0.5-mile downstream of the Shoshone Dam. Site 1 includes two large pools divided by riffle. Freshwater Consulting conducted habitat suitability analysis using a spreadsheet-based model and output from the 2D hydraulic model. Suitable habitat area was modeled for flows between 50 and 3000 cfs for four focal species in their adult life stage – Brown Trout, Rainbow Trout, Mountain Whitefish, and Flannelmouth Sucker. The seven selected flow rates modeled were 50, 250, 700, 1020, 1250, 1400, and 3000 cfs.

CPW reviewed and participated in the initial model scoping and selection of appropriate focal species and associated HSC. Site-specific HSC are derived from direct observations of actual

fish locations within river habitats. In the Shoshone Reach, deriving site-specific HSC was not possible due largely to safety concerns given dangerous river hydraulics, as well as time limitations. It is standard and accepted practice to use existing HSC from literature or comparable studies based on professional judgement when site-specific HSC is not possible. For the Shoshone Reach, HSC used previously for the Colorado River Wild and Scenic reach were adapted to include fish habitat preferences that are unique to a high-gradient, canyon study area such as the Shoshone Reach, namely deep pools. Adult life stages were selected because the characteristics of the canyon generally favor these larger-bodied, mature species.

3.1.2 Results Freshwater Consulting Habitat Modeling – 2023-24

Results summarized below are from the September 30, 2024 Freshwater Consulting Report. Results show that suitable habitat area (or WUA) increases rapidly between 50 to 700 cfs for all species. For the salmonid species (Brown Trout, Rainbow Trout, and Mountain Whitefish), WUA continues to increase precipitously up to 1020 cfs. Maximum WUA occurs at 1020 cfs for Brown Trout, 1400 cfs for Rainbow Trout, 1250 to 1400 cfs for Mountain Whitefish, and 700 cfs for Flannelmouth Sucker. Habitat suitability for Flannelmouth Sucker is lower than the other species overall and declines at flows greater than 700 cfs. This is because the preferred depth of Flannelmouth Sucker ranges between 1 to 4 feet with declining suitability at depths greater than 4 feet. Alternatively, HSC for salmonid species are high for depths 10 feet and greater. Given the abundance of deep water in the pool and run habitats that dominate Site 1, these flow-habitat relationships are explained.

Overall WUA, calculated by averaging the results of the four fish species, is maximized at 1250 cfs with modest declines at flows in the 1400 to 3000 cfs range. The decline in WUA at flows greater than 1400 cfs is driven in large part by high water velocities that are less suitable for all species. The initial results for Site 1 show the highest habitat availability for Brown Trout and Rainbow Trout, Mountain Whitefish, and Flannelmouth Sucker at flows in the range of 700 to 1400 cfs. The results show modest declines in suitable habitat between 1400 and 3000 cfs, although there is still suitable habitat available for fish species at higher flows. As incremental flows between 1400 and 3000 cfs were not assessed by Freshwater Consulting, it is difficult to directly evaluate the relationship between these higher flows and WUA.

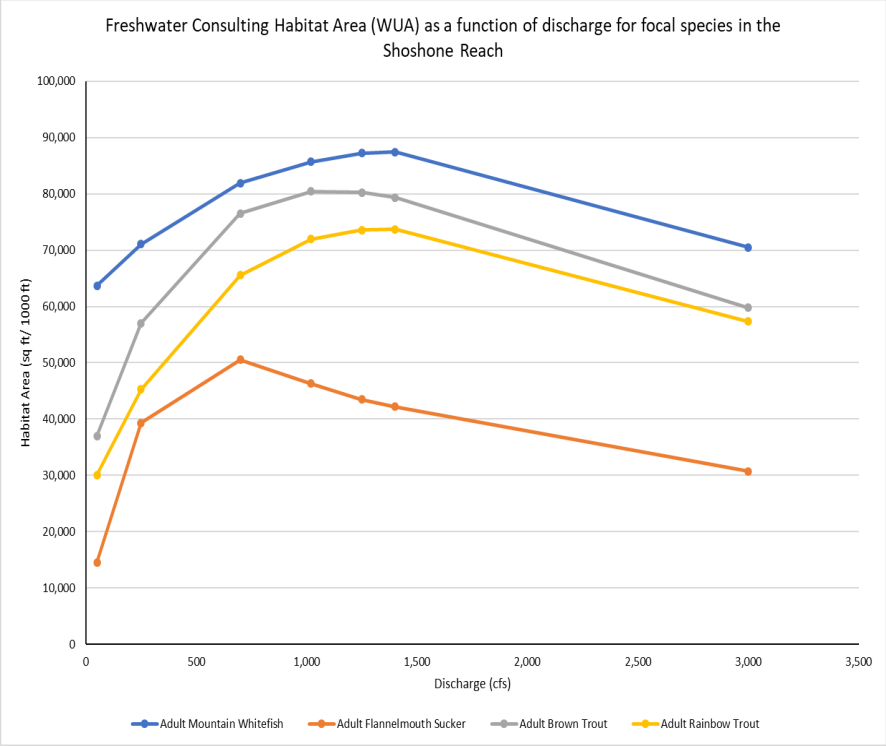


Figure 1: Freshwater Consulting assessment of Weighted Usable Area (WUA, square-feet per 1000 linear-feet of stream) across a range of river flows (cubic feet per second, CFS) for Site 1 in the Shoshone Reach of the Colorado River for four focal fish species.

3.2 Hydraulic Habitat Model Limitations

The Shoshone Reach is a high-gradient confined canyon with highly variable streambed roughness, water depths, and velocities (GEI, 2025). Within Colorado, there are multiple examples of canyon reaches like the Shoshone Reach supporting dynamic and high quality habitats for coldwater sportfish such as Brown Trout and Rainbow Trout, including the No Name Reach on the Colorado River, Gunnison Gorge on the Gunnison River, and Cheesman Canyon on the South Platte River. This is evidenced in abundance and biomass metrics documented in CPW fish surveys. Like the Shoshone Reach, many portions of these river reaches have hydraulic conditions that limit surveying efforts or make them impossible due to safety concerns. Complex hydraulics in canyon reaches like the Shoshone Reach also present nuanced fish habitat use that can be over-simplified by hydraulic habitat modeling.

The Freshwater Consulting results were developed from a single site with somewhat homogenous habitat features and a relatively coarse spatial resolution with a grid size of approximately 4 x 4 feet. While this grid size is appropriate for IFIM, it is unable to represent all microhabitat refugia used by fish. Site 1 is a pool dominated reach with two large pools divided by a boulder and cobble riffle. The reach was bound on the downstream end by a rapid created by an alluvial fan from Devils Hole Creek. This reach was selected for the survey because of surveyor safety concerns given hydraulic conditions at the time of the

survey. The limited hydraulic habitat perspective did not account for more complex habitat features present in the Shoshone Reach that are exploited by fish.

Much of the usable fish habitat in the Shoshone Reach, especially at higher flows, is in the form of velocity refuges created by variable bed substrate, large boulders, and the boundary layer of the streambed. 2D models simulate hydraulics in lateral and longitudinal directions, producing depth-average values for water velocity that moderate the variability in velocity throughout the water column. The use of depth-average velocity to calculate habitat suitability underestimates the amount of suitable habitat available in streambeds, particularly in rivers with high roughness like the Shoshone Reach of the Colorado River. Microhabitats and near-bed features used by fish are not captured with the depth-average velocities produced by the hydraulic model. Water velocities are typically lowest along the stream bed, and the variability in channels with high roughness will be even more pronounced. In channels with high roughness, actual velocities along the stream bed can be 40 to 60% lower than the depth-average velocity. Therefore, habitat suitability models which rely on depth-average velocity do not account for fish-favorable velocities in roughness features. In the Shoshone Reach, this likely resulted in an underestimate of suitable fish habitat.

3.2.1 Overview Ecosystem Sciences Habitat Modeling – 2024-25

During fall 2024, CRD contracted River Restoration and Ecosystem Sciences, an Idaho consulting firm, for additional modeling to better understand the relationship between fish habitat and flows in the Shoshone Reach. During the fall and winter of 2024-25, River Restoration and Ecosystem Sciences performed fieldwork to assess a second study site (Site 2) and address the limitations in the initial analysis. The addition of Site 2 increased the spatial coverage of the hydraulic habitat model and introduced increased channel complexity and habitat features into the model. The upper terminus of Study Site 2 is immediately downstream of Site 1 and the reach is approximately 1830 feet long. Site 2 is lower gradient and less constrained with a greater variety of habitat features, including a split-channel island, more variety in the bed composition, and complex riffle, run, and pool habitats. Adding Site 2 increased the total spatial representation of habitat evaluated to include approximately 29% of the Shoshone Reach. Lastly, five additional higher flow rates were also modeled for both sites to develop a better understanding of the habitat-flow relationships between 1500 and 3000 cfs. For the 2024-25 modeling effort, habitat suitability was evaluated at flows of 50, 250, 700, 1020, 1250, 1400, 1500, 1750, 2000, 2250, 2500, and 3000 cfs.

3.2.2 Results Ecosystem Sciences Habitat Modeling – 2024-25

Results summarized below are from the April 22, 2025 Ecosystem Sciences report. Results for Site 1 assessed by Ecosystem Sciences (Figure 2) demonstrate a similar trend to the Freshwater Consulting results (Figure 1) with steep increases in WUA for each species between 50 and 700 cfs. For Brown Trout and Rainbow Trout, WUA continues to increase sharply until 1020 cfs. Maximum WUA occurs at 2250 cfs for Brown Trout and Rainbow Trout,

2000 cfs for Mountain Whitefish, and 1500 cfs for Flannelmouth Sucker. Overall WUA is maximized at 2250 cfs. Above 2250 cfs, WUA generally plateaus and slightly declines between 2500 and 3000 cfs. This differs from the Freshwater Consulting Site 1 evaluation, but it is difficult to compare the two because incremental flows between 1400 and 3000 cfs were not evaluated by Freshwater Consulting.

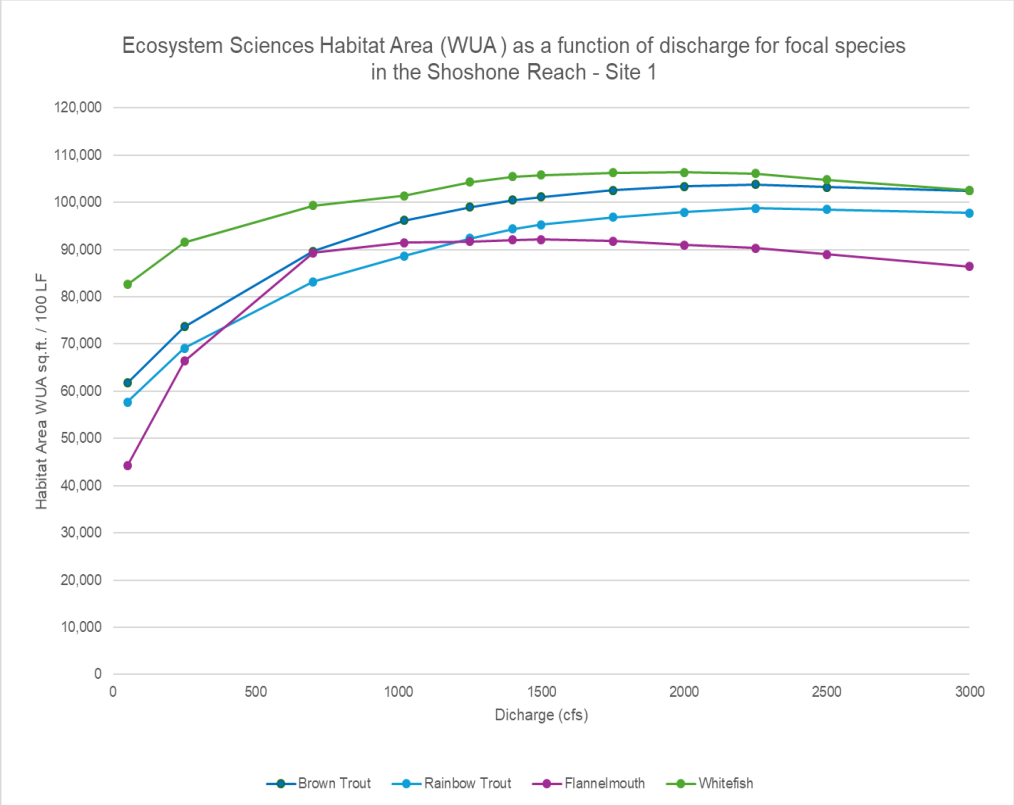


Figure 2: Ecosystem Sciences assessment of Weighted Usable Area (WUA, square-feet per 1000 linear-feet of stream), across a range of river flows (cubic feet per second, CFS) for Site 1 in the Shoshone Reach of the Colorado River for four resident fish species.

Results for Site 2 (Figure 3) demonstrate a trend of gradual and consistent increases in WUA for all four species as flows increase (as compared to the dramatic increase followed by a plateau in Site 1). Site 2 has a less constrained channel and floodplain compared to Site 1. Site 2 has more habitat complexity and depositional features that create a mid-channel island that splits the river at lower flows. Site 2 also contains deep pool and shallow riffle features similar to Site 1. For the four species evaluated, maximum WUA occurs at relatively high flows with a maximum WUA at 3000 cfs for the salmonid species and 2000 and 3000 cfs for Flannelmouth Sucker. Benefiting from the hydraulic complexity within Site 2 and supporting their lower depth and velocity preferences, WUA for Flannelmouth Sucker is greatest at Site 2. As flows increase in Site 2, portions of the islands inundate, and the split channels expand and connect, increasing the variety of depth and velocity conditions suitable for Flannelmouth Sucker. Conversely, for adult salmonids, WUA is lower at Site 2 than Site 1, though Site 2 still contains important habitats.

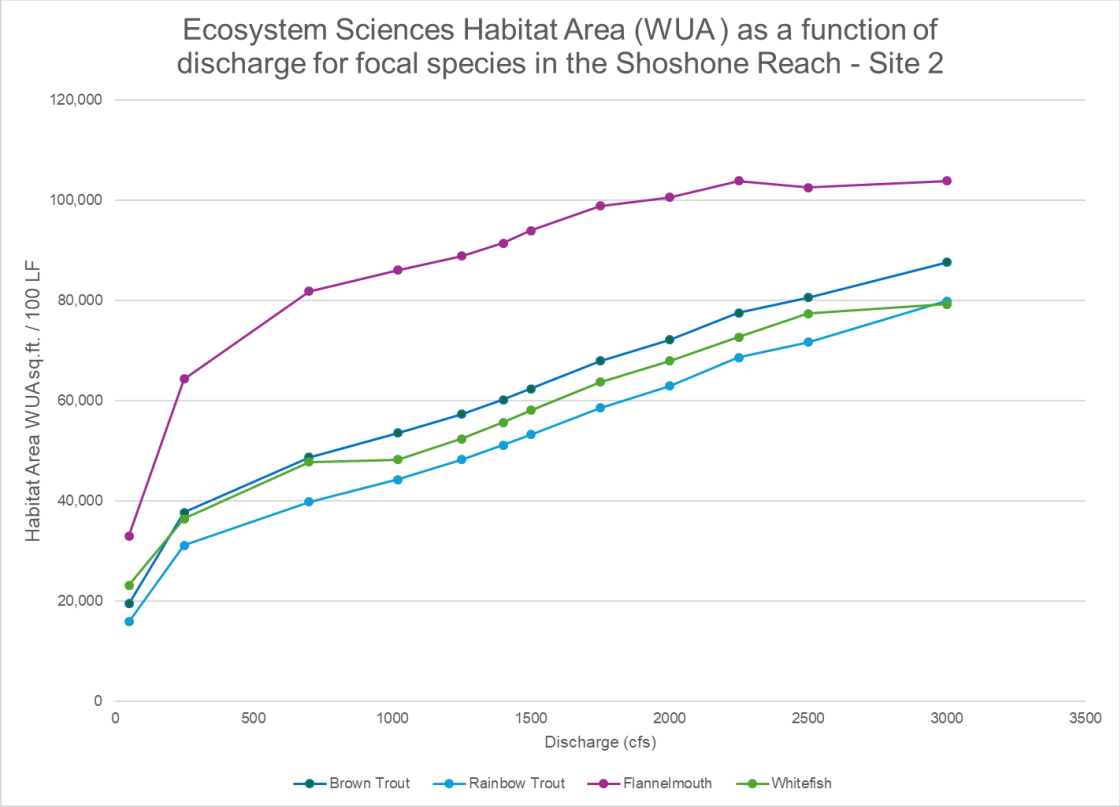


Figure 3: Ecosystem Sciences assessment of Weighted Usable Area (WUA, square-feet per 1000 linear-feet of stream), across a range of river flows (cubic feet per second, CFS) for Site 2 in the Shoshone Reach of the Colorado River in Glenwood Canyon for four resident fish species.

Adult life stage species were the focus of the habitat modeling because of complex hydraulic conditions in the Shoshone Reach. While not specifically modeled, juvenile trout will benefit from the same lower velocity, shallow habitats that benefit Flannelmouth Suckers. These conditions provide suitable rearing conditions for juvenile trout. Spawning habitat was not explicitly modeled but gravel bars provide spawning habitat for fish including Bluehead Suckers and Flannelmouth Suckers at a wide range of flows. Gravel bar deposits are present around the island features at Site 2 and is where Brown Trout redds were observed in late Fall 2024 (Photo 7).

3.2.3 Addressing Modeling Limitations

The Shoshone Reach is a high-gradient river with highly variable streambed roughness, water depths, and velocities which contributed to high velocities represented by the hydraulic model that under-represented actual suitable fish habitat availability. To address this issue, Ecosystem Sciences used an additive model to estimate the composite habitat suitability by adding depth and velocity suitability for each cell from the hydraulic model. Conversely, Freshwater Consulting used computations that multiplied depth and velocity suitability to estimate the composite habitat suitability score for each cell. The limitation of the multiplicative approach for composite suitability is that high depth-average velocities will result in low or zero habitat suitability scores for areas where suitable velocities are actually

present along the rough streambed. In Freshwater Consulting's computations, velocity suitability scores of zero will drive the overall habitat suitability to be deemed unsuitable. This misrepresents velocity refuges used by fish and underestimates suitable habitat because in reality suitable velocities exist along the streambed in roughness features. In fact, a substantial amount of these roughness features exist in the Shoshone Reach due to the highly variable substrate, velocities, and depths (GEI, 2025). Therefore, suitable habitat is under-represented by traditional IFIM modeling computations in steep canyon reaches like the Shoshone Reach. When using an additive model to estimate habitat suitability to account for a high degree of roughness in the channel, WUA results account for microhabitat features that provide important fish habitat.

3.3 Discussion and Conclusions on Flow-Habitat Relationships

Given the limitations and uncertainties discussed above, it is helpful to review the results from the Freshwater Consulting and Ecosystem Sciences reports in conjunction with one another. Freshwater Consulting used a more traditional approach for IFIM that multiplied depth and velocity suitability to estimate the composite habitat suitability and associated WUA. As previously discussed, this approach likely underestimated suitable habitat used by fish in the Shoshone Reach due to the use of depth-average velocity, particularly at higher flows. The Freshwater Consulting results indicate that overall WUA was highest between 1250 to 1400 cfs at Site 1 when averaged across the four fish species. Overall WUA increased steeply from 50 to 700 cfs before plateauing between 1020 and 1400 cfs and then declining from 1400 to 3000 cfs. As no flow values were evaluated between 1400 and 3000 cfs, it is not clear how WUA changed in between these values.

The Ecosystem Sciences report analyzed WUA at two sites within the Shoshone Reach, including the same site evaluated by Freshwater Consulting (Site 1), using an additive approach for estimating composite habitat suitability from modeled water depths and velocities. This approach was intended to address the aforementioned limitation of using depth-average velocity to calculate the composite habitat suitability. When averaged across all species, WUA peaked at 2250 cfs at Site 1. Similar to the Freshwater Consulting results, WUA increased sharply for all species between 50 and 700 cfs. WUA then increased gradually between 700 and 2000 cfs, and declined slightly between 2250 and 3000 cfs. At Site 2, there was a very steep increase in WUA between 50 and 250 cfs and a more moderated increase between 250 and 700 cfs when averaged across species. WUA then increased steadily from 1020 to 3000 cfs with no evidence of a distinct plateau.

When considered together, the habitat suitability studies by Ecosystem Sciences and Freshwater Consulting indicate that using the Shoshone water rights of 1250 and 158 cfs for a total of 1408 cfs would benefit fish habitat, as WUA consistently increased at both sites from 50 to 1400 cfs on average. However, the two reports differ in what happens to WUA above 1400 cfs. The Freshwater Consulting report indicates the WUA declines at 3000 cfs. In contrast, the Ecosystem Sciences report indicates that WUA continues to increase (Site 2) or remain relatively stable (Site 1) for flows greater than 1400 cfs. Given the limitations of

using depth-average velocity to estimate the total amount of suitable habitat in the Shoshone Reach, which provides complex and dynamic conditions that support fish, it is likely that habitat suitability does not decrease significantly as flows increase up to 3000 cfs due to the presence of lower velocities near roughness features.

3.3.1 Other Considerations in Assessing Flow-Habitat Relationships

With regard to suitable habitat, the importance of deep pools in habitat suitability models is often underestimated and modifications for the presumed importance of deep pools in the Shoshone Reach are substantiated by CPW research. Recent CPW research shows that residual pool depth is the most important physical habitat variable driving Brown Trout population biomass. Additionally, this research shows that Quality Brown Trout were only present in pools with depths of 3 feet or greater and total fish biomass increased with increasing residual pool depth (Kondratieff and Richer 2022). In addition to this research, many other studies from Colorado rivers have shown the value of deep pools in providing important habitat functions for native Cutthroat Trout and Mountain Whitefish, such as depth cover, overwinter and low-flow refugia (Harig et al. 2000, Behnke 2002, Beinstadt et al. 2004). Important pool habitat exists in the Shoshone Reach even under dewatered conditions. Additional water provided by the instream flow acquisition will support refreshening flows to maintain these pool habitats.

High flows provide important geomorphic and ecological functions related to sediment transport and habitat for benthic macroinvertebrates. Flushing fine sediment is critical to maintain habitat for fish and macroinvertebrates, especially in locations that receive episodic sediment inputs, which has been a recurring issue in Glenwood Canyon following recent wildfires. As wetted area increases with discharge, there is more habitat available for macroinvertebrates, the primary prey resource for the fishery. Higher flows may also activate new pathways through high-gradient rapids and steep drops, which could improve conditions for fish movement in some locations, providing access to a more optimal refuge habitat. The combination of increasing WUA and improved geomorphic and ecological functions indicates that using the Shoshone water rights for instream flow would be beneficial for the fishery in the study reach.

Instream flows in the Shoshone Reach will increase suitable habitat for coldwater sportfish and native species. Recent habitat suitability studies have demonstrated that when greater flows are present, the amount of usable habitat for Rainbow Trout, Brown Trout, and Mountain Whitefish increases substantially up to 1400 cfs (Freshwater Ecosystems 2024 and Ecosystem Sciences 2025) and will improve or maintain habitat to flows approaching 3000 cfs (Ecosystem Sciences 2025). Restored instream flows in the Shoshone Reach will increase wetted habitat area for fish and macroinvertebrates and will maintain pool depths that provide important cover and refugia in the Shoshone Reach, which, based on these corroborating studies, will promote increased fish abundance and enhanced angling opportunities for Quality Trout.

4. Colorado River System Assessment

In addition to benefitting the natural environment within the Shoshone Reach, the proposed acquisition will provide benefits throughout the Upper Colorado River by providing a call that maintains the historic flow regime and will continue to support the quality of fisheries. The following sections describe the benefits provided by the Shoshone water rights beyond the benefits to the Shoshone Reach.

4.1 Upper Colorado River Wild and Scenic Reach

Four segments of the Colorado River from Kremmling to No Name Creek in Glenwood Canyon (Map 2) were identified by the Bureau of Land Management (BLM) and U.S. Forest Service White River National Forest (WRNF) as eligible for inclusion in the Wild and Scenic Rivers system due to their Outstandingly Remarkable Values (ORVs). ORVs are unique or exemplary river-related values highlighted for protection for future generations. Within the Colorado River, the specific values include fishing, boating, scenic viewing, hiking, and geological features. The Wild and Scenic designation comes with protections from significant future channel and streamside development and can include federally-held water rights. Due to competing water needs and development in the Colorado River, a stakeholder group was formed to develop a plan to protect and enhance these values in lieu of a federal Wild and Scenic designation. The Upper Colorado River Wild and Scenic Stakeholder Group (SG) includes both east and west-slope water providers, local interests, environmental groups, and state agencies. The SG adopted a Wild and Scenic alternative management plan with the goal of protecting the ORV's without limitations imposed by the federal designation and water right. CPW is a cooperating agency in the SG Plan and participates in large part because the fishery in the Colorado River between Kremmling and Glenwood Springs is an important recreational asset with a high number of Quality Trout markers, high biomass, and high usage, the foundation of the Fishing ORV. CPW's fishery management goals include managing for desirable species of Brown Trout, Rainbow Trout, Mountain Whitefish, Bluehead Suckers, Flannelmouth Suckers, Roundtail Chub, sculpin, Speckled Dace, and Cutthroat Trout. Long-term fishery monitoring sites were established by CPW in 2008 throughout the Upper Colorado River Wild and Scenic reach to monitor fish population metrics and ensure that the Fishing ORV is protected (Map 3).

A key component of the SG Plan is "Long-Term Protection Measures" identified by the SG to provide for significant protection of the ORVs. The SG Plan specifically identifies the Shoshone water rights as critical to maintaining streamflows and protecting the ORVs in the Colorado River by calling water through the upstream Wild and Scenic segments to the power plant. According to the SG Plan, "this administrative call generally results in stream flow through the subject stream segments in amounts greater than would exist in the absence of the administrative call." Securing ISF water rights decreed to the CWCB was another key component to protecting ORVs on the Colorado River between Kremmling and Dotsero. In 2013, three ISF reaches were appropriated by CWCB on the Colorado River between the Blue River and the Eagle River confluence. CPW was involved in the quantification of these ISF segments and their associated flow rates. In addition to helping maintain flow-related ORVs,

the senior call by the Shoshone water rights helps to satisfy the CWCB's ISF rights, which are junior in priority. Maintaining adequate streamflows is crucial for supporting streamflow-influenced ORVs, specifically recreational fishing, floatboating, wildlife, botanical, and scenic qualities.

Table 4: Decreed ISF rights in the Wild and Scenic reach of the Colorado River

Segment	Decreed flow rates (cfs)	Priority Date
Colorado River between Blue River and Piney River	750 cfs (8/1 – 9/15) 500 cfs (9/16 – 5/14) 600 cfs (5/14 – 7/31)	07/12/2011
Colorado River between Piney River and Cabin Creek	800 cfs (8/1 – 9/15) 525 cfs (9/16 – 5/14) 650 cfs (5/15 – 7/31)	07/12/2011
Colorado River between Cabin Creek and Eagle River	900 cfs (5/15 – 6/15) 800 cfs (6/16 – 9/15) 650 cfs (9/16 – 5/14)	07/12/2011

4.2 Temperature Exceedances

Maintaining adequate seasonal streamflows is not only crucial for preserving ORVs but also plays a significant role in regulating water temperature. The Upper Colorado River's water temperature is influenced by seasonal precipitation, ambient air temperature, and flow conditions. The river flowing downstream from higher to lower elevation climates influences the natural warming trend from Kremmling to Glenwood Springs, with peak runoff periods temporarily moderating temperature differences along the stream gradient with high snowmelt flow volumes. During late summer and early fall, heat accumulation becomes more pronounced, particularly during low flow periods and when upstream reservoir releases are minimized. According to data reported annually by the SG, acute temperature standard exceedances did not occur between 2021 and 2025, as measured by the Daily Maximum (DM) temperature. However, chronic temperature standards exceedances (maximum weekly average temperature, MWAT) are a recurring issue across wet, dry, and average year-types during summer months. In 2023, an average water year, exceedances of the chronic temperature standard occurred upstream near Catamount and Red Dirt Creek beginning in early August and chronic temperature exceedances in Glenwood Canyon persisted for 3 to 4 weeks. In 2024, a wet water year, chronic temperature standard exceedances returned at Catamount and extended downstream through Glenwood Canyon from July through August, enduring for 2 to 3 weeks between Catamount and Red Dirt Creek and extending nearly 6 weeks from Dotsero to Glenwood Springs. Chronic temperature exceedances indicate repeated and extensive thermal stress is occurring in coldwater fishes during the summer months. Additional stresses such as hooking and handling stress from anglers or sediment

caused by monsoonal rain events, can create compounding impacts to fish health and mortality.

In 2010, CDPHE identified a reach of the Upper Colorado River from Kremmling to the Roaring Fork River on Colorado's Section 303(d) List of Impaired Waters due to repeated temperature exceedances that impair Aquatic Life Use (CDPHE Regulation #93). CDPHE identifies this segment at the lowest level of attainment, #5 - Impaired without a Total Maximum Daily Load (TMDL) plan, thus it has been a High Priority for TMDL development. In December 2024, CDPHE finalized Regulation #33 to create distinct water quality standards for the Upper Colorado River Basin. Regulation #33 specifies that temperature should maintain normal diurnal and seasonal fluctuations with no abrupt changes and not increase temperature at a magnitude, rate, and duration deemed deleterious to the resident aquatic life. The regulation sets temperature standards for the segment of the Colorado River between its confluence with the Blue River and the Roaring Fork River that are an amalgamation of Coldwater Stream temperature standards similar to those developed for Tier 1 species (Brook Trout & Cutthroat Trout) and Tier 2 species (other coldwater fishes) species depending on season.

Since the temperature impairment listing, stressful summer water temperatures above 70°F for coldwater sportfish in the Colorado River have become increasingly frequent. Seasonally high water temperatures resulting from low flows and hot ambient air temperatures can cause stress that impacts fish health, spawning success, and increases disease and mortality. Sediment flows from summer monsoonal rains can amplify physical stress on fish directly through tissue abrasions on skin and gills, and indirectly by enhancing solar radiation on the turbid waters. During sustained periods when daily water temperatures peak above 70°F and fish stress, disease, or mortality is observed in areas of moderate to high angling pressure, CPW implements voluntary fishing closures informing anglers not to fish in affected river reaches to protect local coldwater sportfisheries. Mountain Whitefish appear to be the most sensitive to summer stressors as mortalities with high temperatures, handling stress, and sediment events are documented more frequently than other fishes. Furthermore, their once notable spawning runs are significantly diminished in Grizzly Creek and No Name Creek in Glenwood Canyon. These same factors affect Rainbow Trout and Brown Trout where CPW has documented disease outbreaks and physiological stress from low water and high temperatures cause ubiquitous lesions and fungal infections on unusual numbers of trout and furunculosis outbreaks in the Eagle River, a tributary in close proximity to Glenwood Canyon.

Adequate and reliable river flows associated with the Shoshone call can help maintain water temperatures for popular coldwater sportfish. When ambient air temperatures are high in the late summer, additional flows can help mitigate excessive river warming. Greater flows not only moderates temperature effects directly, but it can also increase available wetted habitat, alleviate fish crowding, which reduces stress and disease transmission, and improves river connectivity to allow fish to move to more optimal habitat conditions elsewhere. In addition to Long-Term Protection Measures identified by the SG to protect the ORVs, the SG has identified Tier 2 "Cooperative Measures" which are voluntary actions to improve stream

conditions to protect the ORVs. Strategic releases from upstream reservoirs have been implemented in recent years to supplement low flows and mitigate harmful temperatures in the Colorado River.

4.3 Anchor ice and winter temperature issues

Low flows can also affect aquatic organisms in the winter. During periods of low flow, cold temperatures can impact fish in the Colorado River. When temperatures drop well below freezing, depleted baseflows can lead to the formation of anchor ice and ice dams that impound floating ice and water and deplete downstream reaches. Anchor ice can eliminate occupiable habitat for macroinvertebrates and fish. During freeze-thaw cycles, the ice dams can break, releasing a wave downstream that scours the riverbed causing localized mortality to macroinvertebrates and fish and flushes organisms downstream. The breaking of ice dams can also pose hazards for people and infrastructure near the river. In December 2010, an ice blockage on the Shoshone power plant intake prevented diversion to the penstocks and with the dam gates frozen closed, river flows were functionally shut off in the Colorado River between Shoshone Dam and Roaring Fork River from December 14 to 16, with the exception a few tributary inputs and springs. During the extensive dewatering of lower Glenwood Canyon, a fish kill occurred at the canyon mouth near hot spring inputs, leading to documented mortalities of trout and native sculpin due to high water temperatures. Additional streamflows from the proposed acquisition will mitigate incidences like this, as well as anchor ice formation. The proposed acquisition will also supplement baseflows providing additional useable overwintering habitat for fish and macroinvertebrates.

4.4 Lower Glenwood Canyon Fishery Resources

The Colorado River downstream of the Shoshone Reach supports a thriving coldwater sport fishery comprised of Brown Trout, Rainbow Trout, and Mountain Whitefish, as well as the Three Species. Return flows from the Shoshone power plant create and maintain a diversity of habitat features that support reproduction, recruitment, and seasonal needs of resident fishes. With more consistent flows below the power plant outfall, wetted habitat fluctuates more naturally with a less altered hydrograph, and habitat is maintained and connected by gradual seasonal changes in flow. CPW fish surveys from 2021, 2023, and 2024 consistently recorded high trout numbers, particularly quality-sized trout, reaffirming that lower Glenwood Canyon is a premier fishery. Traditional riverine riffle-pool sequences support a productive macroinvertebrate and fish community where sediment transport functions are maintained. These flows sustain a resilient aquatic ecosystem that is essential for both sport fishing and native fish conservation. Two large tributaries located downstream of the power plant, Grizzly Creek and No Name Creek, provide critical spawning habitat for Rainbow Trout, Brown Trout, and Mountain Whitefish. Reproductive habitat is generally limited by the fluvial geomorphology in the mainstem river in Glenwood Canyon, so connection to tributary habitats is important. These tributaries also contribute coldwater inputs as their headwaters originate at elevations well over 10,000 feet in the Flat Tops that encompass the northern portion of Glenwood Canyon. Self-sustaining trout and whitefish populations in the Colorado River are maintained by reproduction and recruitment from coldwater tributaries. Similarly, warm and

cool-water perennial, intermittent, and ephemeral tributaries play an important role in spawning for the native Three Species. Fishing regulations implemented by CPW recommend annual spawning closures for the Colorado River in and around the tributaries of Elk Creek, Canyon Creek in Garfield County, No Name Creek, and Grizzly Creek, as the aggregations of large river fish amassing in relatively small tributary streams are easy targets for anglers. Additional flows provided by the Shoshone water rights help ensure these tributary habitats are accessible, providing critical reproductive habitat and seasonally variable river resources for resident fish. Connectivity within mainstem habitats and accessibility to tributaries are both imperative to sustaining Colorado's outstanding sportfishing opportunities and long-term persistence of native fishes.

4.5 Quality Trout and Gold Medal Fisheries

CPW manages the Colorado River for Quality Trout fishing opportunities including Gold Medal Waters. A Quality Trout is defined as a trout that exceeds 14 inches in length, contributing to a high-quality fishing experience for anglers. Designated Gold Medal Trout fisheries exhibit a high density of Quality Trout (greater than 12 trout over 14 inches per acre) and high trout biomass (greater than 60 pounds per acre) that provide the highest quality fishing experiences. The fishery in the Colorado River provides increased opportunities to capture Quality Trout and reaches that meet Gold Medal criteria are designated Gold Medal Waters. The Colorado River is designated Gold Medal in two reaches upstream of the Shoshone Reach: Fraser to Troublesome Creek and Canyon Creek in Grand County to Rock Creek. Additionally, two tributaries to the Colorado River also contain Gold Metal Waters, the Blue River and Gore Creek. The historical flow regime provided by the Shoshone call and recent efforts to introduce whirling disease-resistant Rainbow Trout support fishery enhancements that strive to meet Gold Medal metrics in Glenwood Canyon. A more recent identification of the Colorado River as a Quality Trout Water from Rock Creek downstream to Rifle signals to anglers the increased opportunity and accessibility to catch large Quality Trout in the Colorado River, including through Glenwood Canyon. Maintaining the historical flow regime in the Colorado River is essential to sustaining the existing high-quality fishery and could facilitate the return of abundant wild Rainbow Trout and push the segment between Glenwood Canyon and Rifle towards a Gold Medal designation.

4.6 Maintaining and Restoring River Connectivity

The Upper Colorado River, including the Shoshone Reach, lies in an ecoregion termed the Colorado Plateau-Wyoming Basin of the Colorado Plateau and is a specified high priority habitat in the SWAP. These larger-order rivers contain habitat features that are unavailable in smaller streams, particularly deep pools and runs, and large backwaters and floodplain areas that are inundated during high flow events. As a result, they comprise the core habitat for several native big-river fish species, though these species are also occasionally found in smaller streams (e.g., the Three Species, Bluehead Sucker, Flannelmouth Sucker, Roundtail Chub, and the federally-listed river species: Colorado Pikeminnow, Razorback Sucker, Bonytail Chub, Humpback Chub). River conditions are considered moderately or highly

impacted in many river reaches due to dams and diversions that have altered the natural hydrograph to varying degrees as snowmelt-driven peak flows are greatly reduced, as are baseflows in many cases. Additionally, dams and diversion structures function as barriers preventing upstream movement of fishes that are highly migratory species which require many miles of connected habitat to move between spawning and rearing, foraging, and overwintering habitats. These hydrological alterations, combined with channelization, bank hardening, introduction of invasive species, and other anthropogenic and climatic stressors, have degraded the condition of associated in-channel and riparian habitats. Colorado's SWAP emphasizes the protection of resources, habitat, and natural processes in these rivers. Specifically, high priority conservation actions include the securing instream flow rights, restoration and maintenance of suitable hydrological regimes, and control of invasive nonnative fish.

The Shoshone Dam disrupts the hydrologic function and river connectivity of the Colorado River, significantly impacting aquatic habitat and fish populations. Immediately upstream of the dam, the river is pooled with a flat gradient and low water velocities, leading to excessive sediment deposition and the loss of essential riffle-run sequences that characterize a healthy river. This habitat degradation diminishes macroinvertebrate productivity, reduces native sculpin habitat, and eliminates crucial refugia for juvenile fish, ultimately limiting food availability and lowering fish productivity. This lentic, highly sedimented habitat favors only the invasive White Sucker that CPW actively removes in the Colorado Basin to prevent hybridization with native Flannelmouth and Bluehead Suckers. Additionally, the dam acts as a physical barrier to upstream and downstream fish movement when diversions are occurring, and an upstream velocity barrier when closed and spilling or when bottom release gates are open. Restricting the upstream movement of fish fragments their populations and reduces access to critical spawning and rearing habitats and optimal river resources that are essential to their persistence. By altering the Colorado River's flow regime and limiting sediment transport and fish passage, the Shoshone Dam severely impacts the ecological integrity of the Colorado River surrounding Glenwood Canyon.

Within the Shoshone Reach, restoring and maintaining a more natural hydrological regime will improve fish passage. With increased water volume, drop heights will be reduced at cascades and boulder drops and downstream pool depths will be increased which increases fish passage probability. Higher flows provide increased cross-sectional habitat connectivity and wetted channel complexity, which provides alternative pathways along the channel margins when velocities in the main channel are unfavorable. Reestablishing river flows will facilitate movement for resident fish species, including desirable sportfish and the Three Species. The Three Species are endemic to the Colorado River Basin and are an important assemblage of fish for the greater Colorado River ecosystem and significant to the natural heritage of the state. Trout, whitefish, and the native Three Species will make large movements to exploit seasonally variable resources and often return to the same places to spawn. Connecting long expanses of river systems allows for nutrient cycling, fish population resiliency, and preserves genetic diversity, which is especially important within declining native species populations like those of the Three Species.

Returning natural flow conditions directly upstream of the Shoshone Dam and through the Shoshone Reach would also enhance macroinvertebrate communities and strengthen the aquatic food web that supports trout and native species populations. Macroinvertebrate surveys upstream of Glenwood Canyon indicate a stable, diverse macroinvertebrate community dominated by mayflies, caddisflies, and other pollution-sensitive taxa, signaling good water quality and nutrient cycling. Perennial flows in the Shoshone Reach could sustain a similar diverse community, ensuring a steady supply of high-quality forage for sport and native fishes alike. Furthermore, with limited riparian communities that would otherwise harbor abundant terrestrial insect food inputs for fish, aquatic macroinvertebrate drift is an essential food resource from upstream (GEI, 2025). Connected river reaches and reliable baseflows would support a thriving ecosystem, promoting fish health and population stability in the Colorado River system as a whole.

4.7 Benefits to Existing Instream Flow Reaches

The continued operation of the Shoshone call results in upstream administration that helps maintain streamflows in the upper Colorado River and many of its major tributaries. When Shoshone is calling, junior water rights are curtailed and/or reservoir replacements are made resulting in increased flows to the Colorado River headwaters and major tributaries like the Fraser, Blue, and Eagle Rivers and their tributaries. Benefits are also realized to many decreed ISF reaches held by the CWCB in the upper Colorado River Basin. The CWCB holds 350 decreed instream flow water rights upstream of the Shoshone Power Plant (CRD, 2025). In their analysis of the Shoshone water rights' impact on existing ISF reaches, CRD analyzed differences in streamflow on two ISF reaches with and without the Shoshone call using the 2024 Colorado River StateMod model. Two ISF reaches were evaluated – the Colorado River between Kremmling and State Bridge and the Eagle River between Lake Creek and Brush Creek.

Based on this analysis, there is a clear trend for both ISF reaches, which experience reduced flows absent the Shoshone call, particularly during dry years and months of August through October. The analysis showed more days when the ISF was satisfied with the Shoshone call in place. Based on CRD's analysis, the Eagle River ISF, decreed for 45 cfs in the winter and 110 cfs in the summer, would see reduced flows by 5 cfs (all years) and 7 cfs (dry years) on average absent the Shoshone call. Impacts on flows in the Colorado River at Kremmling were particularly pronounced due to compounding upstream reductions. In dry years during the months of August through October, flows at Kremmling would be reduced by 80 cfs on average if the Shoshone Water Rights were not exercised and approximately 50 cfs across all years. Under current demands absent the Shoshone call, the amount of days when the ISF reach would be met is reduced by 31% in August through October for dry years and by 19% across all months in dry years. The findings of this analysis are significant, particularly as it relates to the Colorado River near Kremmling, which has been identified by CPW as a Quality Trout Water. The Eagle River has also been identified by CPW as a Quality Trout water.

5. Conclusion & CPW Recommendation

Securing the Shoshone water rights in perpetuity is a concept that has been contemplated for decades. This proposal has broad support from a wide variety of Western Slope constituents spanning irrigation, municipal, recreational, and environmental interests. Many of these interests have also contributed financially to support the project. Permanent protection of the Shoshone water rights has been identified in a number of state-funded planning documents, including the Colorado Basin Round Table's Basin Implementation Plan(s), the Upper Colorado Wild and Scenic Alternative SG Management Plan, and the Middle Colorado River Integrated Water Management Plan. The acquisition of this non-consumptive water right aligns with CPW conservation priorities as specified in the Colorado SWAP. Overall, the corroborating studies conducted within the Shoshone Reach and knowledge-based experience of CPW's aquatic experts demonstrate that the Shoshone water right supports baseflows, habitat connectivity and habitat maintenance, and attenuates seasonally stressful conditions for important sportfish and native fishes. More consistent use of the Shoshone water rights in the Shoshone Reach for ISF purposes will provide significant preservation and improvements to natural ecological processes that support fish and macroinvertebrate communities.

It is the opinion of CPW staff that the best use of this water is to preserve and improve the natural environment at any flow rate up to 1408 cfs (the amount decreed in the senior and junior water rights). Based on hydraulic-habitat modeling, fish habitat also improves in the Shoshone Reach at flows up to at least 3000 cfs. This upper threshold is based on the upper limit of modeled flows in the hydraulic-habitat model. It is our professional opinion that flows greater than 3000 cfs also provide improvements to fish habitat by supporting geomorphic functions (e.g. moving fine sediments required for clean spawning gravels and scour and maintenance of holding habitats), supporting the aquatic food web, supporting thermal refuge areas, and creating additional fish passage pathways. Because the Shoshone Reach has been historically dewatered when the plant is operating, we believe the offered water would establish flows necessary to both preserve and improve the natural environment. Furthermore, the water right preserves the historical flow regime in the Colorado River while improving flows in the Shoshone Reach by adding additional wetted area and suitable fish habitat to a historically dewatered section of the Colorado River.

Given the demonstrated biological benefits within the Shoshone Reach, to the Colorado River headwaters and tributaries, and to the mainstem Colorado River below the power plant, CPW staff believes this acquisition will preserve and improve the natural environment and recommends the CWCB accept the interest in the acquired water. CPW believes the best use of the acquired water rights is to preserve and improve the natural environment in the Shoshone Reach of the Colorado River at any rate up to full decreed amount of 1408 cfs. Fish habitat will also be improved in the Shoshone Reach at streamflows up to at least 3000 cfs.

Photos



Photo 1: Shoshone Dam leakage during November 5, 2025 macroinvertebrate sampling event by CPW staff



Photo 2: CPW fisheries crew surveys the dewatered Shoshone Reach of the Colorado in Glenwood Canyon on October 23, 2024. (Photo Credit: K. Bakich)



Photo 3: CPW aquatic staff prepares to weigh and measure a large Brown Trout captured in an October 23, 2024 fishery survey in the dewatered Shoshone Reach on the Colorado River. (Photo Credit: K. Bakich)



Photo 4: CPW aquatic staff shows off a Rainbow Trout captured during a fishery survey on October 23, 2024 in the dewatered Shoshone Reach on the Colorado River. (Photo Credit: K. Bakich)



Photo 5: Bluehead Sucker collected October 23, 2024 during a novel fishery survey in the dewatered Shoshone Reach on the Colorado River. (Photo Credit: K. Bakich)



Photo 6: Boulder constriction in the dewatered stream in the Shoshone Reach creates a >4-foot pour-over of stream water onto a flat boulder face is insurmountable to fish moving upstream. A small constricted side channel on the left of the photo has high-velocity laminar flows that also restrict upstream fish movement. (Photo Credit: K. Bakich)



Photo 7: The red arrow points to bright, clean gravels in the Shoshone Reach of the Colorado River that are indicative of a trout redd likely created by the spawning activities of local Brown Trout during a site visit in the late fall of 2024.



Photo 8: Low flow channel during November 5, 2024 macroinvertebrate sampling event. (Photo credit: M. May)



Photo 9: CPW staff collected macroinvertebrate data in the low flow channel. 11-5-2024 (Photo credit: M. May)

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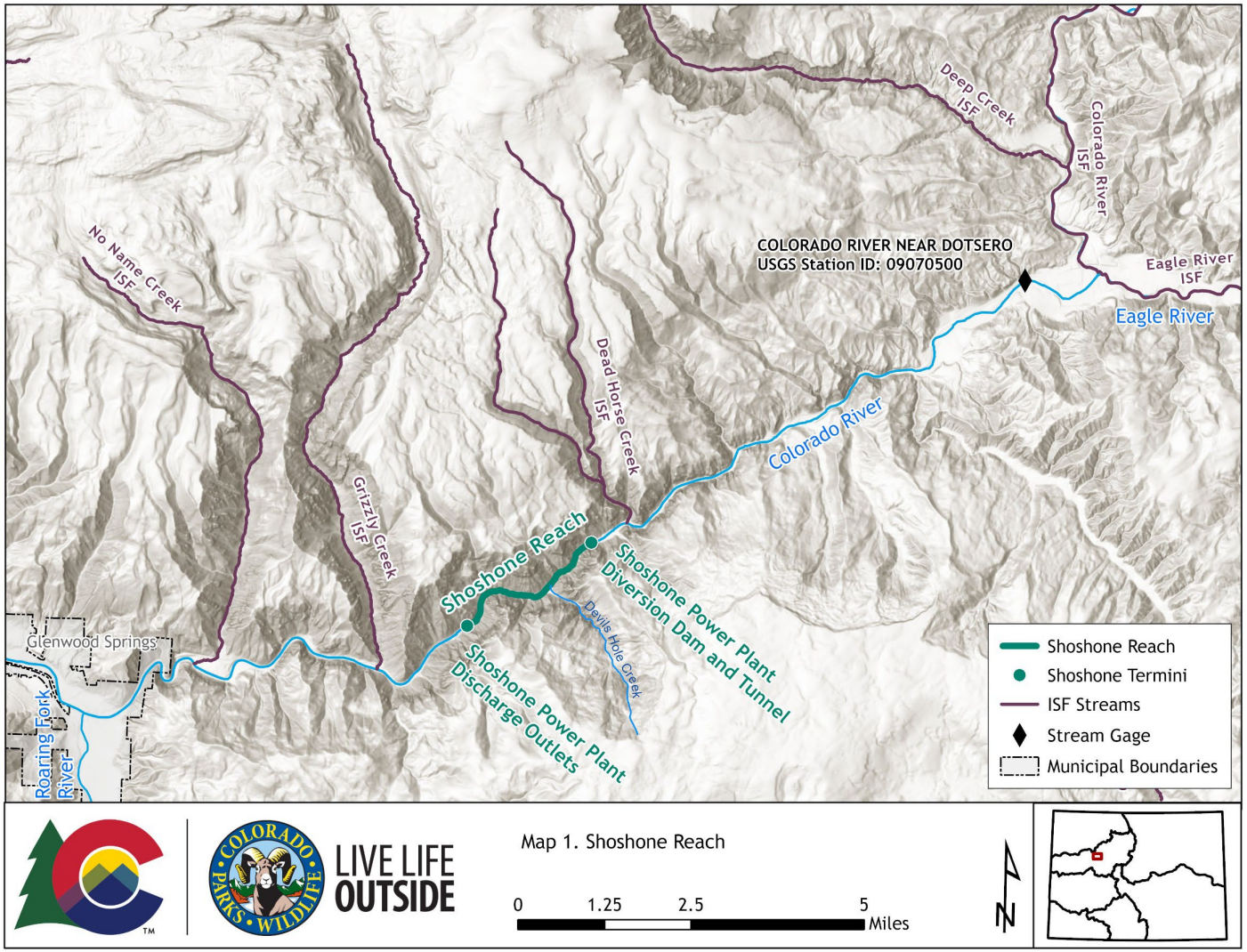
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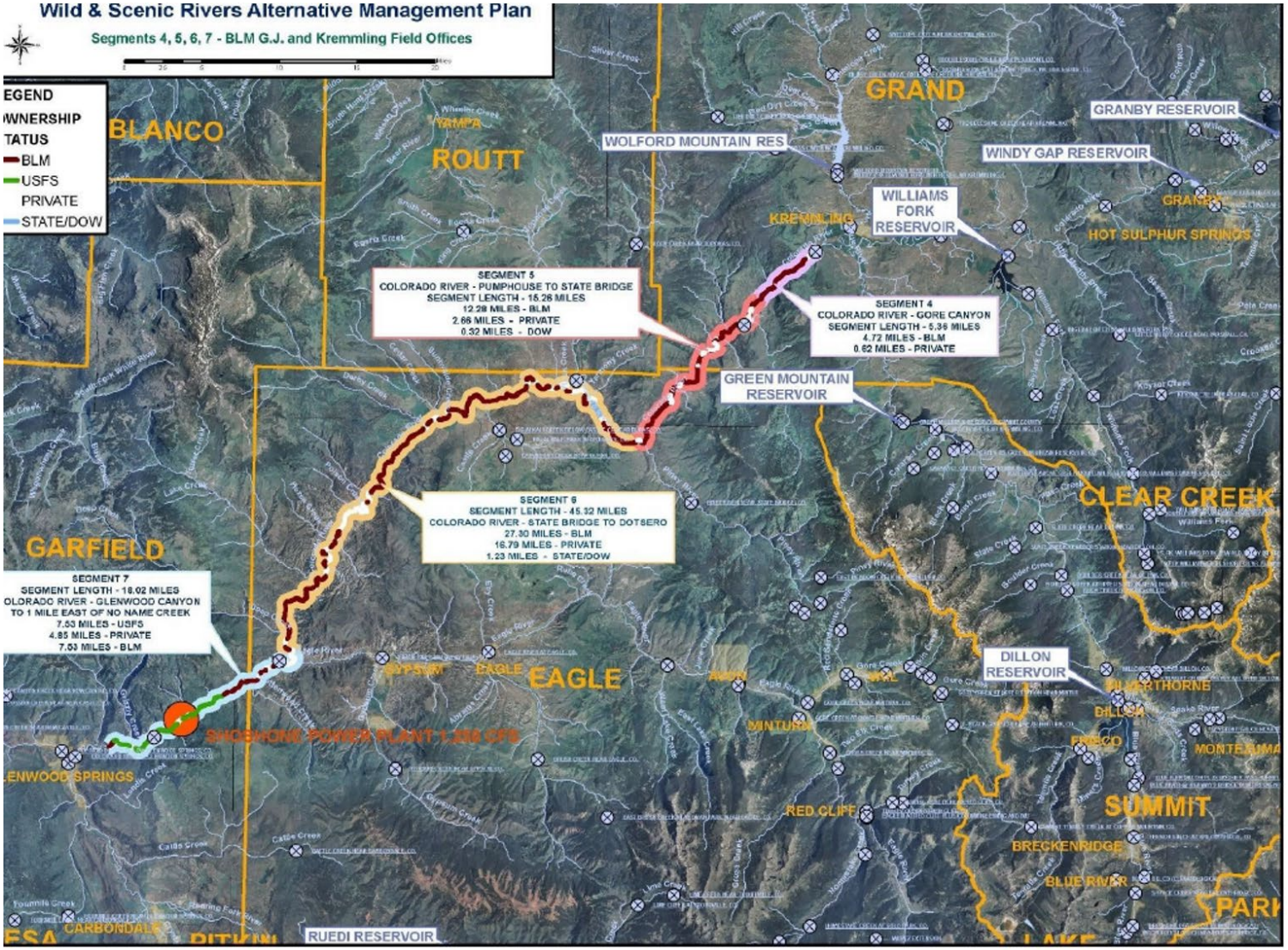
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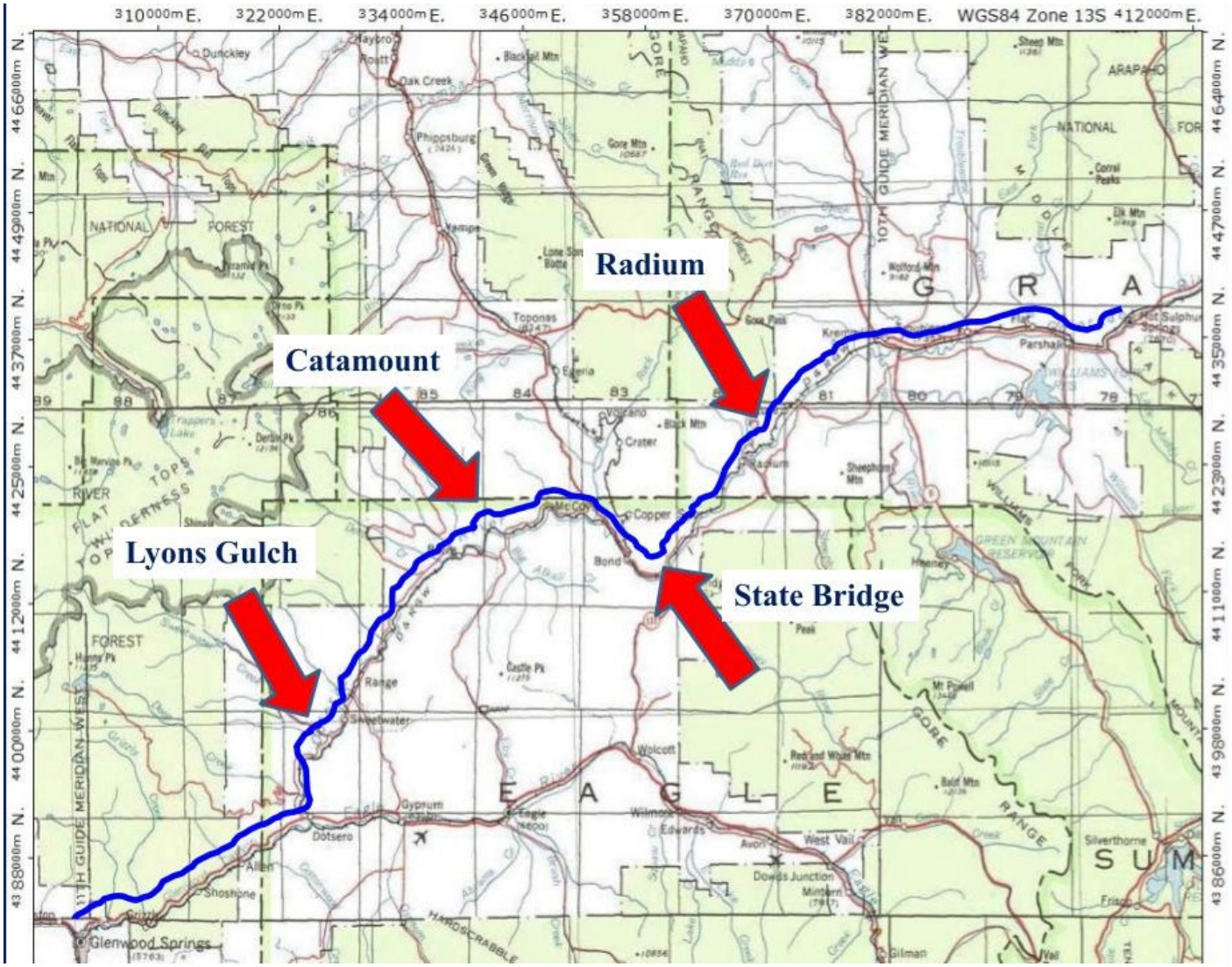
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Map 1. Proposed instream flow reach, the Shoshone Reach, where the Shoshone water rights will be dedicated for ISF use.



Map 2. Upper Colorado River Wild and Scenic Rivers segments (source: Amended and Restated Upper Colorado River Wild and Scenic Stakeholder Group Management Plan)



Map 3. CPW fishery monitoring sites in the Upper Colorado River Wild and Scenic stretch.

Enclosure E
Agenda Item 10.d
CWCB Board Meeting
May 21-22, 2025

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CONCERNING THE APPLICATION FOR WATER RIGHTS OF THE COLORADO WATER CONSERVATION BOARD, PUBLIC SERVICE COMPANY OF COLORADO, and THE COLORADO RIVER WATER CONSERVATION DISTRICT.

In GARFIELD AND EAGLE COUNTIES, COLORADO.

▲ COURT USE ONLY ▲

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Case Number:

Div.: Ctrm:

APPLICATION FOR CHANGE OF WATER RIGHTS

PRELIMINARY DRAFT

1. Names, mailing addresses, e-mail addresses, and telephone numbers of Co-Applicants.

Colorado Water Conservation Board (the "CWCB")
Attn: Director
1313 Sherman Street, Room 721
Denver, Colorado 80203
(303) 866-3441

Public Service Company of Colorado, a Colorado Corporation ("PSCo")
Jeff West, Senior Director, Environmental Services
3500 Blake Street, CO1453-03-MCB
Denver, CO 80205
(303) 571-2762

Colorado River Water Conservation District (the "River District")
Attn: Secretary/General Manager
201 Centennial Street, Suite 200
Glenwood Springs, CO 81601
(970) 945-8522

The above-listed parties shall be collectively referred to herein as "Co-Applicants."

Please send all copies of pleadings and correspondence to:

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1. Summary of Application.

The CWCB is an agency of the State of Colorado created to aid in the protection and development of the waters of the state for the benefit of its present and future inhabitants. Pursuant to section 37-92-102(3), C.R.S., the CWCB is authorized to acquire, by grant, purchase, donation, lease, or other contractual agreement, such water, water rights, and interests in water that are not on the abandonment list in such amount as the CWCB determines is appropriate for stream flows to preserve and/or improve the natural environment to a reasonable degree. The River District is a political subdivision of the State of Colorado charged with, among other duties, promoting the health and general welfare of the inhabitants of the River District by the conservation, use, and development of the water resources of the Colorado River and its principal tributaries. *See* §§ 37-46-101, C.R.S., *et seq*. PSCo is a Colorado corporation and is the owner and operator of the Shoshone hydroelectric power plant ("Shoshone Power Plant") located on the mainstem of the Colorado River in Glenwood Canyon, approximately six miles upstream of the City of Glenwood Springs.

The Shoshone Power Plant produces hydroelectric energy by means of PSCo's diversion of the Shoshone Water Rights, which are more particularly described in paragraph 2 below. Pursuant to the January 1, 2024 Purchase and Sale Agreement between the River District and PSCo (the "PSA"), the River District is the contract purchaser of the Shoshone Water Rights. The "PSA" (including all exhibits) is attached and incorporated hereto as **Exhibit 1.**

At its bi-monthly meeting on September ____, 2025, the CWCB determined that acquiring from the River District the exclusive right to use the Shoshone Water Rights for instream flow purposes in the reach of the Colorado River described in paragraph 3.2., below, is appropriate to preserve and improve the natural environment to a reasonable degree pursuant to section 37-92-102(3), C.R.S. Co-Applicants entered into a Water Rights Dedication and Instream Flow Agreement with the CWCB on September ____, 2025 (the "ISF Agreement," attached and incorporated hereto as **Exhibit 2**). The ISF Agreement grants to the CWCB the exclusive right to use the Shoshone Water Rights to preserve and improve the natural environment within the approximately 2.4 mile-reach of the Colorado River that extends between the Shoshone Diversion Dam and the Shoshone Power Plant's discharge outlets (the "Shoshone Reach"). The PSA provides that PSCo, or its successors and assigns is entitled to a leasehold interest in the Shoshone Water Rights for continued use of those rights for hydropower generation at the Shoshone Power Plant so long as the plant is operating.

By this Application, Co-Applicants seek to add instream flow use by the CWCB to the decreed uses of the Shoshone Water Rights. The change of water rights decree shall confirm that water attributable to the historical exercise of the Shoshone Water Rights for hydropower generation will remain in the stream to preserve and improve the natural environment to a reasonable degree within the Shoshone Reach up to the full decreed rate of the Shoshone Water Rights of available "Natural Flow". For the purposes of this Application, the "Natural Flow" is the amount of water in the Colorado River measured at the streamflow gauge (USGS 09070500) on

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the Colorado River near Dotsero, Colorado, located in Eagle County (the "Dotsero Gage"), including the amount of water usable by the Shoshone Water Rights when those water rights are in priority, except that the "Natural Flow" does not include any water released from storage and conducted into the Colorado River upstream of the Dotsero Gage (accounting for evaporation and transit loss), which water is intended for delivery for use downstream of the discharge outlets for the Shoshone Power Plant.

2. Decreed water rights for which change is sought and structures associated with the decreed water rights.

2.1. Glenwood Power Canal and Pipeline ("Senior Shoshone Water Right").

2.1.1. Previous Decrees. Civil Action No. 466, Eagle County District Court, decreed December 9, 1907, for a conditional water right, which was made absolute on February 27, 1911, in Civil Action No. 553.

2.1.2. Decreed Point of Diversion. The Shoshone Diversion Dam and Tunnel ("Point of Diversion") located on the right bank, being the northerly bank, of the Colorado River whence the North quarter corner of Section Thirty (30), Township Five (5) South, Range Eighty-Seven (87) West of the 6th Principal Meridian bears North 23° 48'20" East 2,414.64 feet, in Garfield County, Colorado.

2.1.3. Source. Colorado River.

2.1.4. Appropriation Date: January 7, 1902.

2.1.5. Decreed Uses. Power, mining, milling, manufacturing, lighting, heating, and traction purposes.

2.1.6. Amount. 1,250 cubic feet per second ("c.f.s.").

2.2. Shoshone Hydro Plant Diversion No. 2 ("Junior Shoshone Water Right").[1]

2.2.1. Previous Decrees. Civil Action No. 1123, Eagle County District Court, decreed absolute on February 7, 1956.

2.2.2. Decreed Point of Diversion. *See* ¶ 2.1.2. above.

2.2.3. Source. Colorado River.

2.2.4. Appropriation Date. May 15, 1929.

[1] The Senior Shoshone Water Right and Junior Shoshone Water Right are collectively referred to herein as the "Shoshone Water Rights" for a total combined rate of 1,408 c.f.s.

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2.2.5. Decreed Uses. Manufacturing and generation of electrical energy.

2.2.6. Amount. 158 c.f.s.

2.3. Priorities, appropriation dates, total decreed amounts and rates of flow, and amounts Co-Applicants intend to change.

2.3.1. Co-Applicants seek to continue to use the full 1,408 c.f.s. decreed to the combined Shoshone Water Rights for the changed use for instream flow purposes, subject to terms and conditions preventing injury to other decreed water rights.

Shoshone Water Rights (all amounts are absolute and are in c.f.s.)			
Priority Date	**Appropriation Date**	**Adjudication Date**	**Total Decreed Rate of Diversion and Diversion Rate Co-Applicants Intend to Change**
December 5, 1905	January 7, 1902	December 9, 1907	1,250 c.f.s.
May 31, 1940	May 15, 1929	February 7, 1956	158 c.f.s.
TOTAL			**1,408 c.f.s.**

3. Detailed Description of Proposed Change of Water Right.

3.1. Addition of Instream Flow Use. In addition to the existing decreed hydropower generation use, Co-Applicants seek water court approval to add instream flow use of the Shoshone Water Rights exclusively by the CWCB pursuant to section 37-92-102(3), C.R.S., and the terms of the ISF Agreement (**Exhibit 2**), to preserve and improve the natural environment of the Shoshone Reach to a reasonable degree at flow rates up to 1,408 c.f.s. of Natural Flow, under their individual priorities, as measured and administered at the Dotsero Gage. Co-Applicants intend for the CWCB to use the Shoshone Water Rights for instream flow purposes to the extent that the Shoshone Water Rights are not being used by PSCo for hydropower generation at the Shoshone Power Plant. Subject to the terms and conditions of the ISF Agreement and the change of water rights decree requested herein, the CWCB shall exercise the Shoshone Water Rights for instream flow purposes to the extent that the water rights are not being exercised by PSCo for hydropower generation at the Shoshone Power Plant.

3.2. Shoshone Reach. The CWCB's instream flow use will occur in the following stream reach of the Colorado River ("the Shoshone Reach"), which is approximately 2.4 miles in length between the upstream and downstream termini. The Shoshone Reach is more particularly described below and is depicted on **Exhibit 3** attached hereto.

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3.2.1. Upstream Terminus – Shoshone Power Plant Diversion Dam and Tunnel.

3.2.1.1. On the right bank, being the northerly bank, of the Colorado River whence the North quarter corner of Section Thirty (30), Township Five (5) South, Range Eighty-Seven (87) West of the 6th Principal Meridian bears North 23° 48'20" East 2,414.64 feet, in Garfield County, Colorado.

3.2.1.2. UTM Zone 13 NAD83; Easting: _____; Northing _____.

3.2.2. Downstream Terminus – Shoshone Power Plant Discharge Outlets.

3.2.2.1. On the right bank, being the northerly bank, of the Colorado River whence the Southeast corner of Section Thirty-five (35), Township Five (5) South, Range Eighty-Eight (88) West of the 6th Principal Meridian bears South 29° 24' 14" East, 1,771 feet, in Garfield County, Colorado.

3.2.2.2. UTM Zone 13 NAD83; Easting: _____; Northing _____.

3.2.3. Maximum Rate of Flow. The maximum rate of flow for the instream flow use of the Shoshone Water Rights will be their combined decreed rate of 1,408 c.f.s. of Natural Flow, under their individual priorities, for the purpose of preserving and improving the natural environment of the Shoshone Reach to a reasonable degree, subject to the terms and conditions of the change of water rights decree requested herein.

4. Quantification of Historical Exercise of the Shoshone Water Rights.

Co-Applicants will determine the historical use of the Shoshone Water Rights over a representative study period that includes wet years, dry years, and average years.

4.1. Historical Use.

4.1.1. The Shoshone Water Rights have been historically administered by the State Engineer and the Division Engineer for Water Division No. 5 (the "Engineers") at the Dotsero Gage, located approximately 8.5 miles upstream of the Shoshone Diversion Dam. The Shoshone Water Rights have historically been diverted by PSCo at the Shoshone Diversion Dam, as described in paragraph 3.2.1. above. The historical use of water attributable to the Shoshone Water Rights has been non-consumptive. The water historically diverted at the Shoshone Diversion Dam and run through the Shoshone Tunnel for delivery to the plant turbines was returned to the Colorado River at the outfall (i.e., discharge outlets) of the Shoshone Power Plant approximately 2.4 miles downstream of the Point of Diversion. *See* **Exhibit 3**. Notwithstanding the foregoing, the practice of diverting water attributable to the Shoshone Water Rights from the Colorado River and

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into the Shoshone Tunnel for delivery to the Shoshone Power Plant means that the historical exercise of the Shoshone Water Rights has been depletive to the Shoshone Reach before the diversions are returned to the Colorado River at the Shoshone Power Plant Discharge Outlets (i.e., the Downstream Terminus described in ¶ 3.2.2. above).

4.1.2. [ ]

4.1.3. [ ]

5. Maintenance of Historical Return Flows.

5.1. Co-Applicants will maintain historical return flows by ensuring that any future use of the Shoshone Water Rights is consistent with the historical exercise of the Shoshone Water Rights, so that water will continue to be available in the stream at the same time, location, and amount at the Downstream Terminus. This maintenance of the historical return flow pattern will prevent injury to downstream water rights. Upon entry of the change of water rights decree requested herein, Co-Applicants shall maintain the return flows that historically accrued to the Colorado River at the location of the Downstream Terminus.

6. Name(s) and address(es) of owners of land on which structures are located.

6.1. _____.

WHEREFORE, the CWCB, PSCo, and the River District request the Water Court to award a change of water rights decree for the Shoshone Water Rights to confirm the addition of instream flow use by the CWCB, pursuant to section 37-92-102(3), C.R.S., to preserve and improve the natural environment to a reasonable degree in the Shoshone Reach, in the amounts and up to the full decreed 1,408 c.f.s. of Natural Flow, as set forth in this application.

Respectfully submitted this ____ day of _____, 2025.

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COLORADO RIVER WATER CONSERVATION DISTRICT

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VERIFICATION

I, _____, state that I have read the foregoing Application for Change of Water Rights and verify its content. I declare under penalty of perjury under the laws of the State of Colorado that the foregoing is true and correct.

_____ _____

Printed Name **Signature**

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COLORADO RIVER DISTRICT
PROTECTING WESTERN COLORADO WATER SINCE 1937

To: Colorado Water Conservation Board

From: Colorado River Water Conservation District
Public Service Company of Colorado

Subject: Technical Memorandum – Proposed Acquisition of an Interest in the Shoshone Water Rights for Instream Flow Use ("Technical Memorandum")

Date: May 6, 2025

The Colorado River Water Conservation District (the "River District") and Public Service Company of Colorado ("PSCo") provide this Technical Memorandum to assist the Colorado Water Conservation Board ("CWCB") in evaluating the proposed acquisition of an interest in the Shoshone Water Rights for instream flow use.

A. Background.

The Shoshone Power Plant is owned and operated by PSCo (an Xcel Energy company, or "Xcel"), and produces approximately 15 megawatts of electricity—enough to serve about 15,000 customers. The Shoshone Power Plant produces hydroelectric power by means of the Shoshone Water Rights, which include the 1905 senior water right in the amount of 1,250 cubic feet per second ("cfs"), and the 1940 junior water right in the amount of 158 cfs (together, the "Shoshone Water Rights"). *See* Attachment 1. The Shoshone Water Rights are fully non-consumptive, so all diverted water is promptly returned to the Colorado River.

The Shoshone Power Plant diverts water from the Colorado River via the "Shoshone Diversion Dam" which is located upstream of the Shoshone Power Plant. Once water is diverted from the river at the Shoshone Diversion Dam, it is conveyed for approximately 2.4 miles through a tunnel in the canyon walls, before dropping 167 feet through two turbines and returning to the Colorado River via discharge outlets located just below the Shoshone Power Plant. *See* Attachment 2, Map 1. Construction of the Shoshone Power Plant began in 1906, and plant operations commenced in 1909.

Figure 1: The Colorado River at the Shoshone Hydroelectric Power Plant



As is customary utility practice for the safe and prudent operation of a hydroelectric power plant, the Shoshone Power Plant was periodically taken offline, in full or in part, to conduct necessary maintenance over the course of its 115-year history. More recently, the power plant has been subject to more extended periods of outage arising from causes beyond PSCo's control. For example, in 2007, the power plant experienced a penstock blow-out resulting in significant damage to the powerhouse that required the plant to be offline for nearly a year. Then, in 2020, the Grizzly Creek Fire burned over 30,000 acres in Glenwood Canyon, destroying transmission lines and threatening the Shoshone Power Plant and its associated infrastructure. Subsequently, in 2021, Glenwood Canyon experienced repeated flooding and debris flow events carrying mud, rocks, and woody materials into the drainage basins of the canyon. These natural phenomena caused the Shoshone Power Plant to go offline for the majority of 2021. Most recently, the plant was offline for more than 15 consecutive months in 2023 and 2024 due to a combination of maintenance requirements and geologic hazard mitigation.

When offline, the Shoshone Power Plant does not generate power. Under these circumstances, or at times when the plant is operating at a reduced level due to issues related to one of the turbines, PSCo cannot *fully* exercise the Shoshone Water Rights. While PSCo has no current plans to cease operations at the Shoshone Power Plant, circumstances beyond its control have an increasing potential to lead to the reduction or abandonment of these important water rights. Unless the Shoshone Water Rights are available for instream flow use, increasingly frequent complete or partial outages of the plant due to natural hazards in Glenwood Canyon combined with the age of the plant are likely to lead to a reduction or complete abandonment of these important water rights. If the Shoshone Water Rights are no longer exercised, the result would be a significant and meaningful reduction in the historical flow regime of the Colorado River and its tributaries both upstream and downstream of the Shoshone Power Plant. The reduction in flow would be most significant during the late summer and early fall which are critical times of the year for the natural environment, fishery resources, recreational users, and water quality for municipal and irrigation

uses (significant stream reductions could also occur during the winter season and in the month of April in some years).

The risk of losing the benefits provided by Shoshone's historical flow regime remains despite the existence of the Shoshone Outage Protocol Agreement dated June 27, 2016 (the "ShOP Agreement," Attachment 3). Under the ShOP Agreement, the signatories—including the River District, Denver Water, the Colorado Division of Water Resources, the Bureau of Reclamation, and the Northern Colorado Water Conservancy District, among others—agreed to an operational approach under which some of the signatories would release or bypass water from their respective systems during certain conditions when the senior Shoshone Water Right would normally place a call for 1,250 cfs but cannot because of an outage at the Shoshone Power Plant.[1] As a term-limited contractual arrangement, the ShOP Agreement does not and cannot provide permanent protection of the historical flow regime created by the exercise of the Shoshone Water Rights. By its express terms, the ShOP Agreement is limited to the protection of a target flow of only 1,250 cfs attributable to the senior Shoshone Water Right during the irrigation season, and the protection of only 900 cfs during the non-irrigation season, which is a reduction from what the plant can and has legally diverted and used. *Id.* at p. 5, § IV.A.2.

Thus, the ShOP Agreement acts as a temporary stop-gap measure to bring some, but not all, of the flow attributable to the Shoshone Water Rights down the river when there is a plant outage. Furthermore, the ShOP Agreement has a limited term and will expire by its own terms in 2056. Importantly, ShOP cannot be made permanent without an Act of Congress. The ShOP Agreement also has numerous limitations that "excuse" water users' flow contributions during dry year conditions when flows attributable to the Shoshone Water Rights would otherwise provide the most benefit to the river. Moreover, the ShOP Agreement was not decreed by a state water court, so it is not binding on non-signatory water users and cannot bind new junior appropriations from diverting water that is contributed to the streamflow by ShOP participants. In contrast, the proposed instream flow agreement between the River District, PSCo, and the CWCB will result in a change of water rights decree, thereby maintaining the Shoshone Water Rights in perpetuity and, by doing so, ensuring the permanent protection of the historical flow regime of the Colorado River and its tributaries upstream of the Dotsero Gage.

B. Proposed Instream Flow Agreement.

The CWCB has authority, pursuant to section 37-92-102(3), C.R.S., to acquire the exclusive right to use the Shoshone Water Rights for instream flow purposes. The statute provides that the CWCB "may acquire . . . such water, water rights, or interests in water [ ] in such amounts as the board determines is appropriate for stream flows . . . to preserve or improve the natural environment to a reasonable degree." C.R.S. § 37-92-102(3). The proposed water right dedication and instream,

[1] While not parties to the ShOP Agreement, Aurora Water and Colorado Springs-Utilities also participate in a roughly identical ShOP arrangement through separate agreements with the River District and other West Slope parties.

flow agreement (the "ISF Agreement," *see* Attachment 4) is consistent with the applicable statutory framework because it will provide the CWCB with the perpetual contractual interest to use the Shoshone Water Rights for instream flow purposes as further described below.

The ISF Agreement provides that the CWCB, the River District, and PSCo will file a water court application[2] as co-applicants to change the Shoshone Water Rights to add instream flow use by the CWCB as an additional decreed beneficial use. Following the entry of the change of water rights decree, the Shoshone Water Rights will be used by the CWCB for instream flow purposes to preserve and improve the natural environment within the reach of the Colorado River in Glenwood Canyon that extends approximately 2.4 miles from the Shoshone Diversion Dam to the Shoshone Power Plant's discharge outlets (the "Shoshone Reach"). Such instream flow use by the CWCB will occur only to the extent the rights are not used for hydropower generation by PSCo at the Shoshone Power Plant and will be subject to the terms and conditions of the change of water rights decree.

C. The CWCB's Acquisition of the Exclusive Right to Use Shoshone Water Rights for Instream Flow Purposes is Appropriate for Preservation and Improvement of the Natural Environment within the Shoshone Reach.

Rule 6e. of the Rules Concerning the Colorado Instream Flow and Natural Lake Level Program, 2 CCR 408-2 (the "ISF Rule(s)") lists the factors the CWCB shall consider in determining whether to accept an interest in water for instream flow purposes. The mandatory criteria established under Rule 6.e are separately examined below in relation to the Shoshone Water Rights. Application of these criteria to the proposed ISF Agreement clearly demonstrates that there is a natural environment in the Shoshone Reach of the Colorado River, that the CWCB's acquisition of the exclusive right to use the Shoshone Water Rights for instream flow purposes in the Shoshone Reach is appropriate and will preserve and improve the natural environment, and that, in accordance with the water court change in use process, the use of the Shoshone Water Rights for instream flow purposes in the Shoshone Reach will not result in material injury to vested water rights.

1. *The natural environment to be preserved and improved by the CWCB's acquisition of the right to use the Shoshone Water Rights for instream flow purposes*.

Instream flow use of the Shoshone Water Rights will occur within the Shoshone Reach, which is an approximately 2.4-mile stretch of the Colorado River within Glenwood Canyon, extending from the Shoshone Diversion Dam to the discharge outlets of the Shoshone Power Plant. The approximate locations of the upstream and downstream points of the Shoshone Water Rights are shown in **Figure 2** and are more particularly described below:

[2] A draft water court application for the contemplated change of water rights for the Shoshone Water Rights is enclosed hereto as Attachment 14.

ISF Upstream Terminus (Shoshone Power Plant Diversion Dam and Tunnel): located on the right bank, being the northerly bank, of the Colorado River whence the North quarter corner of Section Thirty (30), Township Five (5) South, Range Eighty-Seven (87) West of the 6th Principal Meridian bears North 23° 48'20" East 2,414.64 feet, in Garfield County, Colorado.

ISF Downstream Terminus (Shoshone Power Plant Discharge Outlets): located on the right bank, being the northerly bank, of the Colorado River whence the Southeast corner of Section Thirty-five (35), Township Five (5) South, Range Eighty-Eight (88) West of the 6th Principal Meridian bears South 29° 24' 14" East, 1,771 feet, in Garfield County, Colorado.[3]

Figure 2: Proposed Shoshone Instream Flow Reach



The Shoshone Reach is within Glenwood Canyon and is confined on the right bank (north) by a pedestrian path and Interstate 70 ("I-70") and on the left bank (south) by the active Rio Grande Railroad. As described in an August 30, 2024, report prepared by Dr. William Miller, PhD, of Freshwater Consulting, LLC ("Dr. Miller"), the existing aquatic habitat of the Shoshone Reach consists of high-gradient riffles, pools, runs, and rapids dropping approximately 170 feet in elevation over the approximately 2.4-mile stretch. *See* "Shoshone Reach Instream Flow Habitat Data Analysis, Habitat Simulations and Habitat Evaluation of Colorado River from the Shoshone Diversion to the Shoshone Power Plant Outfall" (the "2024 Miller Report," Attachment 5). The Shoshone Reach supports multiple fish species of trout, native suckers, mountain whitefish, and sculpins as well as lower trophic level of periphyton, algae, and benthic macroinvertebrates. *Id.*

[3] The legal description set forth above for the Downstream Terminus (Shoshone Power Plant Discharge Outlets) is an approximate location developed by River District staff and may be supplemented or modified at the time a water court application is filed in Water Division No. 5.

Typical hydrology through the reach includes a high-flow runoff period with a mean peak flow of approximately 10,000 cfs in the late spring and early summer, followed by low flow conditions that can be characterized as "dewatered" during times when the Shoshone Power Plant is fully operating through the late summer and winter. During such "dewatered" periods when the plant is operating, habitat through the Shoshone Reach is connected by small inflows of groundwater and tributary streams and other sources that fill pools and flow through the large boulder and rock substrate. *See* "Shoshone Reach, Instream flow Beneficial Use and Hydraulic Habitat Suitability Assessment" (the "2025 Ecosystem Report," Attachment 6).

In addition to the benefits provided to the Shoshone Reach when the Shoshone Water Rights are not being used for hydropower generation (or are being used only at a reduced rate), the proposed instream flow use of the Shoshone Water Rights also will provide significant benefits to the greater Glenwood Canyon riverine ecosystem. In a 2024 report jointly prepared by the United States Forest Service ("USFS") and the Bureau of Land Management ("BLM") titled "Biological and Recreational Resources Dependent on Colorado River Flows Through Glenwood Canyon" (the "USFS-BLM Report," Attachment 7), the federal agencies noted, among other things, that the Shoshone Reach supports both native and sportfish species, Rocky Mountain bighorn sheep, riparian plant communities, and macroinvertebrates.

Annual fish surveys conducted by Colorado Parks and Wildlife ("CPW") demonstrate that both native and sportfish species reside within Glenwood Canyon, including within the Shoshone Reach. As observed by CPW staff, the variable riverine topography in Glenwood Canyon includes riffles and runs that provide spawning habitat, pools, and refuge from high flows for fish species. Native fish species within Glenwood Canyon include the Flannelmouth Sucker, Bluehead Sucker, Roundtail Chub, Colorado River Cutthroat Trout, Sculpin, and Dace. Sportfish species include Brown Trout, Rainbow Trout, Cutthroat Trout, Rainbow-Cutthroat hybrids, and Mountain Whitefish.

Macroinvertebrate populations play a crucial role in the food web supporting native fish species and serving as a health indicator for aquatic and riparian ecosystems. The USFS-BLM Report notes that within Glenwood Canyon, macroinvertebrate species, which include the crucially important EPT taxa (mayflies, stoneflies, and caddisflies), provide a food source for fish, bird, and bat species. *See id.* (Attachment 7).

Although the canyon walls and man-made infrastructure within Glenwood Canyon limit the extent of riparian vegetation and terrestrial habitat, such vegetation nevertheless exists within the canyon, including narrowleaf cottonwood, chokecherry, red-osier dogwood, box elder, willow, wild rose, skunkbush, riparian grasses, sedges, and rushes. The existing vegetation in Glenwood Canyon provides habitat and food sources for terrestrial and aquatic species, bank stabilization and armoring, and river cover and shading. *See id*.

When the Shoshone Power Plant is operating, water is returned at the plant's discharge outlets (*i.e.*, the Downstream Terminus of the Shoshone Reach) creating high quality and diverse habitat for aquatic species with an abundance of riffles, runs, and pools. In particular, the increased number of riffles support macroinvertebrate productivity and robust fishery. The return flows also benefit the natural environment downstream of the Shoshone Reach by contributing enough flow to the river for effective sediment transport, an important component of aquatic ecosystem functions. Trout, native Sculpin, and Mountain Whitefish are especially benefited by the conditions maintained by the return flows attributable to the Shoshone Power Plant, as these species prefer high gradient reaches with increased sediment movement. *See id.*

Finally, the majority of Glenwood Canyon is part of the White River National Forest ("WRNF") and is managed by the USFS, in partnership with the Colorado Department of Transportation ("C-DOT"). *Id.* In addition to its regionally significant natural environment, Glenwood Canyon is notable for its scenic river corridor, which supports a robust riverine ecosystem while drawing significant human visitors for recreational and other tourism purposes.

2. *The natural flow regime*.

Beginning at its headwaters in Grand County, the Colorado River flows through the State of Colorado generally in a westerly direction for approximately 300 miles, initially traveling through remote mountainous landscapes before descending into the lower elevations of Colorado's West Slope and the Colorado Plateau.

The flow of the Colorado River within Colorado is governed by seasonal snowmelt from the Rocky Mountains, which contributes to the total volume and timing of the streamflow each year. Streamflow in the mainstem of the Colorado River varies significantly on an annual and seasonal basis due to natural variations in hydrology and the impacts of water diversion and storage projects, including 100% consumptive transmountain diversions ("TMDs") from the Colorado River and its headwater tributaries. The river's flow typically peaks in the late spring and early summer months as mountain snow melts and runs off into the river system. During late summer and fall, the flow generally decreases, reflecting the reduced snowmelt and the demands from water diversion projects in the latter, drier part of the water year. Peak spring runoff flows at the Dotsero Gage range from approximately 2,000 to 22,000 cfs with winter base flows generally measured near 900 cfs. The average streamflow recorded at the USGS stream gage on the Colorado River near Dotsero, Colorado (the "Dotsero Gage," USGS 09070500) for the years 1942–2024 is approximately 2,142 cfs, although the annual average amount fluctuates significantly from year-to-year.

Several significant water systems and projects regulate and alter the flows of the mainstem of the upper Colorado River. For example, several significant diversion projects on the West Slope, including TMDs associated with the Colorado-Big Thompson Project, Moffat Tunnel, Roberts Tunnel, the Continental-Hoosier Project, and the Homestake Project, export water from the

headwaters of the Colorado River and its tributaries across the Continental Divide to Colorado's Front Range for municipal, industrial, and agricultural purposes. These TMDs generally consist of a series of tunnels, reservoirs, and pipelines that transport an average 482,200 acre-feet ("AF") of water annually from the Colorado River Basin for use on the East Slope. *See* Attachment 2, Map 2.

Streamflow for the mainstem of the upper Colorado River is measured and the Shoshone Water Rights are administered by the Colorado Division of Water Resources at the Dotsero Gage. The Dotsero Gage is located approximately 8.5 miles upstream of the upper terminus of the Shoshone Reach (*i.e.*, the Shoshone Diversion Dam).

3. *Instream flow use of the Shoshone Water Rights will not result in material injury to existing decreed water rights*.

To be used for instream flow purposes, the Shoshone Water Rights must first be changed by the Division 5 Water Court to add instream flow as an additional decreed use. The CWCB's subsequent use of the Shoshone Water Rights for instream flow purposes will not result in material injury to existing decreed water rights because the change of water rights decree will ensure that instream flow use will only be exercised consistent with historical practice and will include terms and conditions that prevent any injury to other water rights.

The purpose of a change of water rights proceeding is to ensure that use of the water right for the changed purpose does not result in injury to other vested water rights—both upstream and downstream of the subject water right. *See* C.R.S. § 37-92-305(3)(b). When a water right is changed to allow a different or alternate type of use, the water right retains its original priority date. *Colo. Water Cons. Bd. v. City of Central*, 125 P.3d 424, 437 (Colo. 2005). However, the "holders of vested water rights are entitled to the continuation of stream conditions as they existed at the time they first made their appropriation." *Orr v. Arapahoe Water & Sanitation Dist.*, 753 P.2d 1217, 1223 (Colo. 1988).

Under Colorado law, with respect to the determination of historical use of a water right in a change of use case, section 37-92-305(3)(d), C.R.S., provides that:

> Quantification of the historical consumptive use of a water right must be based on an analysis of the actual historical use of the water right for its decreed purposes during a representative study period that includes wet years, dry years, and average years. The representative study period:
>
> (I) Must not include undecreed use of the subject water right; and
>
> (II) Need not include every year of the entire history of the subject water right.

Importantly, the determination of injury in a change of water rights proceeding rests within the exclusive jurisdiction of the water court. *See* § 37-92-203(1), C.R.S.; *see also* § 37-92-305(3), the Division 5 Water Court will determine the historical beneficial use of the Shoshone Water Rights under their original appropriations and limit the amount of water that can be changed based on the amount of water actually and lawfully used over a representative historical period of time. Terms and conditions will be included in the change of water rights decree to ensure that no vested water rights will be injured.

4. *The historical use and historical return flows of the Shoshone Water Rights that may be available for instream flow use.*

To examine the historical use of the Shoshone Water Rights, the River District retained the services of Bishop Brogden Associates ("BBA") to prepare an assessment of the historical use of the Shoshone Water Rights for hydropower production over a defined period of study. A copy of BBA's Draft Preliminary Historical Use Assessment ("HU Assessment") is attached to this technical memorandum as Attachment 8. It is important to note that the HU Assessment is, as the title implies, a preliminary draft assessment of the historical yield of the Shoshone Water Rights. The yield estimates set forth in the HU Assessment may be supplemented or changed in the future as more information and data become available. That said, the estimated yield of the Shoshone Water Rights as described in the HU Assessment is reasonable and well-supported across a sufficiently representative study period.

As discussed above, the quantification of the historical use of the Shoshone Water Rights is a "water matter" that is within the exclusive jurisdiction of the Division 5 Water Court. Therefore, the water court will determine the historical use as an integral part of the change of use case. However, the ISF Rule 6.e provides that the CWCB should consider the "historical consumptive use and historical return flows" of the water rights to be changed to add instream flow use.

The use of water at the Shoshone Power Plant is non-consumptive, which means that all of the water diverted at the Shoshone Diversion Dam and runs through the turbines to generate power is returned to the Colorado River at the outfall of the Shoshone Power Plant, approximately 2.4 miles downstream of the dam. However, the historical exercise of the Shoshone Water Rights with respect to the 2.4-mile Shoshone Reach is almost entirely depletive (there are some losses and sluicing operations associated with the historical exercise that return to the Colorado River within the Shoshone Reach) before essentially 100% of the diversions are returned to the river at the Shoshone Power Plant outfall. Although this situation is different from circumstances where a partially consumptive water right, such as an irrigation water right, is changed to a different type of use, the underlying legal principle is the same—an analysis is conducted to determine the "measure" of the water right to be changed and to make sure that other water users are not injured, including downstream junior users that have come to rely upon the return flow pattern from the historical exercise of the changed water right.

5. *Instream flow use of the Shoshone Water Rights will preserve and improve the natural environment to a reasonable degree.*

Protecting the Shoshone Water Rights by adding an additional beneficial use for instream flow purposes to the decreed uses will preserve and improve the natural environment of the Shoshone Reach to a reasonable degree. The River District engaged Dr. Miller, and Ecosystem Sciences, Inc. ("Ecosystem Sciences") to evaluate the habitat within the Shoshone Reach. The respective conclusions reached by Dr. Miller and Ecosystem Sciences are set forth in the 2024 Miller Report (Appendix 5) and the 2025 Ecosystem Report (Appendix 6). The key findings of both reports are summarized below.

a. 2024 Miller Report.

Using the Instream Flow Incremental Methodology ("IFIM") on a study area within the Shoshone Reach and habitat criteria for one native fish species and three sport fish species, Dr. Miller found that flows between 700 cfs and 3,000 cfs provide a benefit to the aquatic habitat for identified fish species within the Shoshone Reach. *See* Attachment 5. Dr. Miller's analysis of a range of flow that is bounded at 3,000 cfs on the upper end is due to the fact that the Shoshone Water Rights can call for natural flow up to 1,408 cfs to satisfy the plant's demands. However, during naturally low flow periods additional water that is released from reservoirs located upstream of the Shoshone Power Plant may be commingled with the water needed to satisfy the power plant's call on the river, resulting in total flows, as measured at the Dotsero Gage, in excess of the 1,408 cfs that may be diverted at the Shoshone Diversion Dam. *Id.* at pp. 9-10.

As set forth in the 2024 Miller Report, Dr. Miller concluded that future instream flow use of the Shoshone Water Rights will result in more stable baseflows and more consistent wetted area in all year types (*i.e.*, wet, dry, and average years), which would not only improve habitat availability in the Shoshone Reach, but would also support conditions for algae and macroinvertebrate growth, which are critical food sources for fish species, including the four fish species examined by Dr. Miller. *See id.* at pp. 33-34. Dr. Miller noted that the contemplated future instream flow scenario "would provide a substantial increase in habitat and benefit aquatic biota during summer, fall, winter, and early spring as compared to the existing conditions." *Id.*

Notably, the proposed ISF Agreement provides that PSCo would be permitted to continue using the Shoshone Water Rights for hydropower purposes until such time that PSCo determines to cease generating power or the plant is permanently decommissioned. *See* Appendix 5. PSCo's continued hydropower use will mirror or continue the historical reduction of flow within the Shoshone Reach. However, Dr. Miller nevertheless concludes that the new instream flow use of the Shoshone Water Rights would still provide significant benefits to habitat within the Shoshone Reach at all times when the Shoshone Power Plant is not operating due to normal maintenance or unplanned outages up to the evaluated flow of 3,000 cfs measured at Dotsero. *See* Appendix 5 at p. 33; *see also* 2025

Ecosystem Report, Appendix 6, at p. 33 (Dr. Miller's conclusion here is supported by Ecosystem Sciences, which studied a different stream segment and different streamflow regimes.)

In sum, the 2024 Miller Report concludes that future instream flow use of the Shoshone Water Rights would preserve and improve the natural environment in the Shoshone Reach for the following reasons:

- The instream flow use would result in stable base flow conditions with no zero-flow days.
- The instream flow use would produce stable wetted area within the Shoshone Reach during late summer, fall, winter, and spring, creating better conditions for macroinvertebrates and algae, which are important food sources for fish species.
- Average year hydraulic-habitat conditions in summer and winter would experience improved base flows that provide between 81% to 99% of the potential maximum hydraulic habitat in the Shoshone Reach.
- The instream flow use would continue a long-list of indirect benefits upstream and downstream of the Shoshone Power Plant due to water "called-down" to the Shoshone Reach to satisfy the instream flow use of the Shoshone Water Rights.
- Flows transported through the Shoshone Reach as a result of the instream flow use of the Shoshone Water Rights would preserve stream conditions within the reach while simultaneously improving the aquatic habitat.

See generally Appendix 5 at pp. viii, 33.

b. 2025 Ecosystem Report.

The 2025 Ecosystem Report (Attachment 6) builds on and supports the conclusions in the 2024 Miller Report. However, in contrast to Dr. Miller's approach which relied on a comparison between the existing flow regime and a future flow regime created by the additional instream flow use of the Shoshone Water Rights, Ecosystem Sciences utilized the 2024 Upper Colorado River Basin Model ("UCRM") in StateMod to evaluate and compare a range of current and future scenarios. The future scenarios utilized by Ecosystem Sciences accounted for additional Colorado River demands intended to reflect future development on the Colorado River. Ecosystem Sciences used an additive method (as opposed to Dr. Miller's multiplied method) to determine Hydraulic Habitat Suitability from the modeled velocity and depth variables across each site. Despite the different methods used to assess stream habitat, both reports arrived at the same conclusion—instream flow use of the Shoshone Water Rights will preserve and improve the natural environment within the Shoshone Reach at measured flow rates up to 3,000 cfs.

It is worth noting that the 2024 UCRM upon which Ecosystem Sciences' analysis relies also yielded important information regarding the influence that the Shoshone Water Rights have on the Colorado River mainstem. In fact, outputs from the State of Colorado's 2024 UCRM clearly demonstrate that, if the Shoshone Water Rights are not exercised, approximately 31,900 AF to

35,500 AF less water would flow through the Shoshone Reach (under average existing and future dry-year conditions, respectively) than occurs when compared to the StateMod's "baseline" condition (which includes exercise of the Shoshone Water Rights).[4]

Ecosystem Sciences studied two sites—one of which was studied in the 2024 Miller Report—within the Shoshone Reach, which together cover approximately 29% of the reach. *See* Attachment 6 at p. 1. Through its investigation of these two study areas, Ecosystem Sciences concluded that the hydraulic habitat suitability for the same native and sport fish species examined in the 2024 Miller Report would be higher more frequently under a future scenario where the Shoshone Water Rights are permanently protected as compared to a current baseline scenario and a future scenario where the Shoshone Water Rights are not permanently protected by the addition of instream flow use. *See id.* at p. 33. This is particularly true during late summer and early fall seasons. *Id.* The protection of the Shoshone Water Rights through instream flow use also would provide significant help to address high temperatures and other stressors experienced in the Shoshone Reach and upstream reaches. In these respects, Ecosystem Sciences' analysis confirmed Dr. Miller's earlier findings and similarly found that instream flow use of the Shoshone Water Rights will preserve and improve the natural environment of the Shoshone Reach to a reasonable degree at measured flow of up to the evaluated 3,000 cfs at the Dotsero Gage. *See id.* at p. 34.

Another important series of findings in the 2025 Ecosystem Report deals with the reality that flows within the Shoshone Reach are highly variable throughout the year. *Id.* at p. xx. For instance, on days when the Shoshone Power Plant is operational, water is diverted at the Shoshone Diversion Dam (*i.e.*, the ISF Upstream Terminus) for hydropower production and the same diverted water is later returned to the river at the outfall of the power plant (*i.e.*, the ISF Downstream Terminus). During periods when the Shoshone Water Rights are placing an administrative call against upstream junior water rights (*i.e.*, when the natural flow at the Dotsero Gage is less than 1,408 cfs), river flow within the Shoshone Reach will be less than 1,408 cfs and may, at times, have virtually zero flow. Despite these conditions—which result in a partially "dewatered" Shoshone Reach during plant operations—Ecosystem Sciences arrived at the same conclusion as did Dr. Miller:

> During seasonal low flow periods the reach is dewatered when the plant is operating, though habitat in the Shoshone Reach is connected by small inflows of groundwater and tributary streams that fill pools and flow through the large boulder and rock substrate [ ] Habitat persists even during low flow periods, though wetted area in the stream channel is substantially reduced; however, habitat becomes fragmented for upstream fish movement at low flows.
>
> *See id.* at p. 4.

[4] These outputs derive from the State of Colorado's 2024 UCRM baseline model, which is accessible at https://cdss.colorado.gov/modeling-data/surface-water-statemod.

The key conclusions of the 2025 Ecosystem Report indicate that instream flow use of the Shoshone Water Rights will preserve and improve the natural environment in the Shoshone Reach by: (1) sustaining aquatic habitat; (2) fostering stream connectivity; (3) supporting primary and secondary production; (4) regulating stream temperatures; (5) maintaining habitat complexity; and (6) improving the availability of critical refuges for fish species, particularly during seasonal low-flow periods. *Id.* at p. 33. In addition to the specific preservation and improvement benefits observed within the Shoshone Reach, Ecosystem Sciences also concludes that instream flow use of the Shoshone Water Rights "play a significant, though indirect, role in maintaining the health and function of the ecosystems along the Colorado River" by preserving "flows necessary to support upstream and downstream ecosystems". *Id.* at pp. 10, 34. Please refer to the below discussion in Section 12.b. for a summary of these ancillary benefits.

In summary, the 2024 Miller Report and 2025 Ecosystem Report conclude that protecting the historical flow regime by adding instream flow use to the Shoshone Water Rights will preserve and improve the natural environment of the Shoshone Reach to a reasonable degree.

6. *The location of other water rights on the subject stream*.

There are no decreed diversionary or instream flow water rights located within the Shoshone Reach between the Shoshone Diversion Dam and the outfall of the Shoshone Power Plant. However, there are several decreed appropriative rights of exchange that can exchange against the natural flow measured at the Dotsero Gage except at times that the Shoshone Water Rights are calling pursuant to their respective administrative priorities. In addition, there are, of course, thousands of individual water rights located on the Colorado River mainstem and its tributaries upstream and downstream of the Shoshone Reach.

7. *The effect of the acquisition on any relevant interstate compact issue*.

The 1922 Colorado River Compact and the 1948 Upper Colorado River Compact allocate the beneficial consumptive use of water amongst the applicable basins (with respect to the 1922 Compact) and the states (with respect to the 1948 Compact). The proposed instream flow use of the Shoshone Water Rights will replicate the historical use of the water rights for non-consumptive hydropower generation that has existed for more than 100 years. Thus, the use of the Shoshone Water Rights for instream flow purposes will not result in delivering more water than required under compact obligations because there will be no change from the historical exercise of the Shoshone Water Rights for non-consumptive beneficial use. And consequently, maintaining the Shoshone Water Rights as proposed in the ISF Agreement will not impact the State of Colorado's remaining compact entitlement.[5]

[5] As part of the River District's decades-long effort to protect the historical Shoshone flow regime, the River District and other West Slope entities have negotiated comprehensive settlement agreements with Aurora Water and Colorado Springs Utilities (together, the "Cities"). Those agreements provide, in part, that the Cities will not oppose the instream

8. *Instream flow use of the Shoshone Water Rights will support the maximum utilization of the waters of the State of Colorado*.

The use of the Shoshone Water Rights for instream flow purposes will promote the maximum utilization of the waters of the state. Preservation and improvement of the natural environment to a reasonable degree are beneficial uses of water recognized under Colorado law. *See* C.R.S. § 37-92-102(3). Ensuring the future exercise of the Shoshone Water Rights through a change of water rights proceeding to add an alternate use for instream flow purposes will protect the historical flow regime on the mainstem of the Colorado River, upon which many critical water uses and environmental benefits depend. For instance, meeting the demands of the Shoshone Water Rights by administering a call for 1,408 cfs, consistent with historical practice, facilitates efficient water delivery operations in the Grand Valley during low flow periods, while simultaneously ensuring that aquatic habitats and ecosystems are protected.

The instream flow use of the Shoshone Water Rights will provide the continued use of a 115-year-old water right. The non-consumptive nature of the historical use and the proposed instream flow use means that the water used by the Shoshone Water Rights will continue to be made available for appropriation for consumptive purposes after it has been put to beneficial use for instream flow use, thus promoting multiple uses and maximum utilization of the state's water resources.

In addition, the continued exercise of the Shoshone Water Rights supports the ongoing viability of the 15-Mile Reach Programmatic Biological Opinion ("PBO") and the broader Upper Colorado

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flow use of the senior Shoshone Water Right, provided the ISF Agreement with the CWCB and the change of water right decree approved by the water court include language, requested by the Cities, that confirms the instream flow use of the senior Shoshone Water Right will be exercised in compliance with any potential rules on compact administration issued by the State Engineer that may be in effect. Notably, the CWCB has stipulated to similar language in previous water court decrees, including cases in which the CWCB was the applicant.

Inclusion of the following language in the ISF Agreement and in the eventual change of water right decree would effectuate the agreements with the Cities:

> In the event of a curtailment of Colorado water rights, or an imminent threat or expectation thereof, resulting from the State of Colorado's obligations under the Colorado River Compact and/or the Upper Colorado River Basin Compact, the CWCB's exercise of the Shoshone Water Rights for instream flow purposes will be consistent with any duly adopted final rules or regulations of the State Engineer adopted for purposes of fulfillment of Colorado's commitments under either or both compacts, and that are in force, any pending appeal notwithstanding.

The River District believes that including the above language would foster and maintain comprehensive settlements between the West Slope and Front Range transmountain water users. The River District pledges to work in good faith with the State Engineer, CWCB staff, and the Attorney General's Office, as well as with the Cities, to develop language agreeable to all parties prior to the CWCB's formal decision on whether to approve the proposed ISF Agreement.

River Endangered Fish Species Recovery Program (the "Recovery Program"). By way of example (and not limitation), the continued exercise of the Shoshone Water Rights in a manner consistent with historical practice is one of three conditions expressly set forth in the in the 1996 stipulation and agreement entered between the Orchard Mesa Irrigation District ("OMID"), the Grand Valley Water Users Association ("GVWUA"), and the United States Bureau of Reclamation ("Reclamation") and other parties involved in Case No. 91CW247, District Court, Water Division No. 5 (the "Check Case").

Pursuant to the Check Case stipulation and agreement (the "Stipulation"), assuming these three critical conditions are met, surplus water from Green Mountain Reservoir's Historic Users Pool ("HUP") may be quantified and delivered to the critical habitat existing within the 15-Mile Reach of the Colorado River in the Grand Valley. Notably, however, if the Shoshone Water Rights were to cease operating in a manner consistent with historical practice as described in the Stipulation, the failure to meet this condition could trigger a potential loss of the benefits that the HUP surplus water provides to all Colorado River water users within the State of Colorado. The HUP surplus deliveries have averaged approximately 32,000 AF per year, with most deliveries occurring in the critical flow months of August through October. In other words, the continued viability of the Recovery Program is necessary to provide Endangered Species Act ("ESA") coverage for all Colorado River water users in Colorado (both in-basin and transmountain uses). Thus, the use of the Shoshone Water Rights will contribute to the maximum utilization of the state's water resources by helping to ensure existing and future water use can occur with ESA coverage provided by the Recovery Program. The attached memorandum ("Check Case Memo") prepared by respective counsel for the River District, OMID, and GVWUA provides a more in-depth overview of the Check Case and the criticality of preserving the Shoshone Water Rights to the Stipulation and the Recovery Program. A copy of the Check Case Memo, initially prepared as part of the River's District's federal funding application, is attached hereto as Attachment 9.

9. *Whether the water will be available for subsequent use or reuse downstream of the Shoshone Reach*.

The provisions of §§ 37-92-102(3) and 305(3)(b), C.R.S., that require all contracts or agreements for interests in water, and the water court decree implementing the contracts or agreements, to state the CWCB or the lessor, lender, or donor may bring about beneficial use of the historical consumptive use of the leased, loaned, or donated water right downstream of the instream flow reach as fully consumable water are not relevant and do not apply to this acquisition. With respect to the Shoshone Water Rights, the historical exercise of such rights has been entirely non-consumptive, and because the instream flow will mimic the historical non-consumptive operation of the plant there is no associated impact to consumptive use or reuse claims downstream.

10. *The cost to complete the acquisition of the Shoshone Water Rights for instream flow purposes*.

In December 2023, the River District signed a Purchase and Sale Agreement (the "PSA," Attachment 10) with PSCo to acquire and permanently protect the Shoshone Water Rights for $99 million. The fundamental purpose of the PSA is to establish the CWCB's legal ability to use the Shoshone Water Rights for ISF use in a manner that mimics the historical use of the water rights for hydropower generation to protect the historical flow regime while preserving and improving the natural environment. Contemporaneous with the signing of the PSA, the River District's Board of Directors committed $20 million towards the total purchase price. Then, on January 29, 2024, the CWCB voted unanimously to recommend a $20 million investment, subject to specified pre-conditions, to help finance the acquisition. Colorado's General Assembly subsequently approved the CWCB's contribution through the 2024 Water Projects Bill (HB24-1435) with broad bipartisan support. As of the date of this memorandum, 30 water entities, local governments, and regional partners have formally committed over $17 million to finance the acquisition of the Shoshone Water Rights per the PSA. Additional funding contributions are expected based on conversations with other supporters. **Table 1** below includes local funding commitments to date:

Table 1: Local Funding Commitments (as of 05/05/2025)	
Garfield County	$3 million
Eagle County	$2 million
City of Glenwood Springs	$2 million
Ute Water Conservancy District	$2 million
Eagle River Water and Sanitation District and Upper Eagle Regional Water Authority	$1 million
Grand County	$1 million
City of Grand Junction	$1 million
Mesa County	$1 million
Summit County	$1 million
Pitkin County	$1 million
Colorado Mesa University	$500,000
Clifton Water District	$250,000
Grand Valley Irrigation Company	$250,000
Basalt Water Conservancy District	$100,000
Grand Valley Power	$100,000
Grand Valley Water Users Association	$100,000
Middle Park Water Conservancy District	$100,000
Town of New Castle	$100,000
Orchard Mesa Irrigation District	$100,000
City of Rifle	$100,000
Snowmass Water & Sanitation District	$100,000
Town of Silverthorne	$100,000
Mesa County Irrigation District	$50,000
Palisade Irrigation District	$50,000
West Divide Water Conservancy District	$50,000
Kobe Water Authority	$25,000
Town of Parachute	$25,000
De Beque Plateau Valley Soil Conservation District	$5,000
Town of De Beque	$5,000
Total:	$17.11 million

In November 2024, the River District submitted a request for funding under the Inflation Reduction Act's Upper Basin Environmental Drought Mitigation, Bucket 2 Ecosystem ("B2E") Financial Assistance Program to the U.S. Bureau of Reclamation ("Reclamation"), requesting $40 million to be committed towards the $99 million purchase price. Notably, the State of Colorado's state and federal elected officials provided overwhelming support for the River District's B2E application. The River District's B2E application and an index of 58 unique letters of support that articulate the benefits of the Shoshone Water Rights to their communities and interests across the state can be accessed at this link.

On January 17, 2025, Reclamation announced an award of approximately $40 million, allowing the River District's B2E application to proceed towards negotiation of terms and conditions for a secured funding agreement. That award, like many others, is currently under review by the new administration in Washington, D.C. The River District remains optimistic that it will secure funding from the federal government and/or if necessary, through an alternate funding strategy before the end of the change of water rights case, which is the funding deadline in the PSA between the River District and PSCo.

11. *Instream flow use of the Shoshone Water Rights to preserve and improve the natural environment will be administrable by the Division Engineer*.

Following the entry of a change of water rights decree, including any necessary terms and conditions that the Water Court deems necessary, for the Shoshone Water Rights, the Division Engineer for Water Division No. 5 will be able to administer the water rights for instream flow purposes in the manner proposed by the River District, PSCo, and the CWCB. *See* C.R.S. § 37-92-301(3) (providing that the State and Division Engineers administer waters of the state in accordance with decrees adjudicated by state water courts).

12. *Additional benefits associated with the proposed acquisition*.

The exercise of the Shoshone Water Rights protects Colorado's namesake river for the benefit of numerous and diverse water users, recreation interests, and the abundant natural habitats and ecosystems that rely on the Colorado River for survival. *See* Attachment 2, Map 4. And while the anticipated benefits to the natural environment of the Shoshone Reach are a necessary feature of the CWCB's evaluation of the proposed acquisition, the CWCB has the authority to consider other factors in accordance with Rule 6e. of the ISF Rules. We provide the following additional benefits of the acquisition for the CWCB's consideration.

With the assistance of Hydros Consulting, Inc. ("Hydros"), the River District and PSCo have undertaken a comprehensive investigation of the numerous ecosystem, habitat, and environmental benefits of the Shoshone Water Rights, both within and outside of the designated Shoshone Reach. Hydros' analysis is contained in two technical reports: (1) the Shoshone Power Plant Water Rights Yield Assessment, dated September 11, 2024 (the "Yield Assessment," Attachment 11), and (2)

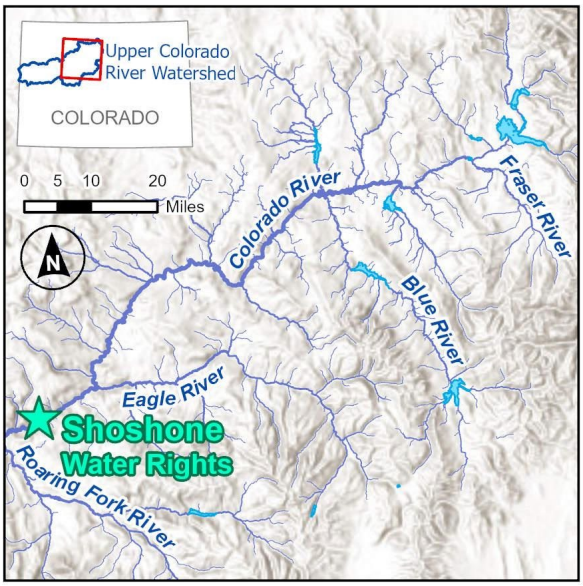
the Addendum to September 11, 2024, Shoshone Power Plant Water Rights Yield Assessment, dated November 7, 2024 (the "Yield Addendum," Attachment 12).

Drawing support from the technical work performed by Hydros, some of the additional benefits afforded by the permanent protection of the Shoshone Water Rights are summarized below:

a. Benefits to Existing Instream Flow Water Rights and Tributaries Upstream of Shoshone Power Plant.

The State of Colorado has recognized the importance of the headwaters region of the Colorado River and currently holds 350 decreed ISF water rights on the Colorado River upstream of the Shoshone Power Plant, and over 120 ISF water rights located downstream of the Shoshone Power Plant, including those on downstream tributaries to the Colorado River. *See* Attachment 13, the "ISF Benefits Memorandum," Figure 1. The numerous ISF water rights located in the upper Colorado River watershed on the mainstem and its tributaries upstream of the Shoshone Power Plant benefit from the seniority of the Shoshone Water Rights and their ability to command flows down the Colorado River on a year-round basis. *See* Attachment 2, Map 3. If the flows attributable to the Shoshone Water Rights were absent from the upper Colorado River mainstem, river levels would be significantly lower (especially in drought years and late in the irrigation season), resulting in a negative impact on the riverine ecosystems that are already stressed by prolonged drought and aridification.

Figure 3: Major Tributaries Upstream of the Shoshone Power Plant



The attached memorandum titled "Shoshone Water Rights Analysis on Decreed Instream Flow Reaches in the Colorado River Watershed" (the "ISF Benefits Memorandum," Attachment 13) provides a more detailed analysis of how protecting the historical exercise and administration of the Shoshone Water Rights will benefit existing decreed ISF reaches in the Upper Colorado River Watershed. As described in the ISF Benefits Memorandum, the reduction in flow that would occur in the absence of the administration of the Shoshone Water Rights would lead to more strain on the upstream and downstream ISFs examined in the memorandum, thereby translating to fewer days when the ISFs would be satisfied. *See id*. The ISFs studied in the ISF Benefits Memorandum include tributaries as well as the Colorado River mainstem and are representative of the Shoshone Water Rights' range of influence across the basin. *Id.* The primary conclusion of the ISF Benefits Memorandum is that the exercise of the Shoshone Water Rights supports ISF reaches upstream of the Shoshone Power Plant in meeting target flows (especially in dry years and in critical months of the later irrigation season) while having a negligible impact on tributaries downstream of the power plant, including on the Roaring Fork River. *Id.* at pp. 1-2.

b. Maintaining Streamflow through Upper Colorado River Wild and Scenic Alternative Management Plan River Sections.

The Upper Colorado Wild and Scenic Stakeholder Group ("Stakeholder Group") was formed in 2007 following a report by BLM on the eligibility of rivers in the Upper Colorado River Basin for Wild and Scenic River designation. The BLM report identified 84 miles of the upper Colorado River from the Town of Kremmling to No Name Creek in Glenwood Canyon as having Outstanding Remarkable Values ("ORVs") eligible for federal designation as a Wild and Scenic River. The Stakeholder Group, which includes over 20 entities (including the River District and the State of Colorado), developed an alternative plan to a federal Wild and Scenic designation with an intention to balance permanent protection of the ORVs, provide certainty for the Stakeholder Group, ensure water project yield, and provide flexibility for water users along the upper Colorado River. The Stakeholder Group's "Alternative Management Plan" lists the continued exercise of the Shoshone Water Rights as one of four identified long-term protection measures for streamflow-influenced ORVs on the Colorado River from Kremmling to No Name Creek.[6] The Shoshone Water Rights provide base flows through the subject river segments that support aquatic habitat, lower water temperatures, and maintain minimum boatable flows.

The USFS-BLM Report confirms the importance of the Shoshone Water Rights to the federal wild and scenic designated reaches given that flows necessary to satisfy the Shoshone Call also support fisheries for native species, sport species, and aquatic invertebrates. *See* Attachment 7, pp. 16–17. The USFS-BLM Report also identifies the foundational need for the Shoshone Water Rights to maintain wild and scenic suitability for recreation through a reach that saw approximately 150,000 boater "visitor" days in 2022. *Id.* at pp. 14, 16. The USFS-BLM Report concludes by stating

[6] *See* Amended and Restated Upper Colorado River Wild and Scenic Stakeholder Group Management Plan (last revised July 2024), p. 63.

"[o]peration of the [Shoshone Water Rights] supports [ORVs] in three reaches of [the] Colorado River that have been determined to be eligible for designation into the National Wild and Scenic Rivers System." *Id.* at p. 17.

c. Recreational Benefits.

Colorado's robust recreational economy relies heavily on the Colorado River mainstem, with flows provided by the Shoshone Water Rights strengthening the state's iconic river recreation industry throughout Grand, Summit, Eagle, Garfield, and Mesa Counties. River recreation in Colorado is estimated to contribute $18.8 billion annually to the state's gross domestic product, with approximately $4 billion coming directly from the Colorado River Basin on the West Slope. *See* Attachment 2, Map 5.[7] As temperatures rise and streams diminish, the exercise of the Shoshone Water Rights provides security for this industry, protecting the recreational fishing and boating that sustain local businesses and attract water-based tourism.

The USFS-BLM Report estimated that in 2022 approximately 150,000 commercial and private boat recreationalists used the Colorado River between Kremmling and into Glenwood Canyon during the summer months with interest in river recreation growing each year. *See* Attachment 7, pp. 14, 16. The USFS-BLM Report goes even further to report on how flows impact recreational experiences, which shows the importance of protecting the Shoshone Water Rights that ensure higher flows are available for recreationalists above and below the Shoshone Reach:

> These flow-dependent activities rely heavily on the amount of water in this stretch of the river. Based on input from the outfitters and experience, these commercial operations typically cease when river flows drop below 1,200 cfs. The floating visitor experience diminishes drastically once flows drop below this level.
>
> *Id.* at p. 16.

The USFS-BLM Report also reported that outdoor recreation on BLM-administered lands in the Kremmling Field Office and Colorado River Valley Field Office contributes $145.7 million and over 1,100 jobs annually. *Id.* at p. 14.

d. Water Quality Improvements.

Communities that rely on the mainstem of the Colorado River for their drinking water supplies benefit from the enhanced water quality provided by the exercise of the Shoshone Water Rights because the flows attributable to the Shoshone Water Rights dilute salinity and sediment. These communities can experience high treatment costs during low flow conditions when concentrations of Total Dissolved Solids ("TDS") become elevated. Taste, odor, and color are affected when

[7] *See* Business for Water Stewardship, *Economic Contributions of Water-related Outdoor Recreation in Colorado*, https://businessforwater.org/wp-content/uploads/2020/05/SA_BWS_FactSheet_Digital_CO_1PG.pdf.

flows decrease due to the potential loss of the Shoshone Call. Without the higher flows of clean and cold headwater-sourced supplies provided by the Shoshone Call, a higher concentration of salinity and other water quality constituents creates increased costs for municipal drinking and wastewater treatment.

Clifton, the City of Rifle, and the Towns of DeBeque, Silt, Parachute, and Battlement Mesa are all West Slope communities which draw and treat water directly from the Colorado River as their primary domestic water supply. Securing the permanent exercise of the Shoshone Water Rights by including an alternate instream flow use will sustain critical flows and water levels in the Colorado River on a year-round basis, especially in dry years, thereby maintaining water quality through the dilution of pollutants and sediment naturally present in the river. The presence of sediment is of particular concern for a stretch of 103 river miles from the Colorado River's confluence with the Roaring Fork River to the confluence with the Gunnison River on the "Monitoring & Evaluation List" within Colorado's Section 303(d) List of Water-Quality-Limited Segments Requiring Total Maximum Daily Loads. While this reach is not listed for impairment, the "Monitoring & Evaluation" classification signifies there is "reason to suspect water quality problems".

e. Agricultural Benefits.

As discussed in Section C.8. above, all agricultural use (and all other consumptive uses) of Colorado River basin water within Colorado depends very significantly on the continued success of the Recovery Program. The Shoshone Water Rights are a critical piece to this puzzle because the exercise of the Shoshone Water Rights is one of the three express conditions in the important Check Case Settlement that allows a Green Mountain Reservoir Historic Users Pool surplus to be declared, released from storage, and delivered for the benefit of the endangered fish species. In many years, the HUP Surplus water is by far the single largest source of water delivered to benefit the endangered fish species—thus making it a very important component of the Recovery Program.

Additionally, the historical exercise and administration of the Shoshone Water Rights helps to support Colorado's robust agricultural economy, which is responsible for generating approximately $47 billion annually in economic activity in Colorado.[8] By way of example, the historical flow regime created by the Shoshone Water Rights protects and improves water quality especially in low flow periods for water users up and down the Colorado River mainstem. Agricultural producers benefit significantly from improved water quality, bringing greater agricultural production to the West Slope. High salinity levels in the Colorado River, which are expressed by the concentration of TDS, can negatively impact water use and crop yields, especially

[8] *See* Legislative Council Staff, *A Snapshot of Colorado Agriculture*, Issue Brief (March 2024), https://leg.colorado.gov/sites/default/files/r23-286_agricultural_economy_in_colorado_0.pdf; *see also* Colorado Department of Agriculture, *The Economic Contribution of Agriculture to Colorado's Economy*, (February 14, 2020), https://drive.google.com/file/d/1ZJm_G8ng_1csUQvZw_iiMsn6DYSDjm_X/edit.

for salt-sensitive cash crops, such as stone fruits, grapes, vegetables and seed crop production by up to 25%.[9]

f. Upper Colorado River Endangered Fish Recovery Program.

All Colorado River water users in the State of Colorado, whether located on the eastern or western side of the Continental Divide, rely upon the continued success of the Recovery Program and continued ESA compliance for streamlined permitting processes for over 1,250 water projects located in Colorado since 1988.[10] As explained in Section C.8., above, one of the ways in which the continued exercise of the Shoshone Water Rights benefits water users is by ensuring that Green Mountain Reservoir's HUP "Surplus" can continue to provide water for delivery to the 15-Mile Reach as provided by the terms of the Check Case Stipulation. *See* Attachment 9.

[9] *See* Colorado State University Extension, Master Gardener, *CMG Garden Notes #224 Saline Soils* (revised October 2015), https://cmg.extension.colostate.edu/Gardennotes/224.pdfm, p. 224-1; *see also* United States Geological Survey, *State News Release: New study demonstrates how climate and irrigation influence salinity of waters in the Upper Colorado River Basin* (February 8, 2024).
[10] *Id.* (detailing 1,272 projects in Colorado that have benefited from ESA Section 7 Consultations from 1988-2023).

Index of Attachments:

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Attachment 2: Maps
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Attachment 14: Draft Water Court Application

Attachment 1a

Decreed 6/11/1956

SHOSHONE HYDRO PLANT DIVERSION - NO. 2

That under former decree of the Court said ditch was numbered 2 and awarded a priority for 1,250.0 cubic feet of water per second of time under and by virtue of the original construction; that said ditch under this decree is entitled to Priority No. 328 for 158.0 cubic feet of water per second of time under and by virtue of the first enlargement; that the date of initiation of said appropriation was the 15th day of May, 1929; that the name and post office address of the claimant is Public Service Company of Colorado, a Colorado corporation, 900 15th Street, Denver, Colorado; that said diversion system is used in the manufacturing and generation of electrical energy and the source of supply is the Colorado River;

That the method of diversion consists of a diversion dam, tunnel and penstocks utilized by said claimant for the generation of electricity and the diversion dam is located on the Colorado River in Garfield County, State of Colorado, in Section 30 of Township 5 South, Range 87 West of the 6th Principal Meridian. The adit or headgate of the tunnel (formerly DeRemer Canal and Pipeline) is located on the right bank, being the northerly bank, of the Colorado River in the County of Garfield, State of Colorado, whence the North quarter corner of Section Thirty (30), Township Five (5) South, Range Eighty-seven (87) West of the 6th Principal Meridian bears North 23°48'20" East 2,414.64 feet, more or less;

That there be allowed to flow into said ditch and diversion system from said Colorado River for the use aforesaid and for the benefit of the party entitled thereto under and by virtue of the first enlargement, Priority No. 328 for 158.0 cubic feet of water per second of time relating back to and dating from the 15th day of May, 1929;

That said Priority No. 328 hereby awarded, to the extent of 158.0 cubic feet of water per second of time, is hereby made absolute and unconditional.

1250.0
158.0
Total - 1408.0 Cu. Ft.

Attachment 1b

STATE OF COLORADO)
)ss
COUNTY OF EAGLE)

IN THE DISTRICT COURT.

In the matter of the application of the Glenwood Light and Water Company a Corporation, for the adjudication of its priority of right to the use of water for domestic and other purposes from Grizzly Creek in Water District No. 53, Garfield County, Colorado;
and
In the matter of the adjudication of priorities of water rights in Water District No.53, in the State of Colorado, for beneficial purposes other than Irrigation.

No. ~~466~~ 583
FINDINGS AND DECREE.

Now on this 27th day of February A.D.1911, this matter coming on for hearing and adjudication before the Court upon the petition of the Central Colorado Power Company, one of the claimants herein, to make final and absolute its decree heretofore rendered concerning the Glenwood Power Canal and Pipe Line and upon the Supplemental Statement of Claim of said Company asto said Glenwood Power Canal and Pipe Line, pursuant to an order made by this Court entered on the 14th day of November A.D.1910, said The Central Colorado Power Company appearing by J.T.Adams and C.T.Taylor, its Counsel Frank W.Allen and John Thomas appearing by C.S.Rowe, their Counsel and the Town of Glenwood Springs appearing by E.J.De Lan, Esq., Its Counsel and to the claims of the Central Colorado Power Company having been duly considered and dismissed by the Court and there being no objections or exceptions to the hearing of the evidence concerning said Glenwood Power Canal and Pipe Line or to the entry of the findings and decree concerning the same hereinafter refered to; said hearing having been commenced on Monday the 27th day of February A.D.1911 at 10 o'clock A.M. at the Court House at Red Cliff, Eagle County, Colorado, pursuant to said order of this Court, dated November 14th 1910, and

It further appearing to the Court and the Court doth find that notice thereof was given in manner and form and within the time as re provided in said order by the Clerk of this Court by publishing said notice in not less than one public newspaper in each of the counties

This is just a readjudication of part of 466

0349

into which Water District No.53, State of Colorado, extends, namely; the counties of Eagle,Grand, Routt,and Garfield; that said notice contained a copy of said order of November 14th 1910 and was published in such papers not less than once each week, until four successive weekly publications had been made; the last of which was made and published in each case upon a day previous to the day fixed for the commencement of said hearing; that the said notice so published in Eagle County was published in the Eagle County Blade; that the said notice so published in Grand County was published in the Kremling News and Middle Park times; that said notice so published in Routt County was Published in the Steamboat Pilot; that said notice so published in Garfield County was in the Glenwood Post; that each and all of said newspapers are published ~~in~~ within the State of Colorado,having been published continuously and uninterruptedly in each of said counties during a period of more than twenty-six consecutive weeks prior to the first publicationof each of said notices and were and are newspapers within the meaning and requirements of the laws of the State of Colorado; and

It further appearing to the Court and the Court doth find that said notice was also served upon all such parties to this action who have filed statements of claim or claims in this proceeding, claiming priority or priorities of right to the use of water for beneficial purposes in said Water District No.53 at least ten days prior to the time of said hearing; that the only party or parties who have filed any statement or statements of claim or claims in this proceedings and who thereby entitled to notice other than posting or publication were and are The Glenwood Light and Water Company and the Town of Glenwood Springs and D. Broughton; that said parties and each thereof were duly served with said notice within the time and in accordance with the provisions of said order; and

It further appearing to the Court and the Court doth find that ten printed copies of said notice were posted in ten public places in said water district not less than twenty days from the day so appointed which copies were posted or caused to be posted by said The Central Colorado Power Company;and

It further appearing to the Court and the Court doth find that each and all of said notices as given, published, posted and served were in all things given, published, posted and served within the time and in the manner provided by said order of November 14th 1910, and that all persons and associations and corporations entitled to notice of this proceeding were duly and regularly notified thereof in the manner provided by law and in accordance with the orders of this Court; and the Court having heard the evidence adduced as well as having considered the evidence heretofore taken in the matter and being fully advised in the premises, as to

THE GLENWOOD POWER CANAL AND PIPE LINE,

the Court doth find:

That heretofore and on to-wit: the 4th day of August A.D. 1903, a decree of this Court was duly made and entered of record in a certain proceeding then pending in said Court, entitled: "In the matter of the application for the adjudication of priority of right to the use of water for the Dellemor Canal and Pipe Line and its extention from the Grand River, for power and manufacturing purposes in Water District No. [illegible]", that in said proceeding there was duly adjudicated and decreed to the said canal and pipe line for the use and benefit of the owners thereof, their heirs and assigns for said purposes, 3500 cubic feet of water per second of time of the waters of the Grand River, with priority dating from January 7,1903,to be diverted into said canal and pipe line through the headgate thereof, conditioned however, that the final completion of said canal and pipe line, and auxiliary works in connection therewith, and the application of the waters aforesaid to said beneficial purposes, should be completed and consumated with all due diligence, and within a reasonable time.

That thereafter, and on to-wit: the 9th day of December A.D. 1907,a decree of this Court was duly made and entered of record in this proceeding, among other things awarding to the Glenwood Power Canal and Pipe Line, for the use and benefit of the owners thereof, 1250 cubic feet of water per second of time with priority No.2 dating from the 7th

day of January, 1902, for power, mining, milling, manufacturing, lighting, heating and traction purposes, conditioned, however, that the work of construction thereon should be diligently and continuously prosecuted and the waters of said Grand River to be diverted by means of said canal and pipe line, should be applied to the beneficial uses aforesaid within a reasonable time; that part of the waters decreed as aforesaid to The DeRemer Canal and Pipe Line, was and is used at the Glenwood Power Canal and Pipe Line, the headgate of which pipe lines are substantially at the same point, as will more fully appear from said proceedings.

That it was provided in the decree of the Glenwood Power Canal and Pipe Line, that it should not be taken to operate as a denial or dismissal of the rights theretofore adjudicated to The DeRemer Canal and Pipe Line,

That the work of construction upon said canal and pipe lines and each thereof was at all times diligently and continuously prosecuted until the completion thereof; that 1200 ~~350~~ cubic feet of water per second of time has been diverted and used in the County of Garfield and State of Colorado by means of ~~said~~ Glenwood Power Canal and Pipe Line, (formally a part of the DeRemer Canal and Pipe Line) and applied to the beneficial purposes aforesaid, within the State of Colorado, with all due diligence and within a reasonable time, by reason whereof said claimant is entitled to a final order and decree of this Court, making absolute the decrees of heretofore rendered, the said decree to be for 1250 cubic feet of water per second of time of the waters of the Grand River and its Tributaries to be diverted by means of ~~said~~ Glenwood Power Canal and Pipe Line for power, for mining, milling, and manufacturing, lighting, heating and traction purposes, with priority No.2 dating from the 7th day of January, 1902, in said Water District No. 56.

That said Glenwood Power Canal and Pipe Line, as constructed and completed is as follows:

The name of said canal and pipe line is the Glenwood Power Canal and Pipe Line.

The name of the owner thereof is the said Central Colorado Power Company, a Colorado corporation.

The Postoffice address of said company is Denver, Colorado.

The headgate of said Glenwood Power Canal and Pipe Line is located at a point on the right bank being the northerly bank of the Grand River in the county of Garfield, State of Colorado, from which stream the said canal and pipe line derives its supply of water, at a point whence the north quarter corner of Section Thirty (30),Township Five (5) South, Range Eighty-seven (87) West 6th P.M. bears north 83° 45' 30" East 2414,04 feet.

The general course thereof is westerly from said headgate.

That said canal and pipe line consists of a diverting dam located upon the Grand River at the headgate thereof; a gravity line; a pressure pipe line consisting of two pipes running from the gravity line to the power house at the lower end of said pipe line where electrical power is generated by means of water passing through said Glenwood Power Canal and Pipe Line, All in Garfield County, Colorado, and thence transmitted and used by means of transmission and distribution lines and other electrial appliances to various parts of the State.

The length of said gravity line is 12,403 feet and consists of a tunnel with concrete walls and floor 10 feet 8 inches in width and 12 feet high,inside measurement; the grade thereof is five-tenths (5) feet per Thousand (1000) feet.

The length of said pressure line as constructed is 937 feet and the grade thereof is a fall of 165 feet in said Distance; each section of said line as constructed consists of a pipe 108 inches in interior diameter.

The purposes for which the water is used and to be used is for power , mining, milling, manufacturing, lighting, heating and traction purposes.

The carrying capacity of said canal and pipe line is 1300 cubic feet of water per second of continuous flow.

The date of the appropriation of water by origional construcyion of said canal and pipe line is the 7th day of January A.D.1902 and the amount of water appropriated by and under said construction is 1250 cubic feet of water per second of time.

The work of construction upon said Glenwood Power Canal and Pipe Line was commenced under the name of the DeRemer Canal and Pipe Line on the 6th day of Januagy 1902, by J.R. DeRemer and others, the grantors by

mense conveyances of said claimant The Central Colorado Power Company.

On the 10th day of April A.D. 1902 The Grand River Power and Transmission Company duly located The Grand River Power and Transmission Company's Canal and Pipe Line appropriating 300 cubic feet of water per second of time. The Central Colorado Power Company is grantee and present owner thereof.

The said DeRemer Canal and Pipe Line and the Grand River Power and Transmission Company's pipe line and other projects and the rights of way and water rights for said canals and pipe lines and projects have been acquired and are now owned by said The Colorado Power Company and are now a part of said Glenwood Power Canal and Pipe Line.

The said Glenwood Power Canal and Pipe Line has its headgate substantially at the same point and the lines thereof substantially along the line of the said DeRemer Canal and Pipe Line, for which a right of way was granted by the United States to J.R.DeRemer and others under Section 8 of the Act of Congress of July 26, 1866 (U.S.R.S) Section 2339) and the laws, rules and regulations supplementary thereto and passed in furtherance of the purposes of said Act; which right of way was on the 20th day of August, 1903, approved by the Secretary of the Department of the Interior of the United States and was thereafter granted to and acquired by said The Central Colorado Power Company with the approval of the Secretary of the Interior and is now owned by said The Central Colorado Power Company.

The said Glenwood Power Canal and Pipe Line also has its headgate substantially at the same point and the lines thereof substantially along the line of said The Grand River Power and Transmission Company's Canal and Pipe Line, for which a right of way was granted by the United States to said company under Section 9 of the Act of Congress of July 26, 1866 (U.S.R.S. Section 2339) and laws, rules and regulations supplementary thereto and passed in furtherance of the purposes of said Act; which right of way was on the 19th day of November, 1903, approved by the Secretary of the Department of the Interior of the United States and was thereafter granted to and acquired by said The Central Colorado Power Company with the approval of the Secretary of the Interior and is now owned by said The Central Colorado Power Company.

the work of construction upon said Glenwood Power Canal and Pipe Line was continuously and diligently prosecuted at a great cost and difficulty and was completed on or about May 24th, 1909, and water diverted through said canal and pipe line and used for beneficial purposes aforesaid and ever since said time the water from the Grand River has been and is now being used by means of said canal and pipe line for such beneficial purposes tothe extent of 1250 cubic feet of water per second of time and by reason whereof the decrees concerning said canal and pipe line are hereby ratified confirmed and approved to the extent of 1250 cubic feet of water per second of time of the Grand River with priority No. 2 dating from January 7th 1902.

The work necessary for the construction of said canal and pipe line has been of great difficulty and performed at an outlay of great cost and expense and among other things has consisted of expensive surveys and re-surveys for the purposes of determining the most feasible and practical rout and location thereof; as well as the building of tunnels and costly engineering construction; that the Grand River at and near the point of diversion thereof is walled in by masses of almost purpendicular solid rock and the route of said canal and pipe line passes through precipitous cliffs and solid walls of granite rock all of which it was necessary to overcome in the construction of said canal and pipe line, and that all of the work thereon was necessary as a part and in furtherance of the completion of said canal and pipe line.

Therefore, as to the Glenwood Power Canal and Pipe Line itiis hereby ORDERED,ADJUDGED AND DECREED, that said Glenwood Power Canal and Pipe Line is entitled to priority No. 2. It is claimed and owned by The Central Colorado Power Company, organized and existing under the laws of the State of Colorado, and is a part of said company's water power system. The water to be diverted by means thereof is used and to be used for power, mining, milling, manufacturing, lighting, heatingand traction purposes to the extent of 1250 cubic feet of water per second of time, continuous flow through said canal and pipe line for said purposes, to be taken from the Grand River through said canal and pipe line from its headgate located on the right bank, being the northerly bank, of the Grand River, from which it derives its supply of water, at a point whence the north Quarter Corner

of Section 30, Township 6 South, Range 87 West, 6th P. M. bears north 38° 48' 26" East 2414.64 feet, running thence in a generally westerly direction from said headgate and the decrees heretofore entered concerning said Glenwood Power Canal and Pipe Line are hereby ratified, confirmed and approved to the extent of 1250 cubic feet of water per second of time of the Grand River with priority No.2 dating from January77, 1902.

And it is hereby,

FURTHER ORDERED, ADJUDGED AND DECREED, that there be allowed to flo into said canal and pipe line from said Grand River for the beneficial uses and purposes aforesaid and foe the use and benefit of the patty or parties lawfully entitled thereto and under by virtue of the appropriatin by origional construction at any and all times, during any and all season 1250 cubic feet of water per second of time, the appropriation of which water took effect on and said priority No.2 dates from the 7,of January 1902.

Provided However, that after the waters of the Grand River shall have been used for the beneficial purposes aforesaid by means of said canal and pipe line,the said waters shall be returned to the stream not less than two miles above the Town of Glenwood Springs, in Garfield County, Colorado.

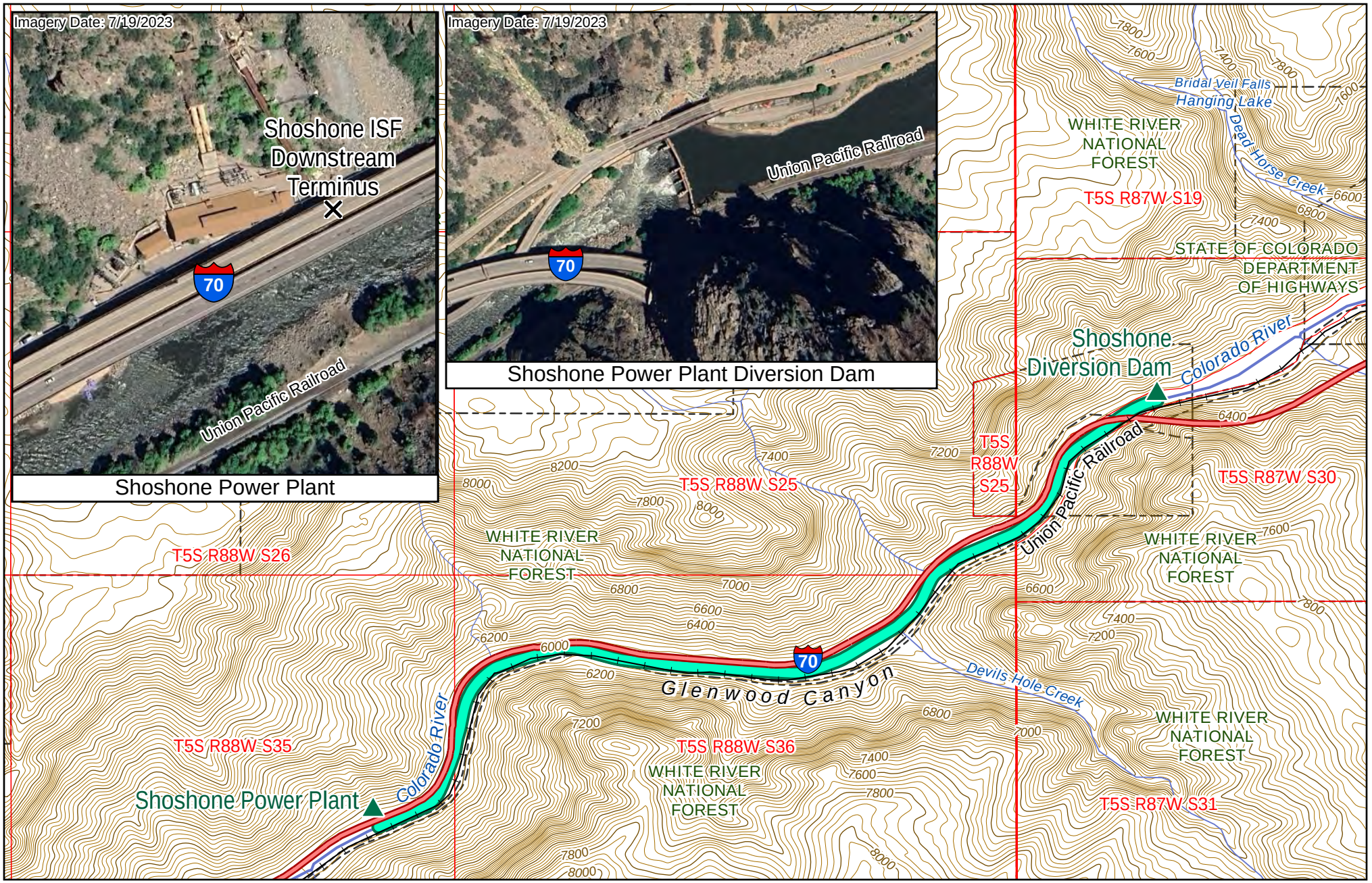
IT IS FURTHER ORDERED by the Court that each and every person interested in or claiming any ditch, canal or reservoir in this proceeding whether as to the decrees heretofore rendered or as to this supplementary decree shall receive from the Clerk of this Court, on the payment of the sum of $2.50 for each certificate and a further sum of 20¢ per folio for the matters contained therein a certificate under the Seal of the Court showing the date or dates and the amount or amounts of the appropriation adjudged in favor of such ditch, canal, flume, pipe line or reservoir under and by virtue of the construction, extension and enlargments thereof severally; also specifying the number of said ditch, canal,flume or pipe line and of each priority to which the same may be entitled by reason of such construction, extention and enlargment, if any.

Done in open Court at Red Cliff, Eagle County, Colorado, this 27th day of February A. D. 1911.

By the Court,

Chas. Cavender,
Judge.

Attachment 2



Map 1: Shoshone Instream Flow Reach Project Map

State: Colorado

County: Garfield

Created Tuesday, March 4, 2025

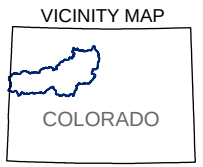
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Proposed Shoshone ISF Reach Project Boundary

TRUE-NORTH MAGNETIC-NORTH

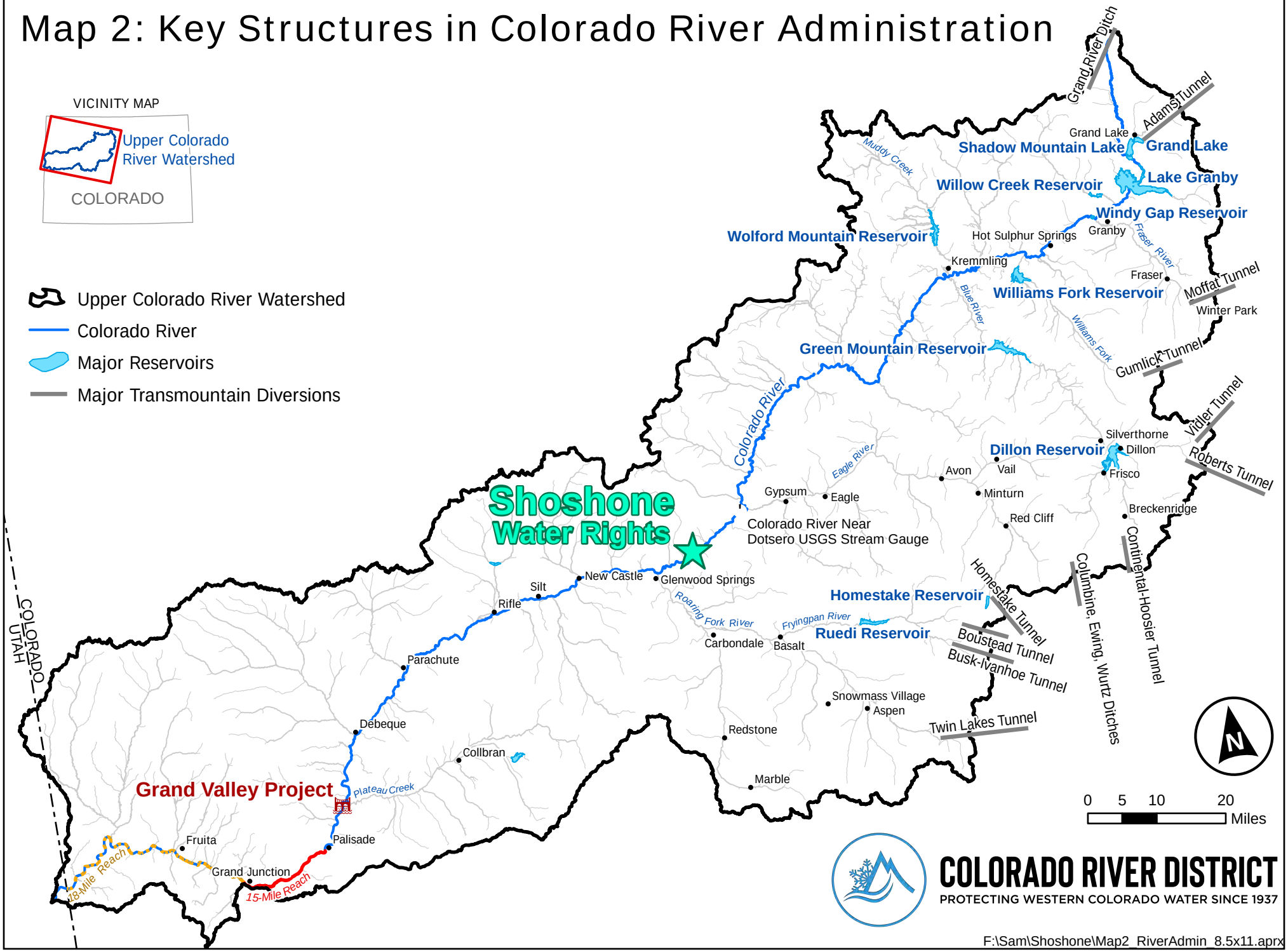




COLORADO RIVER DISTRICT

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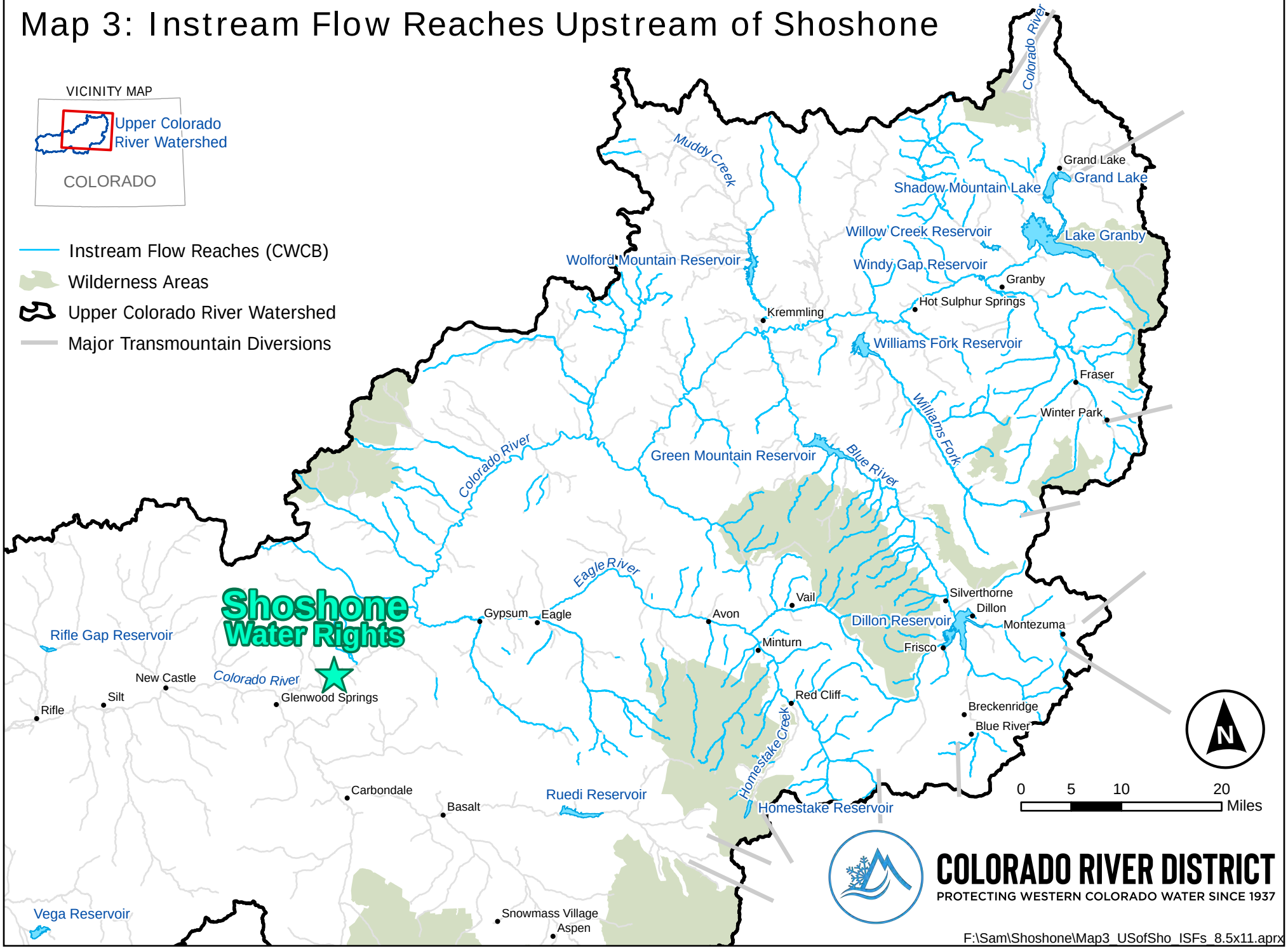
Map 2: Key Structures in Colorado River Administration



COLORADO RIVER DISTRICT
PROTECTING WESTERN COLORADO WATER SINCE 1937

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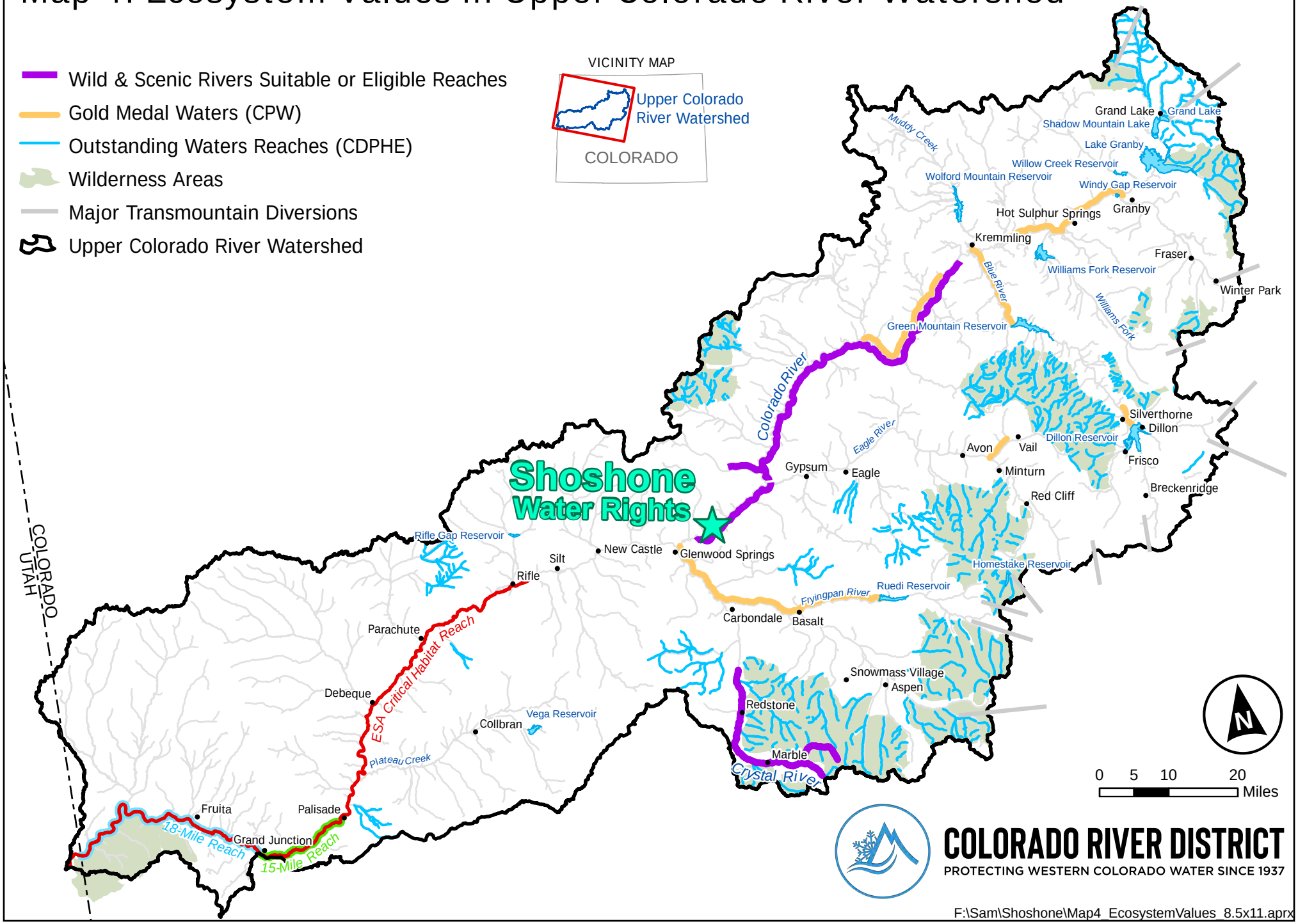
Map 3: Instream Flow Reaches Upstream of Shoshone



COLORADO RIVER DISTRICT
PROTECTING WESTERN COLORADO WATER SINCE 1937

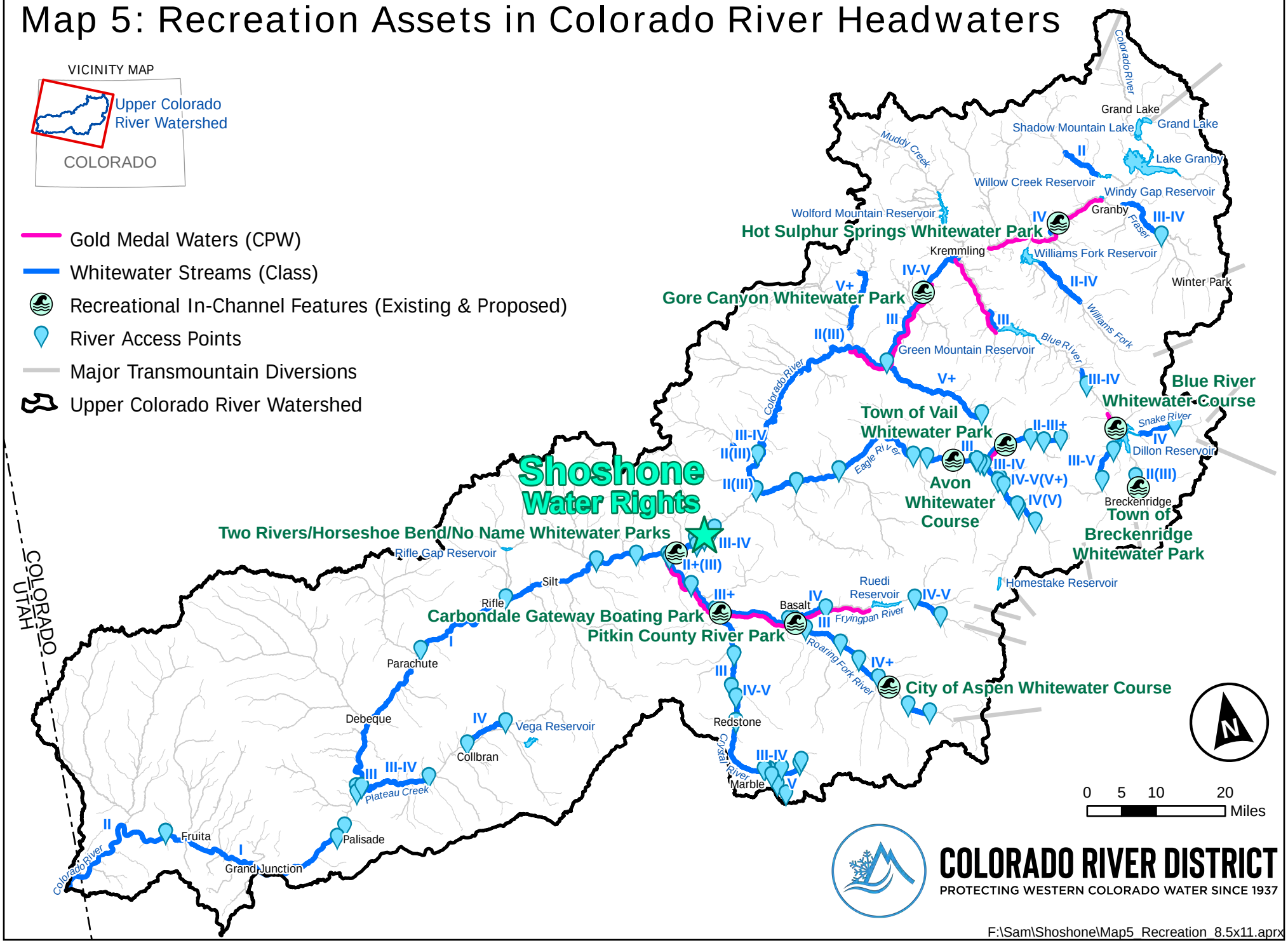
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Map 4: Ecosystem Values in Upper Colorado River Watershed



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Map 5: Recreation Assets in Colorado River Headwaters



COLORADO RIVER DISTRICT
PROTECTING WESTERN COLORADO WATER SINCE 1937

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SHOSHONE OUTAGE PROTOCOL
AGREEMENT NUMBER 13XX6C0129
INCLUDING THE
UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION, THE STATE OF COLORADO, DIVISION OF WATER RESOURCES, THE CITY AND COUNTY OF DENVER, ACTING BY AND THROUGH ITS BOARD OF WATER COMMISSIONERS, THE COLORADO RIVER WATER CONSERVATION DISTRICT, THE MIDDLE PARK WATER CONSERVANCY DISTRICT, THE NORTHERN COLORADO WATER CONSERVANCY DISTRICT, THE MUNICIPAL SUBDISTRICT, NORTHERN COLORADO WATER CONSERVANCY DISTRICT, THE GRAND VALLEY WATER USERS ASSOCIATION, THE ORCHARD MESA IRRIGATION DISTRICT, AND THE GRAND VALLEY IRRIGATION COMPANY

THIS AGREEMENT is made this 27th day of June, 2016, and includes the **UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION** (Reclamation), the **STATE OF COLORADO DIVISION OF WATER RESOURCES** (DWR), **THE CITY AND COUNTY OF DENVER acting by and through its BOARD OF WATER COMMISSIONERS** (Denver Water), the **COLORADO RIVER WATER CONSERVATION DISTRICT** (River District), the **MIDDLE PARK WATER CONSERVANCY DISTRICT** (Middle Park), the **NORTHERN COLORADO WATER CONSERVANCY DISTRICT** (Northern Water), the **MUNICIPAL SUBDISTRICT, NORTHERN COLORADO WATER CONSERVANCY DISTRICT** (Subdistrict), the **GRAND VALLEY WATER USERS ASSOCIATION,** the **ORCHARD MESA IRRIGATION DISTRICT**, and the **GRAND VALLEY IRRIGATION COMPANY**, hereinafter collectively referred to as the "Parties".

I. EXPLANATORY RECITALS

The following statements are made in explanation:

A. When the Shoshone Power Plant is operating, the Shoshone Call can command the flow in the Colorado River and its tributaries in certain stream conditions by exercising the Shoshone Water Rights against upstream junior water rights. When the Shoshone Call is being administered, junior water rights cannot store or divert water without providing replacement water to offset their depletions to the river system as necessary to prevent injury.

B. Whenever the Shoshone Power Plant is subject to a shutdown for repair, maintenance, or other reasons, the Shoshone Call cannot be exercised, and river flows may drop.

C. Certain Parties desire to keep the flow regime of the Colorado River as it has been historically influenced by the Senior Shoshone Call.

D. The Parties agree to implement the operational procedures described in this agreement during a Shoshone Outage.

E. This Agreement will provide greater certainty for the administration of water rights.

F. As is explicitly provided for in this Agreement, certain Parties to this Agreement are only agreeing to be bound by specifically identified sections of this Agreement.

NOW, THEREFORE, in consideration of the foregoing recitals and mutual covenants hereinafter set forth, the Parties hereto agree as follows:

II. DEFINITIONS

Where used herein, unless specifically expressed otherwise or obviously inconsistent with the intent herein, the following definitions apply to this Agreement. Nothing in these definitions alters or amends any existing or future agreement between all or various Parties to this Agreement:

A. "15-Mile Reach" is the reach of the Colorado River which extends from the point at which the tailrace common to the Grand Valley Power Plant and the Orchard Mesa Irrigation District pumping plant returns to the Colorado River below the Grand Valley Irrigation Company diversion dam, downstream to the confluence of the Colorado River and Gunnison River (definition verbatim from the Stipulation and Agreement incorporated into the decree entered in Case No. 91CW247, Colorado Water Division 5).

B. "2007 Shoshone Agreement" is an agreement between Denver Water and Public Service Company of Colorado d/b/a Xcel Energy, effective January 1, 2007, concerning reduction of the Shoshone Call.

C. "Dotsero Gauge" is Gauge Number 09070500 on the Colorado River, near Dotsero, Colorado, which is operated by the United States Geological Survey, Colorado Water Science Center.

D. "End of Fill Season" is the end of the Green Mountain Reservoir fill season as defined in the Green Mountain Reservoir Administrative Protocol.

E. "Grand Valley Entities" are the Grand Valley Water Users Association, the Orchard Mesa Irrigation District, and the Grand Valley Irrigation Company.

F. "Green Mountain Reservoir 1935 First Fill Storage Right" is the storage right for Green Mountain Reservoir with a priority date of August 1, 1935, from the Blue River and its tributaries in the amount of 154,645 acre-feet (AF).

G. "Green Mountain Reservoir 1935 Senior Refill Storage Right" is the storage refill right for Green Mountain Reservoir with a priority date of August 1, 1935, from the Blue River and its tributaries in the amount of 6,316 AF.

H. "Green Mountain Reservoir 1935 Direct Flow Hydropower Right" is the direct-flow right with a priority date of August 1, 1935, from the Blue River and its tributaries in the amount of 1,726 cubic feet per second (cfs) for the generation of electrical power at the Green Mountain Power Plant.

I. "Green Mountain Reservoir Administrative Protocol" is the protocol for administration of Green Mountain Reservoir that will result from the procedures that will be specified in the Green Mountain Reservoir Protocol Agreement by and among Reclamation, Denver Water, Northern Water, the Subdistrict, the City of Colorado Springs acting through its Utilities Department, River District, Middle Park, Grand Valley Water Users Association, Orchard Mesa Irrigation District, Grand Valley Irrigation Company, Palisade Irrigation District, Climax Molybdenum Company, Ute Water Conservancy District, and the State Engineer and Division Engineer for Water Division 5, Colorado Division of Water Resources.

J. Green Mountain Reservoir Historic User Pool Operating Criteria is the operating criteria set forth in Exhibit D of the Orchard Mesa Check Case Stipulation and Agreement.

K. "Green Mountain Reservoir Marketing Allocation" is a 20,000 AF marketable yield available for contracting from the Power Pool.

L. "Green Mountain Reservoir Operating Policy" is the Operating Policy for Green Mountain Reservoir, Colorado-Big Thompson Project, Colorado (Volume 48, No. 247 Federal Register December 22, 1983; as amended in Volume 52, No. 176 Federal Register September 11, 1987).

M. "Historic Users' Pool" ("HUP") is water to be released from the Green Mountain Reservoir Power Pool as described in paragraphs 2 and 3 of the Green Mountain Reservoir Operating Policy.

N. "Non-Winter Season" is the period of any year from March 25 through November 10 of any year.

O. "Orchard Mesa Check Case Stipulation and Agreement" is the September 4, 1996, agreement incorporated into the decree entered October 1, 1996 in Case No. 91CW247, District Court, Colorado, Water Division 5.

P. "Power Pool" is 100,000 AF of water stored primarily for power purposes in Green Mountain Reservoir and available for such other uses in western Colorado as provided in Senate Document 80.

Q. "Senate Document 80" is the "Manner of Operation of Project Facilities and Auxiliary Features" section of the Synopsis of Report document referenced in the Act of August 9, 1937, 50 Stat 564, 75 Congress, 1st Session, which authorized the Colorado-Big Thompson Project.

R. "Senior Shoshone Call" is a request to the state water officials to curtail diversions of junior water rights to produce a flow at the Dotsero Gauge sufficient for diversion at the Shoshone Dam of 1,250 cfs for power purposes at the Shoshone Power Plant.

S. "Shepherded Streamflow Reservoir Releases" are those reservoir releases in rate and volume made for the reservoir owners' purposes of increasing stream flows either at the Shoshone Power Plant, in the 15-Mile Reach, or at other stream locations at rates and volumes in excess of the stream flows that would exist at these locations in the absence of such reservoir releases (including streamflows that may exist as a result of releases, power diversions, or bypasses made pursuant to this Agreement), provided such releases are made for decreed beneficial uses for instream or in-channel purposes at any such locations including, but not limited to, endangered fish species purposes within the 15-Mile Reach.

T. "Shoshone Call" is a request to the state water officials to curtail diversions of junior water rights to produce a flow for beneficial use at the Shoshone Power Plant pursuant to the Shoshone Senior Right or the Shoshone Junior Right.

U. "Shoshone Junior Right" is the water right decreed for and associated with the Shoshone Power Plant adjudicated for 158 cfs on February 7, 1956, with an appropriation date of May 15, 1929.

V. "Shoshone Outage" is whenever the Senior Shoshone Call cannot be fully exercised because the Shoshone Power Plant is subject to a shutdown for repair, maintenance, or other reasons. For the purposes of this Agreement, a Shoshone Outage does not include a cumulative total of 17 days during January and February of each Winter Season, when the Shoshone Senior Right is not calling for water due to regularly scheduled maintenance at the Shoshone Power Plant.

W. "Shoshone Outage Protocol" is a combination of the respective described actions to be taken by each of the Parties.

X. "Shoshone Power Plant" is owned and operated by Public Service Company of Colorado, d/b/a/ Xcel Energy ("Xcel"), and is located on the mainstem of the Colorado River in Glenwood Canyon. The Shoshone Power Plant produces hydroelectric energy by means of the Shoshone Water Rights.

Y. "Shoshone Senior Right" is the water right decreed for and associated with the Shoshone Power Plant adjudicated for 1,250 cfs on December 9, 1907, with an appropriation date of January 7, 1902.

Z. "Shoshone Water Rights" are both the Shoshone Senior Right and the Shoshone Junior Right.

AA. "Start of Fill Date" is the date between April 1 and May 15 fixed annually by the Secretary of the Interior as the start of fill of Green Mountain Reservoir.

BB. "Windy Gap Project" and "Windy Gap Firming Project" shall have the meanings defined in the Windy Gap Firming Project Intergovernmental Agreement ("WGFP IGA").

CC. "Winter Season" is the period from November 11 of any calendar year through March 24 of the next calendar year.

III. TERM OF AGREEMENT

A. This Agreement will remain in effect for 40 years unless terminated sooner pursuant to paragraph III.B, below. Any of the Parties have the right to request renewal of this agreement for an additional 40-year term upon written request to all other Parties on or before two years prior to the expiration of this agreement. The Parties agree to negotiate any requests for renewal in good faith.

B. This Agreement may be terminated upon written mutual agreement of all Parties.

C. This Agreement may be amended at any time by written consent of all Parties hereto.

D. Notwithstanding paragraph III.B, Reclamation may, at any time, terminate its participation in this Agreement for just cause upon providing written notice to all other Parties.

IV. DESCRIPTION OF SHOSHONE OUTAGE PROTOCOL ACTION BY PARTIES

A. Actions by the River District, Middle Park and Denver Water.

1. This Section IV.A is an Agreement between the River District, Middle Park and Denver Water. Other parties are not bound by this Section IV.A.

2. Outage During the Non-Winter Season. If a Shoshone Outage occurs during the Non-Winter Season and results in a flow of the Colorado River at the Dotsero Gauge below 1,250 cfs (not including Shepherded Streamflow Reservoir Releases), then the River District, Middle Park and Denver Water agree that they will operate their water resources as if the Senior Shoshone Call was being administered in order to result in a flow of not more than 1,250 cfs at the Dotsero Gauge (not including Shepherded Streamflow Reservoir Releases).

3. Denver Water, the River District, and Middle Park will not participate in the Shoshone Outage Protocol during periods of certain very dry Non-Winter Seasons that meet the definition of a Water Shortage in accordance with this paragraph IV.A.3. For the purposes of this paragraph IV.A, a Water Shortage exists when the following two conditions exist:

a. Using the procedures described in Exhibit A of the 2007 Shoshone Agreement (copy attached hereto for reference) and based on the "normal" scenario, Denver Water predicts that reservoir storage in its system on July 1 will be at or below 80% full; and

b. The "most probable" forecast of streamflow prepared by the Natural Resources Conservation Service (NRCS) or jointly by NRCS and the Colorado Basin River Forecast Center (or such other forecast that the River District, Denver Water and Middle Park agree to use) indicates that the April – July undepleted flow of the Colorado River at the Kremmling gage will be less than or equal to 85% of average. If no forecast for the Kremmling gage is available, then the Dotsero gage will be used.

4. Denver Water will make projections prior to March 25th, and again in early May and late June to determine whether a Water Shortage exists.

a. If a projection made under paragraph IV.A.3 above meets the conditions for a Water Shortage, then the Shoshone Outage Protocol will not apply during the period from that projection to the next projection. If a projection does not meet the conditions for a Water Shortage, then the Shoshone Outage Protocol will apply during the period from that projection to the next projection; provided, however, that the Shoshone Outage Protocol will not apply during any period when the Shoshone Call is relaxed under the 2007 Shoshone Agreement.

b. If the projection made in June under paragraph IV.A.3 above meets the conditions for a Water Shortage, then the Shoshone Outage Protocol will not apply during the remainder of the Non-Winter Season that year. If the projection made in June does not meet the conditions for a Water Shortage, then the Shoshone Outage Protocol will apply during the remainder of the Non-Winter Season that year.

5. Outage During Winter Season. If a Shoshone Outage occurs during the Winter Season and flows at the Dotsero Gauge are at or below 900 cfs, the River District, Denver Water, and Middle Park agree that they will operate their water resources as if the Senior Shoshone Call were on the Colorado River in the amount of 900 cfs, subject to the following:

The Shoshone Outage Protocol will not apply fully to Shoshone Outages that occur during certain very dry Winter Seasons, when the overall storage in Denver Water's system is less than 79% of capacity on November 1. For purposes of this Agreement, the reservoirs that will be considered in determining overall storage for Denver Water are those reservoirs listed in Exhibit A to the 2007 Shoshone Agreement (Antero, Eleven Mile, Cheesman, Marston, Chatfield, Gross, Ralston,

Dillon, Williams Fork, and Wolford Mountain), but excluding any reservoirs under storage restrictions due to maintenance, repairs or orders from the Colorado State Engineer.

a. If the storage is less than 79%, but more than 63% of capacity, then the Shoshone Outage Protocol will be applied at half the normal effect during that Winter Season. For example, if Denver Water would be required to bypass or replace 60 cfs under the full operation of the Shoshone Outage Protocol, Denver Water would be required to bypass or replace 30 cfs if the Shoshone Outage Protocol is applied at half the normal effect.

b. If the storage is equal to or less than 63%, but more than 49% of capacity, then the Shoshone Outage Protocol will be applied at one-fourth the normal effect during that Winter Season.

c. If the storage is equal to or less than 49% of capacity, then the Shoshone Outage Protocol will not be applied during that Winter Season.

6. As between the River District, Denver Water, and Middle Park, releases from Wolford Mountain Reservoir shall be accounted to the various accounts at Wolford Mountain Reservoir in the same manner that would have occurred if the Shoshone Senior Right had been exercised.

7. Prior to any final decree that is entered to amend the Windy Gap Project water rights to implement the Windy Gap Firming Project, Middle Park's water resources in this Shoshone Outage Protocol will be limited to water released on Middle Park's behalf from Wolford Mountain Reservoir. Subsequent to any final decree that is entered to amend the Windy Gap Project water rights to implement the Windy Gap Firming Project, Middle Park's water resources in this Shoshone Outage Protocol may include water released on its behalf from Wolford Mountain Reservoir, and Windy Gap Project water released from Granby Reservoir. Any such release of Middle Park's Windy Gap Project water resources will be consistent with the water court decrees for such resources and with any final Windy Gap Firming Project Intergovernmental Agreement by and between the Municipal Subdistrict, its Windy Gap Firming Project Water Activity Enterprise, Board of County Commissioners of Grand County, Middle Park, River District, and Northwest Colorado Council of Governments.

B. Actions by the Subdistrict.

1. The Municipal Subdistrict agrees to the operation by Reclamation of Green Mountain Reservoir as contemplated by this Agreement and will not object to the operation of Green Mountain Reservoir in the manner described in this Agreement, unless any person or entity (other than the Municipal Subdistrict or Northern Water):

a. Objects, in any judicial or administrative forum, to the operation of the Windy Gap Project or Windy Gap Firming Project in the manner described in this Agreement;

b. Asserts, in any judicial or administrative forum, that an historic or a future operation of the Windy Gap Project or Windy Gap Firming Project including, without limitation, the performance of this Shoshone Outage Protocol in accordance with this Agreement, is in violation of Senate Document No. 80, the Blue River Decree, or the decrees for the Windy Gap Project or Windy Gap Firming Project; or

c. Asserts, in any judicial or administrative forum, that bypasses of water otherwise divertible by the Windy Gap Project count toward Windy Gap Project diversions.

2. Operation of Windy Gap Project.

a. Nothing in this Agreement shall alter or amend the Intergovernmental Agreement between the Subdistrict, Grand County, Middle Park, the Northwest Colorado Council of Governments (NWCCOG) and the River District fully executed in 2016 ("WGFP IGA"), including, without limitation, Paragraph IV.K. of the WGFP IGA, which remains in full force and effect and provides, with respect to the subject of the Shoshone Outage Protocol, that [abbreviations and short-forms in the quoted text below rely on definitions set forth in the WGFP IGA]:

K. Shoshone Outage Protocol.

1) For purposes of this WGFP IGA, the Shoshone Outage Protocol means that the Windy Gap Project and WGFP will operate as described in this paragraph IV.K.1), IV.K.2), and IV.K.3) during periods when the Shoshone Power Plant is shutdown or otherwise not able to divert the full amount of its 1,250 cfs senior water right due to repair, maintenance, or other reasons ("Shoshone Outage"). When the Windy Gap Project's participation in the Shoshone Outage Protocol is in effect pursuant to this WGFP IGA, the Windy Gap Project and WGFP will bypass the amount of water that the Windy Gap Project and WGFP would have been required to bypass if the Senior Shoshone Call had been in effect in order to result in a flow of not more than 1,250 cfs at the Dotsero gage on the Colorado River (not including any water released for endangered fish species purposes). For purposes of this WGFP IGA, a Shoshone Outage does not include a shutdown of the Shoshone Power Plant for regularly scheduled maintenance for a cumulative period of 17-days during the period of November 1 through March 15.

2) The Windy Gap Project and WGFP will operate in accordance with the Shoshone Outage Protocol from July 16-April 14 of each year. Prior to WGFP Completion, the Windy Gap Project and WGFP may operate in accordance with the Shoshone Outage Protocol during the period of April 15-July 15 on a voluntary cooperative basis. Following WGFP Completion, the Windy Gap Project and WGFP will operate in accordance with the Shoshone Outage Protocol during the period April 15 – July 15 at any time during this period when the combined amount of Windy Gap Project Water stored in Chimney Hollow Reservoir and Windy Gap Project Water stored on behalf of WGFP Participants in Granby Reservoir is greater than 50% of the Active Capacity of Chimney Hollow Reservoir.

3) Participation in the Shoshone Outage Protocol by the Windy Gap Project and WGFP during the period of April 15-July 15 will be limited to a total maximum volume of foregone pumping equal to 10,000 acre feet (30 days with one pump running) in one year, a total of 20,000 acre feet (60 days with one pump running) in any 3 consecutive year period, and a total of 30,000 acre feet (90 days with one pump running) in any 5 consecutive year period.

4) The Subdistrict agrees that it will participate in good faith in negotiations to achieve permanent management of the flow of the Colorado River to address certain flow changes that result during a Shoshone Outage.

3. Nothing in this Agreement shall create, modify, alter or amend the contractual relationships between Reclamation and the Municipal Subdistrict.

4. No Waiver.

a. Except as expressly provided herein, this Agreement shall never give rise to any claim, defense, or theory of acquiescence, bar, merger, issue or claim preclusion, promissory estoppel, equitable estoppel, waiver, laches, unclean hands or any other similar position or defense concerning any factual or legal position regarding the parties respective positions regarding the operation of the Windy Gap Project and Windy Gap Firming Project. This Agreement shall not have the effect of precedent or preclusion on any factual or legal issue in any other matter. The Subdistrict expressly reserves its rights to assert any legal or factual position or challenge the legal or factual position taken by any other party on any other matter

C. Actions by Northern Water.

1. Northern Water agrees to the operation by Reclamation of Green Mountain Reservoir, as contemplated by this Agreement and will not object to the operation of Green Mountain Reservoir in the manner described in this Agreement, unless any person or entity (other than the Municipal Subdistrict or Northern Water):

    a. Objects, in any judicial or administrative forum, to the operation of Green Mountain Reservoir in the manner described in the Shoshone Protocol Agreement; or

    b. Asserts, in any judicial or administrative forum, that an historic or a future operation of Green Mountain Reservoir or the Colorado-Big Thompson Project including, without limitation, the performance of this Shoshone Outage Protocol in accordance with this Agreement, is in violation of Senate Document No. 80 or the Blue River Decree.

2. This Agreement meets the requirements of the first sentence of Paragraph 3 of the Intergovernmental Agreement between Northern Water, Grand County, Middle Park, and the River District fully executed in 2016.

3. Nothing in this Agreement shall create, modify, alter or amend the contractual relationships between Reclamation and Northern Water.

D. Actions by Reclamation.

1. Subject to the provisions of paragraph IV.G.4 of this Agreement, Reclamation will participate in the Shoshone Outage Protocol when either of the following conditions are met:

    a. The Shoshone Outage occurs between the Start of Fill Date and the End of Fill Season and Reclamation projects with 90% probability that a total of 154,645 AF will be accounted toward the volumes of water calculated in accordance with paragraphs II.A.3.b.i through II.A.3.b.v of the Green Mountain Reservoir Administrative Protocol prior to the Green Mountain Reservoir End of Fill Season, and that Reclamation projects with a 90% probability that after the End of Fill Season any volume of Bypassed Storage Water Owed To Green Mountain Reservoir by the Cities will be available to Reclamation pursuant to the Green Mountain Reservoir Administrative Protocol.

or;

    b. The Shoshone Outage occurs after the End of Fill Season and a total of 154,645 acre feet have been accounted toward the volumes of water identified in paragraphs II.A.3.b.i through II.A.3.b.v of the Green Mountain Reservoir Administrative Protocol and that any Bypassed Storage Water

Owed to Green Mountain Reservoir by the Cities will be available to Reclamation.

c. Capitalized terms in paragraphs IV.D.1.a and b have the same meaning as set forth in the Green Mountain Reservoir Administrative Protocol.

2. Green Mountain Releases Under Shoshone Outage Protocol: Reclamation will bypass storable inflow, exercise the Green Mountain Reservoir 1935 Direct Flow Hydropower Right, and/or make releases from previously stored water in its Power Pool as follows:

a. The daily total reservoir release will be equivalent to the amount that would have been required had the Senior Shoshone Call been in place on that day in the amount of 1,250 cfs during the Non-Winter Season and 900 cfs during the Winter Season, subject to the following conditions:

i. The daily total release will not exceed the release that would have been made had the Senior Shoshone Call been in place on that day and all junior water rights had been curtailed or the appropriate amount of replacement or augmentation water made available.

ii. In order to prevent any unintended impact to the HUP by this Agreement, during a Shoshone Outage, the Grand Valley Entities will not request any direct delivery of HUP water without first placing a call with the Division 5 Engineer's Office, unless Reclamation and the Grand Valley Entities agree that such a call is not necessary to prevent impacts to the HUP.

b. Except as provided in paragraph IV.D.2.c, below, the total volume of storage water released from the Power Pool for Shoshone Outage Protocol purposes from the Start of Fill Date will not exceed the sum of the following:

i. 2,000 AF

plus;

ii. The amount of uncontracted water in the Green Mountain Reservoir Marketing Allocation.

plus;

iii. The amount of water that would have been released for HUP beneficiary purposes had the Senior Shoshone Call been in place during the Shoshone Outage period.

c. Reclamation may, at its own discretion, bypass storable inflow, exercise the Green Mountain Reservoir 1935 Direct Flow Power Right, or release additional water from the Power Pool to assist in meeting the purposes of Shoshone Outage Protocol if it deems that conditions make additional water available.

3. Accounting: The Green Mountain Reservoir releases, bypasses, and power diversions shall be accounted for as follows:

a. Bypass of Inflow and Power Diversions: Reclamation will bypass storable inflow or exercise the Green Mountain Reservoir 1935 Direct Flow Hydropower Right to the extent that a bypass of inflow would have been required by a Senior Shoshone Call. The accounting of discretionary power releases and bypassed storable inflow will be consistent with the Green Mountain Reservoir Administrative Protocol.

b. Release of Stored Water: All releases of stored water shall be charged to the aggregate Power Pool rather than individual allocations in the Power Pool. However, the HUP allocation will be reduced by the amount of water that was released from Green Mountain Reservoir in accordance with paragraph IV.D.2.b.iii, above.

E. Actions by the Grand Valley Entities and Reclamation.

1. This Section IV.E is an Agreement between the Grand Valley Entities and Reclamation. Other parties are not bound by this Section IV.E.

2. Subject to the provisions of Paragraph IV.E.3, below, the Grand Valley Entities and Reclamation agree, solely for purposes of paragraph 3.b.(3) of the Orchard Mesa Check Case Stipulation and Agreement, that the Shoshone Water Rights continue to be exercised in a manner substantially consistent with their historical operation for hydropower production at their currently decreed point of diversion.

3. Paragraph IV.E.2, above, shall not be effective:

a. During any period of time in which any Party is not in compliance with their obligations described in this Agreement; or

b. During any period of time in which storage releases or bypasses of water made pursuant to this Agreement are being diverted or exchanged in a manner that results in flow at the Dotsero Gauge that is materially lower than the flow that otherwise would have been produced by the Shoshone Senior Call; or

c. If the United States terminates its participation in this Agreement pursuant to Paragraph III.D., above.

F. Actions by DWR.

The DWR shall administer water released, bypassed, or diverted for power purposes pursuant to this Agreement as follows:

1. Reservoir releases from Wolford Mountain Reservoir shall be administered as Shepherded Streamflow Reservoir Releases for in-channel recreation and fishery purposes and, as directed by the River District for subsequent consumptive uses, within the boundaries of the River District pursuant to the decree entered in Case No. 87CW283, Water Division 5. The River District will provide information to the Division Engineer for Water Division 5 to support the intended in-channel recreation and fishery purposes. Bypasses of storable inflow at Wolford Mountain Reservoir will be accounted toward the fill of the Wolford Mountain Reservoir storage decree for the then-current storage season on an instantaneous store and release accounting basis. Any bypasses made pursuant to this Agreement shall not be accounted toward the next fill season's storage volume for Wolford Mountain Reservoir. If a hydroelectric power facility is constructed to use inflow to Wolford Mountain Reservoir, then any diversions used to generate power may be accounted toward the exercise of the direct flow power right decreed in Case No. 87CW283 and will not count toward the fill of the then-current fill season's storage account for Wolford Mountain Reservoir provided the direct flow power right is operated and administered under the same priority as the storage right.

2. Reservoir releases and direct diversions at Williams Fork Reservoir to generate power will be accounted as releases or diversions made for power purposes and will not be accounted toward the decreed storage volume for Williams Fork Reservoir. Bypasses of storable inflow at Williams Fork Reservoir that are not used to generate power will be accounted toward the fill of the Williams Fork Reservoir storage decree for the then-current storage season on an instantaneous store and release accounting basis. Any such bypasses made pursuant to this Agreement shall not be accounted toward the next fill season's storage volume for Williams Fork Reservoir.

3. Reservoir releases, diversions for power purposes, and the bypass of storable inflow from Green Mountain Reservoir without power generation will be accounted for in accordance with the Green Mountain Reservoir Administration Protocol. Releases and the bypass of storable inflow shall be administered as Shepherded Streamflow Reservoir Releases to the Shoshone Power Plant or to and through the 15-Mile Reach as directed by Reclamation.

4. Bypasses of water otherwise divertible by the Windy Gap Project will not count toward the diversion amount for the Windy Gap Project. Releases of Windy Gap Project water from storage will be accounted in accordance with the then current

Windy Gap Project water right decrees, and subject to paragraph IV.A.7 of this Agreement.

Shepherded Streamflow Reservoir Releases shall be shepherded and protected by DWR under C.R.S. §§ 37-87-102(4) and 37-87-103 or as otherwise provided by law to accomplish the reservoir owners' purposes for making such releases as is consistent with the reservoir owners' legal use of such stored or storable waters. The intent is to continue the historical practice of administering such releases to produce increased flows in the 15-Mile Reach above the flows that would otherwise occur in the 15-Mile Reach, and to accommodate any new releases to be made for such or similar purposes.

G. Notice and Cooperation.

1. Notification to DWR. The Parties will work cooperatively to timely notify DWR, through the Division Engineer for Water Division 5, of operations pursuant to the Shoshone Outage Protocol.

2. The Parties will not divert or exchange any of the water released, diverted for power purposes, or bypassed by any of the Parties pursuant to this Agreement at any location upstream of the current location of the Shoshone Power Plant, or otherwise operate their systems or water rights in a manner that will diminish the benefit to the stream system at any location upstream of the current location of the Shoshone Power Plant of the releases, diversions for power purposes, and bypasses of water made pursuant to this Agreement.

3. Subject to the express conditions and limitations of this Agreement, the Parties will cooperate in good faith to achieve the goals of this Agreement of managing the flow of the Colorado River to maintain the historical flow regime of the Colorado River influenced by the exercise of the Shoshone Senior Right and to mitigate the impacts of any Shoshone Outage. If any party believes that the goals of this Agreement are not being met, including but limited to circumstances where water released or bypassed pursuant to this Agreement during a Shoshone Outage is diverted or exchanged by persons or entities who are not parties to this Agreement at locations upstream of the Dotsero Gauge, then any Party may, in its discretion and in good faith, issue a written notice to the other Parties of such circumstances. Upon such notice, the Parties will meet promptly and work together in good faith to identify such actions as may be necessary to alleviate the conditions that led to the written notice and to implement such actions to which the Parties may agree or any such actions that can be implemented by a subset of the Parties to which that subset may agree.

4. Notwithstanding any provision in this Agreement to the contrary, none of the Parties are obligated by this Agreement to participate in the Shoshone Outage Protocol

during such periods that a Shoshone call reduction is in effect pursuant to the terms of the 2007 Shoshone Agreement (copy attached for reference).

V. SEVERABILITY AND REFORM

Wherever possible each provision of this Agreement shall be interpreted and implemented in such manner as to be effective and valid under applicable law. If any provision or portion of this Agreement is determined to be invalid or unenforceable, the remaining provisions shall remain in full force and effect unless the remaining provision's effectiveness is explicitly dependent upon the invalid or unenforceable provision. The Parties agree to reform this Agreement to replace any such invalid or unenforceable provision with a valid and enforceable provision that comes as close as possible to the intention of the stricken provision. The provisions of this Agreement shall be reasonably and liberally construed to achieve the intent of the Parties.

VI. COMPENSATION

Consideration for the actions pursuant to this Agreement is in providing greater certainty in the administration of water rights, and in the resolution among some of the Parties of certain unresolved issues. There will be no charge for water released under this agreement.

VII. GREEN MOUNTAIN RESERVOIR

Subject only to the express exceptions provided herein, the Parties agree not to challenge Reclamation's operation of Green Mountain Reservoir under this Agreement as inconsistent with Senate Document 80 or the Green Mountain Reservoir Operating Policy. The Parties will work in good faith to address any conflicts that may arise between the operations contemplated by this Agreement and the Green Mountain Reservoir Administrative Protocol. Any conflict that may arise shall be resolved in a manner that is consistent with Senate Document 80, the Blue River Decree, the Green Mountain Reservoir Operating Policy, and the Green Mountain Reservoir Administrative Protocol.

VIII. COLORADO RIVER COOPERATIVE AGREEMENT

Nothing in this Agreement shall be interpreted to constitute compliance with, or satisfaction of, the obligations of Article VI.C of the Colorado River Cooperative Agreement between Denver Water and seventeen West Slope entities.

IX. NO WAIVER

The Parties agree that nothing contained in this Agreement including, but not limited to, any Party's forbearance in the exercise of any Party's right to divert, store, and beneficially use water pursuant to its decrees, is intended nor shall it be construed to give rise to any claim, defense, or theory of acquiescence, bar, merger, issue or claim preclusion, promissory estoppel, equitable estoppel, waiver, laches, unclean hands or any other similar position or defense concerning the operation of such Parties' water rights.

The Parties agree that except as expressly provided herein, this Agreement shall never give rise to any claim, defense, or theory of acquiescence, bar, merger, issue or claim preclusion, promissory estoppel, equitable estoppel, waiver, laches, unclean hands or nay other similar position or defense concerning any factual or legal position regarding the Parties respective positions regarding the operation of the Colorado-Big Thompson Project. The Parties further agree that they do not intend this Agreement to have the effect of precedent or preclusion on any factual or legal issue in any other matter. The Parties expressly reserve their rights to assert any legal or factual position or challenge the legal or factual position taken by any other Party or third-party on any other matter.

X. REGULATION AND DISTRIBUTION OF WATER

Nothing in this Agreement abridges the obligations of the DWR established by Section 37-92-304(8), Colorado Revised Statutes (2011), or other applicable law.

XI. PRIOR VERSIONS.

This Agreement replaces and supersedes the 2013 Shoshone Outage Protocol Agreement that was executed by some, but not all, of the Parties to this Agreement.

XII. SIGNATURES of PARTIES

UNITED STATES DEPARTMENT OF THE INTERIOR

By: _____

Michael J. Ryan, Regional Director
Great Plains Regional Office
Bureau of Reclamation
P.O. Box 36900
Billings, MT 59107-6900
(406) 247-7600

STATE OF COLORADO, DIVISION OF WATER RESOURCES

By: Dick Wolfe 7-12-16

Dick Wolfe, State Engineer
1313 Sherman Street, Suite 821
Denver, CO 80203
(303) 866-3581

DocuSign Envelope ID: 3BA65EFC-2942-4AA6-9753-BCCC13CC953E

DENVER WATER

By: _____

James S. Lochhead, CEO/Manager
1600 W. 12th Avenue
Denver, CO 80204-3412
(303) 628-6000

REGISTERED AND COUNTERSIGNED:
CITY AND COUNTY OF DENVER

By: _____

Timothy M. O'Brien, CPA
Auditor

APPROVED AS TO FORM

_____
LEGAL DIVISION

COLORADO RIVER WATER CONSERVATION DISTRICT

By: _____

Eric Kuhn, General Manager
P.O. Box 1120
Glenwood Springs, CO 81602
(970) 945-8522

MIDDLE PARK WATER CONSERVANCY DISTRICT

By: Duane Scholl

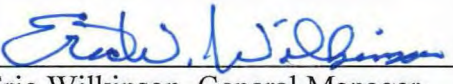
Duane Scholl, President
P.O. Box 145
Granby, CO 80446
(970) 887-3376

NORTHERN COLORADO WATER CONSERVANCY DISTRICT

By: 

Eric Wilkinson, General Manager
220 Water Avenue
Berthoud, CO 80513
(800) 369-7246

MUNICIPAL SUBDISTRICT,
NORTHERN COLORADO WATER CONSERVANCY DISTRICT

By: 

Eric Wilkinson, General Manager
220 Water Avenue
Berthoud, CO 80513
(800) 369-7246

GRAND VALLEY WATER USERS ASSOCIATION

By: Mark Harris

Mark Harris, Manager
1147 24 Road
Grand Junction, CO 81505-9639
(970) 242-5065

ORCHARD MESA IRRIGATION DISTRICT

By: _____

Max Schmidt, Manager
668 38 Road
Palisade, CO 81526
(970) 464-7885

GRAND VALLEY IRRIGATION COMPANY

By: Phil Bertrand

Phil Bertrand, Superintendent
668 26 Road
Grand Junction, CO 81506
(970) 242-2762

2007 SHOSHONE AGREEMENT
(as referenced in
Agreement Number 13XX6C0129)

Please reference the following number on all billings or payments.
Contract # 10766A

AGREEMENT CONCERNING
REDUCTION OF SHOSHONE CALL

This Agreement is between the City and County of Denver, acting by and through its Board of Water Commissioners (Board), and Public Service Company of Colorado d/b/a Xcel Energy (Company).

Recital

The Board's ability to store water in its reservoirs for beneficial use by its customers is adversely impacted, especially in dry years, by the Company's Shoshone Call. Following the drought year of 2002, a brief relaxation of the Shoshone Call during the spring of 2003 provided some benefit to storage reservoirs operated by both west slope and east slope entities, including the Board. Although a more comprehensive and long-term agreement on relaxation achieved through multi-party negotiations may be desirable, the Company and the Board agree to a relaxation of the Call under the provisions in this Agreement. The Company agrees to participate in developing a long-term program of relaxation, including a relaxation of the junior Shoshone Call, with the Board, other water users on the Colorado River and appropriate west slope entities.

Agreement

1. Agreement to Relax Call. When a water shortage occurs, as defined in Paragraph 2, the Company agrees to reduce the Shoshone Call to a one-turbine call of 704 cfs. If the Call is relaxed and the flow of the Colorado River at the Shoshone Power Plant, together with flows contributed by intervening tributaries, is not sufficient to meet the then-current demand of the major Grand Valley water rights, up to 1950 cfs (commonly referred to as the "Cameo Call"), then the level of the Shoshone Call will be adjusted to an amount greater than 704 cfs so as to avoid the initiation of a Cameo Call.

2. Water Shortage Defined. For purposes of this Agreement, a water shortage occurs when the following two conditions are met:

a. Using its regular methodology and based on the "normal" scenario, the Board predicts that reservoir storage in its system on July 1 will be at or below 80% full; and

b. The Most Probable forecast of streamflow prepared by the Natural Resources Conservation Service (NCRS) or jointly by NCRS and the Colorado Basin River Forecast Center indicates that the April – July flow of the Colorado River at the Kremmling gage will be less than or equal to 85% of average. If no forecast for the Kremmling gage is available, then the Dotsero gage will be used.

3. Timing of Relaxation of Call. If the two forecasts described in paragraph 2 occur in March, then the call will be relaxed beginning March 14 until May 20, inclusive, in accordance with this Agreement. If the two conditions described in paragraph 2 occur in April or May forecasts, then the Call will be relaxed in accordance with this Agreement until May 20, inclusive. The methodology that the Board uses to predict system storage shall be substantially the same as that described in the attached Exhibit A.

4. Power Interference. The Board agrees to pay power interference to compensate the Company for its incremental cost of replacement power and energy as a result of relaxing the Shoshone Call, regardless of which entity ultimately stores the water not called. The procedure for determining power interference is shown in Exhibit B.

5. Potential for Longer Call Relaxation. The Company agrees to consider a longer period of relaxation when water supplies are more severely impacted than described in paragraph 1, if such longer period is defined cooperatively between the Board, the Company and appropriate west slope entities.

6. Water for the Company's Facilities. The Board agrees to deliver water as described in this paragraph to the Company's Cherokee, Arapahoe, or Zuni Power Plants or a future Company power plant located within the Board's Combined Service Area. The Company will select the plant or plants to which the water will be delivered. Deliveries to the Arapahoe, Zuni or a future plant will be made to the South Platte River. Deliveries to the Cherokee plant will be made, at the Board's choice, to the South Platte River or through the Board's Recycled Water Plant. The Board may choose in its discretion the type of water delivered to these facilities, so long as the water is suitable for their use. The Board will not deliver water under this paragraph to the South Platte River downstream of the Cherokee plant's diversion structures. Any water delivered by the Board to the Company under this paragraph shall be used by the Company only at the plants listed in this paragraph 6 and only for purposes for which the Board's water rights have been decreed.

6.1 Amount of Water. The Board shall deliver under this paragraph 6 an amount of water equivalent to 15% of the "net water" it is able to store or divert as a direct result of the reduction of the Shoshone Call. "Net water" is defined as the total amount of water the Board is able to store or divert as a direct result of the reduction of the Shoshone Call at the following facilities, less any deductions described below:

a. Water stored or diverted at the Board's Dillon Reservoir, less any water spilled from Dillon after filling and any water bypassed from Dillon for flood management purposes; and

b. Water stored or diverted at the Board's Williams Fork Reservoir, less any water spilled from Williams Fork after filling and any water bypassed from Williams Fork for flood management purposes; and

c. Water stored in the Board's account in Wolford Reservoir, less any water spilled from the Board's account after filling; and

d. Water diverted through the Board's Moffat Tunnel, less any water spilled from the Fraser Collection System in excess of the Forest Service minimum bypass flow requirements; and

e. Water stored or diverted at any western slope reservoir or storage account acquired or constructed by the Board after the date of this agreement, less any water spilled after filling and any water bypassed for flood management purposes.

6.2 Schedule for 15% Water Delivery. The Board shall make deliveries under this paragraph 6 between June 1 in the same calendar year as the Shoshone Call is reduced and March 31 of the following calendar year. The delivery schedule will be subject to approval by the Company.

6.3 Cost of Water Delivered. For each acre foot of water delivered to the Company under this paragraph 6, the Company shall reimburse the Board for the Board's power interference payments at the same rate per acre foot as the Board paid to the Company under paragraph 4.

7. Water for West Slope Entities. The Board agrees to make available to entities on the west slope, at no charge to the recipients, an amount of water equivalent to 10% of the "net water" it is able to store or divert as a direct result of the reduction of the Shoshone Call. "Net water" is defined in paragraph 6.1. The Board may choose in its discretion the method of delivery that is consistent with its water right decrees, so long as the delivery method is suitable for each recipient's desired use. The Board shall deliver the water in the same calendar year as the Shoshone Call is reduced. The Board agrees to cooperate with the Colorado River Water Conservation District to determine the particular west slope entities and the proportionate share of the water to be made available to each entity.

8. Additional East Slope Participants. The Board and the Company agree to make a good faith effort to secure commitments from the Municipal Subdistrict of the Northern Colorado Water Conservancy District, the City of Aurora and Colorado Springs Utilities to deliver to the Company, at no charge, 15% of their additional water diversions that result from a relaxation of the Shoshone Call, in accordance with paragraph 6, and to deliver 10% of the water diverted or stored to west slope entities in accordance with paragraph 7.

9. Priority System. Water made available by the relaxation of the Shoshone Call will be allocated in accordance with the priority system.

10. No Warranties. The Company is not warranting or representing that the diversion and use by the Board of additional water as a result of the relaxation of the Shoshone Call is administrable or lawful. To the extent that the State Engineer or a court with jurisdiction determines that the diversion and use by the Board of additional water as a result of the relaxation of the Shoshone Call is not administrable or lawful, the Company can continue to place the Shoshone Call notwithstanding this Agreement.

11. Increased Call for Company Operations. If the Company in its sole discretion determines that additional river flow is required for safe operation of the Shoshone Hydroelectric Station or the Company's electrical system, then the Company may increase the Call, notwithstanding this Agreement.

12. Operational Meeting. The Company agrees to meet with the Board each October to discuss operation of the Shoshone Call and any planned outages of the Shoshone Plant for repair or maintenance during the following twelve months so that the parties may better coordinate their activities.

13. Sale of Shoshone Water Rights. In the event the Company should determine that it is in its best interest to sell the Shoshone water rights, it agrees to do so only on an open bidding basis in which the Board shall have an equal opportunity to purchase the water rights as all others. If the Company sells the Shoshone water rights to an entity other than the Board, the new owner shall have the right to terminate this Agreement two years after closing of the sale.

14. Term. This Agreement shall be effective as of January 1, 2007 and will terminate on February 28, 2032.

15. Prior Agreement. The previous Letter Agreement between the Company and the Board dated April 14, 1986, is hereby terminated in its entirety.

IN WITNESS WHEREOF, the Board and the Company have executed this Agreement.

ATTEST:

PUBLIC SERVICE COMPANY OF COLORADO d/b/a XCEL ENERGY

Asst. Secretary — Carol J. Peterson

By: _____
President and CEO
Public Service Company of Colorado

Reviewed
Legal
3/31/06

CITY AND COUNTY OF DENVER,
acting by and through its
BOARD OF WATER COMMISSIONERS

ATTEST:

Secretary

President

APPROVED:

Director of Planning

Director of Finance

APPROVED AS TO FORM:

Legal Division

REGISTERED AND COUNTERSIGNED
Dennis J. Gallagher, Auditor

By:

Title:
Deputy Auditor

Exhibit A

DESCRIPTION OF PROCEDURES USED BY THE BOARD
FOR RESERVOIR PROJECTIONS

Denver Water projects future reservoir levels monthly in the springtime and less frequently throughout the rest of the year. Active storage levels (excluding the dead storage pools) for the10 largest reservoirs in Denver's system (Antero, Eleven Mile, Cheesman, Marston, Chatfield, Gross, Ralston, Dillon, Williams Fork, and Wolford Mountain) are forecasted. Calculations of gross and net aggregate reservoir contents are made. The calculation of net reservoir contents excludes any water in Denver's system owed to others (primarily Green Mountain Reservoir). The net active storage of the 10 reservoirs will be used in the forecast for the Shoshone call reduction.

The reservoir projections are based on natural streamflow forecasts produced primarily by the Natural Resources Conservation Service (NRCS). However, streamflow forecasts produced by other organizations including the Colorado Basin River Forecast Center, the Bureau of Reclamation, the Northern Colorado Water Conservancy District and Denver Water are also used.

The reservoir projections utilize correlations between natural streamflow and divertible streamflow to estimate how much of the natural streamflow can be diverted under Denver's water rights. Other factors incorporated in the reservoir projections include projections of treated water use, raw water deliveries, evaporation (based on rates approved by the State Engineer's Office), minimum bypass and release requirements, carriage losses assessed by the State Engineer's Office, existing capacities of diversion and conveyance facilities, system outages and river calls. The assumed treated water use considers any water use restrictions approved by the Denver Water Board at the time of the forecast.

Usually, three levels of reservoir projections are produced. These projections are based on three scenarios after the forecast date: "dry", "normal" and "wet" conditions. The "dry" scenario is based on the "reasonable minimum" streamflow forecasts, which have a 90% chance of being exceeded. The "normal" scenario is based on the "most probable" streamflow forecasts, which have a 50% chance of being exceeded. The "wet" scenario is based on the "reasonable maximum" streamflow forecasts, which have a 10% chance of being exceeded. The "normal" scenario will be used for the Shoshone call reduction.

Exhibit B

COMPENSATION FOR POWER INTERFERENCE

The Board agrees to pay power interference to compensate the Company for its incremental cost of replacement power and energy as a result of relaxing the Shoshone Call. The procedure for determining power interference is shown below.

Depletions to Shoshone Power Plant

The Board will compensate the Company for each acre-foot of net turbine flow depletion caused to the Shoshone Power Plant through the relaxation of the Shoshone Call. Net depletions are defined as gross depletions caused by the Board and all other water users upstream of the Shoshone power plant, less any water subsequently released from Green Mountain and Wolford Reservoirs utilized to generate power at the Shoshone plant. Some of the water stored in Green Mountain and Wolford as a result of relaxation of the Call will later be released, run through the Shoshone Plant for power generation, and delivered for use below the plant; such amounts of water do not constitute a net depletion for purposes of calculating power interference. Similarly, amounts of water spilled from Dillon Reservoir, Williams Fork Reservoir, the Board's account in Wolford Reservoir, or a new west slope reservoir or storage account described in Paragraph 6.1(e), and run through the Shoshone Plant for power generation, do not constitute a net depletion for purposes of calculating power interference. Depletions will be calculated at the Shoshone plant and will be adjusted for stream carriage losses assessed by the State Engineer in water rights administration.

Reimbursement to Xcel

The Board will reimburse the Company for power interference at the rate of at least $5.00 per acre-foot of the net depletion described above. The $5.00 per acre-foot minimum will be adjusted on a monthly basis (but not below $5.00 per acre-foot) by the change in the Price of Spot Gas Delivered to Pipelines for Colorado Interstate Gas, Rocky Mountain (Index) as published in "Platts Inside FERC Gas Market Report," compared to a baseline representing the average Index for the first three months of 2006.

Accounting and Payment.

After the Call relaxation has ended, the Board will prepare an accounting of the power interference and provide it to the Company for review. Once final accounting as been determined, the Board will make payment to the Company within 60 days. Upon mutual agreement and the development of mutually agreeable terms, the Board may substitute a delivery of energy to the Company for the payment of power interference.

DRAFT

SHOSHONE WATER RIGHTS DEDICATION AND ISF AGREEMENT

(Shoshone Water Rights)

This WATER RIGHT DEDICATION and ISF AGREEMENT ("Agreement"), is made as of this ____ day of _____, 2025, by and between the Colorado Water Conservation Board ("CWCB"), an agency of the State of Colorado, the Colorado River Water Conservation District ("River District"), a political subdivision of the State of Colorado, and Public Service Company of Colorado, a Colorado corporation ("PSCo"). The CWCB, the River District, and PSCo may be hereinafter referred to individually as a "party," and together as the "parties."

RECITALS

A. The CWCB is an agency of the State of Colorado created to aid in the protection and development of the waters of the state for the benefit of its present and future inhabitants. In 1973, the General Assembly vested the CWCB with the exclusive authority to appropriate waters of the natural stream for minimum stream flows between specific points on a stream to preserve the natural environment to a reasonable degree.

B. Pursuant to section 37-92-102(3), C.R.S., the General Assembly has also vested the CWCB with the ability to acquire, by grant, purchase, donation, lease, or other contractual agreement, such water, water rights, and interests in water that are not on the division engineer's abandonment list in such amount as the CWCB determines is appropriate for stream flows to preserve and/or improve the natural environment to a reasonable degree.

C. The River District was created by the provisions of sections 37-46-101, C.R.S., *et seq*., to promote the health and general welfare of the State of Colorado by the conservation, use, and development of the water resources of the Colorado River and its principal tributaries. The River District constituents include West Slope governmental entities and water interests that desire to maintain in perpetuity the flow regime within Water Division 5 created by the historical exercise of the water rights that are the subject of this Agreement.

D. PSCo is a Colorado corporation and is the owner and operator of the hydroelectric power plant (the "Shoshone Power Plant") located on the mainstem of the Colorado River in Glenwood Canyon, approximately six miles upstream of Glenwood Springs, Colorado. The Shoshone Power Plant produces hydroelectric energy by means of PSCo's diversion of the following water rights:

(i) The Glenwood Power Canal and Pipeline water right, decreed on December 9, 1907, in Civil Action No. 466, Eagle County District Court, in the amount of 1,250 cubic feet per second of time ("c.f.s.") with an appropriation date

of January 7, 1902, for power, mining, milling, manufacturing, lighting and heating and traction purposes, and as decreed absolute by the Eagle County District Court on February 27, 1911, in Civil Action No. 553 (the "Senior Shoshone Water Right"); and

(ii) The Shoshone Hydro Plant Diversion No. 2 water right, decreed absolute on February 7, 1956, in Civil Action No. 1123, Eagle County District Court, in the amount of 158 c.f.s. with an appropriation date of May 15, 1929, for manufacturing and generation of electrical energy (the "Junior Shoshone Water Right").

Together, these two water rights are referred-to as the "Shoshone Water Rights".

E. The Senior Shoshone Water Right is one of the most senior water rights on the Colorado River. During significant periods of the year, there is not sufficient water to satisfy all water rights decreed on the Colorado River and its tributaries within the State of Colorado. At such times, when the measurable Natural Flow of the Colorado River drops below 1,408 c.f.s. (the sum of 1,250 c.f.s. attributable to the Senior Shoshone Water Right and 158 c.f.s. attributable to the Junior Shoshone Water Right) at the streamflow gauge (USGS 09070500) located on the Colorado River near Dotsero, Colorado ("Dotsero Gage"), the Colorado Division of Water Resources ("DWR") administers a call for the Shoshone Water Rights which results in the curtailment of junior water rights upstream of the Shoshone Power Plant. The Dotsero Gage is the location where the administration and measurement of the Shoshone Water Rights has historically occurred. The "Natural Flow" is the amount of water in the Colorado River measured at the Dotsero Gage, including the amount of water usable by the Shoshone Water Rights when those water rights are in priority, except that the "Natural Flow" does not include any water released from storage and conducted into the Colorado River upstream of the Dotsero Gage (accounting for evaporation and transit loss), which water is intended for delivery for use downstream of the discharge outlets for the Shoshone Power Plant.

F. The Shoshone Water Rights are decreed for non-consumptive hydropower generation use at the Shoshone Power Plant. All of the water diverted by PSCo for hydropower generation use is returned to the Colorado River after such water is conveyed through the Shoshone Power Plant's penstocks and turbines, to a point of return at the plant's discharge outlets that is approximately 2.4 miles downstream of the point of diversion at the Shoshone Diversion Dam and Tunnel, as depicted on the map attached as **Exhibit A**. The approximate locations of the "Shoshone Diversion Dam and Tunnel" and the outfall for the "Shoshone Power Plant Discharge Outlets" are as follows:

i. **Shoshone Power Plant Diversion Dam and Tunnel:** on the right bank, being the northerly bank, of the Colorado River whence the North quarter corner of Section Thirty (30), Township Five (5) South, Range Eighty-Seven (87) West of the 6th Principal Meridian bears North 23° 48'20" East 2,414.64 feet, in Garfield County, Colorado.

ii. **Shoshone Power Plant Discharge Outlets:** on the right bank, being the northerly bank, of the Colorado River whence the Southeast corner of Section Thirty-five (35), Township Five (5) South, Range Eighty-Eight (88) West of the 6th Principal Meridian bears South 29° 24' 14" East, 1,771 feet, in Garfield County, Colorado.[1]

The reach of stream between the Shoshone Power Diversion Dam and Tunnel and the Shoshone Power Plant Discharge Outlets is referred to herein as the "Shoshone Reach." Through this Agreement, the parties seek to preserve and improve the natural environment of the Colorado River within the Shoshone Reach to a reasonable degree.

G. Pursuant to the Purchase and Sale Agreement between the River District and PSCo, with an effective date of January 1, 2024 (the "PSA"), the River District is the contract purchaser of the Shoshone Water Rights. The PSA provides that PSCo, and its successors and assigns, is entitled to a perpetual leasehold interest in the Shoshone Water Rights for continued use of the Shoshone Water Rights for hydropower generation at the Shoshone Power Plant (the "Lease," the form of which is attached to the PSA as "Exhibit D"). The PSA (including all its Exhibits and Attachments) is attached and incorporated hereto as **Exhibit B**.

H. PSCo's historical exercise of the Shoshone Water Rights has resulted in a streamflow regime that has benefitted the natural environment of the Colorado River basin both upstream and downstream of the Shoshone Power Plant. In addition, the historical exercise of the Shoshone Water Rights has provided benefits to water users throughout the Colorado River basin by providing a relatively predictable water rights administration regime both upstream and downstream of the Shoshone Power Plant.

I. The parties wish to continue the general historical call operations and maintain the flow regime of the Colorado River, both upstream and downstream of the Shoshone Power Plant. In furtherance of that effort, and subject to the terms of this Agreement, the River District wishes to dedicate to the CWCB, at no additional cost to the CWCB, the exclusive right to use the Shoshone Water Rights for instream flow purposes within the proposed Shoshone Reach to the extent the water rights are not being used for hydropower generation purposes at the Shoshone Power Plant, subject to the requirements of this Agreement. To that end, and subject to the terms set forth herein, the River District, PSCo, and the CWCB agree to jointly file an application to adjudicate a change of the Shoshone Water Rights in Garfield County District Court, Water Division No. 5, (the "Water Court") to add instream flow use to preserve and improve the natural environment of the Shoshone Reach of the Colorado River to a reasonable degree as an additional beneficial use of the Shoshone Water Rights. Use of the Shoshone Water Rights for instream flow and hydropower purposes shall be subject to any terms and conditions imposed by the change of water right decree to be entered by the Water Court, further described in Paragraphs XX and XX below (the "Decree").

[1] The legal description set forth above for the Downstream Terminus (Shoshone Power Plant Discharge Outlets) is an approximate location developed by River District staff and may be supplemented or modified at the time a water court application is filed in Water Division No. 5.

J. At two regularly scheduled public meetings of the CWCB held on [date], and [date], the CWCB considered the River District's proposed dedication of the exclusive right to use the Shoshone Water Rights for instream flow purposes to the CWCB in accordance with section 37-92-102(3), C.R.S., and the Rules Concerning the Colorado Instream Flow and Natural Lake Level Program ("ISF Rule(s)"), 2 CCR 408-2. At its regularly scheduled meeting on [date], the CWCB determined that it is appropriate to enter this Agreement and that the best use of the acquired interest in the Shoshone Water Rights is use up to the full decreed amount of 1,408 c.f.s., for instream flow use to preserve and improve the natural environment to a reasonable degree within the Shoshone Reach. Such use of the Shoshone Water Rights for instream flow purposes can occur within the Shoshone Reach to the extent the Shoshone Water Rights are not being exercised for hydropower generation purposes at the Shoshone Power Plant, up to the full amount of 1,408 c.f.s. of Natural Flow (hereinafter, the "ISF Rate"), subject to the limitations described in Paragraphs 7 and 9 below.

K. The CWCB, the River District, and PSCo wish to cooperate to implement such legal mechanisms and to obtain such court decree and approvals as are necessary to change the Shoshone Water Rights to include instream flow use for the purpose of preserving and improving the natural environment within the Shoshone Reach, and to protect the Natural Flow ISF Rate through the Shoshone Reach to the extent it is not being exercised for hydropower generation purposes at the Shoshone Power Plant.

AGREEMENT

NOW THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the parties agree as follows:

DEDICATION

1. The Recitals to this Agreement are incorporated by this reference and shall constitute part of this Agreement.

2. The River District hereby dedicates to the CWCB, effective as of the date of closing of the PSA, at no additional cost to the CWCB, the exclusive right to use the Shoshone Water Rights for instream flow use within the Shoshone Reach, to the extent such water rights are not being used for hydropower generation purposes at the Shoshone Power Plant pursuant to the Lease, and subject to the requirements of Paragraph 9 below. The River District shall retain title to the Shoshone Water Rights.

3. This Agreement acknowledges the CWCB's consideration of the Colorado Parks and Wildlife analysis showing a biological need to preserve and improve the natural environment of the Shoshone Reach of the Colorado River to a reasonable degree.

4. The parties intend that the Decree, as further described in Paragraphs XX and XX below, shall confirm that the water attributable to the Shoshone Water Rights up to the available ISF Rate will remain in the stream to preserve and improve the environment to a reasonable

degree within the Shoshone Reach where the CWCB does not presently have a decreed instream flow right, to the extent the Shoshone Water Rights are not being used for hydropower generation purposes.

5. The parties intend that the Decree shall confirm that the Shoshone Water Rights shall be administered by the State Engineer and the Division Engineer for Water Division No. 5 ("Engineers") based on the Natural Flow at the Dotsero Gage. Instream flow use of the Shoshone Water Rights will be administered through the Shoshone Reach where the intended instream flow use will occur with the goal of utilizing the Shoshone Water Rights up to the available ISF Rate without diversion or exchange by intervening water users. The parties intend that the Decree shall also contain an affirmative finding which confirms that the change of the Shoshone Water Rights for the additional instream flow use is administrable by the Engineers and is capable of meeting all applicable statutory requirements.

6. In the event any new infrastructure or stream gaging stations are either necessary or desirable for the implementation of this Agreement, or in the event that any new infrastructure—including measuring devices—are deemed necessary by the Engineers with respect to the Shoshone Water Rights, the parties agree to work cooperatively with each other in good faith to accommodate the installation of any such infrastructure or gaging stations, which are necessary to make water available for use under this Agreement, in an efficient and economical manner.

CONDITIONS ON THE ADMINISTRATION AND EXERCISE OF THE SHOSHONE WATER RIGHTS FOR INSTREAM FLOW USE

7. It is the intent of the parties that the Shoshone Water Rights will be protected for instream flow use to the maximum extent possible as allowed under the Water Court Decree, to the extent the Shoshone Water Rights are not being used for power generation. To implement this mutual intent, the CWCB agrees that it will request administration of the Shoshone Water Rights for instream flow use in the Shoshone Reach of the Colorado River to preserve and improve the natural environment to a reasonable degree at all times when the Natural Flow of the Colorado River as measured at the Dotsero Gage is less than 1,408 c.f.s., subject only to the limitations set forth below:

   a. Any terms, conditions, and limits set forth in the Decree;

   b. Any reduction in instream flow use made pursuant to the terms and conditions of Paragraph 9, below, due to use or planned use of the Shoshone Water Right for power generation; and

   c. During any period wherein the CWCB and the River District jointly agree in writing to reduce the flow rate requested for administration of the Shoshone Water Rights for instream flow purposes.

8. Pursuant to ISF Rule 10, 2 CCR 408-2, the parties shall cooperate in the administration and monitoring of the instream flow use of the Shoshone Water Rights dedicated to the CWCB under this Agreement so that, subject to the terms of this Agreement and the Decree, the CWCB will maximize the use of the Shoshone Water Rights for instream flow purposes to the extent the rights are not being used for hydropower generation purposes at the Shoshone Power Plant. PSCo, the CWCB and the River District shall coordinate with DWR to monitor the flow and calculate the Natural Flow of the Colorado River at the Dotsero Gage as the point of administration for the Shoshone Water Rights for hydropower generation and instream flow use.

9. The CWCB and the River District shall notify PSCo of any request for administration required by the provisions of this Agreement. PSCo shall provide advance written notice to the River District and the CWCB at least thirty (30) days prior to any scheduled operations or maintenance activities that result in a full or partial shutdown of the Shoshone Power Plant, and shall provide notice as soon as reasonably possible of any unscheduled shutdown or reduction of Shoshone Power Plant operations. During the term of the Lease, the parties will coordinate on at least an annual basis to determine how the Shoshone Water Rights will be allocated between hydropower generation and instream flow use in a manner consistent with the terms and conditions of the Decree that (1) maximizes PSCo's ability to exercise the Shoshone Water Rights for hydropower generation purposes; and (2) maximizes the ability to use the Shoshone Water Rights for instream flow purposes to the extent the water rights are not being used for hydropower generation purposes at the Shoshone Power Plant, in a manner that does not reduce the availability of the Shoshone Water Rights for subsequent hydropower use. Upon termination of the Lease, this paragraph, and any other restrictions on the Shoshone Water Rights throughout this Agreement due to hydropower use, shall no longer be in effect, and, subsequent to any permanent decommissioning of the Shoshone Power Plant, instream flow shall be the only use of the Shoshone Water Rights.

10. Each party to this Agreement shall also immediately report, in writing, to the other parties the nature of any communications with the Engineers concerning the administration of the Shoshone Water Rights as contemplated by this Agreement. Following the closing of the PSA, the parties shall identify those persons and provide such contact information (including email and telephone number) to the other parties necessary to effectuate the purposes hereof.

11. Any rights created by this Agreement are contractual rights. Use by the CWCB for instream flow purposes in accordance with this Agreement does not provide the CWCB an ownership right in the Shoshone Water Rights or in any of the River District or PSCo's facilities or water rights as they exist now or may exist in the future.

12. The CWCB's contractual rights to and interest in the Shoshone Water Rights dedicated to the CWCB for use in the Shoshone Reach under this Agreement extends to and terminates at the downstream termination point of the Shoshone Reach, which is the stream accrual point for the current Shoshone Power Plant Discharge Outlets.

NO CREATION OF RIGHT OF SUCCESSIVE USE OF THE SHOSHONE WATER RIGHTS DOWNSTREAM OF THE SHOSHONE REACH

13. This Agreement does not recognize any use or create any right of use by the River District of the Shoshone Water Rights downstream of the Shoshone Reach. Notwithstanding the foregoing, this Paragraph 13 does not prevent any use by the River District or its constituents of the natural stream flow downstream of the Shoshone Reach within the priority system and in accordance with Colorado law and the Decree.

WATER COURT PROCEEDINGS

14. The parties shall file and diligently pursue a Water Court application and any necessary appeals to obtain the Decree in a final, unappealable form confirming a change of water right for the Shoshone Water Rights to include the additional use for instream flow purposes by the CWCB and confirming that the water attributable to the Shoshone Water Rights will be used for instream flow to preserve and improve the natural environment in the Shoshone Reach of the Colorado River to a reasonable degree up to the full amount of the ISF Rate , subject to the terms and conditions of the Decree and this Agreement. In such water court application, the CWCB, the River District, and PSCo shall be co-applicants for the purpose of advancing and protecting their contractual rights under this Agreement, including adjudicating a decreed right to use of the Shoshone Water Rights by the CWCB to preserve and improve the natural environment to a reasonable degree within the Shoshone Reach. Except as otherwise provided in the PSA, to which the CWCB is not subject, each party shall bear its own attorney fees and costs related to its participation in any water court adjudication contemplated under this Paragraph 14. Except for its own attorney fees and court filing fees, the CWCB is not responsible for paying costs of prosecuting the water court application, including the costs of hiring a consulting engineer or other witnesses in furtherance of such application, or attorney fees of any other party incurred in relation thereto.

15. The parties intend that the Decree shall confirm that to the extent the water dedicated under this Agreement is not being used for hydropower generation at the Shoshone Power Plant, such water shall be beneficially used by the CWCB for instream flow purposes to preserve and improve the natural environment of the Colorado River within the Shoshone Reach to a reasonable degree, subject to the terms and conditions of the Decree and this Agreement.

16. The parties agree that the Decree shall not confirm any new appropriation of water. N or shall any claim be included in the Water Court application except as expressly described in this Agreement. The parties further agree that, upon the successful prosecution of the Water Court application described in Paragraph 14, above, and upon the issuance of the Decree by the Water Court, no further claim for approval of any change of water right with respect to the Shoshone Water Rights shall be sought by any of the parties to this Agreement in the future without first obtaining the prior written consent of all the parties hereto. The River District agrees it will not transfer or otherwise encumber the rights to any other person or entity without the express written consent of the CWCB, with the exception of the right to enter into a promissory note and deed of trust to the benefit of

PSCo as provided by paragraph 3.1.d.2 of the PSA. The parties agree to request that the Water Court include an express statement in the Decree setting forth the limitations described in this Paragraph 16, to wit:

a. the decree does not confirm any new appropriation or change except to add instream flow;
b. no further claim for approval of any change of the Shoshone Water Rights will be sought by any of the applicants without written consent of the other applicants hereto; and
c. the River District will not transfer or otherwise encumber the Shoshone Water Rights to any other person or entity without the express written consent of the CWCB.

RECORDS AND ACCOUNTING

17. The River District shall be responsible for maintaining all records and accounting necessary for the implementation of this Agreement, using forms mutually agreeable to the parties, and all records required by the Engineers for the administration of the changed Shoshone Water Rights.

18. The River District will provide accounting related to the operation of this Agreement to the CWCB and PSCo.

MISCELLANEOUS PROVISIONS

19. The term of this Agreement is perpetual unless terminated in accordance with the terms of this Agreement.

20. This Agreement will automatically terminate and be of no further effect in the event that (i) the sale of the Shoshone Water Rights from PSCo to the River District does not close or occur, or (ii) the PSA is terminated or otherwise expires. Except as otherwise provided in the immediately preceding sentence in this Paragraph 20, this Agreement may be amended or terminated by the written agreement of the parties, and any such termination or amendment shall take effect only when signed by all of the parties to this Agreement or their successors in interest.

21. Neither the CWCB nor PSCo is responsible for construction or modification of any structures that may be necessary for use of the Shoshone Water Rights for instream flow purposes.

22. This Agreement shall not be assignable by any party without the written consent of all the parties hereto. Notwithstanding the foregoing, an assignment by PSCo of this Agreement to any successor or assign of its rights under the Lease is approved by the CWCB and River District without separate written consent, however thirty (30) days advanced written notice of the assignment to the River District and the CWCB is required, and PSCo may assign the Lease only to a successive owner or operator of the Shoshone Power Plant for power generation purposes. Notice and contact information shall be provided to all parties concurrent with any assignment. In the event of the termination of the Lease by PSCo or

its successors or assigns pursuant to Paragraph 26, below, the River District and CWCB will not be required to obtain the written consent of PSCo or its successors or assigns to assign this Agreement.

23. Pursuant to section 37-92-102(3), C.R.S., this Agreement shall be enforceable by each of the parties hereto as a water matter according to the terms and conditions of this Agreement. The parties further agree that the exclusive venue for and jurisdiction of any dispute pertaining to the interpretation or enforcement of this Agreement shall be the Water Court (as defined herein); *provided, however*, that before commencing any action for enforcement of this Agreement, the party alleging the violation shall notify the other parties in writing of the alleged violation and the parties shall make a good faith effort to resolve their differences through informal consultation.

24. The parties hereto acknowledge and agree that specific performance of this Agreement shall be the exclusive remedy for failure of any party to comply with any provision of this Agreement. The parties hereby waive any right to seek or collect damages for any breach or violation of this Agreement.

25. Enforcement of this Agreement and all rights and obligations hereunder are reserved solely to the CWCB, the River District, and PSCo, and not to any third party. Any services or benefits which third parties may receive or provide as a result of this Agreement are incidental to the Agreement and do not create any rights for such third parties.

26. The parties anticipate that at some point in the future, PSCo may permanently decommission the Shoshone Power Plant, and the Lease will terminate. In the event that the Lease terminates, then PSCo shall provide written notice to the parties of the termination of the Lease and PSCo's rights and obligations under this Agreement will also be deemed to be terminated; however, all rights and responsibilities between the CWCB and the River District will remain in effect. Upon termination of the Lease, all restrictions on the Shoshone Water Rights throughout this Agreement due to hydropower use shall no longer be in effect, and, subsequent to any permanent decommissioning of the Shoshone Power Plant, instream flow shall be the only use of the Shoshone Water Rights.

27. The provisions of §§37-92-102(3) and 305(3)(b), C.R.S. that require that all contracts or agreements for interests in water, and the water court decree implementing the contracts or agreements, to state the board or the lessor, lender, or donor may bring about beneficial use of the historical consumptive use of the leased, loaned, or donated water right downstream of the instream flow reach as fully consumable water are not relevant and do not apply to this acquisition.

28. In the event the Decree and this Agreement are inconsistent, the Decree shall control.

29. This Agreement shall be construed in accordance with the laws of the State of Colorado and shall be interpreted broadly to give effect to its purposes.

30. Any failure or delay by a party in exercising any of its rights, power, and remedies hereunder or in accordance with laws shall not lead to a waiver of such rights, and the waiver of any single or partial exercise of a party's rights shall not preclude such party from exercising such rights in any other way and exercising the remaining part of the party's rights.

31. Any notice, consent, waiver, request or other communication required or provided to be given under this Agreement shall be in writing and shall be sufficiently given and shall be deemed delivered when: (a) delivered personally; (b) transmitted by email to the then-designated address of the party, provided that a delivery receipt sent by the recipient is received by the sender, provided if the delivery receipt is sent on a non-business day, or after 5:00 p.m. local time at the physical address of the recipient, then the notice will be deemed received on the next business day; (c) two (2) business days after deposit with the United States Postal Service by certified or registered mail, return receipt requested, postage prepaid; or (d) one (1) business day following deposit with a nationally recognized overnight delivery service, in any event, addressed to the applicable party as set forth below, or at such address as either party may from time-to-time specify in writing to the other:

If to the CWCB:

Section Chief
Colorado Water Conservation Board
Stream and Lake Protection Section
1313 Sherman Street, Room 721
Denver, CO 80203
DNR_CWCBISF@state.co.us

and

Jen Mele
First Assistant Attorney General
Natural Resources and Environment Section
1300 Broadway, 7th Floor
Denver, CO 80203
jen.mele@coag.gov

If to PSCo:

Public Service Company of Colorado
Attn: Environmental Services
1800 Larimer Street, Suite 1300
Denver, CO 80202

and

Public Service Company of Colorado
Attn: Legal Dept. – Real Estate
1800 Larimer Street, Suite 1400
Denver, CO 80202

(303) 294-2222
Frances.A.Folin@xcelenergy.com

and

Welborn Sullivan Meck & Tooley, P.C.
Carolyn F. Burr, Esq.
James M. Noble, Esq.
1401 Lawrence Street, Suite 1800
Denver, CO 80202
(303) 830-2500
cburr@wsmtlaw.com
jnoble@wsmtlaw.com

If to the River District:

Colorado River Water Conservation District
General Manager
Andrew Mueller
201 Centennial St., Suite 200
Glenwood Springs, CO 81601
edinfo@crwcd.org

and

General Counsel,
Peter Fleming, Esq.
201 Centennial St., Suite 200
Glenwood Springs, CO 81601
(970) 945-8522
pfleming@crwcd.org

32. Each provision contained herein shall be severable and independent from each of the other provisions such that if at any time any one or more provisions herein are found to be invalid, illegal, or unenforceable, the validity, legality, or enforceability of the remaining provisions herein shall not be affected as a result thereof.

33. The effective date of this Agreement shall be the last date shown on the signature page or pages of this Agreement, provided however that parties' rights and obligations under this Agreement with specific regard to the exercise of the Shoshone Water Rights for instream flow purposes shall not commence until the closing date of the PSA. If the PSA is terminated according to its terms, then this Agreement shall also automatically terminate. This Agreement may be executed in two or more counterparts, each of which when so executed shall be deemed to be an original and all of which when taken together shall constitute one and the same instrument. The counterparts of this Agreement may be executed and delivered by electronic means (including portable document format) by either of the parties and the receiving party may rely on the receipt of such document so executed and delivered electronically as if the original had been received.

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[signature page(s) follow]

IN WITNESS WHEREOF, the CWCB, the River District, and PSCo have executed this Agreement as of the last date of execution.

COLORADO WATER CONSERVATION BOARD

By: _____
Lauren Ris, Director

Date: _____

[signatures continue on next page]

[signature page to Water Right Dedication Agreement (Shoshone Water Rights)]

COLORADO RIVER WATER CONSERVATION DISTRICT

ATTEST:

By: _____
Andy Mueller, General Manager

BY: _____

Date: _____

[signatures continue on next page]

[signature page to Water Right Dedication Agreement (Shoshone Water Rights)]

PUBLIC SERVICE COMPANY OF COLORADO

By:_____
Robert Kenney, President

Date:_____

[signature page to Water Right Dedication Agreement (Shoshone Water Rights)]

Exhibit A
(Shoshone Diversion Dam and Tunnel)

Exhibit B
(Purchase and Sale Agreement)

Final Report (CA23044)

Shoshone Reach Instream Flow Habitat Data Analysis, Habitat Simulations and Habitat Evaluation of Colorado River from the Shoshone Diversion to the Shoshone Power Plant Outfall

Submitted to:

Peter Fleming
Colorado River District
Glenwood Springs, Colorado

Submitted By:

William J. Miller, PhD
Freshwater Consulting, LLC
2404 Thoroughbred Ln.
Bozeman, Montana

September 30, 2024

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Executive Summary

This report documents the evaluation of instream flows for the purpose of protecting and enhancing aquatic resources in the Shoshone Reach of the Colorado River between the point of diversion for the Shoshone Water Rights at the Shoshone diversion dam and the Shoshone Power Plant outfall. The objectives were to determine the current state of the aquatic habitat and aquatic ecosystem in the Shoshone Reach and determine expected changes to the aquatic habitat and aquatic ecosystem due to hydrologic change. The hydrologic change would be from a potential dedication of the Shoshone Hydropower Plant water rights which include a senior right for 1,250 cfs and a junior right of 158 cfs for a total of 1,408 cfs to an instream flow use. This change in water right would allow the total 1,408 cfs to remain in the river as a dedicated instream flow rather than diverted through the hydropower plant.

The instream flow analysis used the general guidelines from the Instream Flow Incremental Methodology (IFIM) which was developed by the US Fish and Wildlife Service in the late 1970s and early 1980s. IFIM is a multi-disciplinary methodology based on ecosystem principles and includes analysis of hydrology, habitat suitability criteria for species of interest, channel hydraulics and predictions of hydraulic-habitat as a function of discharge. In addition, the data from an IFIM approach can be used to interpret other ecosystem responses to change in stream flow. IFIM is specifically designed to evaluate and compare alternative flow regimes. The IFIM approach has been applied to other rivers and streams throughout Colorado.

The Colorado River in the Shoshone Reach is confined on the right by the interstate highway and on the left by the railroad. Habitat within the Shoshone Reach includes rapids, high gradient riffles, deep pools and runs. The Shoshone Reach is approximately 2.4 miles long and has an elevation drop of 170 feet from the diversion dam to the Shoshone Power Hydropower Plant outfall.

One study site was selected based on habitat characteristics that were generally representative of the non-rapid sections of the reach. The site included multiple repeats of riffle, pool and run habitat. The confined, steep gradient river channel does not allow safe access for in-channel measurements at all sections of the Shoshone Reach. The final decision on study site location from those areas deemed representative was determined during the field measurements and based on representativeness of the site and safety for personnel.

Two flow regimes were compared for this analysis, which were existing flows and future flows. Existing flows for the Shoshone Reach were calculated by substracting the amount of water diverted for hydro power production from the flow at the Dotsero gage. The future flows for the Shoshone Reach were the flows that would have been diverted at the power plant but instead allowed to remain in the channel through the Shoshone Reach. The analysis included the comparison of the existing flow regime to the future flow regime for hydrology in average, dry and wet years. The existing flow regime in the

reach includes days of zero flow when the hydropower plant is operating and total river flow is equal to or less than 1,408 cfs. The proposed future flow regime would not have zero flows and the water currently diverted for hydropower production would remain in the river.

A two-dimensional hydraulic model was developed to simulate stream hydraulics for flows from 50 cfs up to 3000 cfs. Specific flows of 50, 250, 700, 1,020, 1,250, 1,400 and 3000 cfs were simulated. The model was calibrated to the field measured flow of 1,020 cfs. Predictions from the simulated flows for wetted area, depth, and velocity were used in the hydraulic habitat analysis.

The species of interest and habitat suitability criteria for the hydraulic habitat analysis were determined in consultation with Colorado Parks and Wildlife and Colorado Water Conservation Board. The species selected were Rainbow Trout, Brown Trout, Flannelmouth Sucker and Mountain Whitefish. Habitat suitability criteria came from existing data sets that were previously used in other IFIM studies in Colorado.

Wetted area predictions were used to evaluate other biota that were not specifically modeled with habitat suitability criteria. These biota included the lower trophic levels of algae and macroinvertebrates that provide food resources for fish. The wetted area for the existing flow regime has many days at or near zero area due to diversion for hydro power production. The loss of wetted area results in partial or total mortality of algae and macroinvertebrates and the loss of food resources for fish. The loss of wetted area also requires fish to move out of the reach or be stranded. Research in other portions of the Colorado River has demonstrated that 1.5 to 2 months are required for algae and macroinvertbrate productivity to recover to the density and biomass that was present prior to the loss. The future flow regime does not have zero flow days and has stable consistent wetted area in all year types. These stable flows would allow macroinvertebrates to complete their annual life cycles and provide stable habitat area for algae and macroinvertebrates.

The hydraulic-habitat analysis predicted the maximum habitat availability for fish species at flows from 700 cfs to 1,400 cfs depending on the species. The zero flow days with the existing conditions results in total loss of habitat over extended periods of time. This habitat loss coupled with the concurrent loss of food productions results in substantial impacts to fish species in the Shoshone Reach. Future condition flows result in habitat conditions that are near the maximum potential habitat for the Shoshone Reach for all fish species. The future conditions result in stable flows during base flow periods that provide stable habitat and stable food resources for the fish species in the Shoshone Reach.

Based on the available hydrology and the habitat-discharge functions, the future flows (the Shoshone Hydropower Plant water rights which include a senior right for 1,250 cfs and a junior right of 158 cfs for a total of 1,408 cfs plus the bypassed/shepherded flows, which can result in a total flow of up to approximately 2,500 cfs to 3,000 cfs at the Dotsero Gage) would provide a substantial increase in habitat and benefit aquatic biota

during summer, fall, winter, and early spring as compared to the existing conditions. These flows up to approximately 2,500 cfs to 3,000 cfs therefore will help to preserve and improve the natural environment in the Shoshone Reach.

There also are indirect benefits to other sections of the Colorado River from the Shoshone Hydropower Plant water rights. These water rights are administered at the Dotsero Gage upstream from the Shoshone Reach, however, the water is conveyed from the upper sections of the Colorado River upstream of the Dotsero gage downstream to the Shoshone Reach and benefits all of the intervening reaches of the upper Colorado River. Similarly, the Colorado River downstream of the Shoshone Reach benefits from the Shoshone Hydropower Plant water rights.

In summary, the future conditions with the Shoshone Hydro Power Plant water right in place as an instream flow in the Shoshone Reach would result in the following:

- Stable base flow conditions with no zero flow days.
- Stable wetted area during future conditions in late summer, fall, winter and spring for better conditions for macroinvertebrates and algae which are food sources for fish species.
- Average year hydraulic-habitat conditions in summer and winter base flows that provide from 81% to 99% of the potential maximum hydraulic habitat.
- Continuation of indirect benefits upstream and downstream of the Shoshone Reach from water delivered to the Shoshone Reach.
- Flows from 1,400 to 3,000 cfs provide additional benefit to the aquatic habitat in the Shoshone Reach.
- Overall improved instream conditions to preserve and enhance the aquatic habitat.

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Introduction

This report documents the evaluation of instream flows for aquatic resources in the Shoshone Reach of the Colorado River between the point of diversion for the Shoshone Water Rights at the Shoshone diversion dam and the Shoshone Power Plant outfall (Figure 1). Habitat within the Shoshone Reach includes rapids, high gradient riffles, deep pools and runs. The objectives were to determine the current state of the aquatic habitat and aquatic ecosystem in the Shoshone Reach and determine expected changes to the aquatic habitat and aquatic ecosystem due to hydrologic change. The hydrologic change would be from a potential dedication of the Shoshone Hydropower Plant water rights which include a senior right for 1,250 cfs and a junior right of 158 cfs for a total of 1,408 cfs to an instream flow use. This change in water right would allow the total 1,408 cfs to remain in the river rather than diverted through the hydropower plant.

The report and analysis included input of data from hydraulic model simulations and calculation of habitat area by life stage for each simulated flow. Hydraulic and habitat model simulations included analysis for a range of flows (50, 250, 700, 1,020, 1,250, 1,400 and 3,000 cfs). A two-dimensional hydraulic model was developed for a single study site in the reach (River Restoration 2023). The modeled site was approximately 1,850 feet long and included multiple habitat types found within the Shoshone Reach (Figure 1). The species of interest for the Shoshone Reach study were determined in consultation with Colorado River Water Conservation District (River District) and other entities (Colorado Parks and Wildlife (CPW) and the Colorado Water Conservation Board (CWCB)) as determined by River District staff. Habitat suitability criteria for the species of interest were used in previous studies on what is now the Upper Colorado River Wild and Scenic Alternative Management Plan section of the Colorado River (Miller and Swaim 2011; See also Appendix A this report) with modifications as determined by CPW staff. Hydrology data for habitat time series analysis was provided by the River District.

This study followed the general guidelines of the Instream Flow Incremental Methodology (IFIM) (Bovee et al. 1998). IFIM is a multi-disciplinary approach to evaluating instream flow alternative management scenarios and includes components of hydrology, river hydraulics, and biological data. River hydraulics include simulation of a range of discharges to predict change to the wetted area, depth and velocity that may affect the aquatic biota. The output of the combination of hydraulic model results with habitat use data is generally referred to as hydraulic-habitat. Biological data analysis included evaluation of wetted area as it may affect aquatic biota such as periphyton, macroinvertebrates and available fish habitat.

Study Area

The Colorado River in the Shoshone Reach is subject to several human induced factors. The river channel is bordered by Interstate Highway 70 on river right and the railroad on river left. River discharge is impacted by large headwater reservoirs, transbasin diversions, and diversions for off-channel uses. The Shoshone Reach study area extends from the diversion dam near the Hanging Lake Trailhead parking lot adjacent to I-70 downstream to the Shoshone Power Plant outfall (Figure 1). The total distance for the Shoshone Reach is approximately 2.4 miles. The Shoshone Reach has sections of rapids, high gradient riffles, runs and deep pools. The overall gradient is steeper than the upstream reaches of the Colorado in non-canyon reaches. The river elevation drops over 170 vertical feet over the 2.4-mile distance with extremely steep gradients in areas with rapids (Figure 2).

The total area for each major habitat type (riffle, pool and run) for the Shoshone study reach was approximated from the aerial images from Google Earth Pro based on surface characteristics. The Shoshone reach is dominated by high gradient riffle and rapids with smaller proportions of pools and runs (Table 1). The study site was selected based on the presence of multiple habitat types and the ability to safely obtain the data needed for the hydraulic and habitat models. The study site within the Shoshone Reach has multiple

repeats of habitat types of riffle, run and pool habitat that are representative of the lower gradient, non-rapids habitat within the Shoshone Reach (Figure 3). The Shoshone Reach supports multiple fish species of trout, native suckers, mountain whitefish and sculpins (Kendall Bakich CPW, personal communication 2024; CPW file data). These same species have been collected by CPW upstream and downstream of the Shoshone Reach in the Colorado River. There are no quantitative data on fish populations in the Shoshone Reach due to the river conditions that restrict safe access for population sampling efforts. Shoreline sampling by CPW in 2023 showed the presence of Brown Trout and Rainbow Trout. In addition to fish, the river also supports the lower trophic levels of periphyton, algae, and benthic macroinvertebrates. These trophic levels are important food resources for the higher trophic levels and are dependent on continuous river flow for completing their life cycle. The periphyton supports benthic invertebrates and fish, benthic macroinvertebrates support fish species.



Figure 1. Shoshone Reach study area and study site. Colorado River flows from upper right to lower left. Source: Google Earth Pro July 17, 2023.

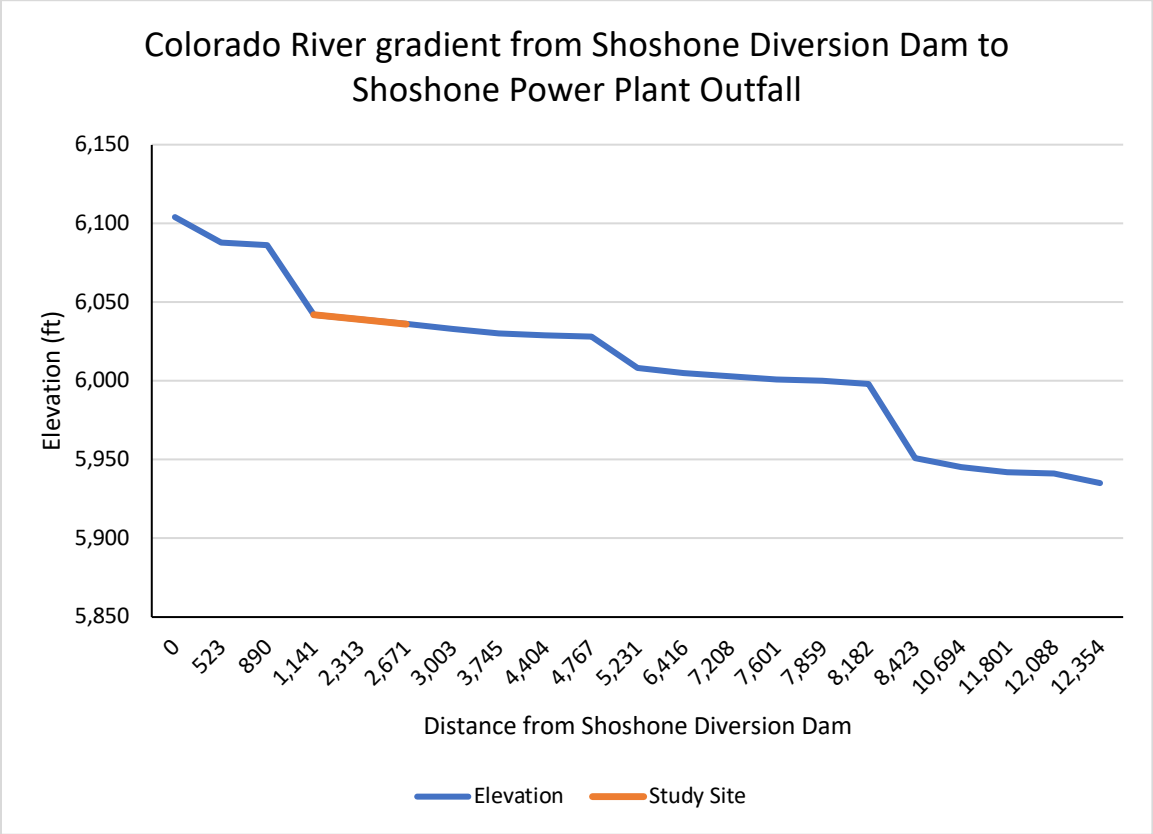


Figure 2. Approximate gradient of Colorado River in the Shoshone Reach (Shoshone diversion dam to Shoshone Power Plant outfall) Source: Google Earth Pro Aerial Image July 19, 2023.

Table 1. Habitat type and percentage for Shoshone Reach, Colorado River (source: Google Earth Pro aerial images July 19, 2023).

Habitat Type	Summed length (ft)	Percent
Riffle	5363	42%
Rapid	5045	39%
Run	332	3%
Pool	2121	16%
Total	12861	100%



Figure 3. Aerial image of Shoshone Reach Study Site with approximate delineation of habitat types. Source: Google Earth Pro Aerial Image July 19, 2023.

Methods

There are several methodologies available to evaluate riverine habitat (Annear et al. 2004; Stalnaker et al. 1995). These include simple standard setting methods such as R2Cross up to more complex methods that evaluate multiple parameters to better address complex water management problems. The Instream Flow Incremental Methodology (IFIM) is a multidisciplinary methodology and was developed to evaluate complex water management problems (Bovee, 1982; Bovee et al. 1998; Stalnaker, 1995). IFIM includes sound ecological principles in the methodology (Bovee et al. 1998). The IFIM approach has been used in other instream flow evaluations in Colorado including the Colorado River, Dolores River, Cache La Poudre River and South Platte River basins.

The general approach to evaluating instream habitat in the Shoshone Reach follows the guidelines of IFIM. The analysis sequence includes collection of field data for stream topography, bathymetry, and hydraulic parameters, and fish habitat use data. These field data are the input parameters for hydraulic modeling and habitat suitability analysis. The hydraulic model output and habitat suitability are combined to calculate habitat area as a function of discharge for a range of flows. This function is combined with hydrology scenarios to determine change in habitat over time (Figure 4). In addition to the data used for fish habitat, hydraulic model results for wetted area were used to infer changes to other non-modeled biological conditions such as changes to habitat for benthic macroinvertebrates.

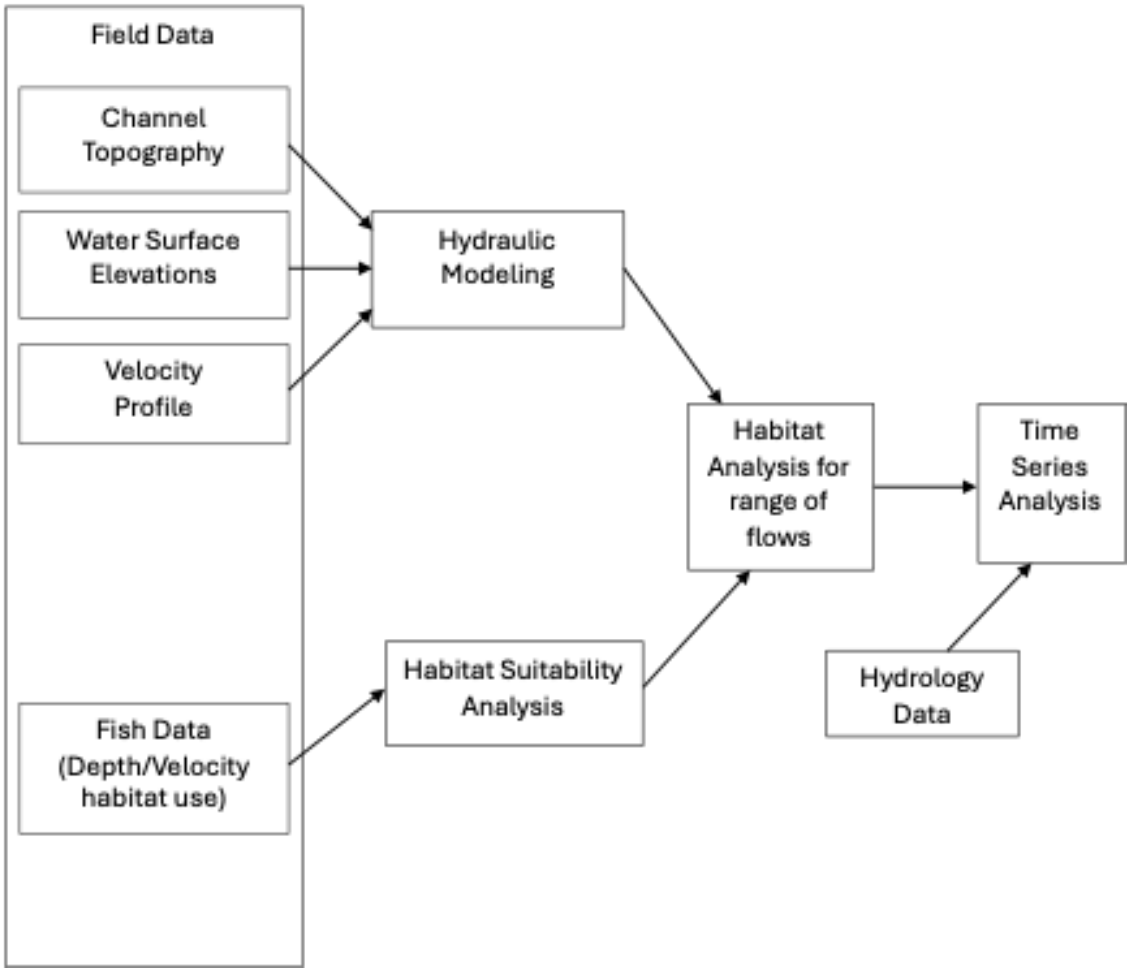


Figure 4. Flow chart of analysis sequence for instream flow study.

Two-Dimensional Hydraulic Modeling

Two-dimensional hydraulic modeling was completed by River Restoration (River Restoration 2023, See Appendix B and Appendix C). The 2-D model uses the georeferenced field data collected from the site. Data inputs include site topography, substrate, and flow impediments; a stage-discharge relationship at the downstream end of the site; and calibration and validation data throughout the site. The survey data was used to develop a grid system to represent the stream geometry as a mesh. Model mesh was approximately 4 ft by 4 ft for the site (River Restoration 2023). This mesh was combined with the hydraulic data to simulate water depths and depth averaged velocities for the range of flow conditions for 50, 250, 700, 1,020, 1,250, 1,400, and 3,000 cfs. The water depth and depth averaged velocity from the hydraulic model are required to be consistent with the data collected for the fish habitat use, which also is water depth and depth averaged velocity.

Hydrology

The River District provided the hydrology time series for the Shoshone Reach. The hydrology data included hydrology from actual gage data using the USGS Colorado River near Dotesero gage (Dotsero Gage) located just upstream of the Shoshone Reach over a period of record of 1973-2003. The data are presented as an irrigation year (Nov 1-Oct 31) with three typical hydrologic conditions based on the following years: Wet – 1997, Average – 2000, and Dry - 2001. The years were selected to get a range of hydrologic conditions from wet to dry and also were years the Shoshone Hydropower plant operated. The hydropower plant operation data was needed so "existing" conditions in the Shoshone Reach could be evaluated. Actual gage data is the "future" or proposed condition of the Shoshone Reach for each of these sample years, assuming the scenario that the Shoshone Water Rights are not used for hydro-power generation

purposes but are instead being exercised by the CWCB for instream flow purposes, causing all flow to go through the Shoshone Reach. Existing conditions were assumed to be historical flow at Dotsero Gage flow less 1,408 cfs to mimic the typical historical operations of the Shoshone Power Plant of diverting all available flow up to 1,408 cfs as described further below. The three sample year types for existing and future conditions were used in the habitat time series.

Water Right Administration

The Dotsero Gage (USGS 09070500) is an administrative point utilized by the Colorado Division of Water Resources ("DWR") to measure all streamflow in the river at the location of the gage. In addition, DWR has historically relied on the Dotsero Gage as the point of administration for the Shoshone Water Rights. DWR uses the Dotsero Gage to measure both the amount of un-depleted, natural flow as well as the amount of bypassed flow associated with shepherded releases from reservoirs located upstream of the gage. For purposes of this report, the "natural flow" includes the amount of water divertible by the Shoshone Water Rights when those water rights are in priority but does not include any bypassed water or releases from upstream reservoirs administered for downstream water use below the Shoshone Reach. Those bypass flows (i.e., shepherded releases), which are also administered at the Dotsero Gage, are those reservoir releases made for the purposes of increasing streamflow at certain downstream locations in excess of the natural flow that would exist at these locations but for the bypass water, such as releases for irrigators in the Grand Valley or for environmental flows to benefit the 15-Mile Reach.

Importantly, DWR does not administer the shepherded bypass water at the Dotsero Gage to satisfy any calls for administration of the senior and junior Shoshone Water Rights. Instead, DWR accounts only for the available natural flow at the Dotsero Gage whenever a Shoshone Call is placed to determine whether upstream junior water rights must be curtailed to ensure that sufficient natural flow is available for beneficial use at the Shoshone Power Plant where such water is diverted from the river. Similar operating

conditions have been assumed for the future-conditions hydrology in this Report such that if the Shoshone Water Rights are utilized for instream flow purposes the Shoshone Call would be based solely on the amount of natural flow as measured at the Dotsero Gage, not including the amount of shepherded bypass water. Thus, the Shoshone Reach could have flows greater than 1,408 cfs at certain periods when the Shoshone Call has been placed but is not being fully satisfied. This is because DWR administers the Shoshone Call based solely on available natural flow at the Dotsero Gage but does not administer any shepherded bypass water to satisfy the call even though such bypass water does eventually flow through the Shoshone Reach for downstream beneficial uses.

Habitat Suitability Curves

Species habitat suitability criteria are required for the hydraulic-habitat analysis. Habitat suitability criteria that accurately reflect the habitat requirements of the species of interest are essential to conducting meaningful and defensible habitat analyses (Bovee 1982). A previous study in the Colorado River from Kremling to Dotsero, Colorado (Miller and Swaim 2011) incorporated habitat suitability criteria for the same species of interest as in this study (Table 2). The habitat suitability criteria include adult trout, adult Mountain Whitefish, and adult Flannelmouth Sucker. Other species considered for this analysis were Bluehead Sucker and Mottled Sculpin. Habitat suitability criteria were not available for Mottled Sculpin. Bluehead Sucker were not explicitly modeled in the study due to a lack of sufficient number of data observations, however, the data that was available shows an overlap in the depth and velocity used with Flannelmouth Sucker (Miller 2024).

Table 2. Species of interest for habitat analysis.

Common Name	Scientific Name
Rainbow Trout	*Oncorhynchus mykiss*
Brown Trout	*Salmo trutta*
Mountain Whitefish	*Prosopium williamsoni*
Flannelmouth Sucker	*Catostomas latipinnus*

The habitat data for the species of interest came from several sources and have been used in previous studies on the Colorado River (Miller and Swaim 2011). The data for adult trout was collected by direct observation at several locations in rivers in Colorado. The data was collected by personnel from Colorado Division of Wildlife (now CPW) and US Fish and Wildlife Service in 1988 and 1989 (Colorado Division of Wildlife 1989). Those observations were used to develop habitat preference suitability indices for depth and velocity and corrected for habitat presence (Wilding 2012).

Criteria for Mountain Whitefish used for this analysis came from Bovee (1978). The criteria for adult Flannelmouth Sucker were updated in early 2024 from a combination of data from radio telemetry studies on the Colorado River near Grand Junction, existing data from a range of rivers and literature review of habitat and population studies (Miller 2024). Additional habitat criteria for Flannelmouth Sucker were incorporated into the final suitability criteria as documented by Miller (2024). The habitat suitability criteria for Flannelmouth Sucker are also being used as a proxy for Bluehead Sucker criteria for this study. Bluehead Sucker feed by scaping on hard substrates and are known to feed in faster riffle habitat with cobble and boulders whereas Flannemouth Sucker feed on softer substrates in somewhat slower velocities so the habitat response shown for Flannelmouth Sucker may approximate habitat response to flow for Bluehead Sucker but not fully depict all areas suitable for Bluehead Sucker. The suitability indices for all species are listed in Appendix A.

Habitat Modeling

The habitat modeling for this analysis will follow the concepts of IFIM (Bovee 1982, Stalnaker et al. 1995). IFIM requires hydraulic data and simulations; habitat use data expressed as habitat suitability criteria; and hydrology data for a range of stream discharge conditions. The 2-D hydraulic analysis and simulations were described above.

Habitat suitability modeling for each species of interest was accomplished through a spreadsheet model. The spreadsheet instream habitat model relies on inputs from both the two-dimensional hydraulic modeling and the habitat suitability criteria described above. Data corresponding to flow depths and depth averaged velocities provided by the two-dimensional hydraulic modeling were developed for each flow rate within the study site. Specific habitat criteria developed from the suitability analyses described above were then used to calculate habitat area. Multiple data sets of usable habitat were generated, corresponding to each species and flow of interest. The usable habitat area for each species of interest is the result of combining the hydraulic simulations for each flow with the habitat suitability function for each species. Summation of total habitat for each species and simulated flow results in a habitat-discharge relationship by species that becomes input for the habitat-time series analysis.

The habitat–discharge relationships are a set of theoretical functions based on channel shape and hydraulics. The actual habitat realized by the species is a function of the discharge at the site over time combined with the habitat–discharge function and results in the habitat time series.

Habitat Time Series

The actual habitat experienced by the fish in any river depends on the flow regime of the river. The relative abundance of habitat conditions over time is an integral part of the comparison of flow regimes. Generally, the habitat time series is the comparative

analysis used for the decision point in IFIM. Habitat time series produces the data needed to compare a range of flow conditions over time and to compare different flow scenarios. The habitat-discharge relationships for each study site were used as input data for the habitat time series. This analysis allowed a comparison between the existing flow regime and alternate flow regimes to determine available habitat with each time series.

Habitat time series evaluations were conducted on two flow regimes representing the existing hydrologic condition and the potential future condition with water flowing in the Shoshone Reach. For each flow regime assessed, we conducted both hydrology and habitat time series analysis for wet, average and dry hydrology to calculate both flow and habitat statistics. These values allowed a direct comparison of the changes that occur in both flow and habitat under a range of conditions. These tabular data were displayed for each flow scenario to represent the spatial habitat distributions.

Habitat time series was completed using a spreadsheet format that combines the hydrology over time with the habitat use as a function of discharge. These values are converted to area of habitat for the study site and then area of habitat for the Shoshone Reach to compare change in habitat over time for each flow of interest.

Results

The study components include results from the hydraulic model for depth, velocity, and wetted area at each simulated flow, available hydraulic-habitat at each modeled flow and comparison of daily habitat for a range of hydrologic year types. Wetted area is used to infer changes to the non-modeled biological data and to more fully understand the range of conditions that may be available to fish species. The hydraulic-habitat analysis provides the data needed to determine change in available habitat at specific discharges and provides the data to evaluate change in habitat with changes to hydrology on a daily time step.

The hydraulic model mesh and hydraulic parameters provide the basic physical data for the analysis. These data include the area for wetted channel area for each flow. The wetted area for the study site has the sharpest decline in area as the flow declines from 250 cfs to 50 cfs (Figure 5). Flows higher than 250 cfs have a gradual increase in wetted area up to the highest simulated flow of 3,000 cfs.

Wetted area or wetted channel perimeter is a measure of the total aquatic habitat available under varying flow levels and can also be used as an indicator of stream food web function. Primary and secondary trophic levels (algae and benthic macroinvertebrates, respectively) are positively correlated to stable wetted area (Rees et al. 2008). Many of the key macroinvertebrates such as Mayflies, Stoneflies, and Caddisflies, have annual life cycles and require continuous flow for a year or more to complete their life cycles. Any disruption or loss of habitat due to loss of wetted area during a single year results in either a decrease or total loss in productivity and directly impacts the food resources available to other species. A day or days of zero flow can eliminate primary and secondary food productivity due to mortality of algae and macroinvertebrates and take weeks to return to previous levels (Rees et al. 2008).

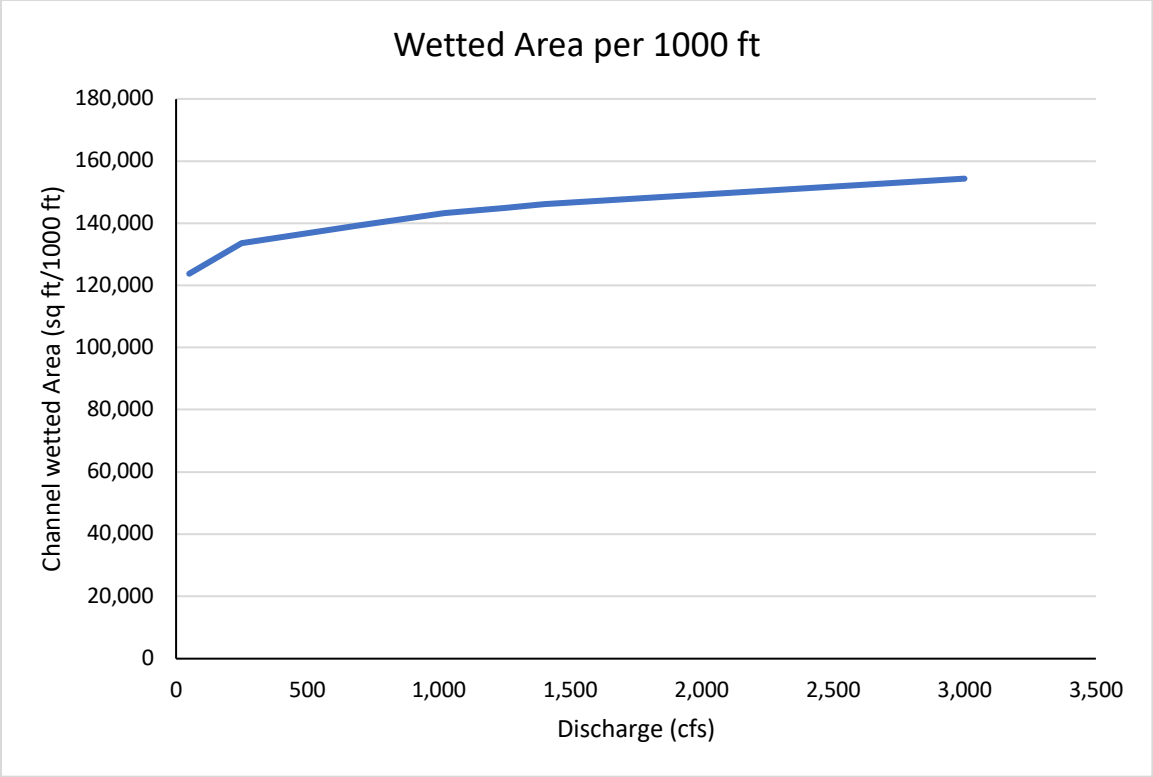


Figure 5. Shoshone Reach Colorado River channel wetted area as a function of discharge.

The hydrology for the reach was graphed to display the comparison between the existing conditions and future conditions for average (Figure 6), dry (Figure 7) and wet (Figure 8) hydrologic conditions. There are extended periods of zero flow days, particularly in winter, for the existing conditions in all hydrologic years. The number of zero flow days are 235, 183 and 134 with existing conditions for dry, average, and wet hydrologic years, respectively. Peak flows during runoff range from approximately 2,500 cfs in dry years to approximately 14,000 cfs in wet years for existing conditions. The base flows under future conditions (when the Shoshone Hydropower Plant is offline) are lowest in winter with flows ranging from approximately 750 cfs in dry years to approximately 1,000 cfs in average and wet years. There are no zero flow days in future conditions. This is a substantial change in flows during base flow periods under future conditions compared to the existing hydrologic conditions in all hydrologic years.

The hydrologic time series comparing existing and future conditions demonstrates that the existing flows result in a total loss of wetted area in all sample year types (Figure 9, Figure 10, Figure 11). Daily flows greater than 3,000 cfs (the highest flow in the 2-D model) were not plotted to limit the data analysis to the range of the hydraulic model. There are also sporadic losses to wetted area during late summer into the fall for existing conditions. There are extended periods of total loss of wetted area from late fall through spring for existing conditions. The loss of wetted area is most impactful to the algae and benthic macroinvertebrates. These species are not as mobile as fish species and require longer times to recolonize the channel after flows return. The general annual life cycle for macroinvertebrates includes adult emergence and egg deposition in late spring through summer, eggs hatch and nymph stages mature from summer through the next spring to early summer when adults emerge and the cycle repeats. Loss of wetted area, either partial or complete, results in a loss of food resource productivity and loss of habitat for mobile fish species. Stable wetted area as shown in the future condition's hydrology time series with the 1,408 cfs water right in the Shoshone Reach is beneficial to primary and secondary trophic levels and fish habitat. In addition, the bypassed/shepherded flow that is added to the 1,408 cfs water right provides an additional amount of wetted area (approximately 4% at 3,000 cfs) and is beneficial to the aquatic ecosystem. The additional wetted area provides more area for macroinvertebrate emergence. The shoreline areas with large substrate provide velocity refuge habitat for fish. The benefit to the lower trophic levels would provide improved ecological conditions for the higher trophic levels and result in more robust ecological conditions in the Shoshone Reach.

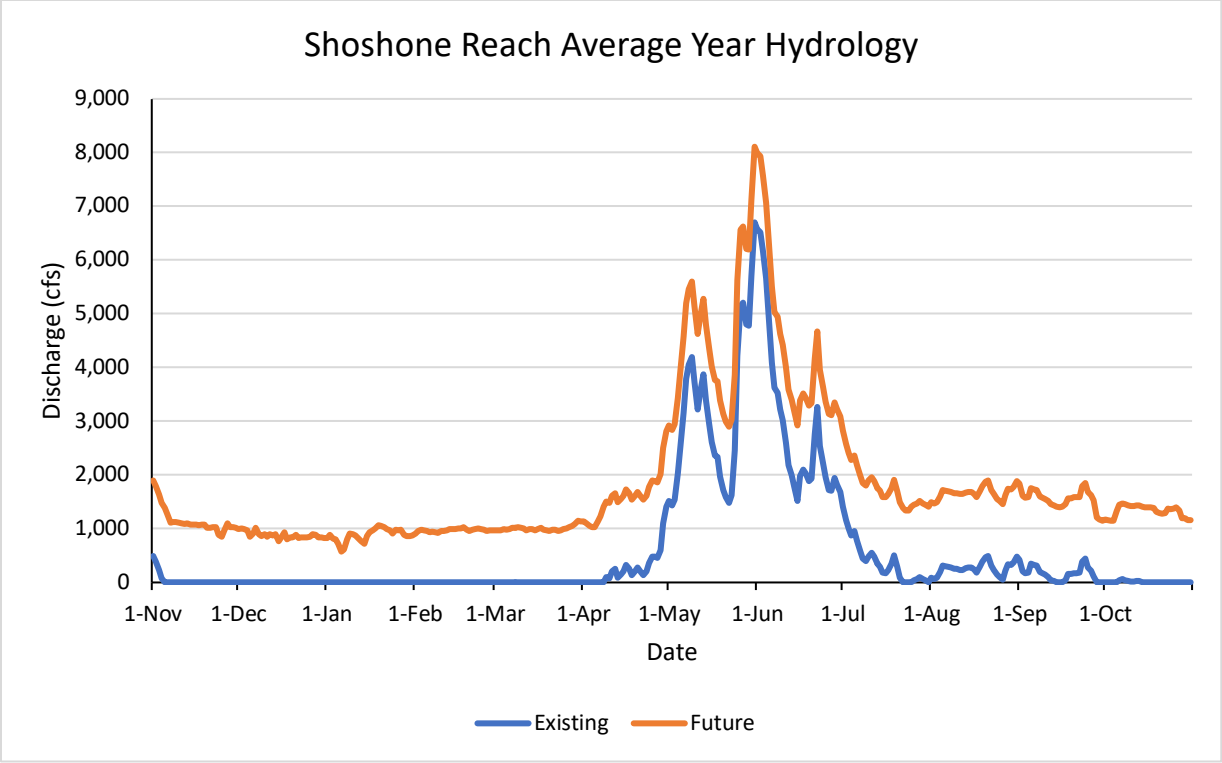


Figure 6. Shoshone Reach, Colorado River comparison of existing and future average year (2000) hydrology.

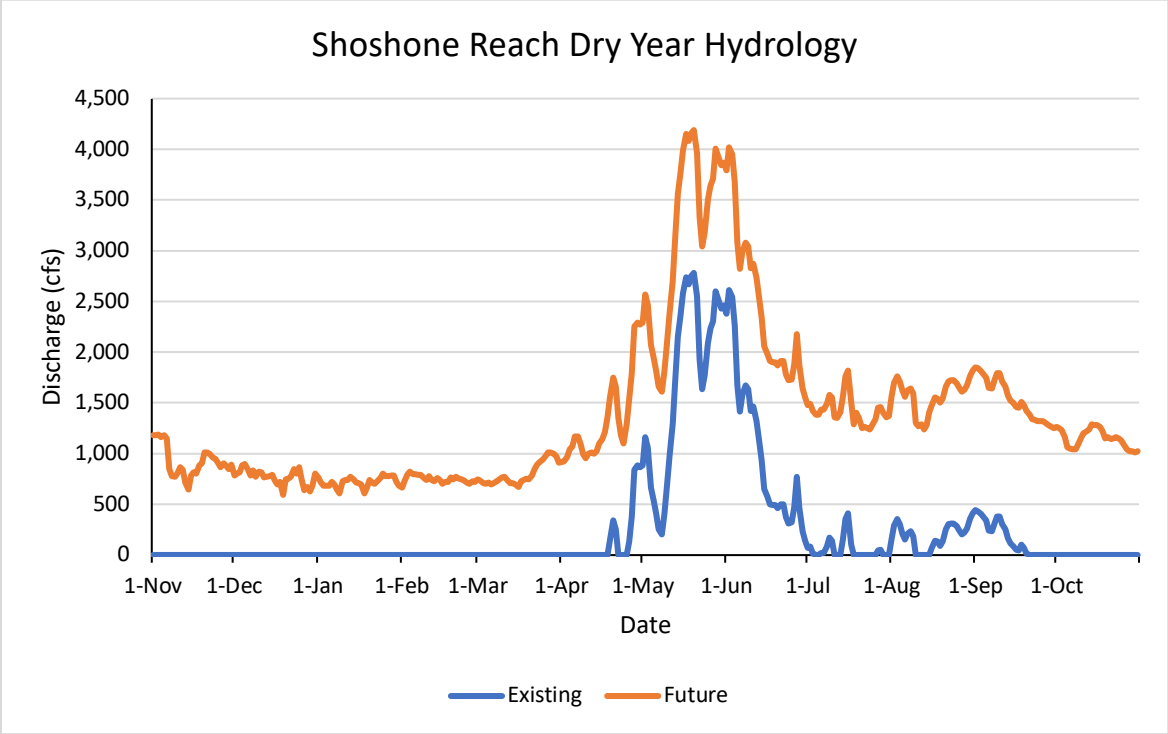


Figure 7. Shoshone Reach, Colorado River comparison of existing and future dry year (2001) hydrology.

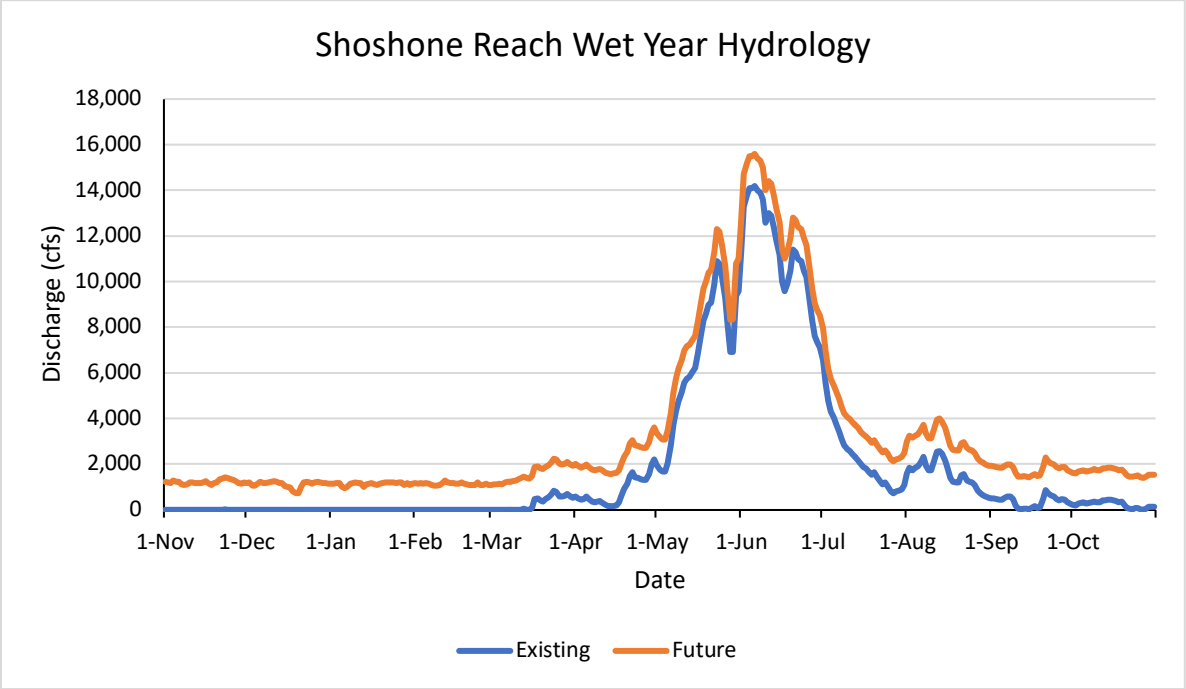


Figure 8. Shoshone Reach, Colorado River comparison of existing and future wet year (1997) hydrology.

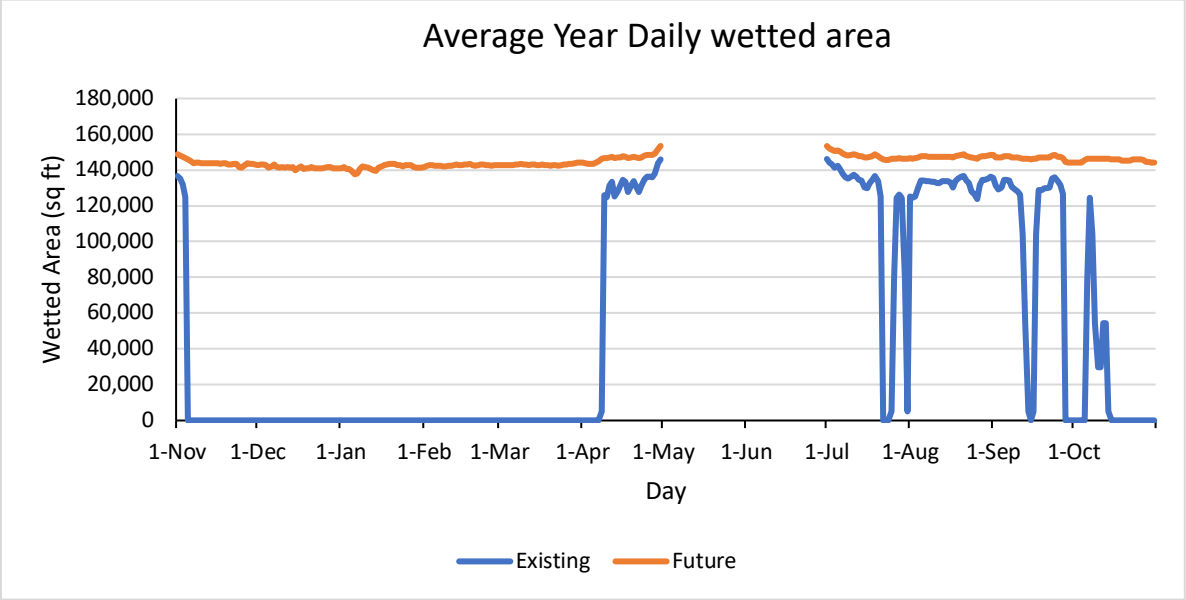


Figure 9. Shoshone Reach average year (2000) daily wetted area comparison of existing and future conditions.

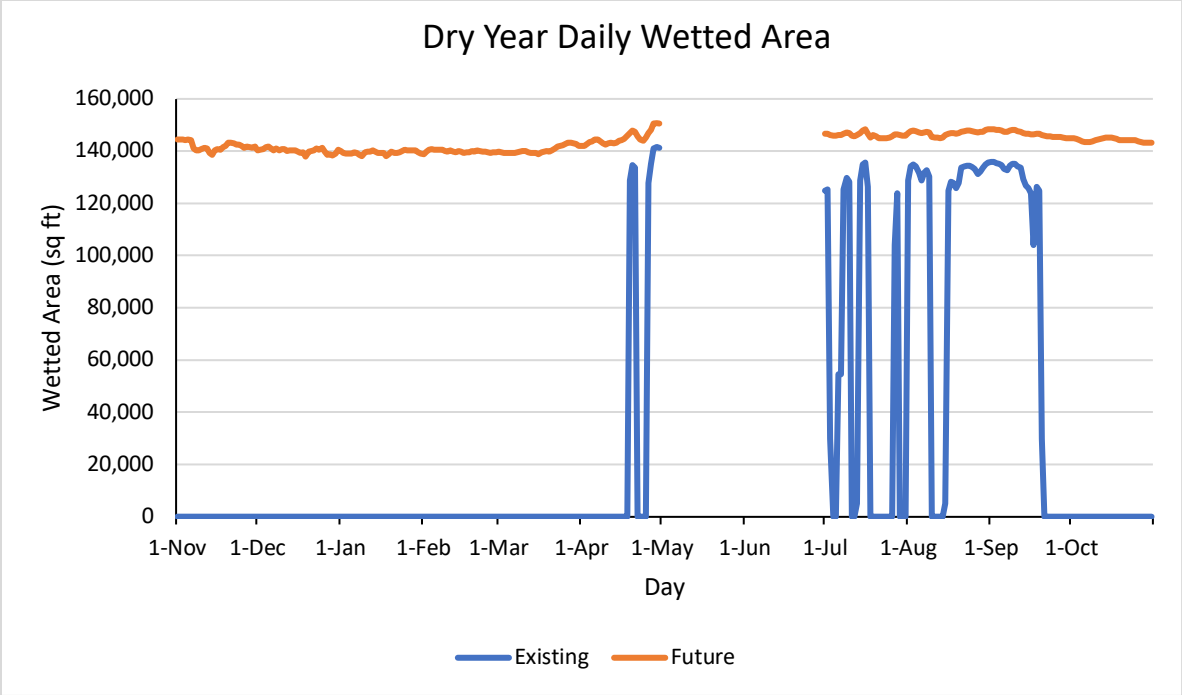


Figure 10. Shoshone Reach dry year (2001) daily wetted area comparison of existing and future conditions.

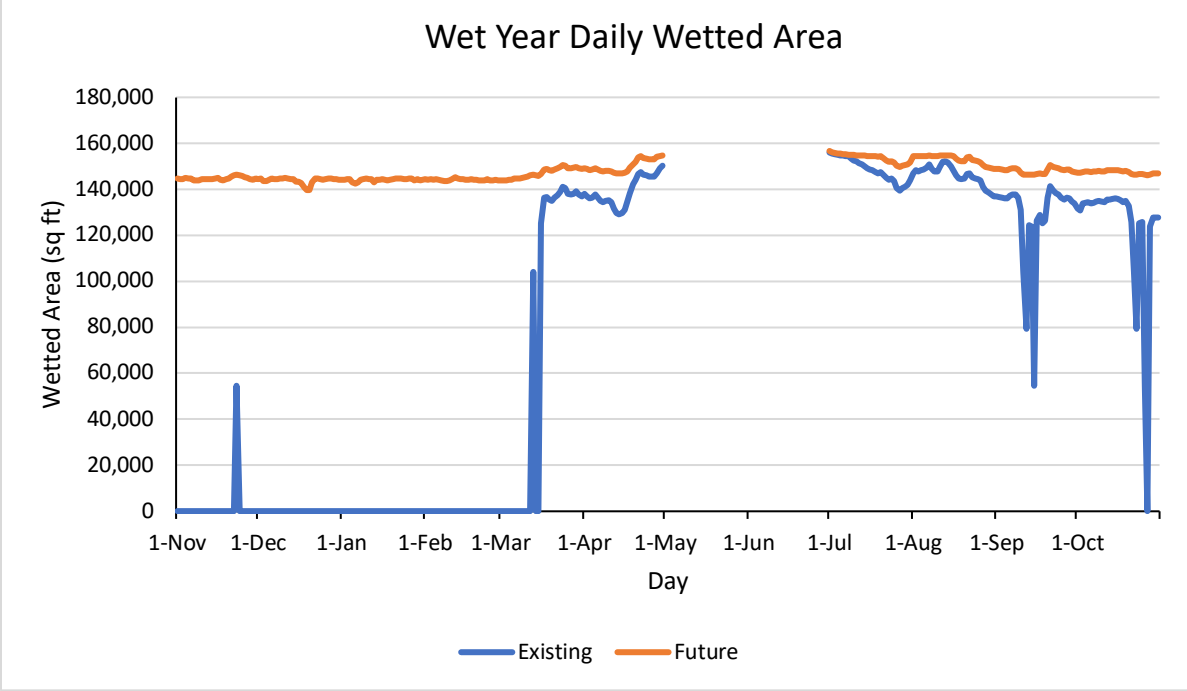


Figure 11. Shoshone Reach wet year (1997) daily wetted area comparison of existing and future conditions.

Habitat Modeling Results

Habitat for each species is a function of both habitat quantity and habitat quality. These characteristics vary with discharge. Habitat area with IFIM is an indicator of usable habitat for each species but does not directly reflect population level changes due to other contributing factors that determine population change. The amount of usable habitat area is an indication of aquatic conditions for the species and can reflect long-term population trends. Small short-term changes in habitat area (other than zero flows) should not be equated with a one-to-one correspondence to short term change in population.

The model results for Rainbow Trout, Brown Trout, Mountain Whitefish and Flannelmouth Sucker show the highest habitat availability at flows that range from 700 cfs to 1,400 cfs (Figure 12, Figure 13). Habitat availability declines quickly as flow decreases from 700 cfs likely caused by decline in wetted area and less suitable depth and velocity characteristics. There is a gradual decline in habitat availability as flow increases up to 3,000 cfs. The reduction in habitat at high flows is likely due to higher water velocities that are less suitable for the species. There is still usable habitat available for fish species as flows increase from 1,500 cfs to 3,000 cfs.

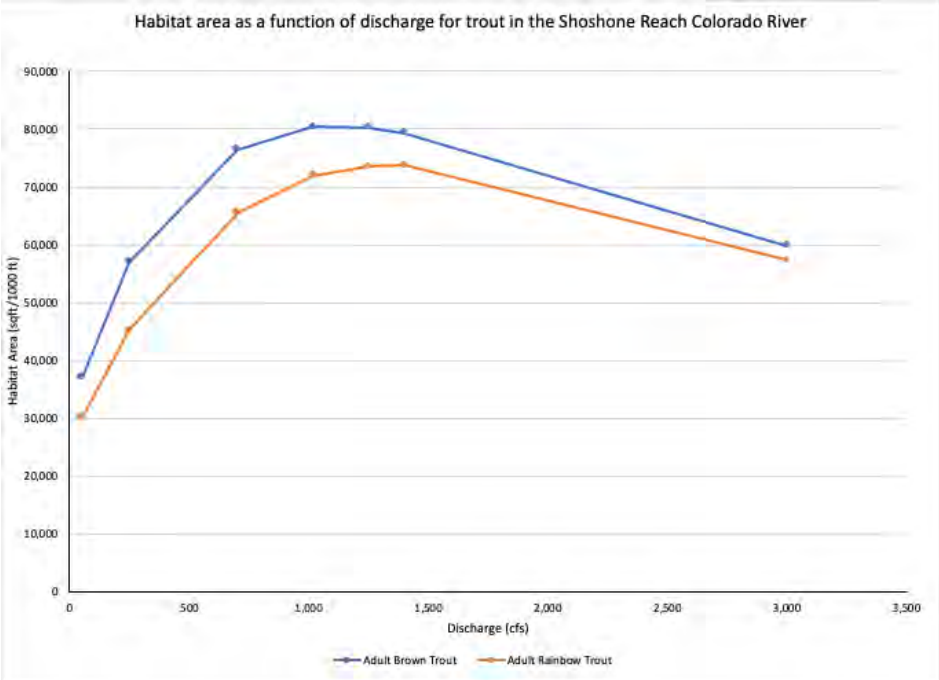


Figure 12. Habitat area as a function of discharge for trout in the Shoshone Reach Colorado River.

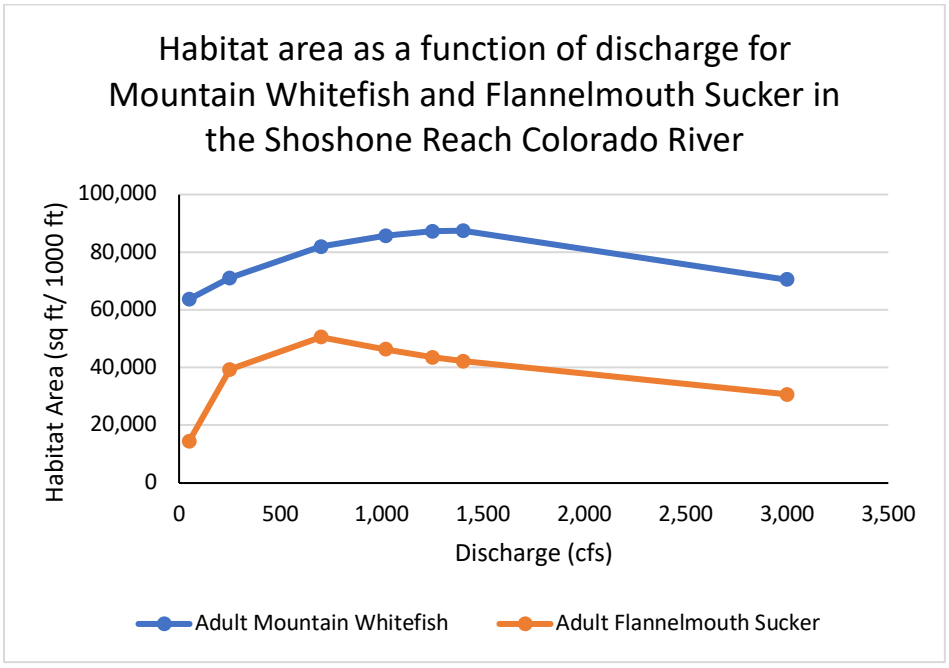


Figure 13. Habitat area as a function of discharge for Mountain Whitefish and Flannelmouth Sucker in the Shoshone Reach Colorado River.

Bypassed/sheperded flows at the Dotsero Gage may increase the discharge up to approximately 2,500 cfs to 3,000 cfs. These bypass/shepherded flows add to the wetted area, which benefits macroinvertebrates while maintaining usable habitat for fish species. The additional wetted area when flows are approximately 2,500 cfs to 3,000 cfs would also provide areas of velocity refuge habitat for fish species in the large boulders and rip-rap present in the reach.

There is a substantial amount of suitable habitat at flows of 3,000 cfs for all species. The amount of habitat for each species and life stage at 3,000 cfs compared to the maximum potential habitat area for each species ranges from 61% up to 81% of the maximum (Table 3). The higher baseflows in winter and late summer to fall are also beneficial to fish. The future condition winter base flow in average years would provide 93% to 99% of the maximum potential habitat for fish species. The future condition late summer to fall base flows in average years would provide 81% to 98% of the potential habitat for fish species (Table 3).

Table 3. Percent of habitat area provided by 3000 cfs and winter and summer average year base flows compared to maximum potential habitat by species.

Species and life stage	Percent of habitat area at 3000 cfs compared to maximum potential habitat	Percent of habitat area at average year winter base flow (973 cfs) compared to maximum potential habitat	Percent of habitat area at average year summer base flow (1581 cfs) compared to maximum potential habitat
Adult Brown Trout	74%	99%	98%
Adult Rainbow Trout	78%	96%	98%
Mountain Whitefish	81%	97%	98%
Flannelmouth Sucker	61%	93%	81%

Habitat Time Series Results

The actual habitat conditions experienced by the fish depend on the daily flows in the Shoshone Reach. These variations are shown in the time series plots of habitat. The data for dry, average, and wet year types were used to display the daily change in habitat for those hydrologic conditions.

The habitat-discharge functions were combined with hydrology data for the Shoshone Reach to display habitat over time for dry, average, and wet years. The existing flows range from zero during many days to nearly 14,000 cfs during wet year peak flows. Daily habitat at flows greater than 3,000 cfs (the highest flow in the 2-D model) were not plotted to limit the data analysis to the range of the hydraulic model. Flows higher than 3,000 cfs generally occur during runoff from May through June. The current zero flow days in the Shoshone Reach occur when the total river flows are 1,408 cfs or less which is the full capacity of the Shoshone Hydroelectric Plant. The future flow regime, if the Shoshone Plant is offline and the Shoshone Water Rights are exercised for instream flow purposes would allow the flow to remain in the Shoshone Reach channel downstream of the diversion dam. Such a flow regime would result in a substantial increase in habitat with no days of zero flow for all species in average, dry and wet hydrologic conditions (Figure 14-Figure 25). The future flows result in stable habitat conditions during all year types for all species.

The intermittent nature of the existing flow patterns with days of zero flow among the days of higher flows does not provide productive habitat. When all flow is diverted the Shoshone Reach experiences drying or zero flow which results in a loss of periphyton and macroinvertebrates. Those lower trophic levels provide the food base for the fish species in the reach. Studies on the 15-Mile Reach of the Colorado River near Grand Junction, Colorado demonstrated that the periphyton and macroinvertebrate communities require approximately two months of continuous flow to reach the same pre-disturbance biomass and density (Rees et al. 2008). The loss of the food resources is a negative impact to the fish within the Shoshone Reach. Loss of the food resources in late summer

when fish are feeding to prepare for winter could result in a substantial impact to fish condition and population size. Therefore, under the future flow regime the entire aquatic ecosystem in the Shoshone Reach would be improved with the stable flows and absence of zero flow days. The future flow regime provides consistently stable base flows at levels that provide a substantial increase in habitat for all species compared to existing conditions. Average year hydrology for future conditions show that winter and summer base flows provide 80% or more of the total maximum potential suitable habitat (Table 3).

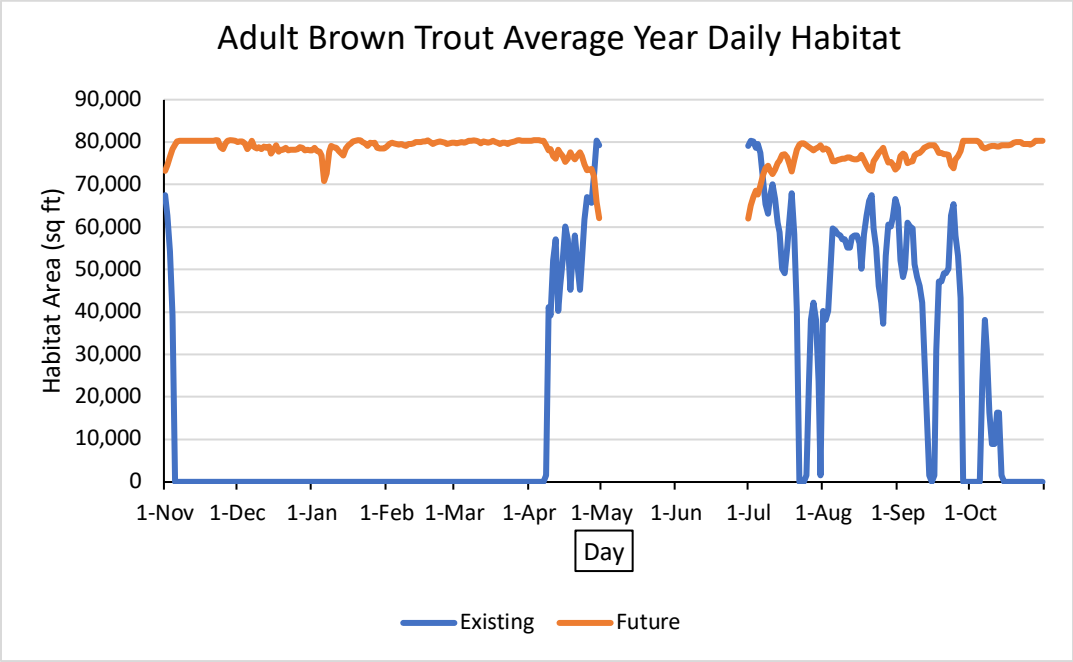


Figure 14. Adult Brown Trout average hydrologic year daily habitat for existing and future conditions.

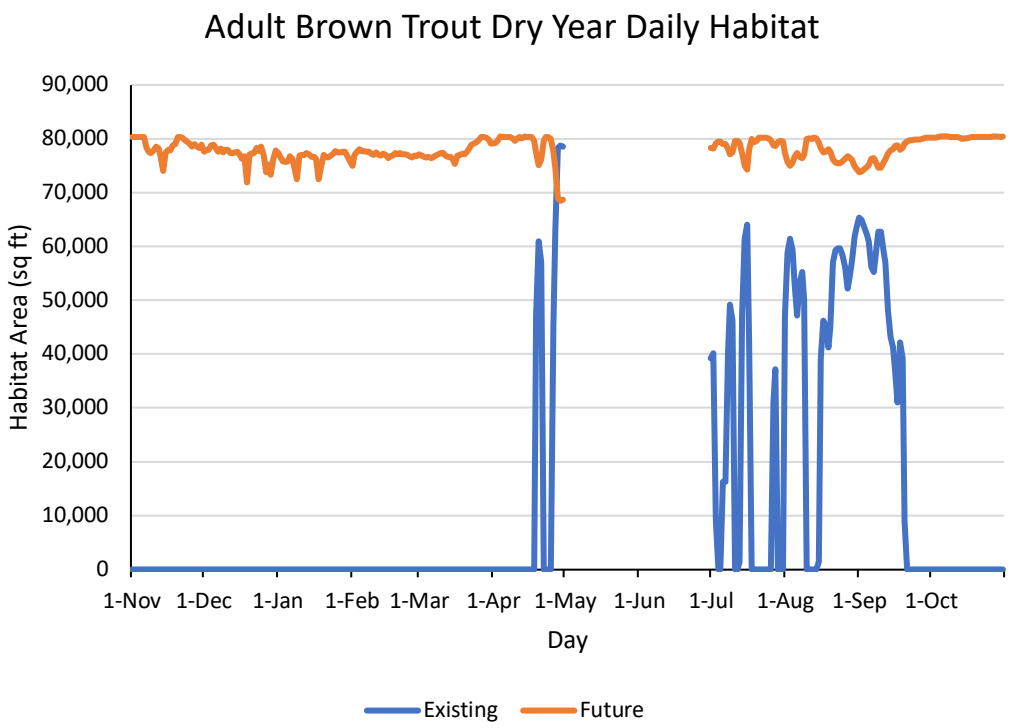


Figure 15. Adult Brown Trout dry hydrologic year daily habitat for existing and future conditions.

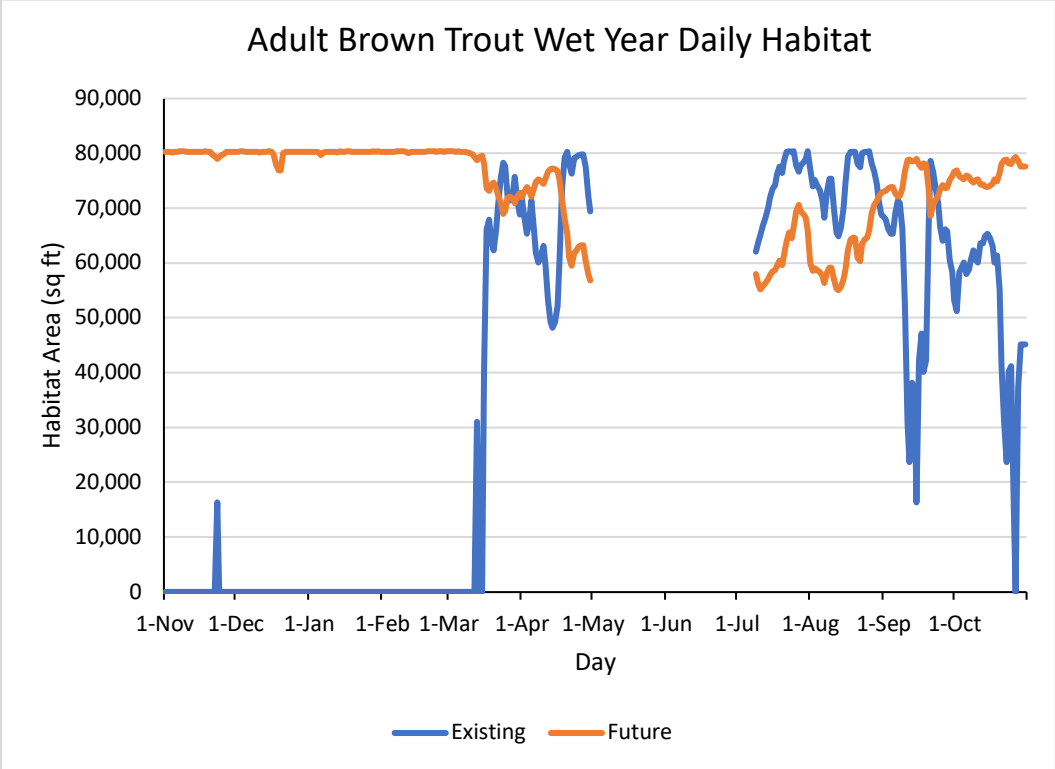


Figure 16. Adult Brown Trout wet hydrologic year daily habitat for existing and future conditions.

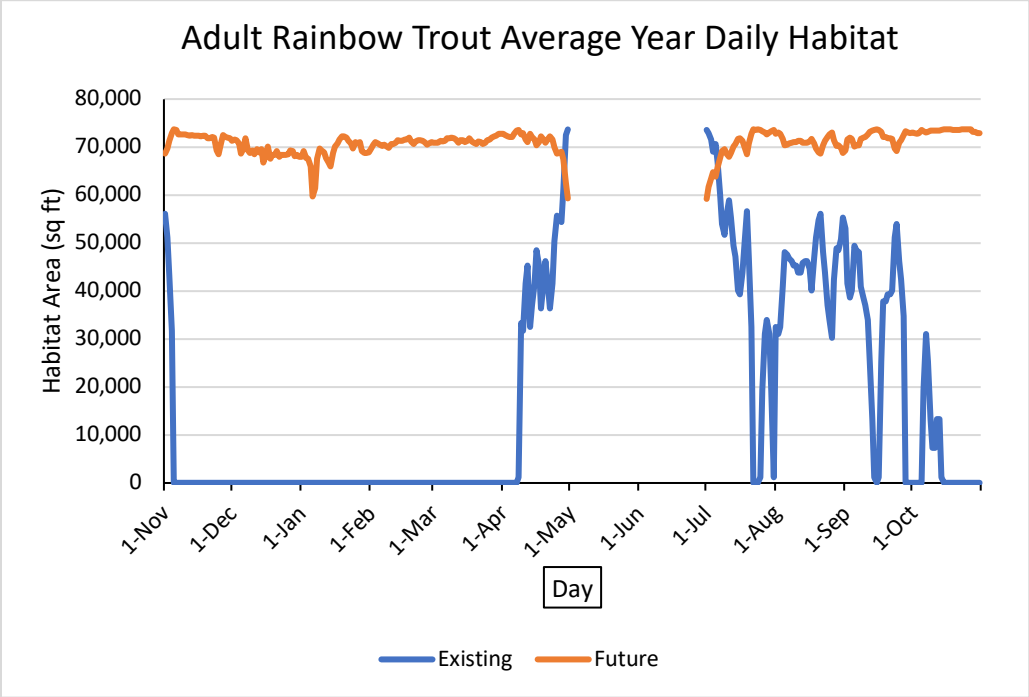


Figure 17. Adult Rainbow Trout average hydrologic year daily habitat for existing and future conditions.

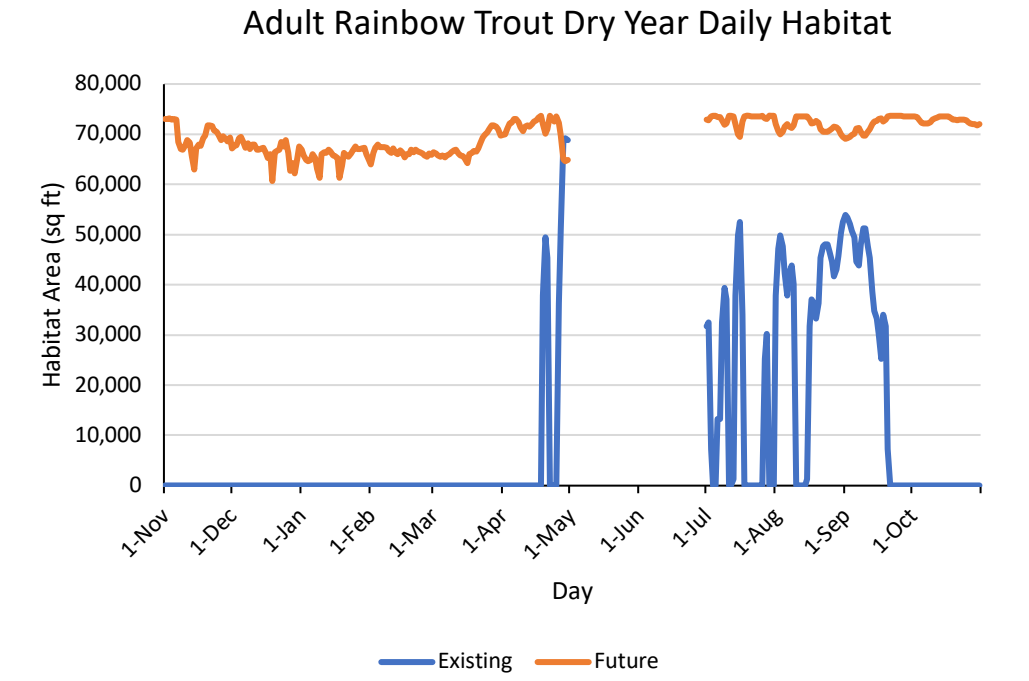


Figure 18. Adult Rainbow Trout dry hydrologic year daily habitat for existing and future conditions.

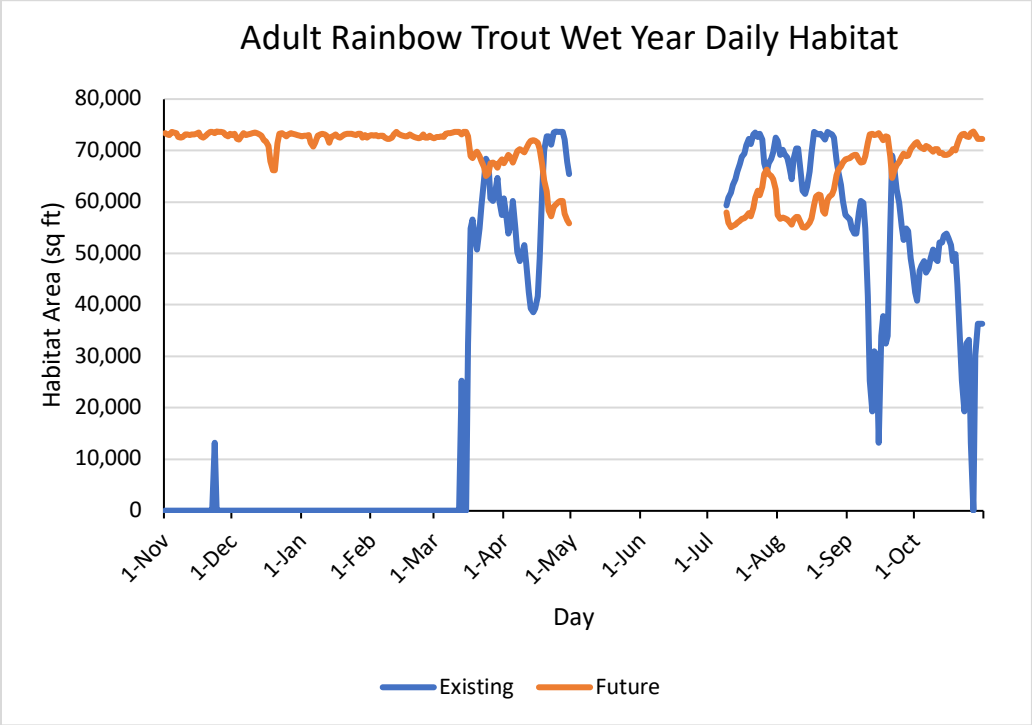


Figure 19. Adult Rainbow Trout wet hydrologic year daily habitat for existing and future conditions.

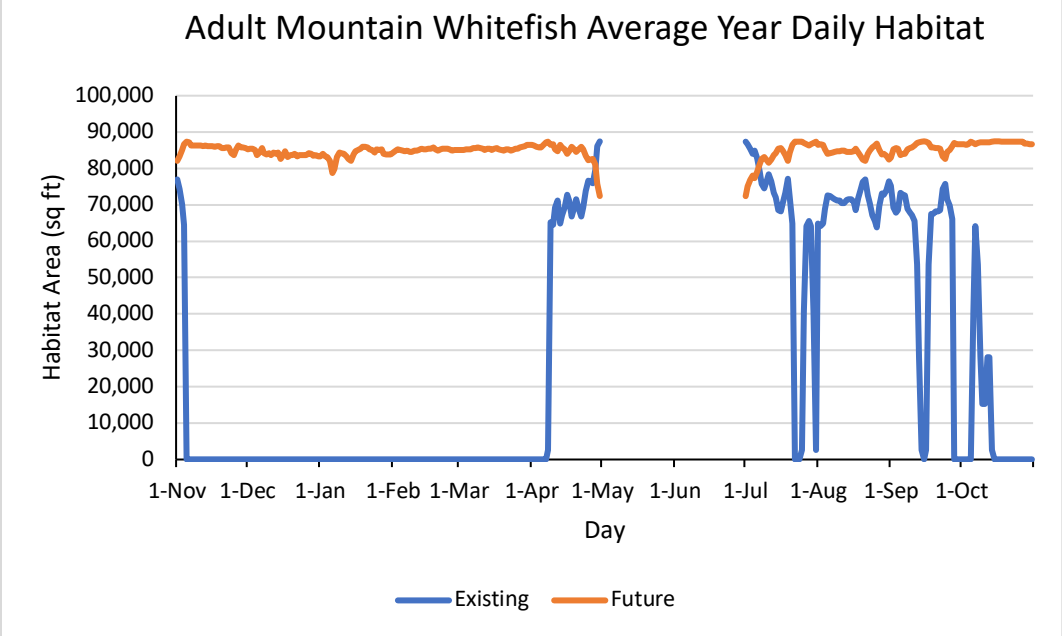


Figure 20. Adult Mountain Whitefish average hydrologic year daily habitat for existing and future conditions.

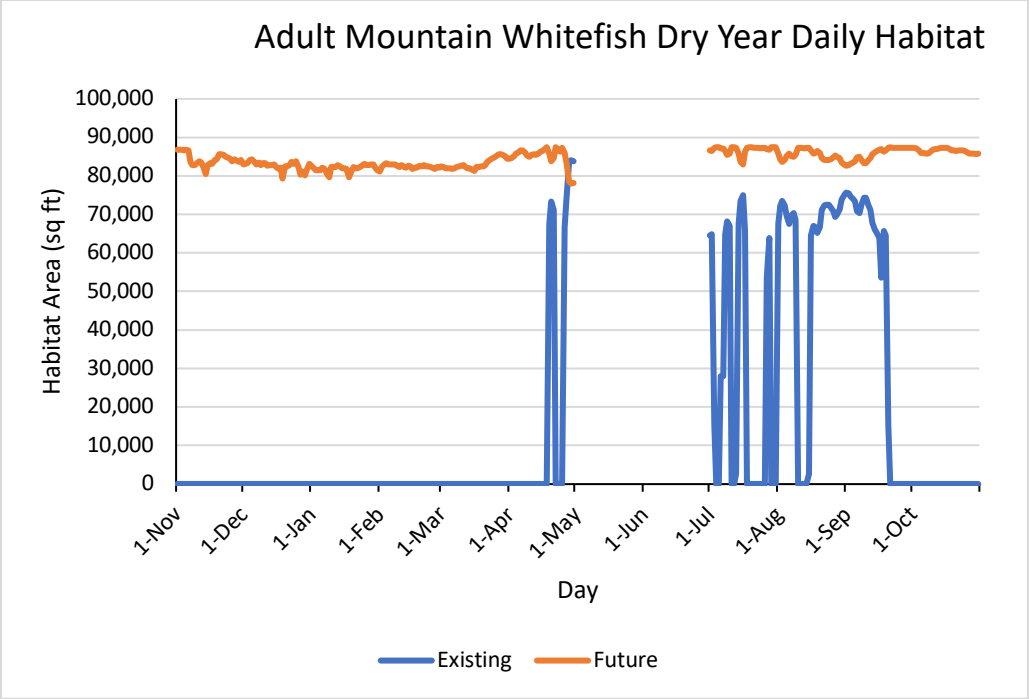


Figure 21. Adult Mountain Whitefish dry hydrologic year daily habitat for existing and future conditions.

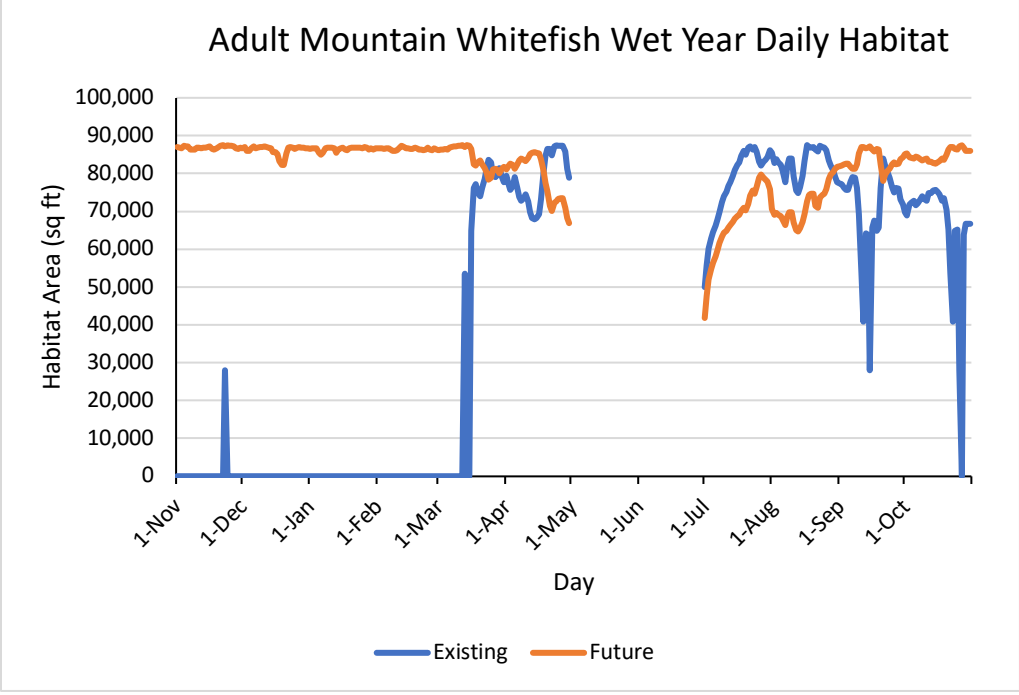


Figure 22. Adult Mountain Whitefish wet hydrologic year daily habitat for existing and future conditions.

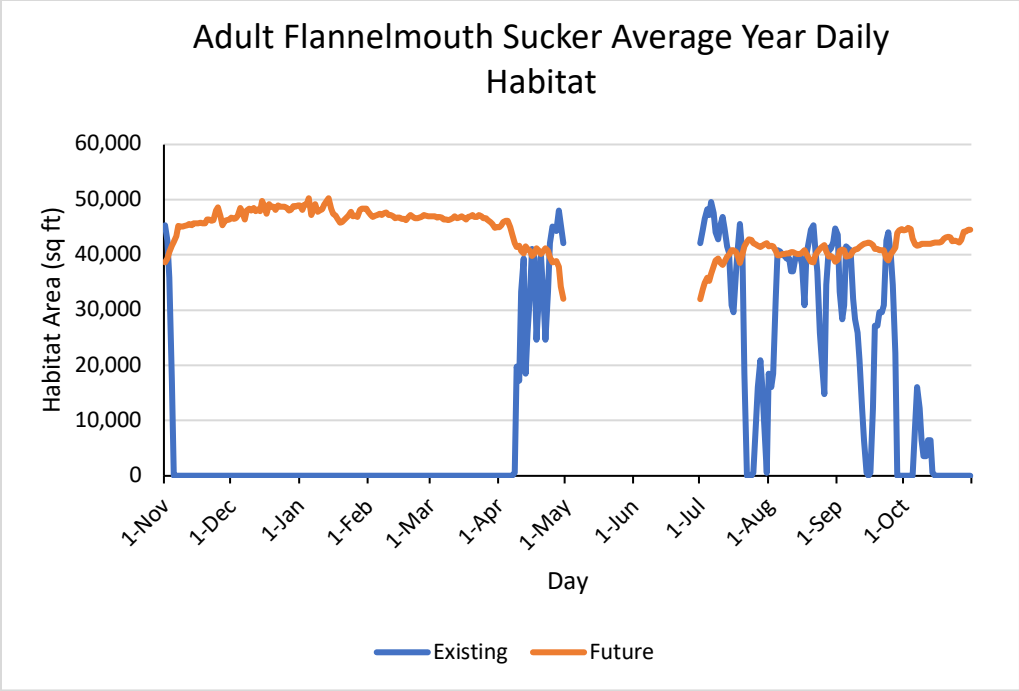


Figure 23. Adult Flannelmouth Sucker average hydrologic year daily habitat for existing and future conditions.

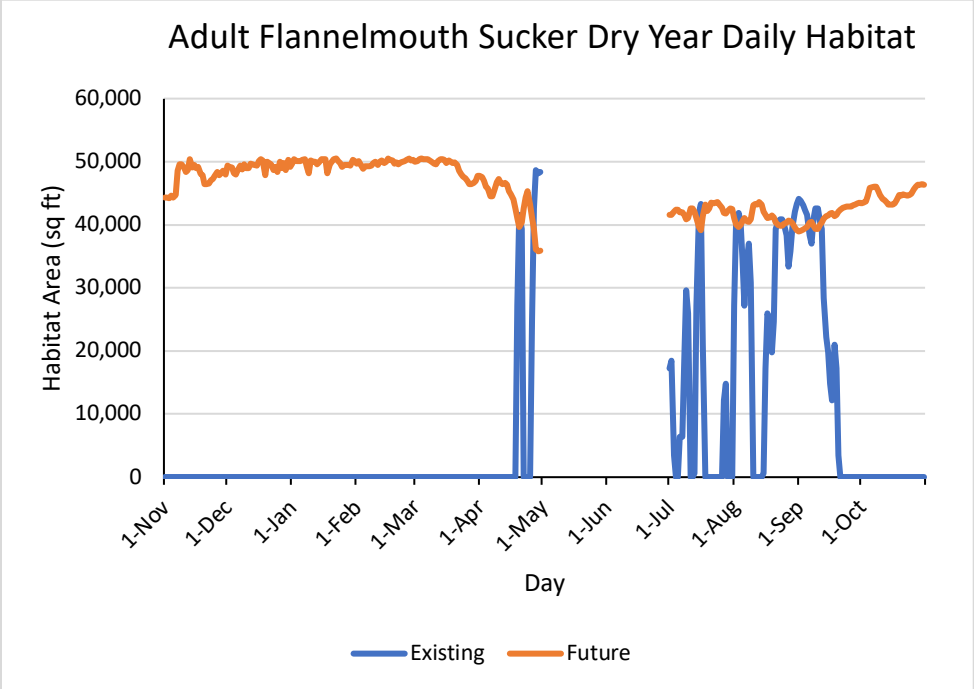


Figure 24. Adult Flannelmouth Sucker dry hydrologic year daily habitat for existing and future conditions.

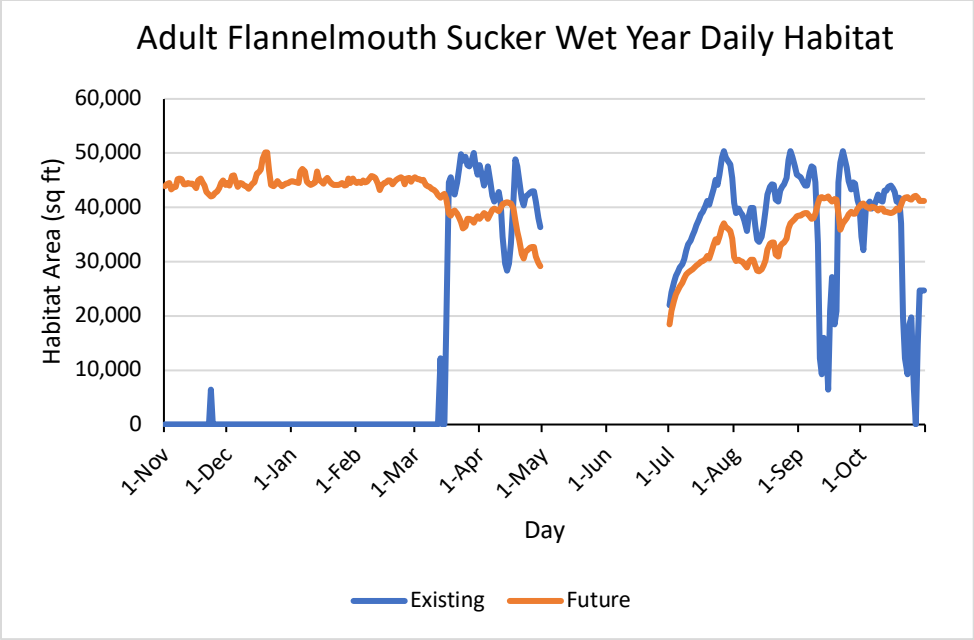


Figure 25. Adult Flannelmouth Sucker wet hydrologic year daily habitat for existing and future conditions.

Aquatic Ecosystem Considerations

Instream flow analysis with IFIM is grounded on ecological principles including flow regime (hydrology), habitat structure, water quality, food sources (trophic considerations), and biotic conditions (Bovee et al. 1998). While IFIM can provide quantitative hydraulic-habitat data from the analysis, these data require interpretation based on other ecological functions. These ecological functions are depicted in hierarchical fashion with the stream function pyramid as developed by Stream Mechanics (Figure 26). Data for all the biological conditions in the Shoshone Reach has not been collected due to logistical limitations, however, biological conditions can be inferred from data collected upstream and downstream of the reach and general knowledge on how riverine aquatic ecosystems function.

The biota in the Colordo River ecosystems and the Shoshone Reach are adapted to a snowmelt-runoff flow regime. The biological adaptation is the response to changes in the physical environment to high runoff flows and low base flows (Lytle and Poff, 2004). Another important component of river ecosystem function is connectivity. Consistent, non-interupted flow is important to connect longitudinal river reaches and allow migration for long distance directed movement such as spawning migration or localized movement of resident fish species (Annear et al. 2004; Cathcart et al. 2015; Thompson and Hooley-Underwood 2019). Colorado River native sucker larvae (Flannelmouth Sucker and Bluehead Sucker) drift downstream after hatch and upstream migration of mature life stages is needed to maintain populations. Maintaining longitudinal connectivity is important to maintaining these native sucker populations. These two sucker species occur upstream and downstream of the Shoshone Reach. A continuous flow in the Shoshone Reach would help to maintain longitudinal connectivity.

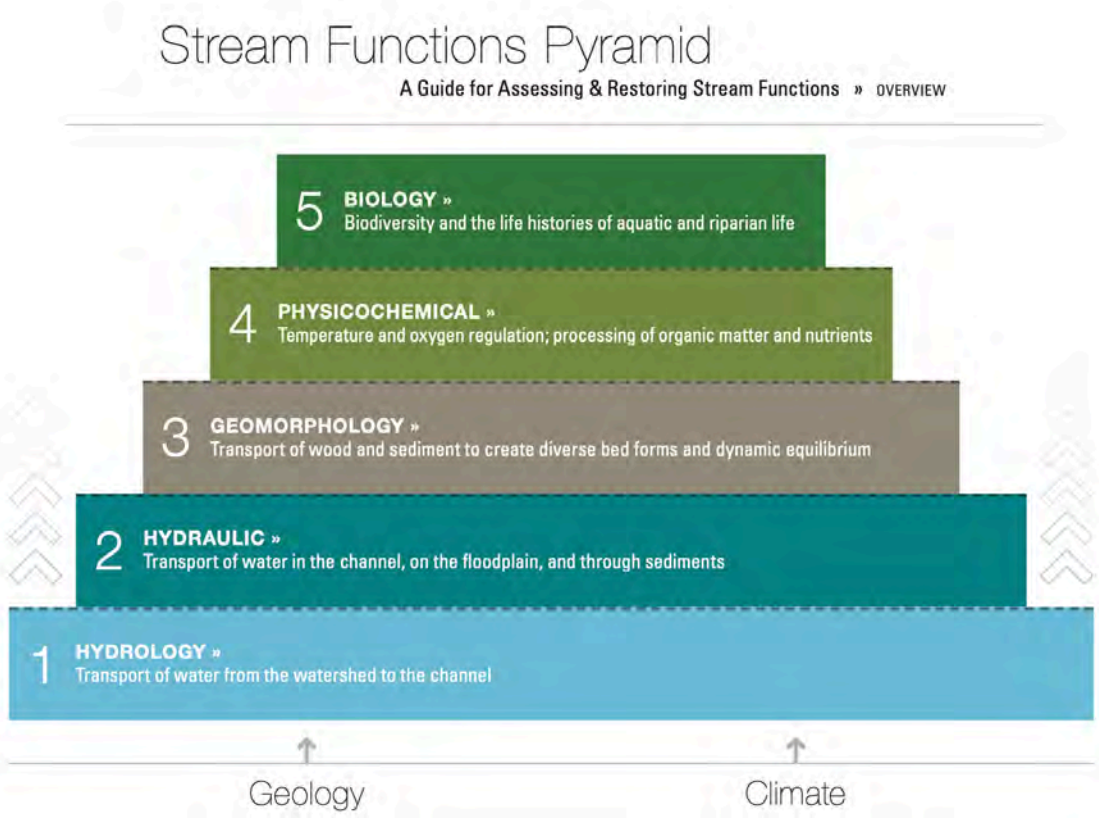


Figure 26. Stream Functions Pyramid showing hierarchical relationship of functions. (Source: Stream Mechanics https://stream-mechanics.com)

Physical components of riverine systems that affect the biota both in the riparian and instream areas include hydrology, geomorphology, and water quality. Hydrology within snowmelt riverine systems usually have spring or early summer peak flows with base flows occurring in summer through fall and winter. The species in the Colorado River are adapted to a snowmelt runoff hydrograph and have adapted their life histories to these events. Fish species use the deeper pools and velocity shelters provided by large boulders and other large instream objects as refuge habitat during high flows.

Base flows are important to maintaining stream productivity and available habitat for both macroinvertbrates and fish. Stable base flows provide consistent habitat conditions and allow long term habitat for less mobile species such as macroinvertebrates. The existing flow regime in the Shoshone Reach does not include stable base flows which are present in the Colorado River upstream and downstream from the Shoshone Reach. The higher, stable future condition base flow could also have a beneficial effect on water temperature in the Shoshone Reach. There are areas with hot springs in this canyon reach of the Colorado River. Higher summer base flow would provide more flow volume and deeper habitats which could provide thermal refuge for aquatic species in the Shoshone Reach.

Conclusions

The Colorado River in the Shoshone Reach is confined by canyon or steep topography throughout the reach and is bounded on the north by the interstate highway and on the south by the railroad. Canyon-bound confined reaches have steeper gradients and larger bed material on the river bottom than the lower-gradient meandering reaches in other sections of the river. These confined reaches have less lateral space for floodplains and less lateral channel movement than lower gradient meandering reaches.

Hydrology in the reach is typical of snowmelt-dominated rivers. Peak flows occur during May and June. Stable flows during non-runoff months provide the conditions needed for

productive food sources for fish and other trophic levels. The existing flow regime in the Shoshone Reach has both sporadic times in summer of zero flow and extended winter periods of zero flow. Zero flow is detrimental to primary and secondary trophic levels, is a negative impact to species that rely on these trophic levels for food and eliminates fish habitat which results in outmigration of fish or mortality. The stable flow regime and stable wetted area under the future conditions are beneficial for productivity at all trophic levels.

Habitat for most species and life stages is most abundant at flows between 700 and 1,400 cfs. Habitat abundance for most species and life stages decreases rapidly at flows less than 700 cfs. There is a gradual decrease in habitat as flows increase from 1,400 cfs to 3,000 cfs when the bypassed/shepherded flows are present in late summer, however, there is still much greater habitat availability compared to the habitat availability for flow less than 700 cfs. The future condition summer and late summer wetted area is relatively stable for the flows from 1,400 cfs to 3,000 cfs and provides stable habitat for algae, macroinvertebrates and fish.

Based on the available hydrology and the habitat-discharge functions, the future flows (the Shoshone Hydropower Plant water rights which include a senior right for 1,250 cfs and a junior right of 158 cfs for a total of 1,408 cfs plus the bypassed/shepherded flows, which can result in a total flow of up to approximately 2,500 cfs to 3,000 cfs at the Dotsero Gage) would provide a substantial increase in habitat and benefit aquatic biota during summer, fall, winter, and early spring as compared to the existing conditions. These flows up to approximately 2,500 cfs to 3,000 cfs therefore will help to preserve and improve the natural environment in the Shoshone Reach. The higher continuous summer base flow for future conditions would benefit all aquatic biota and eliminate the abrupt loss of food and habitat as seen during the zero flow days with existing condition flows. Stable winter flows would allow macroinvertebrates to complete their life cycles within the Shoshone Reach, which increases overall trophic productivity, and provide over winter habitat for all fish species.

There also are indirect benefits to other sections of the Colorado River from the Shoshone Hydropower Plant water rights. These water rights are administered at the Dotsero Gage upstream from the Shoshone Reach, however, the water is conveyed from the upper sections of the Colorado River upstream of the Dotsero gage downstream to the Shoshone Reach and benefits all of the intervening reaches of the upper Colorado River. Similarly, the Colorado River downstream of the Shoshone Reach benefits from the Shoshone Hydropower Plant water rights.

In summary, the future conditions with the Shoshone water right in place as an instream flow in the Shoshone Reach would result in the following:

- Stable base flow conditions with no zero flow days.
- Stable wetted area during future conditions in late summer, fall, winter and spring for better conditions for macroinvertebrates and algae which are food sources for fish species.
- Average year hydraulic-habitat conditions in summer and winter base flows that provide from 81% to 99% of the potential maximum hydraulic habitat.
- Continuation of indirect benefits upstream and downstream of the Shoshone Reach.
- Flows from 1,400 to 3,000 cfs provide additional benefit to the aquatic habitat in the Shoshone Reach.
- Overall improved instream conditions to preserve and enhance the aquatic habitat.

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Appendix A – Habitat Suitability Criteria for Trout, Flannelmouth Sucker and Mountain Whitefish.

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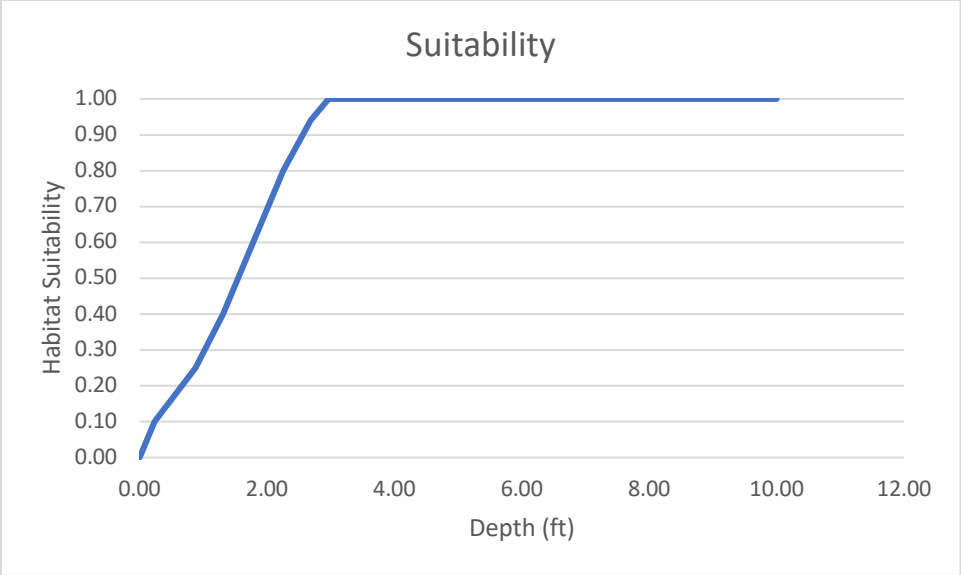


Figure A-1. Adult Brown Trout Depth Suitability Criteria.

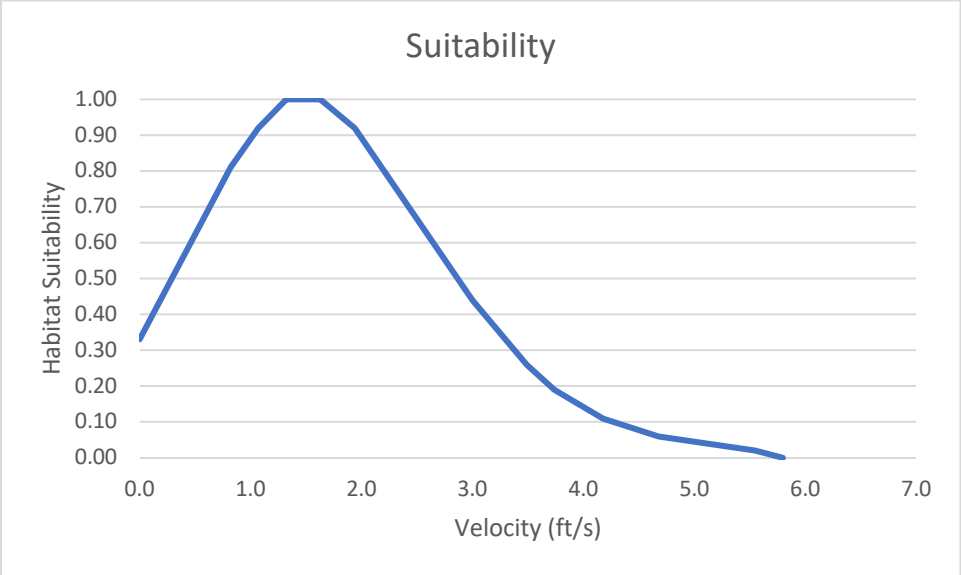


Figure A-2. Adult Brown Trout Velocity Suitability Criteria.

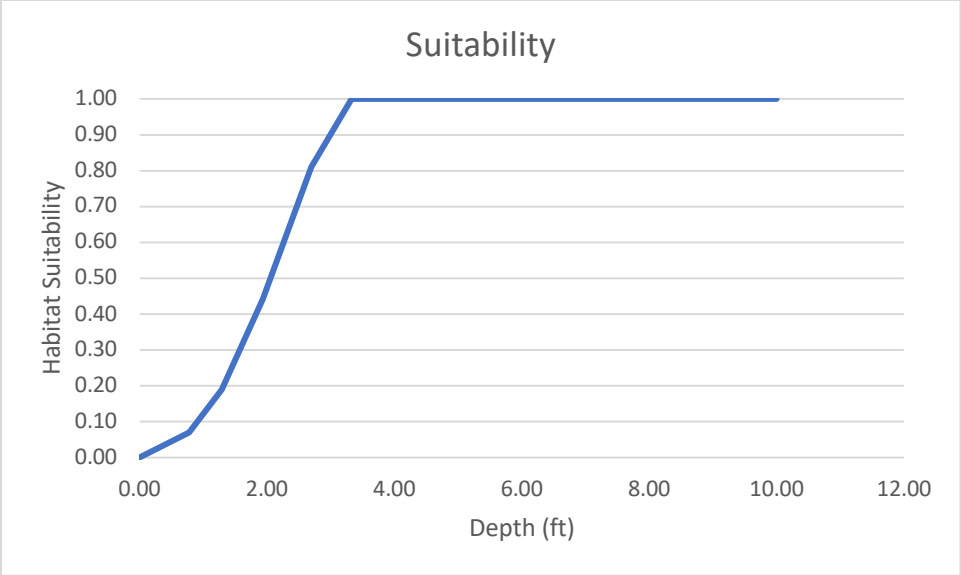


Figure A-3. Adult Rainbow Trout Depth Suitability Criteria.

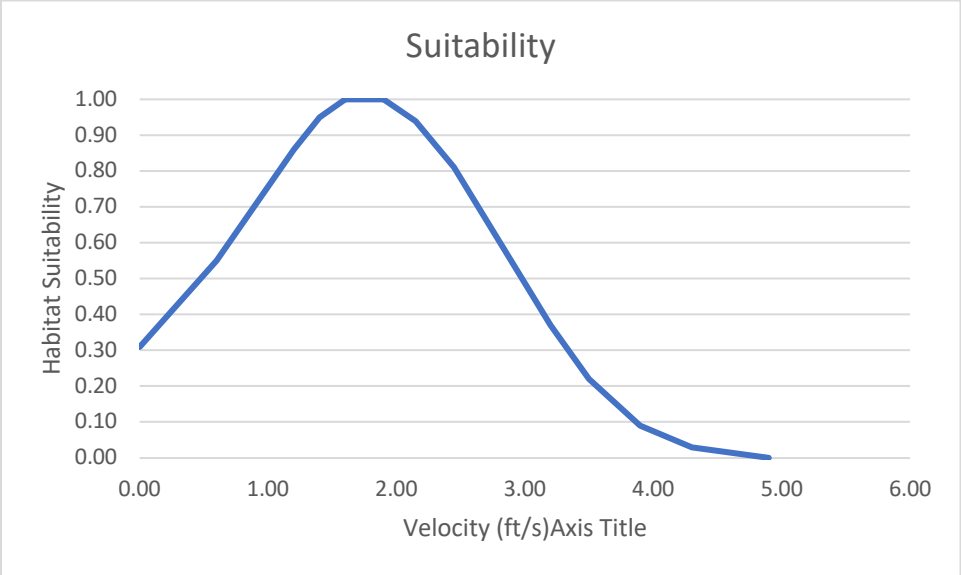


Figure A-4. Adult Rainbow Trout Velocity Suitability Criteria.

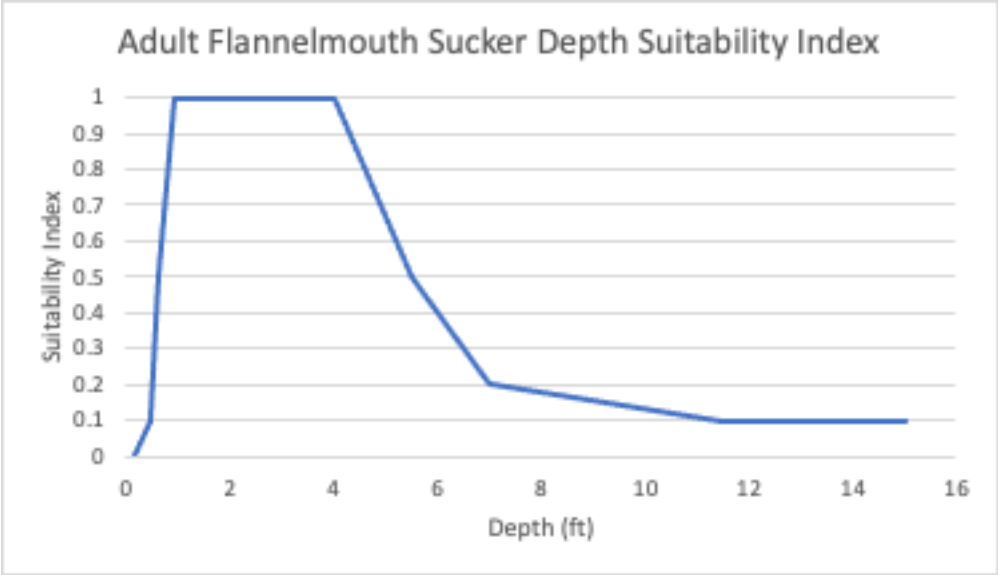


Figure A-5. Adult Flannelmouth Sucker Depth Suitability Criteria

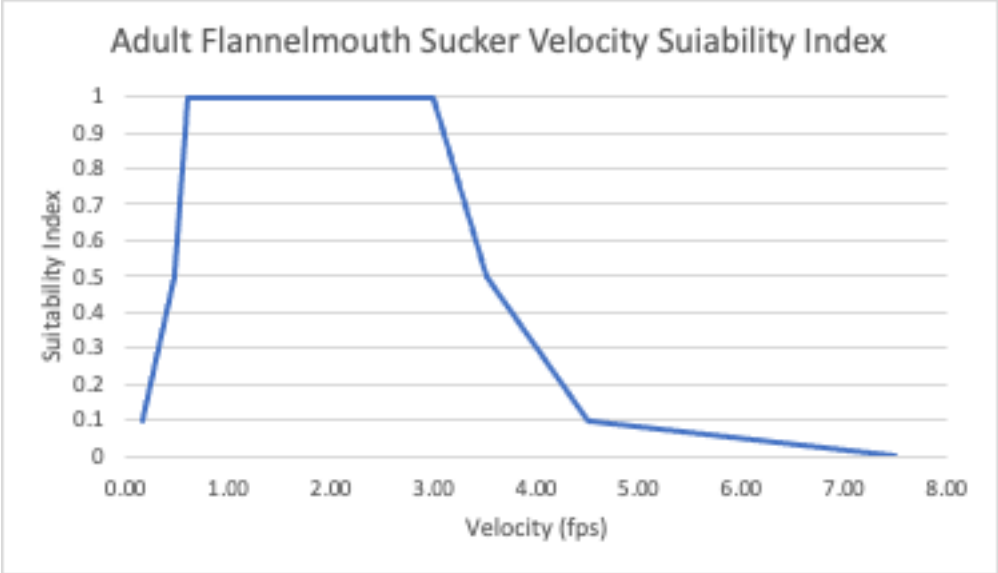


Figure A-6. Adult Flannelmouth Sucker Velocity Suitability Criteria

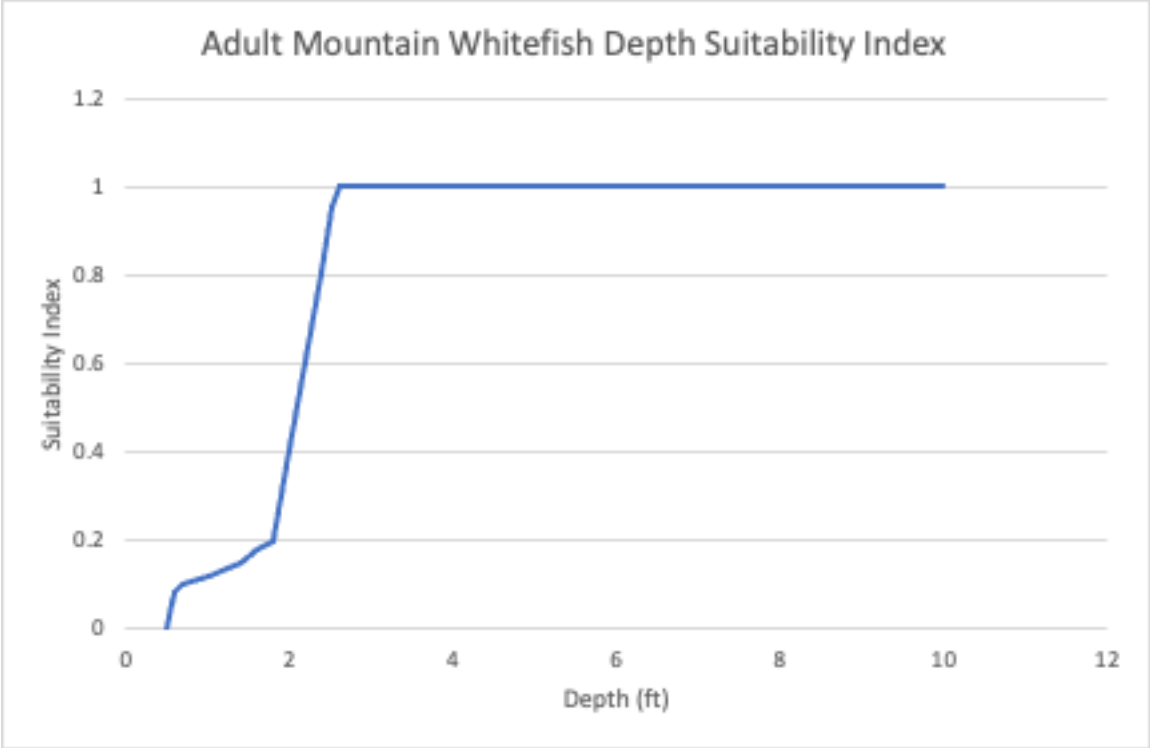


Figure A-7. Adult Mountain Whitefish Depth Suitability Criteria.

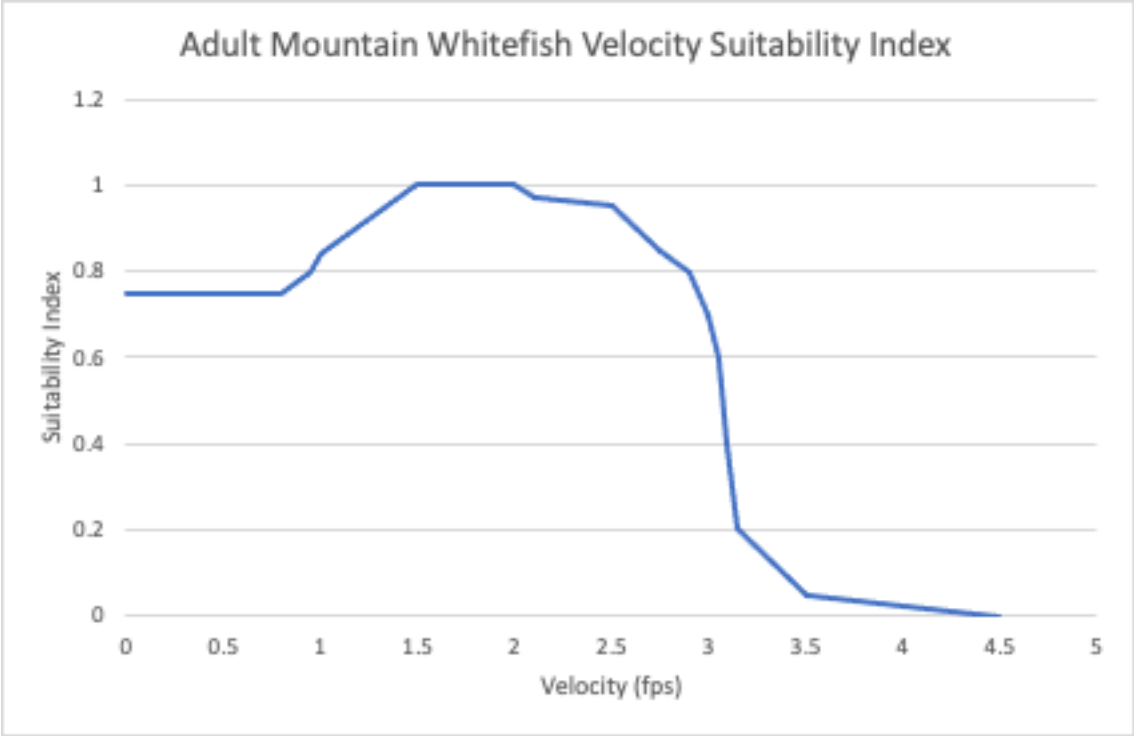


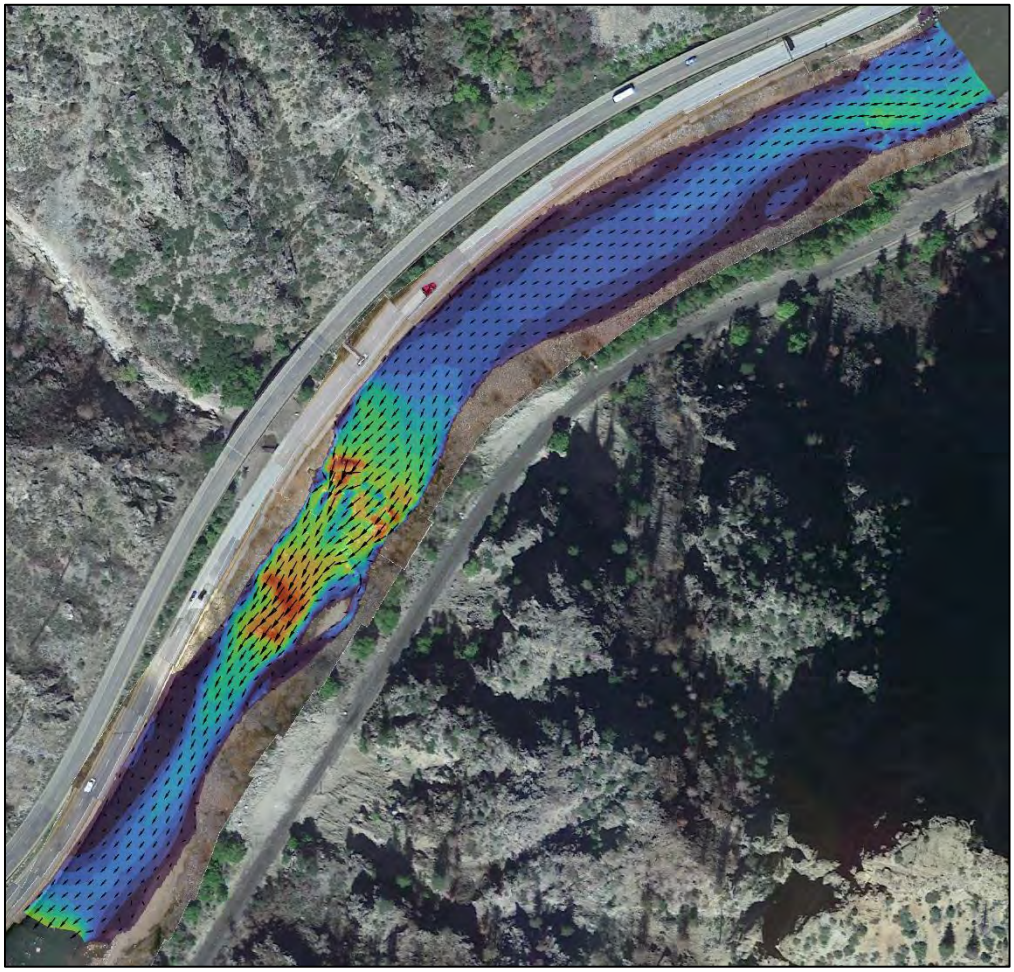
Figure A-8. Adult Mountain Whitefish Velocity Suitability Criteria.

Appendix B – Hydraulic Modeling Report

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GLENWOOD CANYON AQUATIC HABITAT STUDY
COLORADO RIVER, COLORADO

HYDRAULIC MODELING REPORT – 2023



PREPARED BY RIVERRESTORATION.ORG, DECEMBER 2023

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Russell Bair, PE – River Engineer; russell.bair@riverrestoration.org

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RESULTS DATA APPENDICES

GlenwoodCanyon_DEM_ft.tif
50cfs_results.xlsx
250cfs_results.xlsx
700cfs_results.xlsx
1020cfs_results.xlsx
1250cfs_results.xlsx
1400cfs_results.xlsx
3000cfs_results.xlsx

1. INTRODUCTION

A 2 dimensional (2D) hydrodynamic model was used to simulate a variety of low flow conditions for a study reach on the Colorado River in Glenwood Canyon. The model was based on a digital elevation model (DEM) developed from hydrographic survey data collected over an 1854 foot reach (Figure 1). The goal was to provide spatially discrete data and weighted values of water depth, velocity, shear stress, and a Froude value for use in a usable habitat analysis.

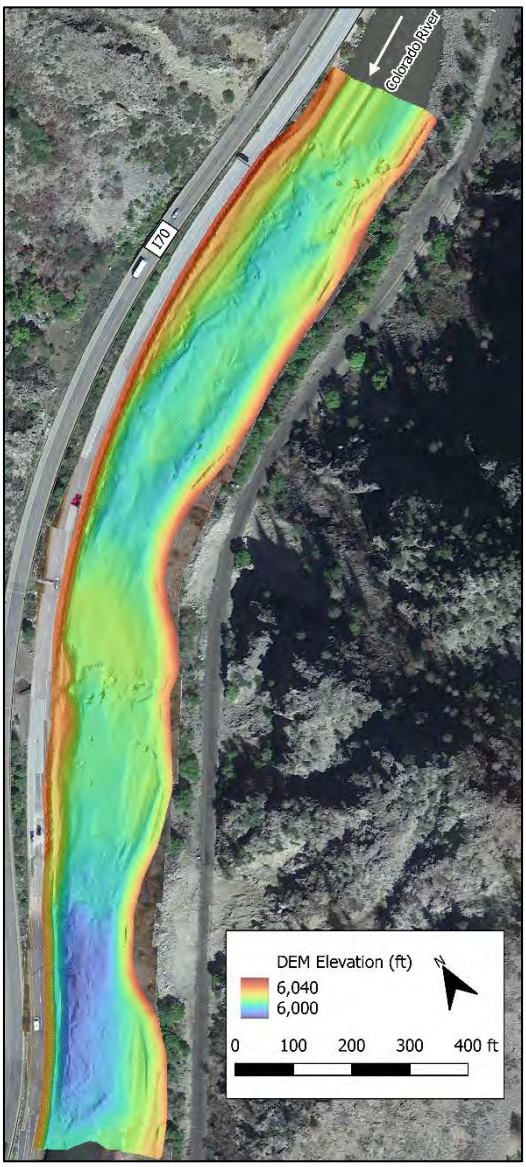


Figure 1. Glenwood Canyon model domain DEM

2. MODELING METHODOLOGY

2.1. Model Overview

Hydrographic survey data (see Glenwood Canyon Survey Report) was used to develop a DEM for the study reach. Point elevations and breaklines were used to characterize bed features like pools, rapids, and individual boulder features. This DEM is available in a geotiff format in the associated data appendices. This DEM was converted into an irregular 2D mesh with a cell sides targeted to a length of 4' within the channel using SMS software. Due to the SMS software interpolating an irregular mesh, a range of cell side lengths were modeled. Both three and 4 sided cells exist in the irregular grid, leading to a range in cell areas. These cells represent the elevations of the bed and provides calculations locations with discrete boundaries for a solver to calculate a depth-averaged result within. Depth-averaged two-dimensional velocity modeling simulates hydraulics in the streamwise and lateral directions, averaging values through the water column in the vertical. SRH-2D is a two-dimensional numerical model widely implemented for hydraulic applications and was used to simulate conditions within the project reach.

The SRH-2D model requires a spatially distributed friction element in addition to elevation for each cell. This can be provided in the form of a Manning's n value layer. For the model, we used spatially discrete Manning's n values based on the bed sediments observed during the survey. The final values for each area can be found in Figure 2, these values were adjusted within a reasonable range during the model calibration process, discussed below.

The upstream end of the 2D mesh was artificially extrapolated 100' upstream. This is visible in Figure 1 where the channel geometry appears stretched. The extra 100' was added to provide an area for the modeled inflow to non-uniformly distribute before entering the area of interest in the model domain. The extrapolated geometry was developed with the upstream cross section of survey data copied to the

upstream location and directly interpolated in between. Results provided from the modeling process used for the habitat analysis excluded all values in this extrapolated area.

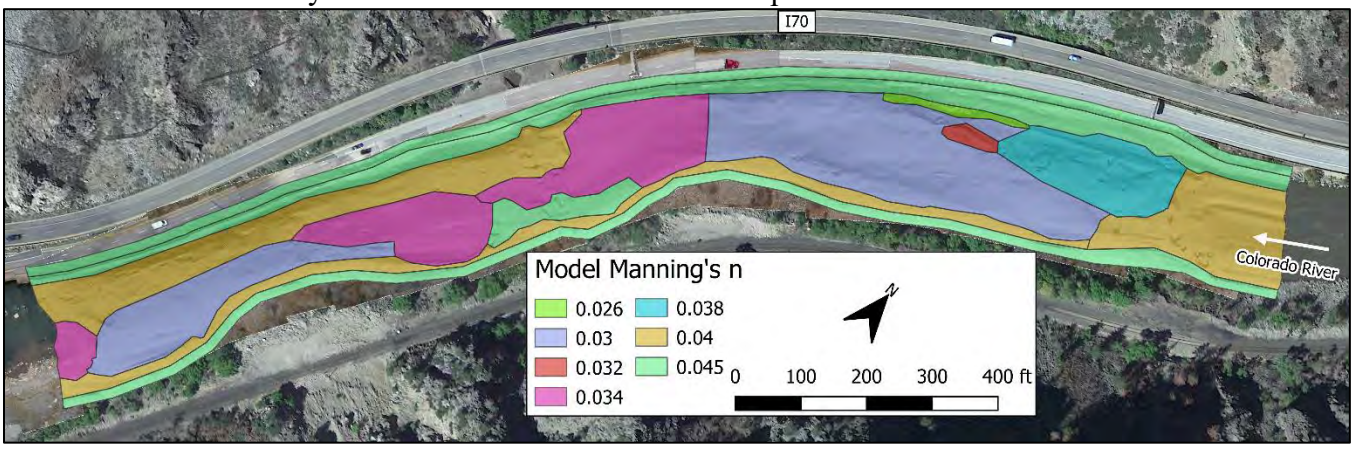


Figure 2. Final spatially distributed Manning's n values used in the SRH-2D hydraulic model

SRH-2D requires an upstream and downstream boundary condition. A steady flow rate was used as the upstream boundary condition for each different flow of interest and the model time was run until a steady state was achieved throughout the model domain. A constant water surface elevation (WSE) was used as the downstream boundary condition for each flow. The downstream boundary in the model domain was set at the crest of a rapid, where the flow exited the pool and passed through the critical state. A known water surface elevation was measured for the survey flow (1020 cfs) and used during the calibration process (discussed below). A 1D critical flow area equation (Eq. 1) based on the geometry of the downstream section of the model was used to calculate the water surface elevation boundary condition for each additional flow of interest. Flows of interest for this study were: 50 cfs, 250 cfs, 700 cfs, 1020 cfs (survey flow), 1250 cfs, 1400 cfs, and 3000 cfs.

Eq. 1 $$Q = \left(\frac{Area^3 * g}{Top\ Width}\right)^{1/2}$$

2.2.Model Calibration

The 2D hydraulic model was calibrated to WSE points captured during the survey flow of 1020 cfs. Calibration consisted of adjusting Manning's n values for different areas of the model within a reasonable range and adjusting the geometry of the DEM at observed control sections that were not sufficiently surveyed for bathymetric data. DEM adjustments were primarily focused on the grade controlling rapid in the middle of the survey area that impacted the large pool upstream and were a challenge to survey in great detail due to safety concerns in the field. The largest adjustment was made on the thalweg on the left side of the channel near the crest of each rapid, where conveyance needed to be increased to match the surveyed upstream water surface slope exiting the pool. After the calibration adjustments were made, the majority of the WSE calibration points were within +/- 0.2' of the model result (Figure 3), which is in line with the expected vertical accuracy of the survey. The majority of the outliers from this range, and the largest outliers, were in the steepest section of the rapid. Here, any given WSE in the model represents a smaller area of the channel. Additionally, less consistent WSE in rapids in the field decreases the accuracy of a given survey value. The large pools and areas of more gradually varying WSE slope all were well matched within the model. Mannings 'n' values were held consistent for all model runs between 50 cfs and 3,000 cfs based on the calibration at 1,020 cfs.

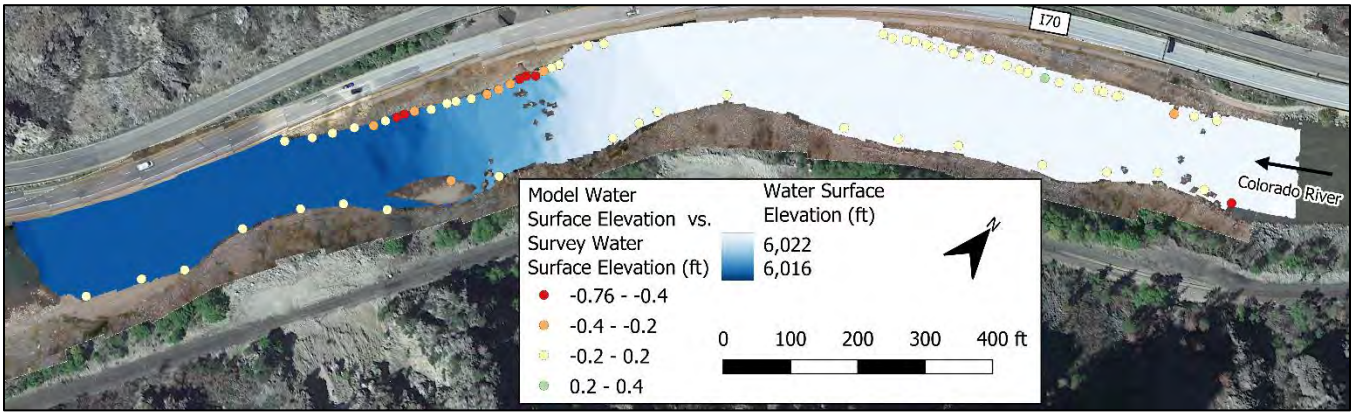


Figure 3. Model Calibration Results

3. RESULTS

3.1. Model Outputs

The model simulations were run until the flowrate into the model came to an equilibrium with the flow rate out of the model and was considered steady state. Results for each were then output for use in the habitat analysis. Results were sampled at the centroid location of each computation cell in the model 2D mesh (Figure 4). These cells represent areas ranging from less than 1 ft^2 to 70 ft^2, with the majority of the cells in the active channel between 5 ft^2 and 15 ft^2. Table 1 lists each of the hydraulic outputs that were sampled at the centroid of each cell.

Table 1. Model Outputs

Output	Unit
Cell Area	ft^2
Centroid X Coordinates	ft
Centroid Y Coordinates	ft
Bed Elevation	ft
Water Surface Elevation	ft
Water Depth	ft
Velocity in X direction	ft/s
Velocity in y direction	ft/s
Velocity Magnitude	ft/s
Froude Number	Dimensionless
Shear Stress	lb./ft^2

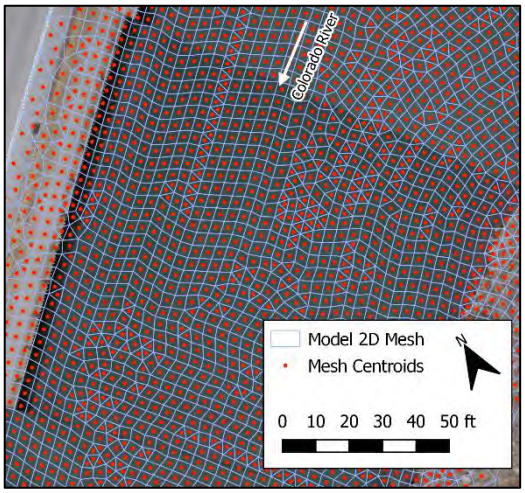


Figure 4. Glenwood Canyon model domain

3.2. Model Results Discussion

The model reach is bound on both sides by steep banks, including areas of vertical concrete in the highway embankment. Across the flow range evaluated the wetted flow area increased 23%. The largest changes in flow area occur around shallow areas of sand deposits near the up and downstream ends of the model as well as in some of the shallow cobble areas of the riffle in the middle of the model. The flow generally increases in velocity and depth as discharge increases (Figure 5). At the lowest modeled flow of 50 cfs

some unwetted areas emerge at the top of the rapid grade control that are larger than just single elevated boulders. At such extreme low flows, it may be reasonable to assume that some of the control section flow would be hyporheic flow between the large bed materials and infiltrate subsurface. The model also represents areas where the channel geometry is overhung by a suspended concrete bike path on the right bank in both pools. The modeled WSE in these areas remains several feet below the path elevations at the highest flow modeled for this analysis, 3000 cfs, but field observations have shown that extreme high flows in the river can reach these vertical obstructions, limiting the applicability of this model to flow levels less than or equal to 3,000 cfs.

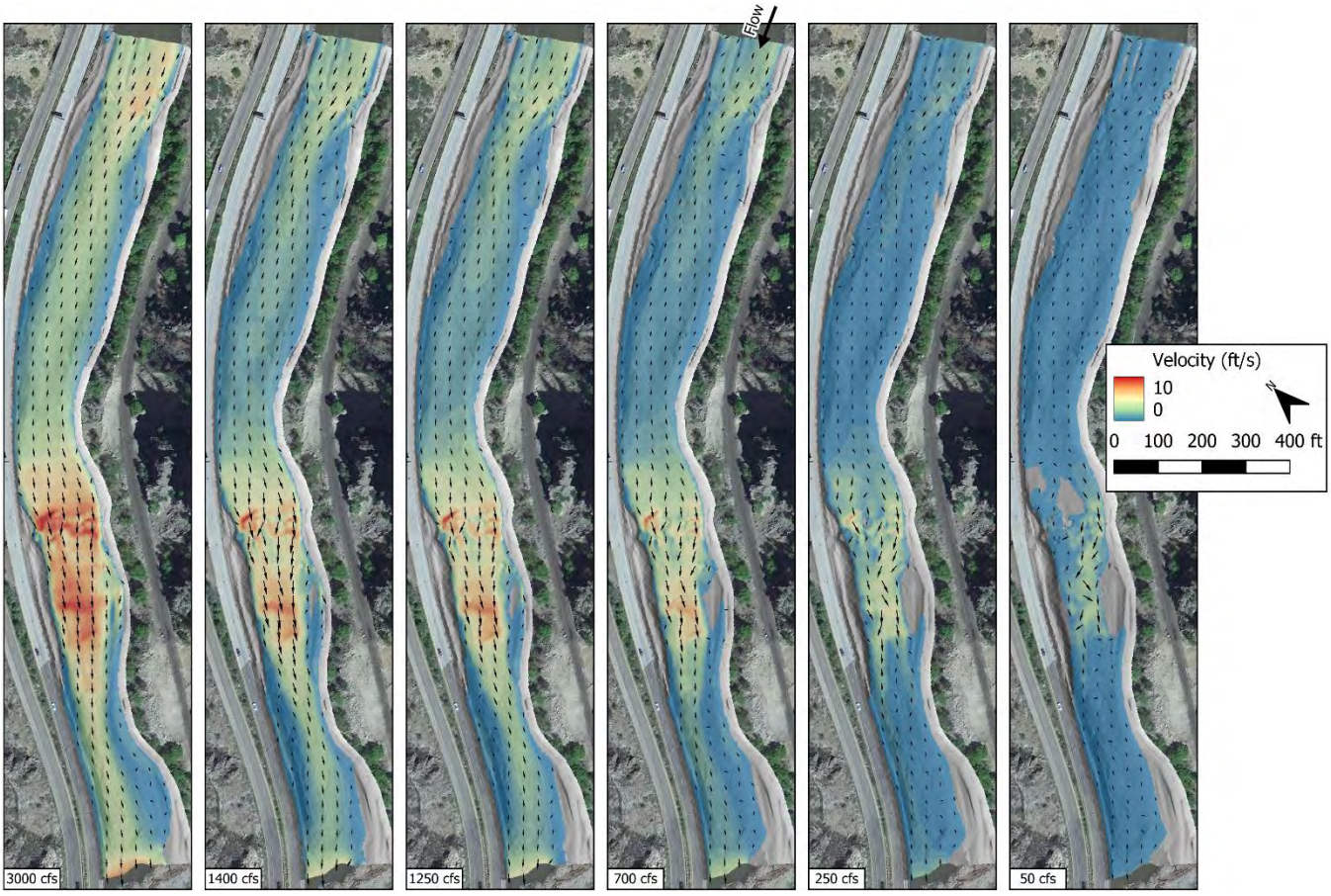


Figure 5. Model results showing velocity at the flows of interest

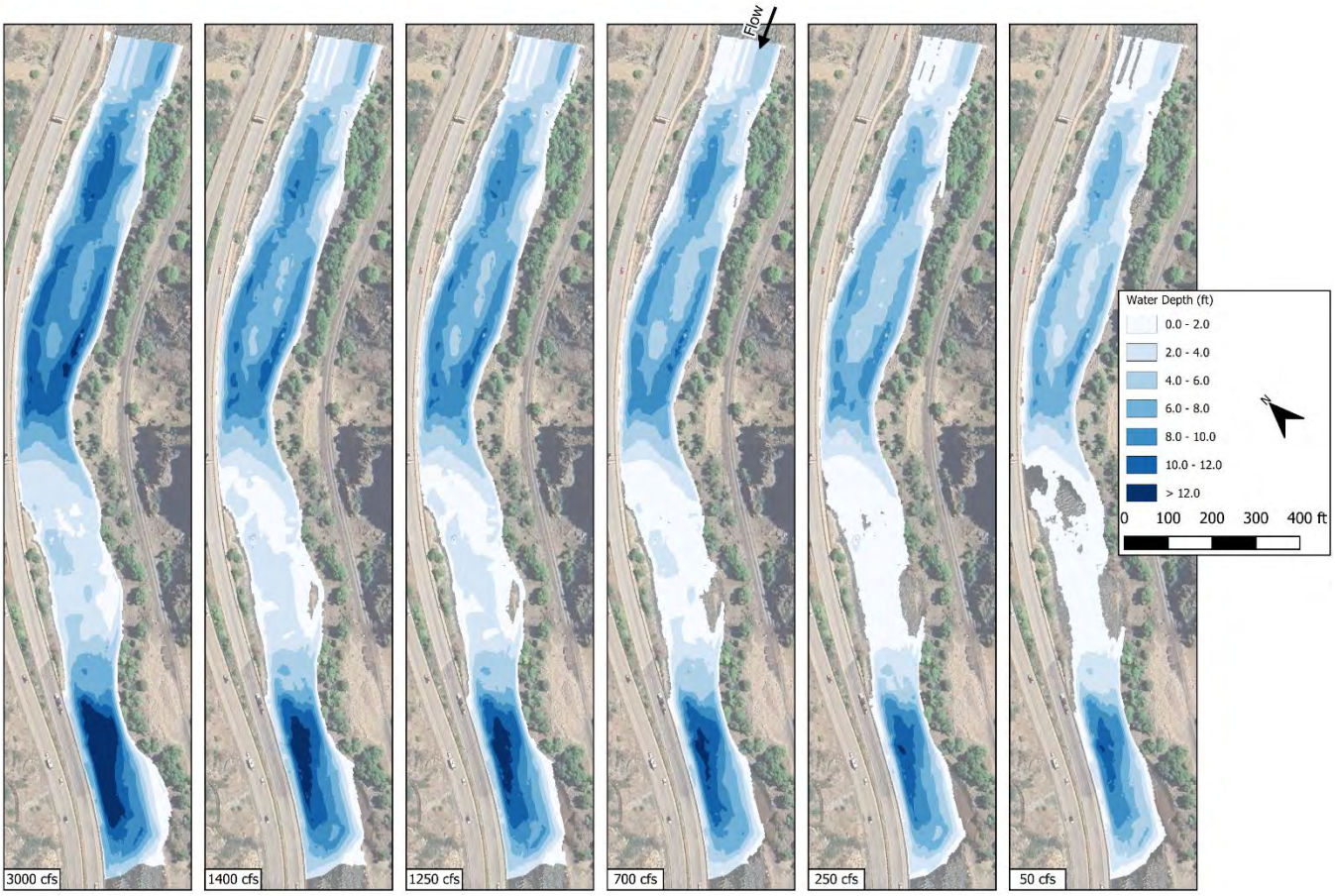


Figure 6. Model results showing depth at the flows of interest

4. SUMMARY

This report explains how survey data collected in Glenwood Canyon were used to create a calibrated 2D hydraulic model. This model was then used to predict hydraulic conditions of the study reach at a range of flows of interest to aquatic habitat at a resolution of approximately 4 ft x 4 ft. The model may have limitations at resolutions less than 4 feet length scale or at flows less than 50 cfs or greater than 3,000 cfs. Results available in the included data appendices can be used in an analysis of the available habitat within the study reach at the specified study flows.

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Appendix C – Hydrographic Survey Report

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GLENWOOD CANYON AQUATIC HABITAT STUDY
COLORADO RIVER, COLORADO

HYDROGRAPHIC SURVEY REPORT – 2023



PREPARED BY RIVERRESTORATION.ORG, DECEMBER 2023

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GlenwoodCanyon_DEM_ft.tif
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1. INTRODUCTION AND SURVEY METHODS

A hydrographic survey covering 1854 feet of the Colorado River in Glenwood Canyon was conducted on November 6th and 8th, 2023. The survey extent encompassed two pool sections divided by a boulder/cobble rapid and bounded by a rapid on the downstream end. Survey was conducted in the channel up the ordinary high water mark (OHWM) evident in the field. A combination of wading and boat-based survey was used to cover the areas of various depths and velocities (Figure 1). The survey was performed using a combination of RTK GNSS, Single Beam Echo Sounder (SBES), and total station. The survey was conducted using the NAD83 State Plane Colorado Central coordinate reference system (CRS) in US survey feet, vertical datum of NAVD88, and using the CONUS18 geoid model. Survey control was based on points provided by CDOT and tied in local control monuments via GNSS observations. Instruments utilized included Trimble R780 and R10 GNSS units, a boat mounted Ohmex SonarMite SBES, and a Trimble 5603 DR 200+ total station.

In addition to the bathymetric survey, the bed material was characterized at each topographic survey point throughout the survey reach and high-resolution ortho imagery was captured from 100’ and 200’ AGL throughout the reach.



Figure 1. Survey Area Overview Map



Figure 2. Survey Methods. GNSS rover (left) and boat mounted GNSS integrated SBES (right)

2. SURVEY CONTROL

The survey was based on control provided by CDOT for monuments recovered in the vicinity of the Hanging Lake rest area. Two control monuments were utilized with the coordinates provided in Table 1; Point 2528 was held as the location of the RTK GNSS base station during both days of the survey and point 2541 was used to check the initial base set up with RTK GNSS rovers. Eight additional control monuments were found and tied into the control network using 180 second RTK GNSS observations. These monuments were on the bike path that paralleled the survey reach and consisted of brass survey markers and "X" marks scrawled in the concrete placed by CDOT. These monuments were used for internal survey checks and as the basis for a total station set up and backsight but coordinates in Table 1 should not be considered survey control quality based on the limited GNSS constellation observed at the bottom of the Glenwood Canyon. Single beam sonar sound speed was adjusted in the field to match stadia rod depth measurements and integrated with either a total station prism or a RTK GNSS rover at different times to measure locations.

Table 1. Control Point information. NAD83 State Planes Colorado Central US Survey Feet, NAVD88, Geoid CONUS18. Coordinates are based on RTK GNSS survey holding 2528 and should not be considered survey control quality for future surveys.

Source	Point	Northing	Easting	Elevation	Description
CDOT	2528	1643610.52	2523096.51	6125.178	CDOT 1075--Type 5S IN CONC BIKE PATH
CDOT	2541	1644023.31	2523811.81	6117.827	CDOT 1075--Type 5S IN CONC BIKE PATH
GPS est.	193	1640379.889	2519661.18	6023.026	Brass Marker PT 193
GPS est.	194	1640815.124	2519923.869	6027.73	Brass Marker PT 194
GPS est.	195	1641175.599	2520304.564	6026.45	Brass Marker PT 195
GPS est.	196	1641401.255	2520778.948	6029.373	Brass Marker PT 196
GPS est.	300	1641308.444	2520530.666	6027.274	Concrete Scrawl X
GPS est.	301	1641008.418	2520098.404	6027.054	Concrete Scrawl X
GPS est.	302	1640601.825	2519781.121	6024.546	Concrete Scrawl X
GPS est.	303	1640170.93	2519540.383	6022.625	Concrete Scrawl X

3. SURVEY CONDITIONS

Site survey took place on November 6th and 8th, 2023. November 6th conditions were cold and clear while on November 8th, scattered snow showers fell throughout the day. The project reach is located approximately 8.5 miles downstream of USGS stream gage 09070500 on the Colorado River near Dotsero, CO. Shoshone Power Plant was shut down during survey and no diversions were expected between the gage and the site during data collection efforts. There are no major inflows between the project reach and gage, so the gage is assumed to well represent the project reach flows. Figure 3 shows the range of flows during the survey, as well as the slightly lower flows during the acquisition of aerial imagery.

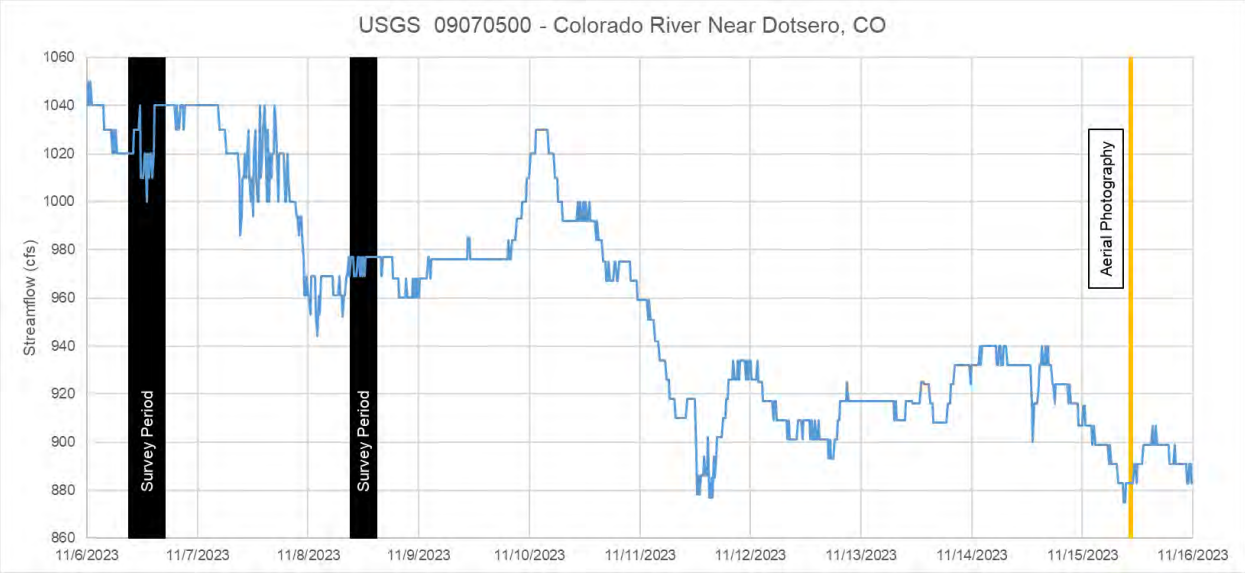


Figure 3. Discharge of Colorado River near Dotsero, Colorado (USGS Gage 09070500) during survey and data aquisition

4. SURVEY RESULTS AND OBSERVATIONS

The survey reach was selected to represent hydraulic characteristics present in the pool/rapid Glenwood Canyon reach of the Colorado River. The survey included two pools divided by one cobble/boulder rapid and was bounded by rapids on the upstream and downstream ends. The rapids generally comprised of large colluvial, and mud and debris flow materials supplied to the main channel from tributaries. Bathymetric and topographic data points were collected to represent bed elevations throughout the survey reach. Information on bed materials including sediment classes and vegetation types were recorded with the points. Areas with depositional sediments and signs of recent maximum high water levels were also recorded, as were water surface elevations (WSE) throughout the reach for the survey flow. There were areas within the survey extent where water was too deep and swift to safely survey on foot or via boat, particularly in some areas around the rapid in the middle of the project reach. Survey was completed to allow for the most accurate interpolation possible in these areas. Additionally, aerial ortho-imagery was collected to help locate larger topographic features such as mid channel boulders.

Survey observations revealed that the bed material varied throughout the study reach. Longitudinal and lateral influences impacted the bed composition. Higher up elevations near the OHWM on each bank consisted of mechanically placed riprap rock materials supporting the highway on river right and railroad on river left (Figure 5). A substantial portion of the river right bank was a vertical concrete wall under a cantilevered bike path with riprap along the right toe (Figure 5). The midchannel consisted of areas of

boulder and large cobbles on the outside of the bend and through the rapids, and large areas of sand deposition on the inside of bends in the pools. Depositional sand included areas of transporting sand over boulders in the upstream pool and also large areas of sand dunes in each pool. A large sandy beach deposit was observed on the inside river left side of the downstream pool. The rapid in the middle of the survey reach and the rapid at the downstream end both consist of large cobble and boulder material (Figure 5) that was delivered from steep tributaries that were impacted by the Grizzly Creek Fire in 2020 and the subsequent debris flows during heavy rain in 2021. The crests of these rapids act as grade controls controlling the water surface elevation of the pools immediately upstream. Sand deposits transition to a lens of alluvially transported large cobble material on the upstream approach of each rapid crest. These cobble materials acted as the hydraulic grade control of each pool at the survey flow. Larger boulders deposited by the tributaries define the main drop in WSE across the rapids. A matrix of small boulders and large cobbles surround the largest boulders with minimal areas of finer depositional material through the rapids until the hydraulic gradient reaches the next pool elevation controlled by the downstream rapid crest and the flow slows. Figure 4 shows the different substrate areas that were identified during the survey overlaid on the final digital elevation model that was created.

Riprap banks throughout the reach were not densely vegetated, but a variety of riparian plant species including willows and cottonwoods were scattered on the banks in pockets around boulders and riprap. Willows, grasses, shrubs, and smaller trees dominated the right bank, while the left bank had more mature cottonwoods.

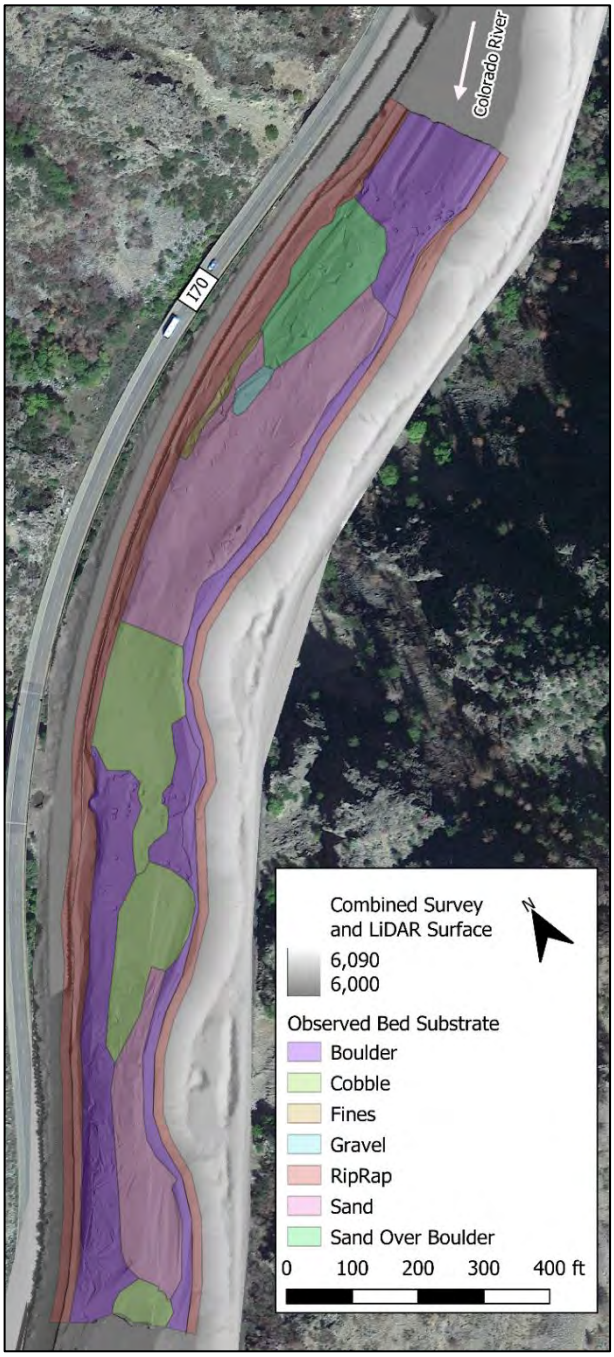


Figure 4. Substrate Areas and DEM



Figure 5. (Left) Looking downstream from the right bank at the rapid in the middle of the survey area. (Right) Aerial oblique drone photo looking downstream from near the upstream end of the survey area. The riprap and concrete nature of the banks can be seen.

5. BASE MAP AND DEM DEVELOPMENT

Survey data were post-processed to remove potential spurious data, mostly in the form of inaccurate SBES depth readings. Interpolation of some topographic data was required in areas that were unsafe to survey, but this was expected from the outset, and the majority of the survey extent was covered by on the ground field survey. A digital elevation model (DEM) was created for the entire surveyed project reach using a triangular irregular network (TIN) to connect surveyed points along with breaklines to represent the existing conditions in the field. Additional breaklines were included to represent boulder clusters and pour overs in rapids based on the collected aerial ortho-images. Elevations for some of these features had to be estimated based on nearby similar elevation features that were surveyed or nearby water surface elevations.

Field survey only took place up to the OHWM. For areas above this elevation, LiDAR data was added to the DEM. This LiDAR DEM data is publicly available data collected on flights in June of 2016 for the Colorado Water Conservation Board (https://coloradohazardmapping.com/lidarDownload). The data is formatted as a geotiff with 3 ft resolution. The LiDAR survey was carried out in the same coordinate reference system as this ground based survey; State Plane Colo. Central, NAD83, NAVD88. The LiDAR survey used the 12B geoid model as opposed to the more recent CONUS18 geoid model, but in the area of interest, this difference is not expected to have an impact. The LiDAR data inserted was well aligned with the surveyed ground elevations and required minimal editing of the DEM to mesh to two surfaces. Because the ground survey went to the elevation of the OHWM, the LiDAR based data inserted at elevations higher than this are not expected to have a meaningful impact on the flow levels of interest for this project.

A continuous bathymetric and topographic DEM surface was created using these data described above. This DEM was used in hydraulic modeling efforts, discussed in the Hydraulic Modeling Report.

6. SUMMARY

This survey was successful in collecting sufficient data to develop a detailed DEM of the study reach in Glenwood Canyon. The DEM developed from this survey and the bed material observations were used to model 2D river hydraulics, which is described in the Hydraulic Modeling Report. The data collection described in this report was sufficient for modeling 2D river hydraulics at, or finer than the target resolution for the habitat analysis which was specified as a 25 sqft computational cell size area.

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SHOSHONE REACH

Instream Flow Beneficial Use and Hydraulic Habitat Suitability Assessment

Shoshone Reach,
Colorado River, Colorado

April 22, 2025

Ecosystem Sciences, LLC
Science · Planning · Design

Shoshone Reach Colorado River

Instream Flow, Beneficial Use and

Hydraulic Habitat Suitability Assessment

Prepared:

April 22, 2025

Prepared for:
Colorado River Water Conservation District

Prepared by:

Ecosystem Sciences

Science · Planning · Design

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EXECUTIVE SUMMARY

The Colorado River Water Conservation District (River District), in collaboration with partners and stakeholders within the Colorado River watershed, is currently working to acquire the water rights (Shoshone Water Rights) associated with the Shoshone Hydroelectric Power Plant (Shoshone Power Plant), located on the Colorado River, in Glenwood Canyon, Colorado. The Shoshone Water Rights are some of the most senior water rights in the Colorado River Basin, making them a central component in future water management strategies and the protection of ecological, economic, and recreational resources in the region.

Currently, Public Service Company of Colorado (PSCo), an Xcel Energy company, owns and operates the Shoshone Power Plant and Shoshone Water Rights. There are two Shoshone Water Rights totaling 1,408 cubic feet per second (cfs), which may be diverted from the river for non-consumptive hydropower generation and returned to the river 2.4 miles (3.8 km) downstream (Shoshone Reach).

The River District proposes to purchase and change the Shoshone Water Rights to include instream flow use. The River District will dedicate the exclusive right to use the Shoshone Water Rights for instream flow purposes to the State of Colorado to protect the non-consumptive flows associated with these rights which will benefit aquatic and terrestrial ecosystems. This assessment includes an instream flow assessment to evaluate the Hydraulic Habitat Suitability (HHS) benefits of various flow scenarios through the Shoshone Reach. This assessment examines the potential effects of a wide range of flow conditions, from very low flow (50 cfs) up to 3,000 cfs. This approach aims to provide a comprehensive understanding of how varying flows would preserve and improve aquatic habitat for species in the Shoshone Reach under different hydrologic scenarios resulting from the Shoshone Water Rights. The flow regime is analyzed in increments to explore the effects of both reduced and increased flows on habitat availability and suitability, with an emphasis on maintaining ecological integrity.

The assessment utilizes broadly accepted scientific procedures for two-dimensional hydraulic habitat suitability modeling. The HHS criteria used for the Shoshone Reach are specific to the fish species of interest. The selected modeling locations include habitat types that are representative of Glenwood Canyon, including pools, riffles, rapids, and runs. This assessment conducts HHS modeling for two study sites within the Shoshone Reach (Site 1 and Site 2). Assessment results include habitat suitability, weighted useable area, and available wetted area for each flow and fish species.

Several fish species occupy the Shoshone Reach, but for this assessment, the primary interest is in determining the needs for adult Rainbow Trout (*Onchoryncus mykiss*), Brown Trout (*Salmo trutta*), Mountain Whitefish (*Prosopium williamsoni*) and Flannelmouth Sucker (*Catostomus latipinnis*). The species of interest were selected by Colorado Parks and Wildlife (CPW) biologists and represent a range of species, including native non-game fish.

The main conclusions of the assessment are strongly supported by habitat modeling results from two representative sites (Sites 1 and 2) in the Shoshone Reach. Together, these sites characterize 29% of the total Shoshone Reach and are highly representative of the overall reach area. At Site 1, habitat suitability and weighted useable area (WUA) scores increase with flow, up to the high range of discharge modeled flows. At the high discharge range modeled, the WUA scores plateau and moderate.

In comparison, Site 2 shows ongoing improvements in habitat suitability and WUA as discharge flows increase, due in part to its greater habitat complexity. Features like large boulders, cobble substrates, islands, high-flow channels, and deep pools create diverse conditions suitable for fish across a wider range of flows than Site 1, providing critical refuges and feeding zones during high flows.

The geomorphic characteristics of Site 2 promote gradual changes in hydraulic parameters (depth and velocity) and wetted extent as flow increases. The progression in overall wetted area as flows increase allows fish to exploit newly wetted areas, that support both primary (e.g., algae) and secondary (e.g., macroinvertebrates) production that underpins the food web.

While Site 1 exhibits higher suitability and WUA at the median range of evaluated flows, Site 2 maintains consistent upward suitability trends at all flows due to its complexity, highlighting the ecological advantages of the physical diversity in the Shoshone Reach. Although hydraulic suitability and WUA scores are useful, they may underestimate the ecological benefits of increased flows. The velocity refuges created by boulders and cobble substrates provide essential microhabitats that the hydraulic model does not fully capture. Higher flows increase wetted area and improve habitat diversity and connectivity, benefiting fish populations and overall aquatic ecosystems.

Under the proposed scenario where the Shoshone Water Rights are permanently protected as an instream flow water right, habitat suitability and WUA for fish in the Shoshone Reach would be higher annually, providing more habitat for all species over current flows. Based on the analysis, the proposed scenario of permanent protection as an instream flow water right would provide the most habitat on an average annual basis (measured by WUA sq. ft. / 1,000 linear feet (LF) of stream) compared to the other scenarios analyzed. Flow levels would more often remain within an optimal range for extended periods and would provide greater flow during the critical late summer and early fall seasons when temperatures and other stressors are at their peak. Additionally, the seniority and non-consumptive nature of the Shoshone Water Rights would yield a benefit to the Colorado River upstream and downstream, extending these advantages beyond the Shoshone Reach. This assessment's findings indicate that the instream flow use of the Shoshone Water Rights would preserve and improve the natural environment through the Shoshone Reach for all modeled species.

The non-consumptive Shoshone Water Rights, if used for instream flow purposes, would not deplete the river’s water supply but would instead maintain river flows that support instream benefits in the Shoshone Reach. However, if these rights were to be diminished or lost, the river would face increased water quality impacts, and habitat loss. Consequently, the Shoshone Water Rights can serve as a critical instream flow tool for balancing water use with environmental conservation, preserving and improving the natural environment.

1.0 INTRODUCTION

The Shoshone Water Rights are comprised of two rights, a 1905 right for 1,250 cfs, and a 1940 right for 158 cfs. The River District is proposing to purchase and change the Shoshone Water Rights to add instream flow as a beneficial use. The River District will dedicate the use of the rights to the Colorado Water Conservation Board (CWCB) for instream flow use to preserve and improve the natural environment of the Shoshone Reach. The CWCB has the authority to acquire water rights, or interests in water, in such amount as the CWCB determines is appropriate for streamflows or for natural surface water levels or volumes for natural lakes to preserve or improve the natural environment to a reasonable degree.

This assessment has been produced to describe conditions and assess the habitat and hydraulic benefits of various flow scenarios in the Shoshone Reach. Using the Instream Flow Incremental Methodology (IFIM), the assessment evaluates the current aquatic ecosystem and evaluates three flow scenarios for the Shoshone Reach: (1) Baseline – representing flows in the Shoshone Reach under existing conditions; (2) Baseline with permanency – representing a future condition where the Shoshone Power Plant is no longer operating and the Shoshone Water Rights are used for instream flow purposes in the Shoshone Reach; and (3) No Permanency – representing a future condition where the Shoshone Power Plant is no longer operating and the Shoshone Water Rights are no longer exercised. The evaluation also considers the potential effects of a broader range of flow conditions, from very low (50 cfs) to 3,000 cfs, to provide a more comprehensive understanding of how varying flows may preserve and improve the natural environment through the Shoshone Reach. These flow levels were selected to reflect both the low and high flow conditions that may occur seasonally or as part of flow management strategies.

This assessment builds on a recently completed instream flow analysis of the reach performed by Dr. William Miller (2024 Miller Report). In the 2024 Miller Report, one study site was selected for modeling based on habitat characteristics that are generally representative of the Shoshone Reach. The study site included multiple habitat types including riffle, pool, and run habitats. The 2024 Miller Report modeled seven discharge flow scenarios, focusing on four species of fish, and utilizing habitat suitability curves for the adult life stages of each species. This assessment retains several features from the 2024 Miller Report and adds a second study site and increases the number of discharge scenarios for both sites. This assessment includes the four fish species and uses the adult life stage HHS curves for each species utilized in the 2024 Miller Report.

The addition of the second study site (i.e., Site 2) doubles the total modeled assessment area for the Shoshone Reach, thus enhancing the spatial representation of the habitat suitability assessment. Overall, this assessment includes two study sites, four fish species, and twelve flow scenarios, leading to a total of 96 HHS results along with wetted available area results for each flow at both study sites.

Glenwood Canyon and Shoshone Reach

The Colorado River flows west-southwest through Glenwood Canyon for approximately 18 miles, from west of Dotsero to Glenwood Springs, Colorado (Figure 1). The river is confined by a narrow limestone canyon and further constrained by a four-lane highway, a railroad, and a bike path. Notable infrastructure includes power lines, Colorado Department of Transportation (CDOT) rest areas, the Shoshone Power Plant and Dam, and the small community of No Name located downstream of the Shoshone Reach. Several tributaries known to contain spawning habitat for Rainbow Trout, Brown Trout, Mountain Whitefish, and other fish species flow into the Colorado River below the Shoshone Reach, notably Grizzly Creek and No Name Creek. The 2020 Grizzly

Creek Fire burned through the canyon, leading to debris flows that significantly impacted the river, highway, and power plant.

Despite human modifications, Glenwood Canyon is ecologically significant, supporting native and sportfish populations, Rocky Mountain bighorn sheep, and unique plant communities. CPW monitors fish and big game in the area, though studies on non-game species are limited. Most of the canyon is managed by the White River National Forest (WRNF) in partnership with CDOT, while the Bureau of Land Management (BLM) oversees smaller sections. Together, these agencies focus on managing recreation while maintaining ecological integrity.

The Shoshone Power Plant has operated for over a century and holds senior water rights in the watershed, ensuring stream flows during priority calls. The operation consists of the Shoshone Dam and a gravity-fed tunnel leading to two penstocks supplying water to two turbines at the Shoshone Power Plant, which can call for the two Shoshone Water Rights. The river in Glenwood Canyon can be divided into three reaches (Figure 1) by Shoshone Power Plant facilities:

1. *Immediately Upstream of the Shoshone Dam*: The impounded water substantially reduces water velocities in this reach. The reduced flow velocity and increased sedimentation within this reach limits aquatic habitat diversity while the dam fragments fish movement upstream and downstream.
2. *Shoshone Reach:* The Shoshone Reach encompasses approximately 2.4 miles of river between the Shoshone Dam and the Shoshone Power Plant return flow outlet. During seasonal low flow periods the reach is dewatered when the plant is operating, though habitat in the Shoshone Reach is connected by small inflows of groundwater and tributary streams that fill pools and flow through the large boulder and rock substrate. This reach contains both the lower and higher gradient sections that provide a complexity of habitat. Habitat persists even during low flow periods, though wetted area in the stream channel is substantially reduced; however, habitat becomes fragmented for upstream fish movement at low flows.
3. *Downstream of the Shoshone Power Plant*: At this point river flows return, stream gradient gradually decreases, enhancing channel complexity and biodiversity. The river regains its natural character with a mix of riffle, run, and deep pool habitats that all contribute to increased habitat diversity in the mainstem. Two tributaries, Grizzly Creek and No Name Creek, provide important spawning habitat for Rainbow Trout, Brown Trout, and Mountain Whitefish resident to the Colorado River, as reproductive habitat is limited by the geofluvial morphology in the mainstem river in Glenwood Canyon. These tributaries also contribute coldwater inputs as their headwaters originate at elevations well over 10,000 feet in the Flat Tops that encompass the northern edge of Glenwood Canyon.

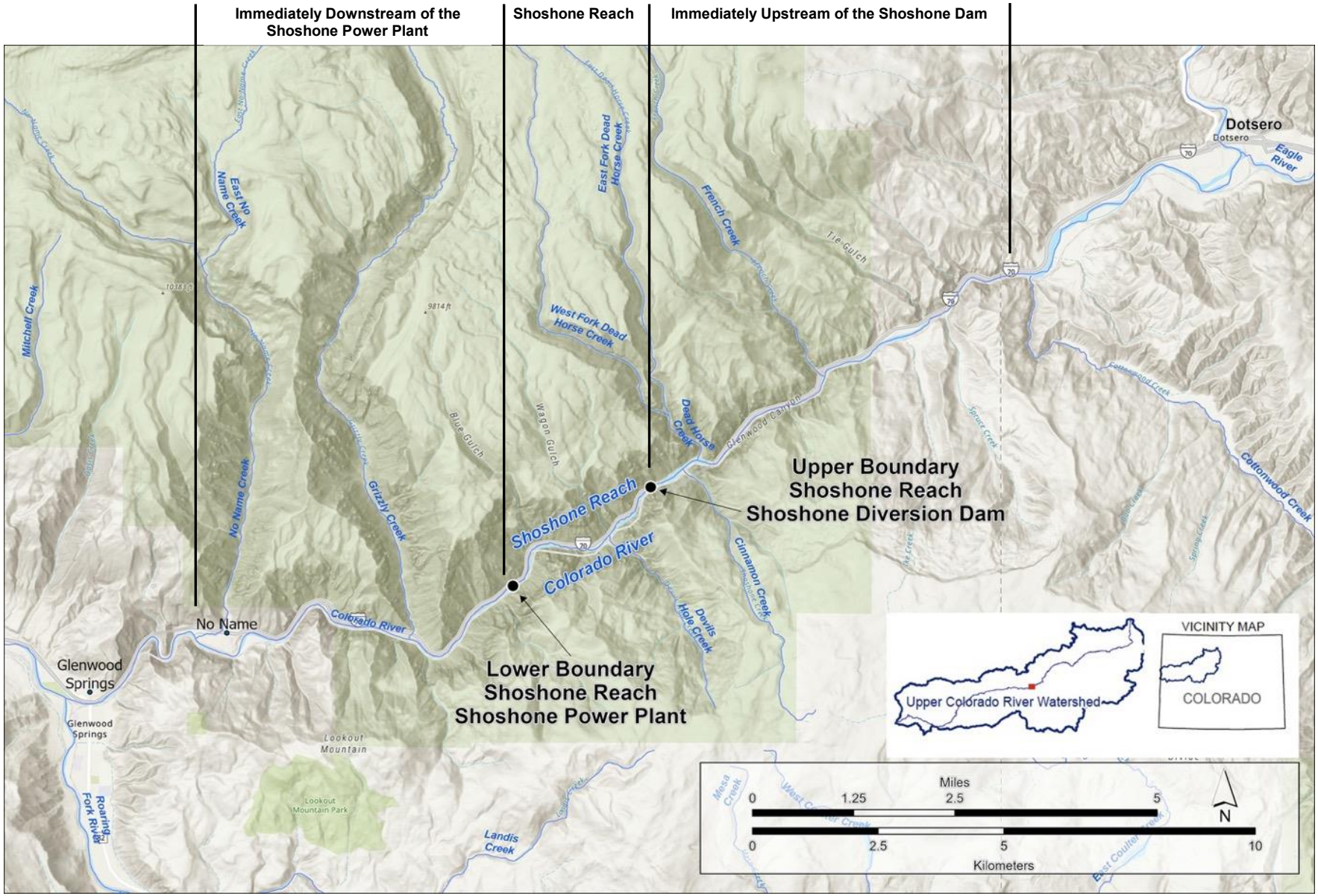


Figure 1: Map of Glenwood Canyon and Location of Shoshone Reach

2.0 SETTING AND CONTEXT

The Colorado Basin is an important watershed in Colorado, extending from the high altitudes of Rocky Mountain National Park to the Utah state line. Covering approximately 9,830 square miles, this basin is vital for both the environment and the economy of the region as stated in the Colorado Water Plan, 2023.

The Colorado Basin features diverse terrains, starting with mountainous areas that are the source of major snowpack, which contribute to the basin's primary water supply, flowing downstream to the dry desert climates of the Colorado Plateau. These snowpacks are crucial resources for water users on both sides of the Continental Divide. Snowmelt, particularly in spring, serves as a key source of water for the basin's tributaries, providing critical seasonal runoff. Geothermal springs in Glenwood Canyon introduce naturally heated water into the Colorado River. While these springs contribute warm water, their effect on the river's overall temperature is relatively localized and minimal due to the river's substantial flow rate. However, during periods of low flow, the influence of these geothermal inputs can become more pronounced, and even lethal, as fish kills have been documented for both Trout and Sculpin below the Shoshone Reach when the river flow was constrained at the dam (CPW, personal communication, 2024).

Nearly three million acres of land in the basin are federally owned. The U.S. Forest Service (USFS) manages the largest share, while the BLM oversees significant rangelands. These public lands serve various purposes. In the upper counties of the basin—such as Grand, Eagle, Summit, and Pitkin—tourism is a dominant industry. Attractions like ski resorts, state and national parks, scenic rivers, and world-class fishing substantially contribute to the local economy. The region also has deep agricultural roots, with ranching and livestock production common in the upper reaches, while the Grand Valley is well-known for its agriculture and cultivation.

The Colorado River Basin encompasses a variety of ecosystems, ranging from alpine environments in the headwaters to desert landscapes in the lowlands. It supports diverse wildlife species and plant communities, many of which depend on the available water from the basin. Maintaining the flow and quality of water in the basin is essential for the health of these ecosystems.

Most of the Colorado's precipitation falls on the western slope of the state. However, most of the population lives on the eastern, front range of the state. This requires up to 50% of the water used in the front range to be transferred from the Colorado Basin in the state's western slope. Transbasin diversions transport water from one geographically distinct river basin to another via pipeline or other engineered methods. The transfer of water out of the Colorado Basin plays a critical role, with considerable amounts of water being exported annually to other basins like the South Platte and Arkansas for agricultural and municipal uses on Colorado's eastern slope. Not only are the Colorado River flows reduced by extensive transbasin diversions throughout its headwaters, like much of the western United States, the river is experiencing the impacts of climate change, including reduced snowpack, earlier spring runoff, and longer, more frequent severe droughts. These changes threaten the predictability of water availability and exacerbate tensions among water users. Key challenges include balancing water usage with the needs of river ecosystem function.

2.1 SHOSHONE WATER RIGHTS

The Shoshone Water Rights were established in the early 20th century, during a significant period of expansion for irrigation and hydropower infrastructure in the western United States. The

Shoshone Power Plant, originally constructed in 1909 and still operational today, was one of the first large-scale hydropower facilities in the region. At the time of its establishment, the water rights associated with the plant were among the earliest granted within the Colorado River watershed. These more senior Shoshone Water Rights (decreed for 1,250 cfs) is consistently one of the foremost calling water rights on the mainstem of the Colorado River, making it extraordinarily important to the flow regime, especially considering the ongoing pressures from increased demand and climate variability within the basin.

The Shoshone Water Rights include two separate absolute water rights associated with the Shoshone Power Plant. The more senior, original Shoshone Water Right was decreed for 1,250 cfs with a priority date of December 5, 1905. The junior Shoshone Water Right was decreed for 158 cfs and is administered with a priority date of May 31, 1940. Together, these water rights total 1,408 cfs. The Shoshone Power Plant operates year-round and when in operation it can lead to dewatering of the 2.4-mile Shoshone Reach shown in Figure 2.



Figure 2: Shoshone Reach - Location of Dam, Intake and Power Plant / Return

The Shoshone Water Rights ensure a consistent flow of water in the Colorado River outside the Shoshone Reach, resulting in positive ecological outcomes, such as maintaining water quality, and flow regimes essential for the resiliency of fish and other aquatic life. If the State of Colorado were to acquire the right to use the Shoshone Water Rights for instream flow purposes, these current benefits would be preserved and the Shoshone Reach itself would experience higher flows and the associated environmental benefits.

Additionally, the Shoshone Water Rights support numerous recreational activities in the region. The steady flow of water in the Colorado River, facilitated by these rights, enables activities like rafting, kayaking, and fishing, which are vital for tourism and local economies. These recreational pursuits rely on reliable water flows to ensure safe and enjoyable conditions for participants.

2.2 INSTREAM FLOW ACQUISITIONS TO PRESERVE AND IMPROVE

The Shoshone Water Rights, under a dedicated instream flow scenario, would play a vital ecological role in preserving and improving the natural environment of the Colorado River. As shown in this assessment, the Shoshone Water Rights would help to preserve and improve habitat for aquatic species, including parts of the natural flow regime which supports the river's ecological functions within the Shoshone Reach. The CWCB may:

> *Acquire, by grant, purchase, donation, bequest, devise, lease, exchange, or other contractual agreement, from or with any person, including any governmental entity, such water, water rights, or interests in water that are not on the division engineer's abandonment list in such amount as the board determines is appropriate for streamflows or for natural surface water levels or volumes for natural lakes to preserve or improve the natural environment to a reasonable degree. CRS 37-92-102(3).*

The concept of environmental or instream flow water rights has gained importance across the western United States, with Colorado leading efforts to protect and restore river ecosystems through recognized water law. This legal framework is crucial in addressing concerns regarding the depletion of freshwater resources and balancing ecological sustainability with development needs. In this way, water law reforms in Colorado, such as the CWCB's Instream Flow Program, have been recognized as successful models for integrating environmental concerns into water management systems.

Under a dedicated instream flow scenario, the Shoshone Water Rights would play a crucial role in ensuring adequate flows are preserved within the Shoshone Reach of the Colorado River at times when the Shoshone Power Plant is not operating. The flow of water that would be provided by instream flow use of the Shoshone Water Rights under these conditions would be essential for preserving and connecting habitats for fish and aquatic invertebrates in the Shoshone Reach, preventing the formation of dry sections in the river that disrupt these ecosystems as discussed further in Section 3.0.

Preserving reliable water flow through Shoshone Water Rights can greatly benefit fish species by keeping water levels and temperatures within the ranges necessary for survival, spawning, and thriving. Healthy stream flows are essential for creating and maintaining a diversity of habitats for reproduction, recruitment, and seasonal needs of fish, ensuring resiliency in a dynamic environment.

2.3 SHOSHONE REACH HISTORICAL CONDITIONS, HYDROLOGY, AND HABITAT

The Shoshone Reach has undergone significant ecological and hydrological changes due to the development of hydropower infrastructure, and water diversions. Before significant changes were made to the Colorado River system, including the construction and operation of the Shoshone Power Plant in 1909 and other water management structures (such as irrigation development, transmountain diversions, and upstream reservoirs), the river's flow was characterized by natural seasonal fluctuations caused by snowmelt in the Rocky Mountains. Without physical barriers and with higher natural water flow, the Shoshone Reach would connect fluvial habitats throughout the entire reach, including high-gradient sections.

Historically, the Shoshone Reach was a confined, high-gradient segment of the Colorado River, that has been further constrained by the construction of an interstate highway and railroads. The natural hydrology and geomorphology of this reach plays a crucial role in shaping habitat availability and aquatic species dynamics. The Colorado River experiences annual high flows driven by snowmelt. Annual spring runoff maintained diverse habitats, such as riffles, pools, and

runs, which allowed a wide range of fish species to thrive. The riparian zones, though limited in extent within the Shoshone Reach, likely provided important habitats for fish refuge, insect populations, and wildlife. These zones supported various plant species adapted to the river's seasonal flooding, contributing to the ecological richness of the area. Additionally, natural thermal gradients in the river created different thermal habitats for cold-water species. The cooler waters from spring snowmelt and the warmer conditions in summer and fall supported the reproduction and growth of fish species. The high-gradient nature of the reach contributes to increased oxygenation of the water, which is beneficial for aquatic life. Large pools within the reach may have offered velocity refuges and important holding habitats for fish during periods of elevated flow.

2.3.1 Changes After the Shoshone Power Plant and Other Water Diversions

The construction of the Shoshone Power Plant, along with other water management projects (such as upstream irrigation, reservoirs, and transmountain diversions), significantly changed the hydrology of the Colorado River, particularly in the Shoshone Reach. These developments altered both the flow patterns and the aquatic habitats of the river.

The Shoshone Reach is impacted by the hydropower operations at the Shoshone Power Plant via reduced and highly variable flows depending on the plant’s operational status. Within the Shoshone Reach, when the plant is fully operating (i.e., when water is diverted into the tunnels and penstocks, bypassing the natural channel), and during natural seasonal low flow periods, sediment transport is inhibited, wetted habitat is reduced, and longitudinal channel/flow connectivity is impaired. The intermittency and loss of wetted habitat limits aquatic invertebrate productivity, the primary food source for resident fish. At low flows, the Shoshone Reach becomes fragmented due to large bed drops in the high-gradient cascade and rapid sections. Additionally, the Shoshone Dam acts as a barrier to upstream fish movement.

Natural high-flow events that once cleared sediment and created essential habitats for native species have declined. Regulated river flows have stabilized riverbed features, altered sediment transport, and reduced ecosystem dynamism. These changes affect spawning habitats and biodiversity. The regulation of the Colorado River and its tributaries has also led to water quality challenges, including temperature fluctuations which impact aquatic ecosystems. Altered flow regimes and habitat modifications have influenced sediment deposition, nutrient cycling, and habitat availability for both native and non-native species (Van Streeter and Pitlick, 1998).

3.0 SHOSHONE INSTREAM FLOW USE BENEFITS

Instream flows are a critical topic in water management, driven by concerns over ecological preservation and improvement. In the 1970s, the CWCB was authorized to appropriate water for instream flow purposes, marking a significant shift in water management that recognizes the importance of healthy river ecosystems. Research shows that maintaining adequate instream flows is crucial for the health of riverine ecosystems, as it supports biodiversity and the overall ecological function of rivers (Rushforth et al., 2022; Martin et al., 2015; Poff et al., 2009).

3.1 WATERSHED BENEFITS

The Shoshone Water Rights are a crucial legal and ecological asset for both the upstream and downstream reaches of the Colorado River. While the Shoshone Water Rights are used for hydroelectric power production, the water rights also play a significant, though indirect, role in maintaining the health and functioning of the ecosystems along the Colorado River.

3.1.1 Upstream Reaches

The Shoshone Water Rights are one of the primary means of controlling water flow in this region. By maintaining reliable flows that stabilize upstream low flow conditions and support vital ecosystem functions.

Wild and Scenic Rivers Management: BLM and WRNF amended their respective resource management and forest plans to incorporate management prescriptions for Wild and Scenic Rivers in Glenwood Canyon and segments of the Colorado River from Dotsero to Kremmling. The agencies identified that these river segments support Outstandingly Remarkable Values (ORVs), which are unique or exemplary river-related values within the region. As a result, the agencies concluded that four river segments are eligible for inclusion in the National Wild and Scenic Rivers System.

During the evaluation of whether the river segments are suitable for this designation, the agencies received an alternative management plan proposal from the Upper Colorado River Wild and Scenic Stakeholder Group.

The BLM and WRNF plan specifically focuses on protecting and enhancing the ORVs that are most dependent on flow conditions. The intent behind adopting this plan is to ensure it is consistent with BLM and WRNF land use authorities and decisions, thereby enabling the federal agencies to better fulfill their management obligations under the Wild and Scenic Rivers Act. The plan includes monitoring streamflow through the Wild and Scenic segments, supplemented by coordinated, cooperative, and voluntary water deliveries when available. This approach aims to balance the permanent protection of ORVs with the needs of stakeholders, the yield of water projects, and the flexibility required by water users.

It is important to note that the plan relies on the existing water rights of the Shoshone Power Plant as a primary long-term protection measure:

> *Existing senior water rights: The Shoshone and Cameo groups of senior water rights generally control the administrative call within the Colorado River Basin. These water rights are located downstream of the subject stream reaches; therefore, an administrative call during dry or average conditions by these water rights can curtail diversions from upstream junior water rights or require the release of water from storage to replace those junior diversions. This administrative call generally results in stream*

flow through the subject stream segments in amounts greater than would exist in the absence of the administrative call.[1]

Aquatic Habitat Health in the Upper Colorado River: The health of aquatic habitats upstream of the Shoshone Reach significantly depends on consistent water flow. Species such as the Colorado River Cutthroat Trout, Rainbow Trout, and various macroinvertebrates rely on reliable flow conditions for survival. The Shoshone Water Rights call down water to the Shoshone Reach (whether through releases from reservoirs or curtailment of junior rights). The Shoshone Water Rights are instrumental in ensuring reliable flows, thus preventing conditions that could threaten these species. Reliable flows promote the development of proper habitats within the river channel and adjacent riparian zones, providing aquatic species with access to food, refuge shelter, and spawning areas. By facilitating regular releases from upstream reservoirs and providing reliable flow, the Shoshone Water Rights helps support the necessary hydrological conditions for a diverse range of plant and animal species to exist. Without these steady water releases, upstream habitats could become vulnerable to drying out, especially during droughts, leading to habitat loss for aquatic species.

Low Water Flow Periods: The Shoshone Water Rights seniority allows them to call for a significant portion of natural flow in the basin up to their combined flow rate, meeting minimum flows during dry years and periods of low flow as feasible. Essentially, the Shoshone Water Rights act as a buffer against extreme hydrological events (such as droughts), contributing to more sustainable flows in upstream reaches. The increasing severity of debris flows associated with intense rainfalls and fire scars, and sediment flows after rain events, can be further mitigated by Shoshone flows. In winter the flows brought downstream by the Shoshone Water Rights also help reduce formation of anchor ice and provide habitat during seasonally low flow periods.

Riparian and Wetland Ecosystems: The riparian areas and wetlands along the Colorado River and upstream of the Shoshone Power Plant respond to fluctuations in river flow. Riparian and floodplain habitats provide essential ecological services but differ in location and function. Riparian habitats, located along riverbanks, feature plants like willows and cottonwoods. They stabilize streambanks, filter pollutants, and regulate water temperatures. These zones are crucial for juvenile fish, providing refuge shelter and abundant food sources, and serve as refuges during high-flow events, protecting fish from strong currents.

Without consistent water curtailment or replacement made in response to the Shoshone Water Rights, riparian vegetation may suffer from reduced water availability, leading to the degradation of wetland ecosystems that support many plants, animals, and migratory bird species.

3.1.2 Downstream Reaches

The Shoshone Water Rights are important for maintaining the ecological health of downstream areas, including important habitats such as wetlands and riparian zones. These habitats are vital for a wide range of species, including fish, amphibians, and waterfowl.

The area immediately downstream of the Shoshone Power Plant (Figure 1) supports a healthy sportfish population consisting of Brown Trout, Rainbow Trout, and Mountain Whitefish. Despite the challenges posed by invasive fish species, native species such as the Flannelmouth Sucker and Bluehead Sucker are frequently found in the Colorado River, particularly in and around Glenwood Canyon. Other native fish in this area include the Bluehead Sucker, Roundtail Chub, Sculpin, and Dace. The Shoshone Power Plant return flows help maintain riffle, run, and pool

[1] https://www.upcowildandscenic.com/uploads/1/3/5/3/135388668/amended_and_restated_sg_plan_july_2024.pdf

habitats. The resilience of the aquatic ecosystem is bolstered by the greater availability of riffle habitats, which enhances the productivity of macroinvertebrates and resident fish.

Water Quality Protection: Downstream water quality is significantly influenced by flow conditions. The Shoshone Water Rights help regulate the amount of water flowing through the system, preventing sudden drops in flow that could degrade water quality. For instance, low flows can increase water temperature and decrease dissolved oxygen levels, both of which are harmful to aquatic species. By maintaining reliable flows, the Shoshone Water Rights support good water quality, particularly temperature, for both aquatic life and human use.

Recreation and Tourism: The Colorado River downstream of the Shoshone Power Plant, particularly through Glenwood Canyon, is a popular recreational area for activities such as rafting, kayaking, fishing, and wildlife watching. Maintaining a reliable flow helps preserve these recreational opportunities by ensuring consistent river conditions, making the river more useable for river enthusiasts. Additionally, the recreation industry is vital to the local economy, and the Shoshone Water Rights contribute directly to the sustainability of this sector.

3.1.3 Shoshone Water Rights and Federally Listed Fish Species

The Shoshone Water Rights are important not only for the local fish community but also may have downstream benefits for four federally listed fish species under the Endangered Species Act (ESA): Bonytail, Colorado Pikeminnow, Humpback Chub, and Razorback Sucker. A consistent Shoshone Call supports the availability of water that may be used to support important habitats in the "15-Mile Reach" of the Colorado River, which extends from the Town of Palisade to the confluence with the Gunnison River in Grand Junction. This area is particularly susceptible to very low water flows because significant water withdrawals occur just upstream of Palisade for agricultural and other purposes. These ESA species are highly sensitive to changes in water flow, temperature, and habitat conditions.

Federally Listed Fish Species in the Colorado River Basin

The Colorado River and its tributaries are home to several ESA-listed fish species that have suffered significant declines due to habitat degradation, water diversions, and invasive species. The four Colorado River endangered fish species are:

- Colorado River Pikeminnow (*Ptychocheilus lucius*) – a large predatory fish historically abundant in the Colorado River but now listed as endangered.
- Bonytail *(Gila elegans)* – a species of riverine fish endemic to the Colorado River system, listed as endangered.
- Razorback Sucker (*Xyrauchen texanus*) – another Endangered species (currently proposed for downlisting to Threatened) that once thrived in the Colorado River but is now restricted to isolated populations.
- Humpback Chub (*Gila cypha*) – a species of riverine fish endemic to the Colorado River system, listed as threatened.

Critical habitat for the four endangered fishes in Colorado River is designated downstream of Glenwood Canyon beginning near Rifle, Colorado, and extends into the lower Colorado River basin. Colorado Pikeminnow and Razorback Sucker Critical Habitat starts at the Highway 13 bridge and includes the 15-Mile Reach identified as crucial to their recovery by the Upper Colorado River Recovery Program. The upstream extent of Bonytail and Humpback Chub Critical Habitat begins below the 15-Mile Reach, approximately 5 miles upstream of the Utah border.

The Colorado River's endangered fish species are highly dependent on specific flow regimes, water temperatures, and habitat conditions that are often disrupted by human activities, including damming, diversion, and water withdrawals. The U.S. Fish and Wildlife Service (USFWS) and other regulatory agencies have developed recovery plans for ESA-listed species in the Colorado River basin. These plans outline specific flow regimes and habitat conditions necessary for the survival and recovery of species.

3.2 SHOSHONE REACH BENEFITS

Permanently protecting the Shoshone Water Rights by adding an instream flow use is a future benefit that would preserve and improve aquatic habitat supporting fish populations, maintain stream health, and ensure ecological integrity within the Shoshone Reach. This section of the river supports a diverse array of species, including Rainbow Trout, Brown Trout, Mountain Whitefish, and Flannelmouth Suckers, and a robust population of macroinvertebrates. The survival of these species relies on adequate water flow conditions, which influence critical factors such as habitat availability, water temperature, oxygen levels, sedimentation, and food resources.

3.2.1 Fishery and Aquatic Habitat Conditions

The Shoshone Reach of the Colorado River plays a role in sustaining aquatic ecosystems, particularly for fish populations that rely on its diverse habitat throughout the year. When the Shoshone Reach is dewatered during plant operations, these valuable functions are impacted.

This section of the river provides important refugia and habitat complexity, ensuring fish have access to a variety of depth zones and structural features. The rough and diverse streambed—composed of boulders, cobbles, and gravels—provides interstitial habitats with numerous small pockets and spaces that fish can utilize for shelter and feeding. These microhabitats remain available even at high flows, providing refuge offering stability during fluctuating conditions.

Fish access the Shoshone Reach when feasible, utilizing available habitat for multiple life-cycle processes, including spawning, rearing, migration, foraging, and refuge. Even during periods of low flow, this reach remains viable for fish populations as it is sustained by spring and small tributary flows that allow downstream connectivity and fragmented connectivity within the reach. Lower flows prevent upstream fish passage in cascade and rapid sections where large bed drops and boulder pour-overs are barriers to fish that either cannot make the extensive jump or cannot swim through the fast laminar flows.

During low flow conditions, the channel functions more like a small stream and currently provides some spawning opportunities to fall spawners (e.g., Brown Trout and Mountain Whitefish) that would otherwise be washed out in higher native flows. The shallower stream-like habitat also offers refuge for juvenile fishes from larger predatory trout. Habitat for macroinvertebrates in the lesser stream channel supports an abundance of EPT Taxa (Ephemoroptera Plecoptera and Tricoptera Taxa) that indicate good water quality functions despite the reduced amount of available wetted habitat. Wetted areas retained during low flows offer connectivity downstream to other parts of the river and sustain juvenile fish that depend on its habitat (CPW personal communication, 2024).

The Shoshone Reach features both high-gradient and low-gradient areas, allowing fish to move between different habitat types based on their needs. This natural variation supports movement between the foraging, resting, and spawning areas that fish need to complete their life cycle.

The Shoshone Reach, when sufficient flow is available, provides important ecological benefits that support fish populations, enhance habitat connectivity, and sustain wildlife. Adding an instream flow use to the Shoshone Water Rights establishes a legal framework that will noticeably preserve and improve the Shoshone Reach, safeguarding long-term ecological balance, fish passage, and habitat resilience across seasons.

3.2.2 Macroinvertebrates

Aquatic macroinvertebrates play a crucial role in maintaining the health and balance of both aquatic and terrestrial ecosystems. Macroinvertebrates, particularly aquatic insects, are essential components of the Colorado River aquatic food webs, serving as primary consumers that feed on organic matter and algae and as prey for fish, amphibians, and birds. By breaking down organic material, they facilitate nutrient cycling, contributing to the decomposition process and improving water quality. Macroinvertebrates also serve as indicators of ecosystem health, as their presence and diversity reflect water quality and habitat conditions. Beyond the water, they are a vital food source for terrestrial insects, bats, and birds, creating a bridge between aquatic and terrestrial ecosystems. For example, emergent aquatic insects like mayflies and caddisflies provide essential energy and nutrients to riparian predators such as birds, bats, and spiders. This can be particularly true in river reaches with confined or limited riparian areas, like that exhibited in the Shoshone Reach. This interconnectedness underscores aquatic macroinvertebrate ecological significance, highlighting the need for their conservation to sustain biodiversity and ecosystem functions across landscapes.

The availability and quality of streamflows play a pivotal role in shaping aquatic ecosystems, directly influencing macroinvertebrate abundance and composition. Macroinvertebrates rely on specific habitat conditions, such as substrate composition, flow velocity, and water quality, to thrive. Adequate flow ensures that these conditions are met, creating diverse and stable habitats that support a wide variety of macroinvertebrate species. These organisms, in turn, serve as a critical food source for fish, forming a foundational link in aquatic food webs. Conversely, insufficient flow can degrade habitat quality, leading to higher water temperatures, lower dissolved oxygen levels, and increased sedimentation—all of which can stress or eliminate sensitive macroinvertebrate species. Such changes not only reduce the diversity and abundance of macroinvertebrates but also negatively affect fish populations that depend on them.

The interconnectedness between flow, habitat, water quality, and macroinvertebrates underscores the cascading effects that flow alterations can have on river ecosystems. When flow levels are reduced, the resulting environmental changes can disrupt the balance needed for a healthy ecosystem. Higher temperatures and lower oxygen levels can create inhospitable conditions for both fish and macroinvertebrates, while excessive sedimentation can smother benthic habitats critical for macroinvertebrate survival. On the other hand, maintaining adequate flow supports optimal conditions, including stable temperatures, high oxygen levels, and balanced sediment transport. These factors promote the health of macroinvertebrate communities, promoting a robust food supply for fish and fostering a resilient aquatic ecosystem. Protecting and restoring natural flow regimes is central to sustaining the intricate relationships that underpin ecosystem resilience and biodiversity.

4.0 INSTREAM FLOW ASSESSMENT OF THE SHOSHONE REACH

4.1 SHOSHONE REACH HYDROLOGY

The hydrologic time series data for the Shoshone Reach, derived from the StateMod modeling tool, were used to assess various flow scenarios. StateMod utilizes USGS flow records along with diversion records from the State of Colorado. This assessment incorporated a new StateMod daily model, the Upper Colorado River Basin Model (2024 UCRM), with modeling results evaluated at the Dotsero Gage (water years 1988-2003) as performed and documented by Hydros (Hydros, 2024). Because of the importance of Shoshone Reach flows for fish habitat in dry years, the StateMod model outputs were focused on dry years for which the record was complete during late summer and early fall (calendar years 1989, 1990, 2001 and 2002) consistent with overlapping dry years utilized by Hydros.

Flows at the Dotsero Gage may exceed the Shoshone Water Rights call for 1,408 cfs due to the administrative practice of shepherding by state water officials in Colorado, or due to snowmelt runoff. Bypassed flows, also known as shepherded releases, refer to water that is released from upstream reservoirs for delivery to downstream users beyond the natural levels expected at those locations. For example, these releases may benefit irrigators or provide environmental flows to the 15-Mile Reach in the Grand Valley.

The Dotsero Gage (USGS 09070500) serves as an administrative point used by the Colorado Division of Water Resources (DWR) to measure and administer streamflow for water rights, including for the Shoshone Water Rights. DWR accounts for two types of measured flow at the Dotsero Gage: (1) the amount of undepleted natural flow; and (2) the amount of shepherded bypassed flow. “Undepleted natural flow” refers to the volume of water that can be diverted under the Shoshone Water Rights when those rights are in priority, excluding any releases from upstream reservoirs that are shepherded for downstream use below the Shoshone Reach.

4.1.1 Shoshone Reach Flow Scenarios

- For this assessment, the River District evaluated and provided three flow scenarios for the Shoshone Reach (Hydros, 2024). Recent disruptions to the traditional flow regime—caused by wildfires, debris flows, and power plant maintenance—indicate that the most representative period of record is from the beginning of the 2024 UCRM model period Water Year 1988 (beginning October 1, 1987) through Water Year 2003. The analysis focused on consecutive months with lower water flows and higher temperatures that stress fish and affect habitat quality, specifically from August to October. This late summer to early fall period is critical for the relationship between water flow, temperature, and fish habitat. During this time, unfavorable habitat conditions for fish have resulted in voluntary fishing closures in the Shoshone Reach (CPW personal communication, 2025).
- Each of the time-series scenarios is an output from StateMod using the daily timeseries in the 2024 UCRM, a water rights administration model developed by the State of Colorado. The three scenarios, illustrated in Figure 3, are as follows:
    - **Scenario 1 (Baseline)**: Represents flows in the Shoshone Reach under existing conditions (Figure 3). This scenario is modeled as the flow at the Dotsero Gage minus the Shoshone Power Plant’s diversions, which is defined as the “Baseline” scenario in the 2024 UCRM and by Hydros (Hydros, 2024). The Shoshone Reach operates like an intermittent stream channel with high flows during runoff and little to no flow in seasonally low water periods, when the entire river flow is often diverted for hydropower production

at the Shoshone Power Plant and the Shoshone Reach flows like a small stream supplied by intervening small springs and tributary inputs.

- **Scenario 2 (Future with Permanency):** Represents a future condition with additional Colorado River build-out demand (Hydros, 2024) in which the Shoshone Power Plant no longer operates, and the Shoshone Water Rights (as defined by the Shoshone Baseline demands) are permanently protected as an instream flow water right (Figures 3). This scenario assumes all flows remain in the Shoshone Reach, corresponding to the Baseline Future model output at the Dotsero Gage (Hydros, 2024).
- **Scenario 3 (Future without Permanency):** Represents a future condition where the Shoshone Power Plant no longer operates, and the Shoshone Water Rights are no longer maintained or able to call (Figures 3) (Hydros, 2024).

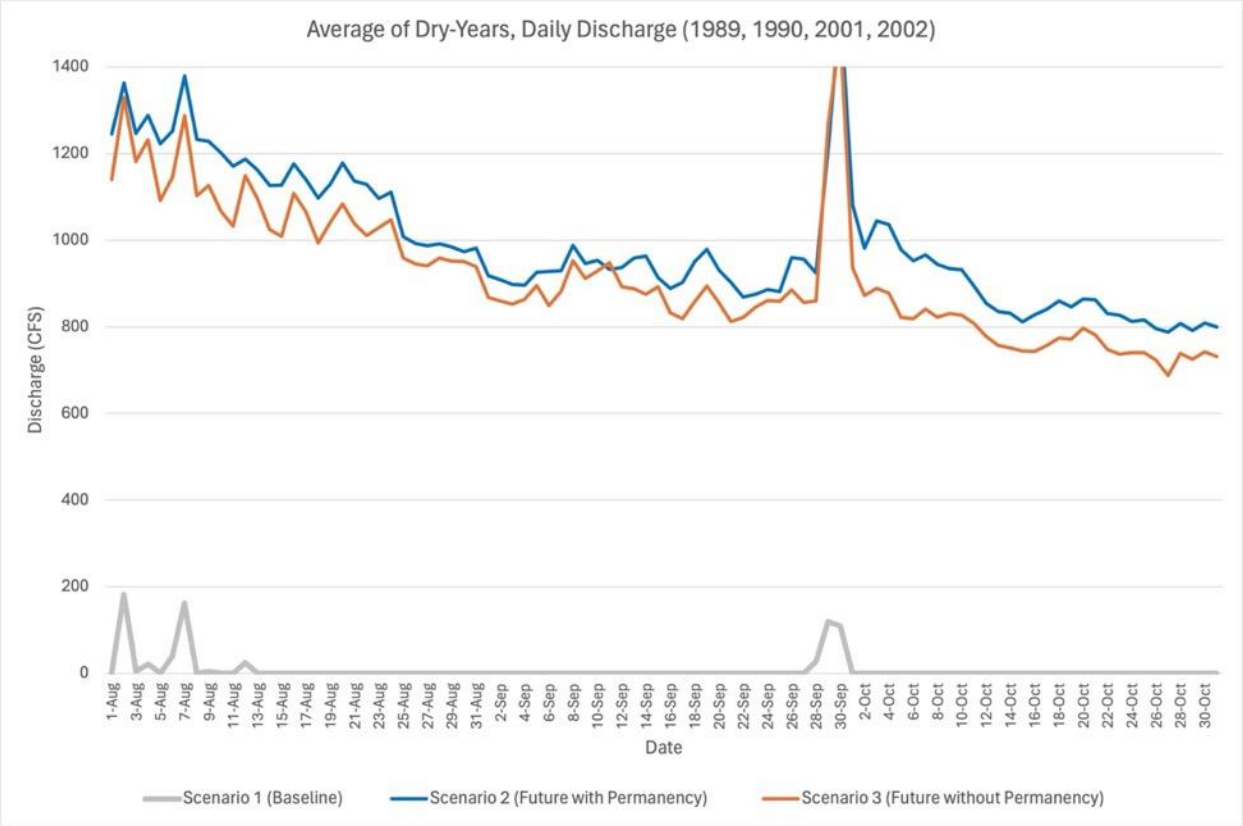


Figure 3: Shoshone Reach Mean Daily Discharge during low flow years 1989, 1990, 2001, and 2002, for each of the three Scenarios.[2]

The analysis indicates that both Scenario 2 (Future with Permanency) and Scenario 3 (Future without Permanency) will result in increased flows within the Shoshone Reach under all conditions, effectively eliminating days with flows below 700 cfs. Scenario 1 would have the most days/year (most frequency) of modeled flows of 250 cfs or less; Scenario 3 would have the most days/year (most frequency) of flows at 700 cfs and 1,020 cfs; Scenario 2 would have the most

[2] Note that the isolated spike in flows observed near the end of September in Figure 3 is attributable to modeled reservoir release operations at the end of the water year that resulted in the 2024 UCRM. These processes, operations, and trends have not occurred historically in September for all years and are unlikely to occur in the future as presented in Figure 3.

days/year (most frequency) of flows at 1,250 cfs, 1,400 cfs, 1,500 cfs, and 1,750 cfs. Differences in frequency of predicted discharges above 2,000 cfs between Scenarios 2 and 3 are nominal, but more frequent than Scenario 1. This informs the interpretation of the hydraulic habitat modeling; the Shoshone Reach is more likely to have flows between 1,250 cfs and 1,750 cfs and less likely to have flows between 700 cfs and 1,250 cfs with Future with Permanency (Scenario 2) than the Future without Permanency.

The analysis of median monthly flows for the entire period of record highlights a significant advantage of Scenario 2 (Future with Permanency), particularly during late-summer months (August–October) when ambient temperatures are still high, demand on storage water is at or near its peak, and cold-water species—primarily Brown Trout and Mountain Whitefish—are spawning (Figure 3).

In Scenario 2, late-summer discharge shows notable increases compared to Scenario 3, with median flow differences of:

- +144 cfs (+11.7%) in August
- +221 cfs (+20%) in September
- +26.9 cfs (+2.8%) in October

These increases provide up to 221 cfs more flow during this critical period, supporting spawning habitat, and aquatic ecosystem health.

The predicted frequency the Shoshone Reach will experience each flow informs the interpretation of the habitat suitability results and when reaches upstream and downstream of the Shoshone Reach will have changes in flow associated with each scenario. The modeled flow scenarios demonstrate that fish and other aquatic biota and other resources (such as recreation), would benefit from higher flows during seasons where they are most in need of those flows (Figure 3).

4.2 EVALUATION OF INSTREAM FLOWS

This section documents the evaluation of instream flows using the IFIM process. The IFIM was used to explore the relationship between various flow scenarios and the hydraulic suitability of flows for focal fish species within the Shoshone Reach of the Colorado River. The study area spans from the point of diversion for the Shoshone Water Rights at the Shoshone Diversion Dam to the outfall of the Shoshone Power Plant. The objectives of this evaluation were to assess the current state of the aquatic habitat to predict expected changes due to potential hydrologic alterations resulting from the proposed change of use of the Shoshone Water Rights. The proposed hydrologic change would involve dedicating the full 1,408 cfs of flow, when available in priority to an alternate use for instream flow purposes, meaning that the otherwise diverted water would remain in the river to support aquatic habitat when the Shoshone Power Plant is not operating.

IFIM is a widely recognized method for assessing the relationship between streamflow and habitat quality for aquatic species. Developed by Bovee (1982), the IFIM uses habitat suitability curves and flow-habitat relationships to model how changes in streamflow affect the availability of suitable habitat for target species (Bovee, 1982; Stalnaker et al., 1995).

HHS is used to quantify the suitability of different habitats for various aquatic species under different flow conditions (Bovee, 1982). Habitat suitability curves were developed based on empirical data and expert judgment, relating the availability of habitat to streamflow parameters such as depth and velocity. The habitat suitability criteria for the fish species examined under this

IFIM were recommended by CPW and Dr. Miller (Miller 2024, Final Report), as habitat suitability curves from the published literature. No changes to the habitat suitability curves were made for this analysis (Appendix B).

Habitat availability was assessed by calculating the effect different flow levels have on the extent and quality of habitat within the study area. This is typically done using hydraulic models and habitat-suitability relationships to predict how different flows influence the quantity and quality of habitat. By simulating a wide range of flows, the evaluation examines how habitat availability for target species changes across different flow regimes (Poff et al., 1997; Bovee, 1982).

Study Sites

Site 1 is 1,854 ft. in length (River Restoration, 2023). The wetted area at 1,400 cfs is 6.1 acres (266,456 sq. ft.) and is representative of 14.4% of the total Shoshone Reach.

Site 2 is 1,830 ft. in length (River Restoration, 2025). The wetted area at 1,400 cfs is 5.9 acres (255,436 sq. ft.) and is representative of 14.2% of the total Shoshone Reach.

Combined, Sites 1 and 2 are representative of 28.6% of the Shoshone Reach (Figure 4).

4.2.1 Objectives

The primary objective was to evaluate the potential changes to aquatic hydraulic habitat (depth and velocity) resulting from incremental changes in flow. The analysis examines a range of flows, which include 50, 250, 700, 1,020, 1,250, 1,400, 1,500, 1,750, 2,000, 2,250, 2,500, and 3,000 cfs. The range of modeled flows allows quantification of how these flow changes influence aquatic species, and habitat availability. The range of flows were selected due to their likelihood of occurring in the reach based on the three scenarios provided (see section 2.6.1).

4.2.2 Discharge Flows Modeled

Currently, the Shoshone Water Rights divert up to 1,408 cfs from the Colorado River for power generation at the Shoshone Power Plant. The proposed change of the Shoshone Water Rights would allow the CWCB to exercise the Shoshone Water Rights, when not being used for hydropower generation, in a manner that would cause the decreed amount of water available to the water rights to remain in the Shoshone Reach to support aquatic ecosystems instead (CWCB, 2021). In addition to evaluating the effect of the proposed new use of the Shoshone Water Rights for instream flow purposes on flow conditions within the Shoshone Reach, the evaluation also considers the potential effects of a broader range of flow conditions, from 50 cfs to 3,000 cfs, to provide a more comprehensive understanding of how the flow changes may affect the Shoshone Reach's aquatic habitat.

The three flow scenarios (1-Baseline, 2-Future with Permanency, 3-Future without Permanency) were analyzed in flow increments to explore the effects of both reduced and increased flows on habitat availability. Flow levels from 50 cfs to 3,000 cfs represent potential hydrologic conditions under current management practices and the proposed instream flow use.

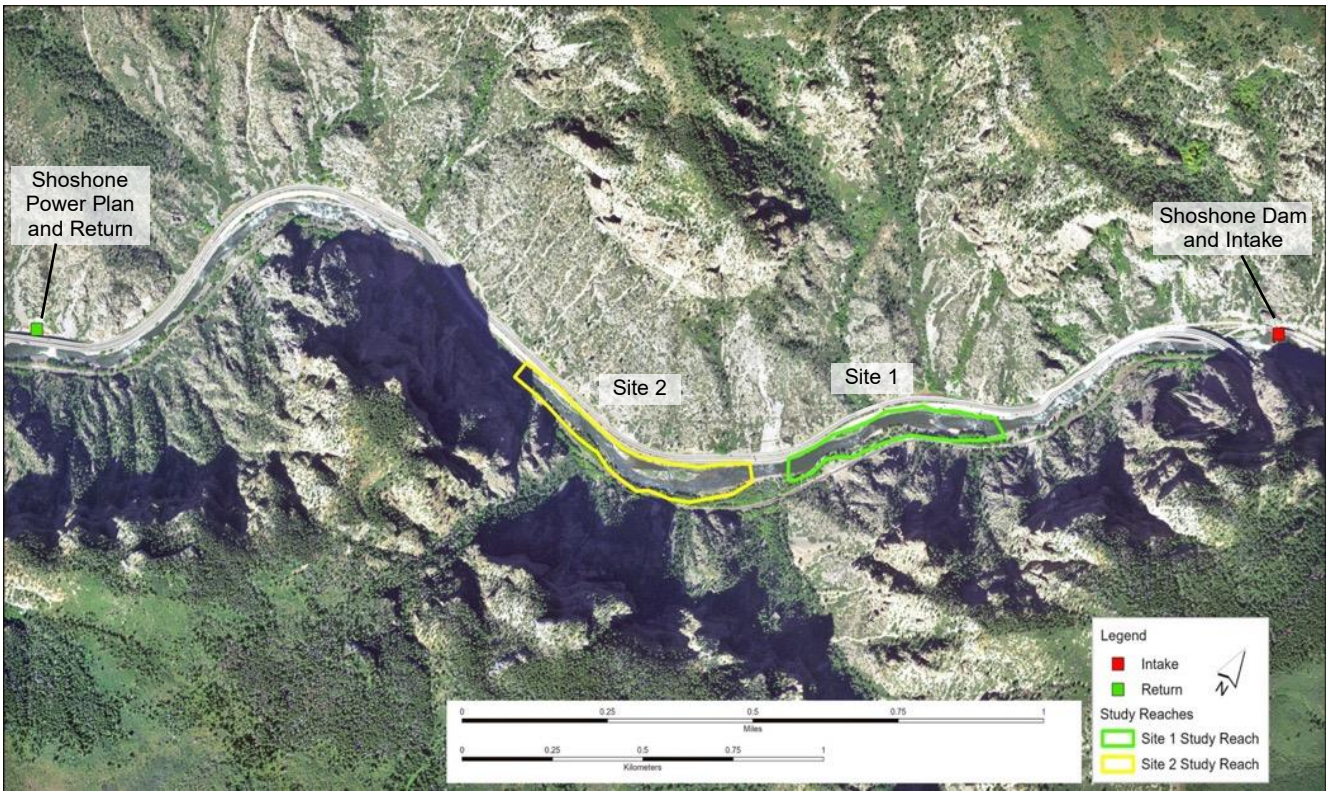


Figure 4: Shoshone Reach - Sites 1 and 2

4.3 METHODS

A two-dimensional habitat suitability model was created for two sites within the Shoshone Reach of the Colorado River (Figure 4). One suitability model was created for the two sites; meaning the same Hydraulic Habitat Suitability (HHS) criteria (velocity, and depth suitability curves) and equation were used for both sites. The two sites were assessed independently from one another. The HHS models were not combined into one continuous reach.

The following sections describe the development and application techniques used to create the two-dimensional model. The model was employed to derive the extent and quality, or suitability, of fish habitat within the two sites over a range of flows. Weighted Usable Area (WUA) is the measure of suitable habitat per species per flow per site and is calculated by multiplying an areas (pixel or polygon) suitability score by that areal extent to determine the actual measure of habitat available to each species at each flow. The extent and quality of suitable habitat is derived for adult Brown and Rainbow Trout, adult Flannelmouth Sucker, and adult Mountain Whitefish. The two-dimensional model examines depth and velocity to identify habitat suitability for each species. Environmental Systems Research Institute's (ESRI) ArcGIS Professional (ArcPro) was used to create and run the two-dimensional model. ArcPro is a Geographic Information System (GIS) platform. Accordingly, all data were converted (e.g., depth, velocity, suitability curves) to GIS consumable data and analyzed in ArcPro. Only the HHS model was run in ArcPro.

The topography (digital elevation model [DEM]) and hydraulic modelling was performed by River Restoration. These reports can be found in Appendix D which provide an in-depth description of the topographic data collection, topographic grid creation and the hydraulic modelling (Appendix D). The results of this work included depth and velocity grids (GIS data) for each modeled flow (e.g., 50, 250, 700, 1,020, 1,250, 1,400, 1,500, 1,750, 2,000, 2,250, 2,500, 3,000 cfs). These datasets were employed to derive the HHS for each species per flow.

4.3.1 Two-Dimensional Habitat Modeling—General Approach

There is considerable research on two-dimensional habitat suitability modeling for fish species. The methods used, computations, and the interpretation of results have been studied and deliberated (Austin 2002, Jowett and Davey 2011, Payne 2020). This research has led to a simple conclusion: that the methods employed to obtain results, and the interpretation of those results, should be dictated by the goals of the project (Austin 2002). The goal of this project, and the two-dimensional model used for the assessment, is to examine the impact that incremental flow changes would have on the extent and quality of habitat for four adult fish species (e.g., Brown and Rainbow Trout, Flannelmouth Sucker and Mountain Whitefish). This assessment evaluates a high gradient, confined canyon reach of river that does not provide optimal habitat for all life stages and species of fish. Therefore, the goal of this assessment is expressly to look at the extent and quality of each adult fish species' habitat, and how that habitat is affected by depth and velocity changes over a range of flows. Furthermore, this assessment is not intended to evaluate permanency of the Shoshone Water Right, rather it is to evaluate HHS benefits of the water right should it be converted to an instream flow beneficial use. Therefore, when the Shoshone Power Plant is not diverting, the flows can be put to beneficial use for the environment.

An additive model was chosen to derive HHS in the Shoshone Reach. The equation for habitat suitability for each species in the Shoshone Reach is:

Fish Species HHS per flow = Depth HHS + Velocity HHS

Additive models resolve some of the criticisms that have been made of conventional habitat suitability criteria and habitat suitability modeling (Jowett and Davey, 2007). The main rationale for employing an additive model rather than a computation including multiplication is to address the depth-averaged velocity issue in high gradient and deeper rivers, such as the Colorado River Shoshone Reach. Depth-averaged velocity output from hydraulic models, which gives one velocity value for the entire water column, often does not account for lower and likely suitable velocities that can occur along the streambed and adjacent to roughness elements that create a hydraulic shadow. In large rivers with boulder substrates, such as the Colorado River through the Shoshone Reach, suitable velocities could be found along the bed in locations where the depth-average velocity would be considered too high. In which case, using a traditional approach of multiplying the depth and velocity suitability to obtain a composite suitability may underestimate the true amount of suitable habitat.

The additive model improves, or overcomes, the depth-averaged velocity because it does not constrain suitable habitat predictions in deep, fast-flowing areas where few data were collected, and where velocity is not consistent throughout the water column (Jowett and Davey, 2007). Large bed material, such as what exists throughout the Shoshone Reach, provides velocity breaks for fish, and enable movement even at high flows, where velocities are extreme. Thus, velocity is not consistent in the water column, and depth-averaged velocities used in 2-D models may not be biologically informative.

Sampling deep and/or fast-flowing habitat types presents significant challenges. These habitat features are common in the Colorado River Shoshone Reach. Field researchers and biologists have reduced capture efficiency when sampling areas with deep and/or swift currents. Species suitability curves are largely based on where humans are able to observe fish species. This bias, resulting from the lack of observations in deep, fast-flowing waters, typically leads to a pronounced negative interaction between velocity and depth in rivers such as the Colorado River Shoshone Reach. The negative velocity-depth interaction means that high average velocity values (e.g., HHS_{vel} > 6.0 feet per second = 0) often exclude potential habitat because the velocity suitability score is zero (Jowett and Davey, 2007). In traditional HHS models, velocity suitability is multiplied by depth suitability (HHS = D*V) to determine an overall suitability metric. Anywhere that velocity suitability is zero is deemed as non-habitat. This velocity-depth interaction has been shown to be a poor predictor of species occurrence in deep fast flowing rivers (Jowett and Davey, 2007). Therefore, the simplified additive model was used for this assessment. Additive models provide a more biologically realistic results and have been shown to be a better predictor of species occurrence than multiplicative models (Jowett and Davey, 2007).

4.3.2 Habitat Suitability Curves

The Habitat Suitability Curves were recommended in the 2024 Miller Report with feedback provided by CPW, and based on local expertise and professional judgement:

> *Habitat data for the species of interest came from several sources and have been used in previous studies on the Colorado River (Miller and Swaim 2011). The data for adult trout was collected by direct observation at several locations in rivers in Colorado. The data was collected by personnel from the Colorado Division of Wildlife (now CPW) and US Fish and Wildlife Service in 1988 and 1989 (Colorado Division of Wildlife 1989). Those observations were used to develop habitat preference suitability indices for depth and velocity and corrected for habitat presence (Wilding 2012)*. (Miller 2024).

Additionally, the 2024 Miller Report provides that:

> *Criteria for Mountain Whitefish used for this analysis came from Bovee (1978). The criteria for adult Flannelmouth Sucker were updated in early 2024 from a combination of data from radio telemetry studies on the Colorado River near Grand Junction, existing data from a range of rivers and literature review of habitat and population studies (Miller 2024). Additional habitat criteria for Flannelmouth Sucker were incorporated into the final suitability criteria as documented by Miller (2024).*

The suitability curves for all species are shown in Appendix B. The numeric suitability curves (Excel files) for each fish species were imported into ArcPro and converted to a GIS table.

4.3.4 Application in Geographic Information System (GIS)

As mentioned above, the habitat suitability modeling used ESRI's ArcPro. Four species were modeled at two sites within the Shoshone Reach of Colorado River. Twelve flow rates were modeled. A total of 96 HHS scenarios were modelled to document the change in extent and quality of habitat for the four fish species in the Shoshone Reach.

Figure 5 below demonstrates the simplified process of taking raw depth and velocity grids, provided by the hydraulic modeling (River Restoration 2023, 2025, Appendix D), and then converted each into a suitable habitat layer for each species. The initial step in the process is to import the depth and velocity grids to ArcPro. The next step is to apply the suitable habitat criteria (HHS Table) to the raw depth and velocity grids using a tool called "Reclass by Table." This step

converts the depth and velocity grids to a suitable habitat layer, based on the suitability curves, with values ranging from 0 to 1. The next step is to add the depth and velocity grids (i.e., additive model) together to create an overall HHS score (additive model maximum = 2) for each species at each flow (Figures A1-A18, Appendix A). Habitat selection by fish often appears to have thresholds. For example, many fish species will use a wide range of depths once the depth has exceeded some critical minimum value (Bovee et al. 1998). For this assessment, the critical minimum HHS depth value for all species was identified as 0.5 feet (CPW Personnel Communication, 2025). Areas of each site where depths were less 0.5 feet were given an overall score of 0 regardless of velocity. HHS values ranged from 0 to 2. A score of zero indicates no habitat. Low HHS values (<0.2) indicate marginal habitat, whereas high or maximum HHS values (2.0) indicate optimal habitat.

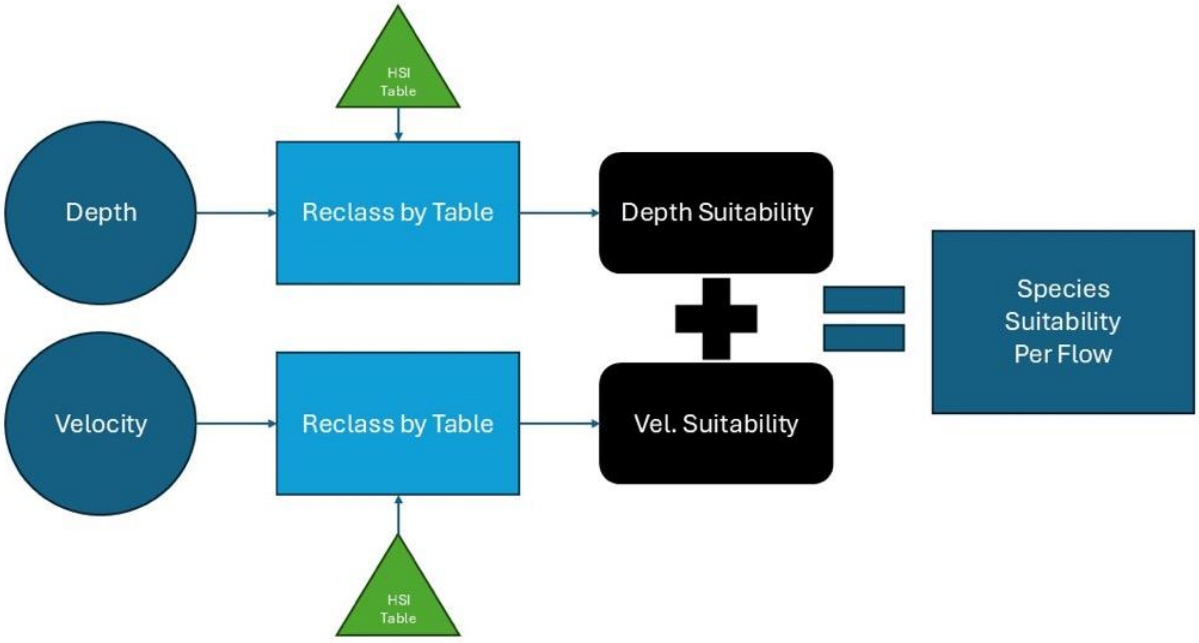


Figure 5. Simplified Process of Creating HHS Layers in ArcPro.

Results discussed below are expressed as Weighted Usable Area (WUA) per species per flow per site. WUA is derived by multiplying each modeled pixel's area by that pixel's HHS (WUA_{pixel} = Pixel * HHS). Effectively, if the additive model (depth HHS + velocity HHS) pixel sum is greater than zero, the pixel offers suitable habitat and the WUA is equal to the pixel area multiplied by the HHS. For the WUA calculation, additive HHS values were converted to a 0 to 1 scale by dividing the additive HHS by 2 (e.g., Additive HHS = 1.4, [1.4/2 = 0.7], WUA = 0.7 * Pixel Area). WUA is further calculated as a linear measurement, where overall WUA per species per flow is divided by the length of the study site to determine square feet of habitat per 1,000 ft of stream. Thus, the WUA figures per site and per species depict square feet of habitat per 1,000 ft of stream length.

4.4 RESULTS

The results presented in this assessment are organized by study site. For each site, results for wetted area per flow (depth >0.1ft) and HHS per species and per flow are presented and described. Minimum suitable depths were based on communication with CPW and set as 0.5 feet

for all species (CPW personnel communication, 2025). HHS results are presented as WUA per species, per flow, and per site.

The two study sites, when viewed together, present a mosaic of instream habitat characteristics that represent the overall Shoshone Reach. Site 1 is 1,854 feet in length (River Restoration 2023). Site 2 is 1,830 feet in length (River Restoration 2025). The combined study sites' total length is 3,684 feet. Together, the study sites comprise 28.6% of the total Shoshone Reach.

4.4.1 Site 1

Site 1 is located roughly ½ mile downstream of the Shoshone Diversion Dam (Figure 4). Site 1 is discernable by two large pools divided by a riffle in the center of the site. Site 1 is narrower (e.g., floodplain width) than Site 2, with a defined channel flowing through the middle of the site. There is limited off-channel areas at Site 1. The two pools within Site 1 provide significant habitat for all species modeled, dependant on discharge and depth.

Site 1 Wetted Area

Wetted area increases with flow at Site 1. Minimum wet area within Site 1 occurs at a discharge flow of 50 cfs, with over 118,000 sq. ft. of linear wetted area per 1,000 ft. of stream (Figure 6). Maximum hydraulic modeled wetted area occurs at the highest flow, 3,000 cfs, and includes over 152,000 sq. ft. of wetted area per 1,000 ft. of stream (Figure 6). Although the adult fish species modeled do not use the entire wetted area, based on HHS criteria, wetted area below the adult species minimum suitability criteria provides food base (e.g., macro-invertebrate habitat when inundated for sufficient duration for colonization) and habitat for non-modeled life stages (e.g., juvenile). Wetted area extent is an important indicator of the overall stream habitat available to modeled species, potential habitat for non-modeled life stages, and stream life-cycle dynamics.

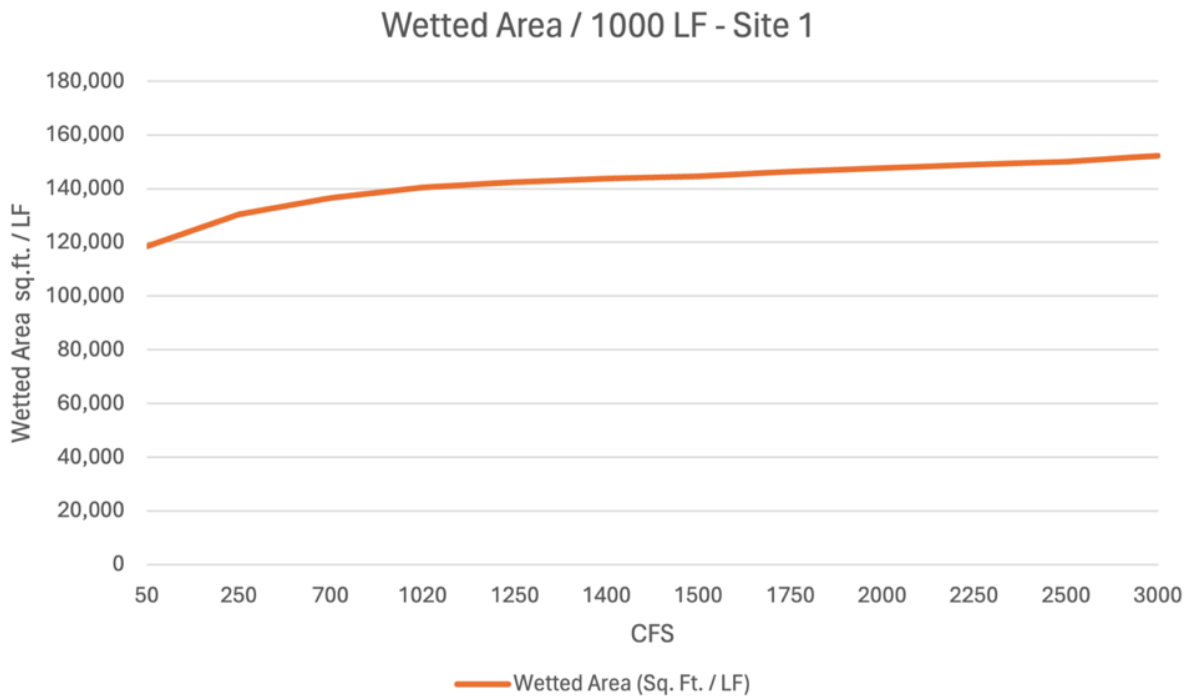


Figure 6. Site 1 Wetted Area Results, all Discharge (cfs) per 1,000 linear feet.

Site 1 WUA Results Per Species

The extent of suitable habitat per 1,000 feet of stream, per adult species modeled, defined as WUA, generally increases with flow at Site 1 (Figures 7, 8, 9, 10). Maximum WUA for Brown and Rainbow Trout occurs at 2,250 cfs (Figure 7 and Figure 8, respectively). As flow increases above 2,250 cfs the suitability of the habitat within the Shoshone Reach for trout species begins to plateau and slightly decline, thus slightly reducing the overall WUA. Adult Flannelmouth Sucker WUA increases from 50 cfs to 1,500 cfs (Figure 9). Above 1,500 cfs, habitat quality (HHS) begins to plateau and then decline as velocity and depth thresholds for the species reach maximum values. Mountain Whitefish maximum WUA occurs at 2,000 cfs at Site 1. Above 2,000 cfs, Mountain Whitefish habitat quality begins to plateau and then slightly decline, thus reducing the extent of WUA for the species (Figure 10). In summary, at Site 1, the extent of adult fish species suitable habitat generally increases with flow, even up to the higher discharges modeled for some species, while others experience a plateau and slight decline.

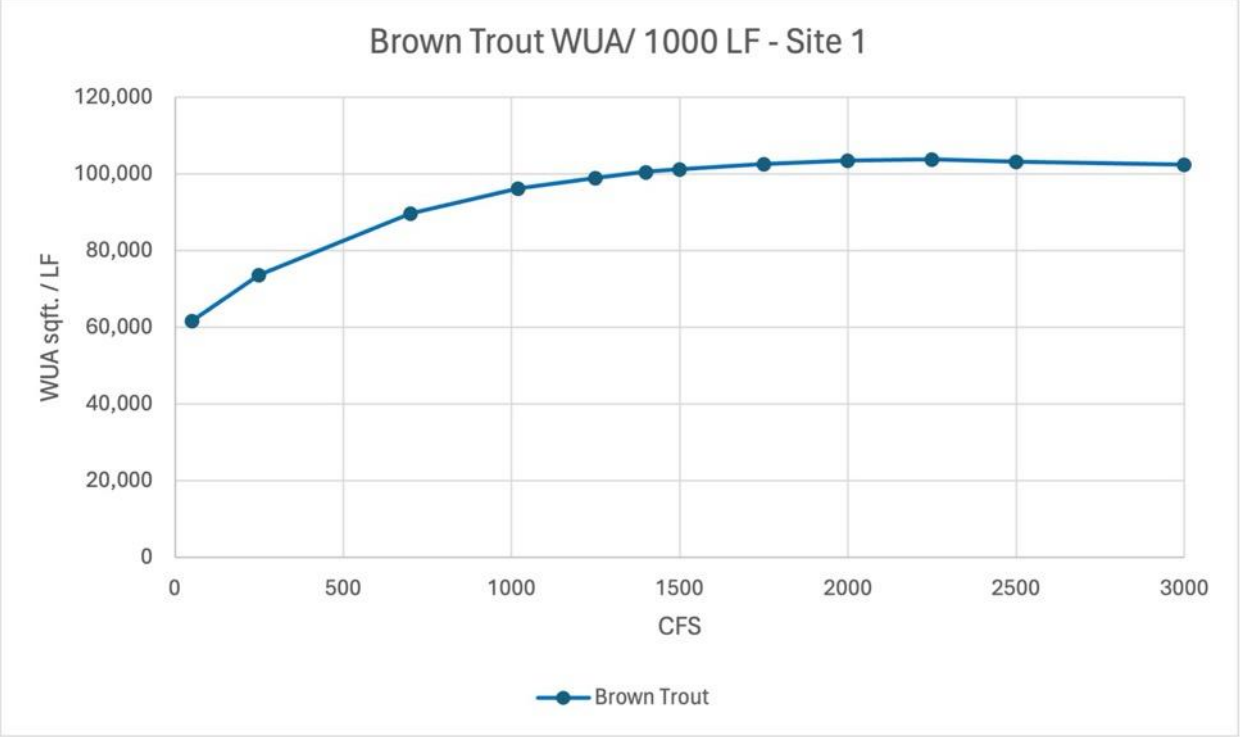


Figure 7. Weighted Usable Area per discharge flow (cfs) for Brown Trout at Site 1.

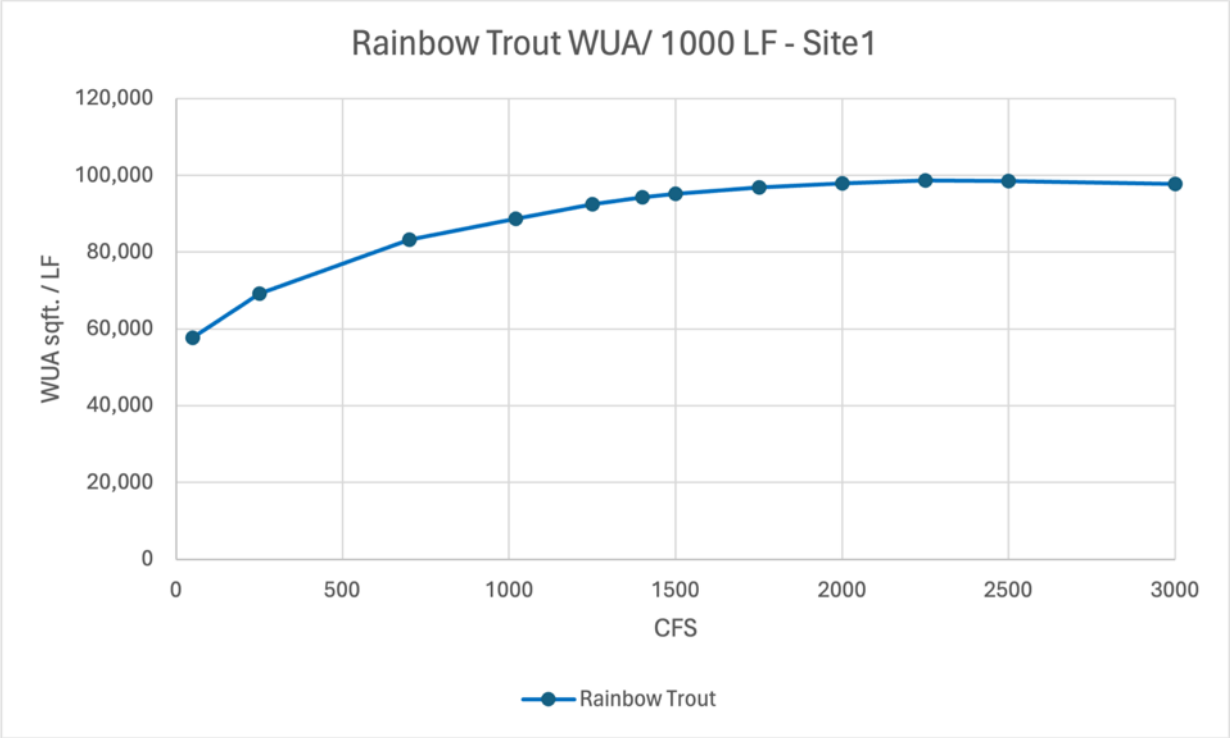


Figure 8. Weighted Usable Area per discharge flow (cfs) for Rainbow Trout at Site 1.

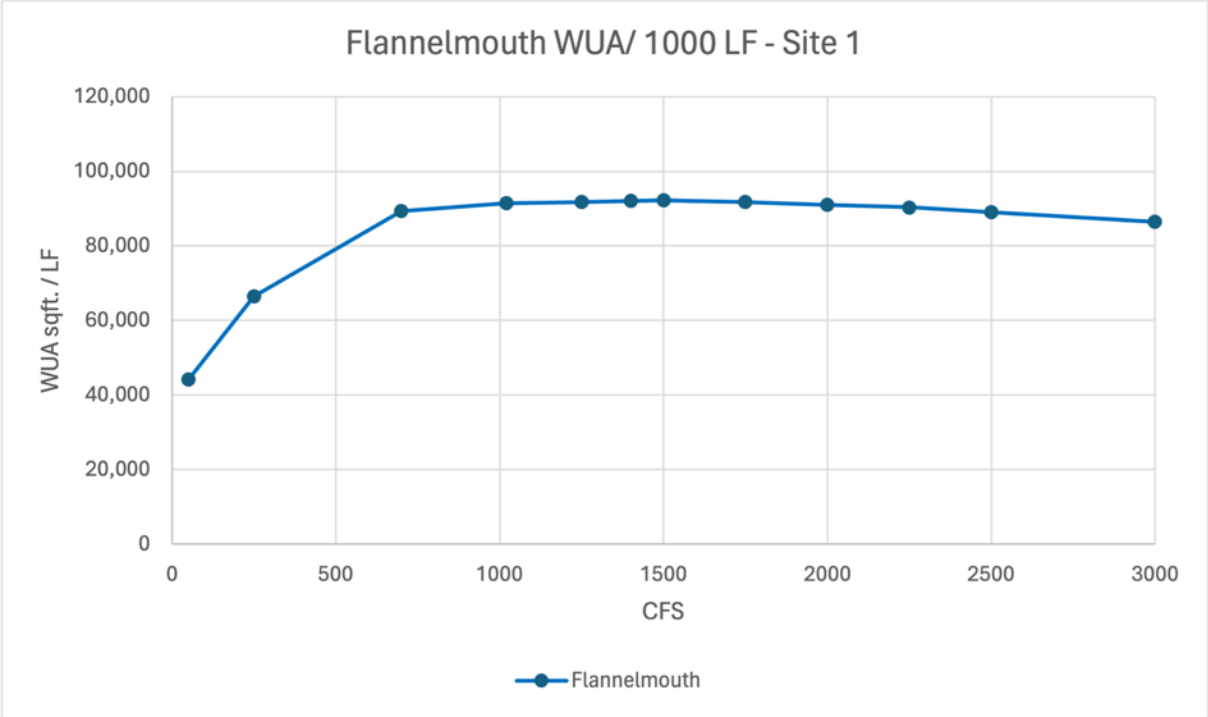


Figure 9. Weighted Usable Area per discharge flow (cfs) for Flannelmouth Sucker at Site 1.

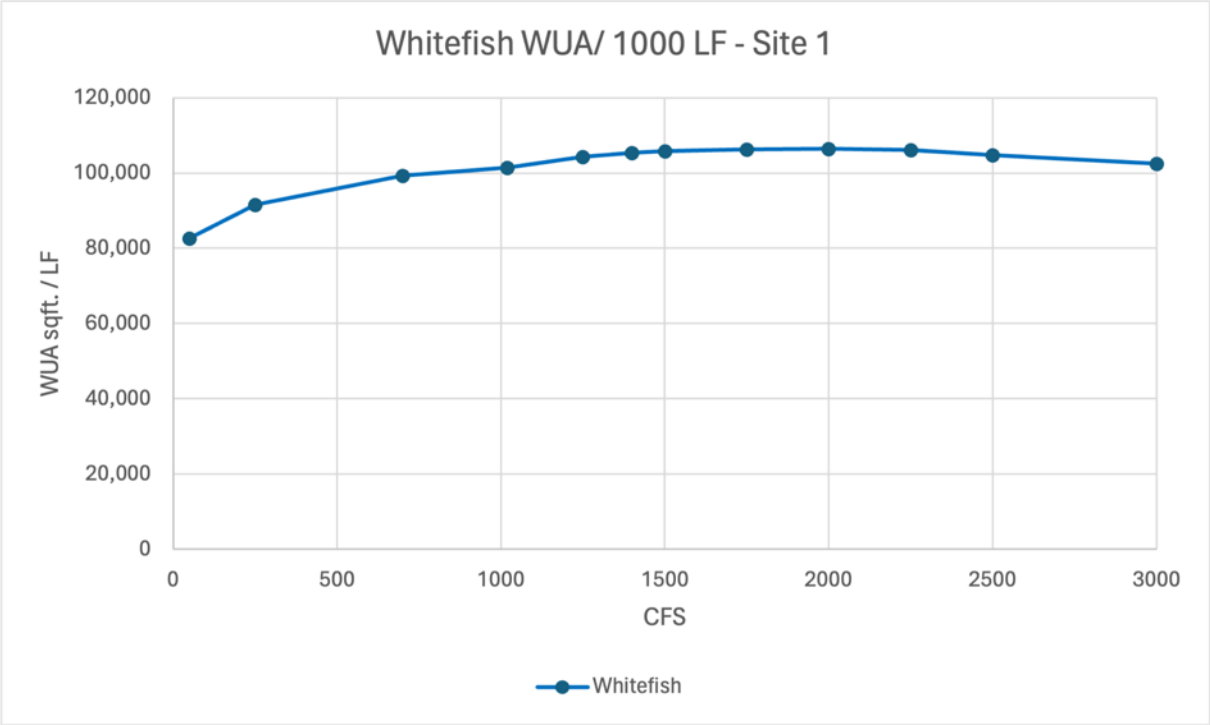


Figure 10. Weighted Usable Area per discharge flow (cfs) for Mountain Whitefish at Site 1.

4.4.2 Site 2

Site 2's floodplain is wider than Site 1's floodplain and provides a notable difference in overall riverine complexity. Site 2 includes two large islands that create a complex channel environment. Portions of the complex channel are wetted at different flows, creating a dynamic environment in which flow volume increases and previously dry areas (e.g., off-channel areas) become wetted and provide accessible habitat. This complexity offers different habitat availability for the four modeled species and demonstrates a diverse habitat (extent and quality) response to increased flows.

Site 2 Wetted Area

In Site 2, wetted area increases with increasing flow volume, like Site 1. However, the increase in wetted area is not as linear as at Site 1. For example, Site 2 wetted area increases significantly from 50 cfs to 250 cfs (Figure 11). Another significant wetted area increase occurs from 250 cfs to 700 cfs of discharge at Site 2 (Figure 11). Above 700 cfs, wetted area increases are similar to Site 1, with varying increases of generally less than 10,000 sq. ft. per 1,000 ft of stream occurring from 1,020 cfs to 3,000 cfs. The greatest wetted extent at Site 2 occurs at 3,000 cfs, with just over 160,000 sq ft of wetted area per 1,000 ft of stream (Figure 11). This is likely the result of high-flow channels being wetted.

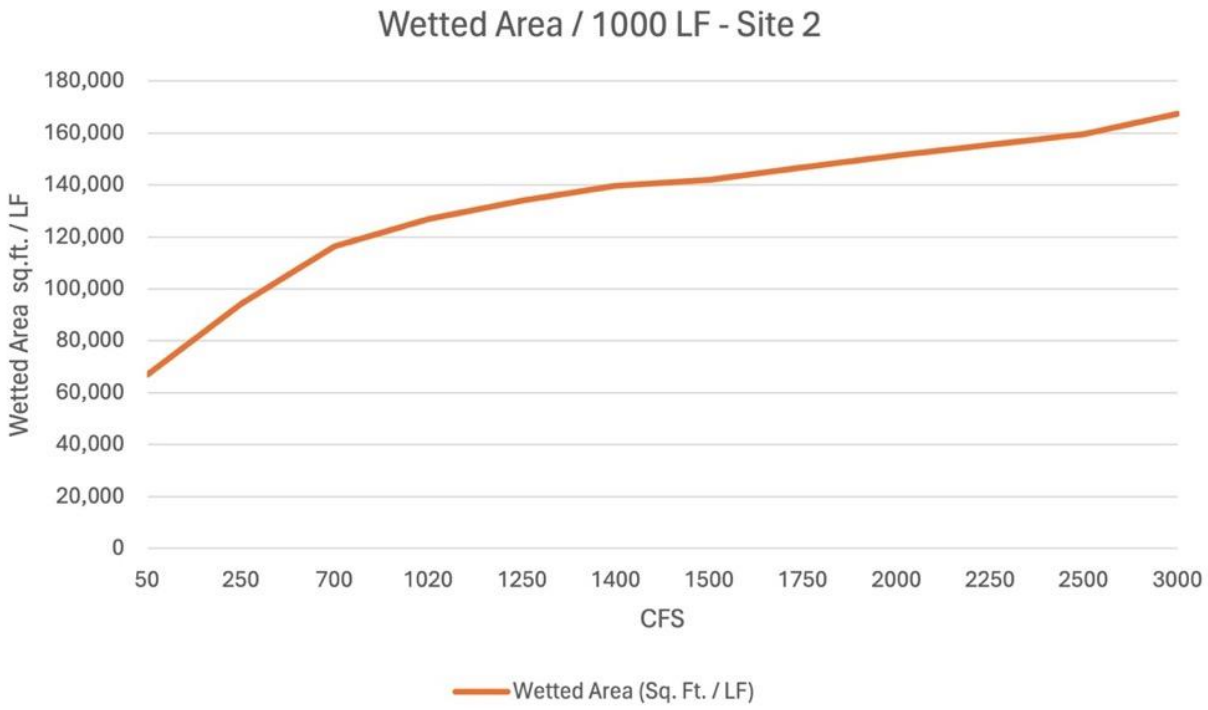


Figure 11. Site 2 Wetted Area Results, all Discharge (cfs) per 1,000 linear feet

Site 2 WUA Results Per Species

The extent of WUA per 1,000 feet of stream, per adult species modeled, increases with discharge flows at site 2 (Figures 12, 13, 14, 15). Noticeably, a large increase in WUA occurs for all species from 50 cfs to 700 cfs. Maximum WUA for Brown and Rainbow Trout occurs at 3,000 cfs (Figure 12 and Figure 13). There is a noticeable increase in WUA between 2,500 cfs and 3,000 cfs for Brown and Rainbow Trout at Site 2. While not modeled, this trend likely indicates that Trout species WUA would continue to increase at flows above 3,000 cfs (Figures 12 and 13).

Flannelmouth Sucker WUA at Site 2 increases up to 2,250 cfs, and plateaus as flows increase towards 3,000 cfs (Figure 14). Mountain Whitefish WUA over the range of flows modeled exhibits a similar curve as the trout species, with gains as flows increase (Figure 15). However, the slope of the Mountain Whitefish WUA curve, between 2,500 cfs and 3,000 cfs begins to plateau and levels off.

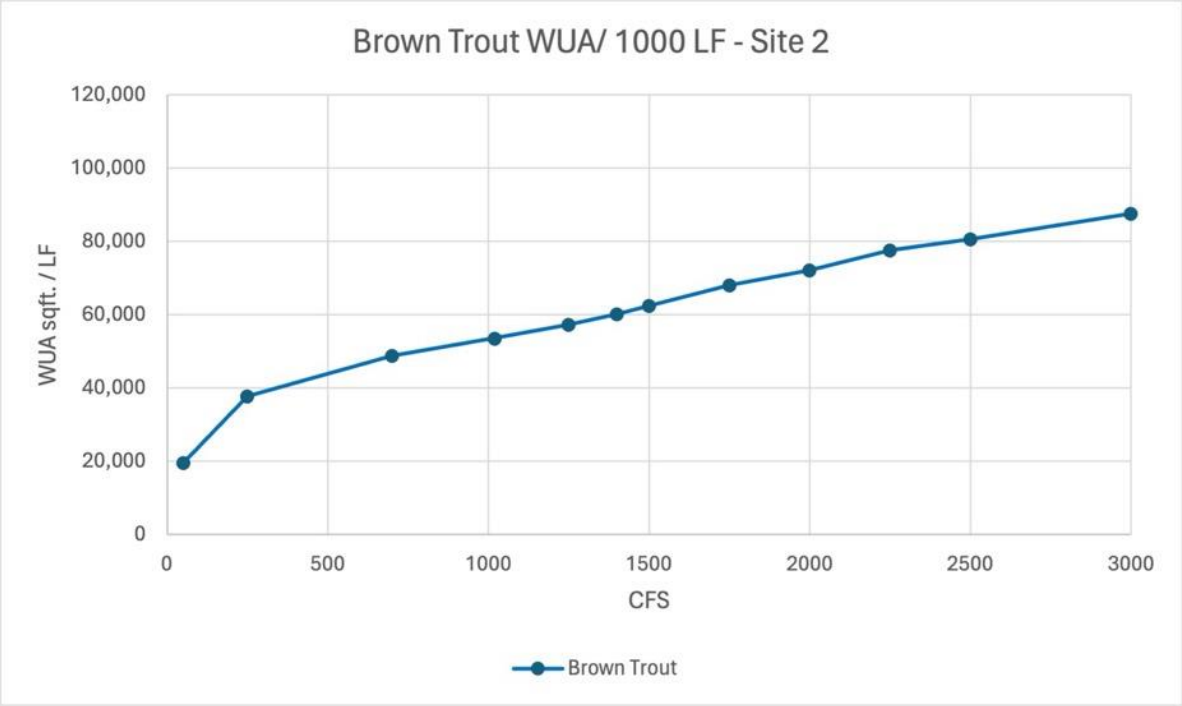


Figure 12. Weighted Usable Area per discharge flow (cfs) for Brown Trout at Site 2.

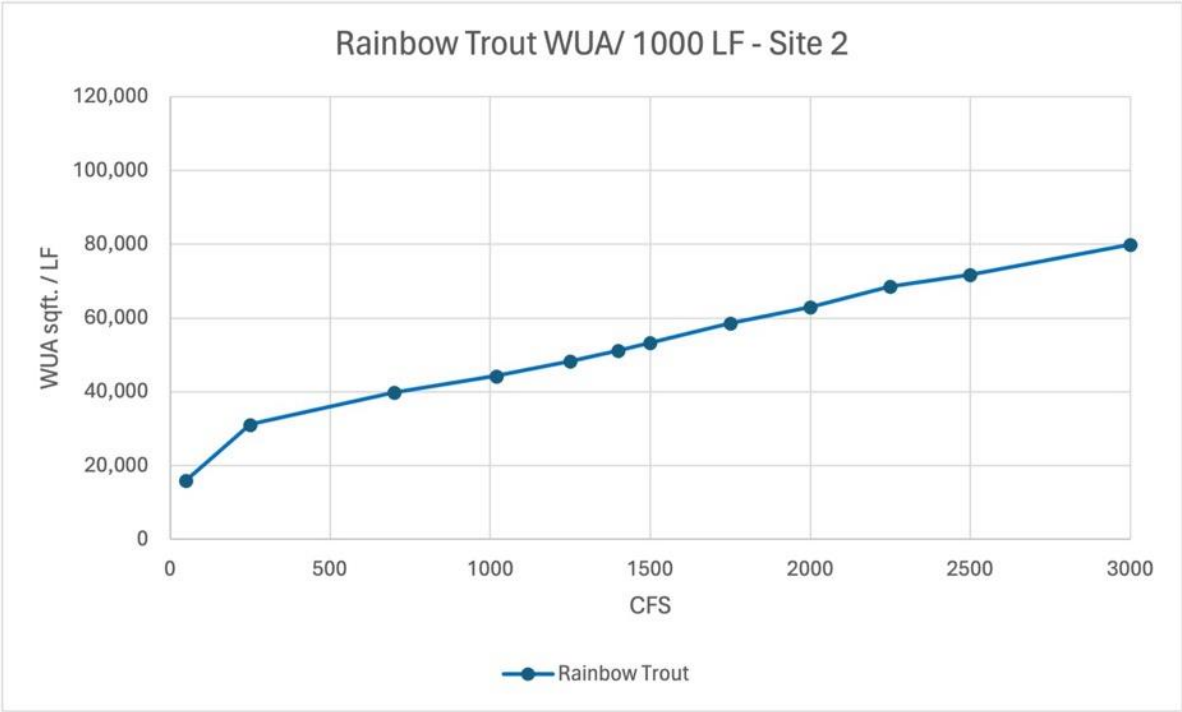


Figure 13. Weighted Usable Area per discharge flow (cfs) for Rainbow Trout at Site 2.

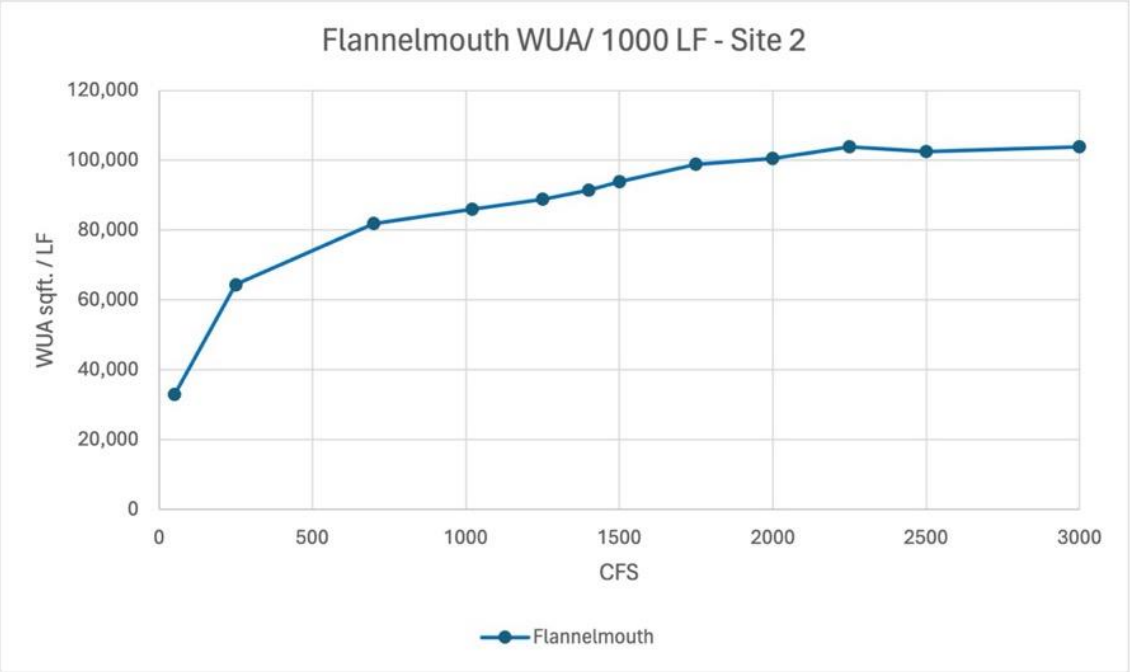


Figure 14. Weighted Usable Area per discharge flow (cfs) for Flannelmouth Sucker at Site 1.

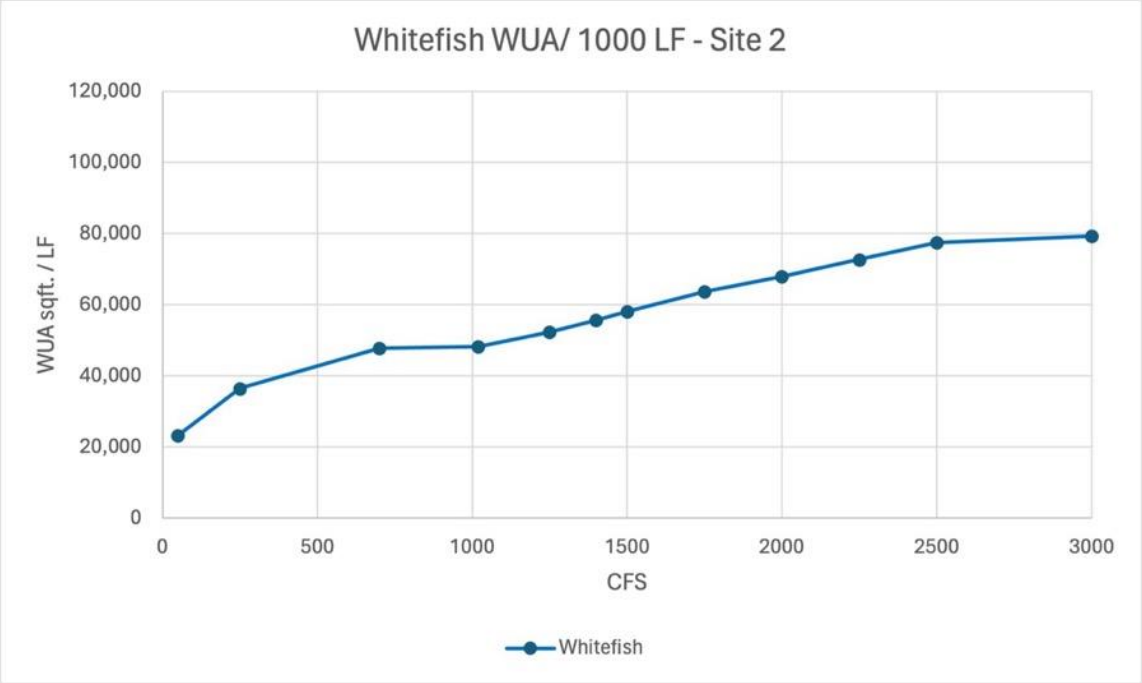


Figure 15. Weighted Usable Area per discharge flow (cfs) for Mountain Whitefish at Site 2.

Visual HHS Results Site 1 and Site 2

Appendix A includes visual layouts of results for each study site reach with flow model and WUA charts (Figures A1-A18, Appendix A).

5.0 DISCUSSION AND CONCLUSION

5.1 DISCUSSION

Hydraulic Habitat Suitability and Wetted Area

The hydraulic suitability results from the expanded IFIM analysis provide useful insights into how varying flow regimes influence habitat quality and availability within the Shoshone Reach of the Colorado River. At Site 1, WUA generally increases with flow, peaking at approximately 2,000 cfs, dependent on species. Beyond this range, suitability scores plateau and slightly decline at maximum discharge flows, primarily due to reductions in velocity suitability. Despite this plateau or slight decline in suitability scores at the highest discharge flows, the wetted area continues to increase, providing additional habitat that helps offset minor reductions in overall hydraulic habitat suitability that is observed beyond and at the higher range of discharge flows. Additionally, the two large pools at Site 1 provide quality habitat for all fish species.

In comparison, WUA at Site 2 continues to improve as flows increase through higher discharge flow scenarios up to the highest modeled flow of 3,000 cfs. This outcome is likely due to the greater habitat complexity at Site 2, which provides a diverse array of hydraulic conditions and microhabitats throughout all flows. For example, wetted area at Site 2 almost doubles from 50 to 700 cfs and continues to increase steadily up to the highest flow modeled. Features such as large boulders, cobble substrates, an island complex, and deep pools contribute to a wider range of depth and velocity conditions, as compared to Site 1, that remain suitable for fish across a broader range of flows. These instream structural attributes not only enhance habitat suitability but also provide critical velocity refuges and feeding zones during high flows in high gradient reaches, further supporting both the modeled and other aquatic species. For example, Brown and Rainbow trout WUA continues to increase at the highest modeled flows (e.g., 2,500 and 3,000 cfs), while Mountain Whitefish and Flannelmouth Sucker WUA plateaus at similar modeled discharges.

The geomorphic characteristics of Site 2 also play a significant role in shaping the hydraulic responses to increasing flows. Site 2's physical diversity promotes steady increase in WUA as flows increase, avoiding the leveling off and slight declines in velocity suitability observed at Site 1. This enhanced connectivity between habitats allows fish to exploit newly wetted areas that are unavailable under lower flow conditions. The expansion of wetted area at higher flows further supports primary (e.g., algae) and secondary (e.g., aquatic macroinvertebrate) production, both of which form the foundation of the river's food web.

The site-specific differences observed in the analysis illustrate the critical role of local channel morphology in shaping hydraulic conditions and habitat availability. These results highlight the ecological benefits of the Shoshone Reach's physical heterogeneity in supporting a range of flows for multiple species.

Although hydraulic suitability scores are a valuable tool for evaluating relative habitat quality, they likely underrepresent the ecological benefits of increased flows for fish and other aquatic species within high gradient, confined canyon reaches like the Shoshone Reach. The abundant velocity refuges created by large boulders and cobble substrates provide microhabitats that are not fully captured in the two-dimensional hydraulic model. These microhabitat pockets, located behind large boulders and cobble substrate, offer shelter for fish, particularly during high flows, reducing the energetic costs of maintaining instream position while also providing foraging opportunities along velocity seams. While the hydraulic model used in this assessment effectively quantifies depth and velocity relationships, it does not account for the influence of substrate and cover

features on microhabitat diversity, or geomorphic benefits of higher flows including flushing fine sediment, maintaining habitat diversity, and recruitment of wood and organics.

The HHS results emphasize the ecological benefits of higher flows within the Shoshone Reach. While flows in the range of 1,500 to 2,250 cfs maximize hydraulic habitat suitability for modeled species at Site 1, the continued increase in wetted area at higher flows supports expanded habitat availability and off-channel (not wetted at lower flows [e.g., under 700 cfs]) connectivity, particularly in reaches with greater habitat complexity, such as Site 2. Higher flow conditions, particularly at Site 2, benefit fish populations and broader aquatic ecosystems by enhancing habitat diversity (e.g., wetting off-channel areas with higher flows) and supporting critical ecological processes.

Microhabitat Features and Interstitial Space

Fish microhabitat use involves interactions of habitat features, behavior, and ecology. Trout benefit from large substrates like boulders and cobbles, which provide shelter, foraging opportunities, and refuge from strong currents. Trout prefer lower flow areas but utilize faster currents as needed. Riffles are essential for food production. Species like Brown and Rainbow Trout favor complex substrates in high-gradient streams for predator evasion and efficient feeding. They seek refuge in areas with slower water and adjust their positions based on flow conditions. The riverbed's stability during high flows can influence available trout refuges.

The influence of hydraulic conditions on habitat selection is significant. Studies have shown that adult Brown Trout can occupy microhabitats with relatively high stream velocities, although juveniles typically favor lower velocities (Raleigh et al., 1984 & 1986). Additionally, the availability of cover, such as woody debris and boulders, plays a critical role in habitat selection, providing both protection from predators and a reliable environment for feeding and growth (Ayllón et al., 2008). The interaction between flow regimes and habitat use is essential for understanding trout behavior in high-velocity rivers. Research indicates that trout from rivers with highly irregular flow patterns are more adaptable and willing to shift habitats compared to those in stable environments (Ayllón et al., 2013). This adaptability is vital for their resilience in fluctuating habitats, allowing them to exploit spatially distinct refugia during periods of high flow (Ayllón et al., 2013). The presence of these substrates can significantly influence the distribution and abundance of trout populations. For example, studies have shown that juvenile trout often seek shelter in boulder-sheltered positions, while older individuals may prefer visually isolated areas along river margins (Ayllón et al., 2008; Ayllón et al., 2010). This behavior is particularly pronounced in high-velocity environments, where the risk of displacement is greater, and the availability of refuge is critical for survival.

The instream microhabitat use by trout in high-velocity rivers is shaped by a multitude of factors, including physical habitat characteristics, hydraulic conditions, behavioral adaptations, and ecological interactions. The presence of interstitial spaces and large substrates plays a pivotal role in providing refuge and foraging opportunities.

Aquatic Invertebrates

A variety of macroinvertebrate species inhabit the Glenwood Canyon. These and other aquatic invertebrates provide important high value food sources for resident fish, birds, and bats and are an important component of the riverscape food web. Flow management is a critical determinant of macroinvertebrate community health. Research shows that reductions in instream flow can lead to increased sedimentation, elevated water temperatures, and lower dissolved oxygen levels, all of which can stress or exclude sensitive taxa like EPT (Poff et al., 1997; Biaou et al., 2024). Conversely, restoring and maintaining adequate instream flows and natural hydrograph

characteristics can enhance habitat conditions, water quality, and promote macroinvertebrate production. Scenario 2, Future with Permanency, would provide reliable flows that support a healthy macroinvertebrate community within the Shoshone Reach. Reliable annual flow would not only enhance the Shoshone Reach's overall ecological value, but potentially support a fishery on par with other world-renowned fisheries. Reliable annual flow volumes, like those proposed in Scenario 2, Future with Permanency, would promote resilient macroinvertebrate communities, supporting a thriving aquatic food web, and improve the Shoshone Reach capacity to function as a healthy fishery.

Fishery

Fish access the Shoshone Reach for seasonal movements, foraging, reproduction, and refuge. Its complex streambed creates microhabitats that provide shelter and feeding opportunities. The reach features both high-gradient and low-gradient areas, allowing fish to move between different velocity zones, enhancing passage and supporting various species.

In flow Scenario 2 (Future with Permanency), the habitat suitability in the Shoshone Reach is higher more often compared to Scenario 1 (Baseline) and Scenario 3 (Future without Permanency). This is because the water flows in this reach would more frequently fall within a higher HHS range for longer durations particularly in the later summer to fall period. The reliable annual flows provided under Scenario 2 (Future with Permanency) would also alleviate the stresses associated with habitat fragmentation that occurs at low flows and when water is diverted to support hydropower operations. Habitat fragmentation occurs when flow is insufficient to provide the depth required for fish species to be able to migrate between habitats. Habitat fragmentation is a common occurrence under existing conditions and can lead to fish kills (personal communication CPW, 2025). If fish get stranded in pools and air temperature and stream temperatures are elevated fish become stressed. This condition has led to CPW calling for salvage operations in the Shoshone Reach (personal communication CPW, 2025). Under Scenario 2 (Future with Permanency) salvage operations in the Shoshone Reach would be unlikely.

Summer Stream Temperatures & Winter Habitat

Preserving and improving the natural environment in the Shoshone Reach by providing reliable instream flow is likely to help regulate water temperatures, particularly during the summer months and early fall when ambient air temperatures are high, and warm spring inputs have the potential to elevate water temperatures. This reach of the Colorado River is listed as impaired for temperature under Section 303(d) of the Clean Water Act, suggesting that elevated temperatures may be affecting aquatic life. Higher flows can help buffer temperature fluctuations by increasing thermal mass and promoting greater mixing, potentially reducing the likelihood of localized thermal spikes. Additionally, increased flow volumes are likely to mitigate the influence of warm groundwater or thermal hot spring inputs by dispersing heat more effectively throughout the water column. Temperature regulation is particularly important for cold-water species such as Mountain Whitefish, Rainbow Trout, and Brown Trout, which are sensitive to thermal stress. Sustaining higher flows through the Shoshone Reach provides important thermal refugia for fish and other aquatic organisms, supporting overall ecosystem health and resilience in the face of warming trends and increasing climatic variability. Based on the three flow scenarios, Scenario 2 (Future with Permanency) would result in increased flows during these critical months compared to Scenarios 1 or 3. Critical flow periods in the Shoshone Reach are late summer (August) through fall (October), when stream flow is often low and ambient air temperatures and solar input is high.

Instream flows during the winter months could improve habitat conditions by increasing wetted area and enhancing holding and foraging opportunities for fish. At unnaturally low winter flows

when most, if not all, of the river flow is diverted through the penstocks, habitat availability can become significantly constrained, limiting the space available for fish to occupy and potentially increasing competition for resources. Additional flow would provide greater access to deep pools, velocity refuges, and complex habitat features, which are critical for fish survival during winter when metabolic rates are lower, and energy conservation is essential. By maintaining even modest instream flows (greater than 1,020cfs), the Shoshone Reach may support habitat complexity and improve overwinter survival rates, contributing to overall fish population stability and resilience.

5.2 CONCLUSION

The instream flow use of the Shoshone Water Rights will preserve and improve flow conditions through the Shoshone Reach and would provide direct ecological benefits by increasing aquatic habitat, fostering connectivity, and supporting primary and secondary production. The proposed instream flow uses within this reach would help regulate stream temperatures, maintain habitat complexity, and enhance the availability of critical refuges for fish, particularly during seasonal low-flow periods.

The assessment's key conclusion, which is the Shoshone Water Rights applied as an instream use would preserve and improve the ecological condition of the Shoshone Reach, is backed by habitat modeling results from two sites in the Shoshone Reach. HHS scores, WUA, and wetted area increase with flow. The complexity of the habitat—featuring boulders, cobble substrates, islands, and deeper pools—creates diverse conditions that support fish habitat for all species at various flow levels, providing critical refuges and feeding zones. The trends of the two sites differ in overall habitat suitability due to their physical diversity. However, both sites provide suitable habitat for all species upwards of 1,500 cfs and above, underscoring the ecological benefits of permanent instream flows in the Shoshone Reach. The velocity refuges formed by boulders and cobble, which are often underrepresented in habitat suitability curves, provides essential microhabitats for several the fish species modeled. Indeed, higher flows enhance availability of wetted area and habitat connectivity (Site 2 specifically), benefiting fish populations and aquatic ecosystems overall.

Although HHS scores are useful in characterizing immediate and direct benefits to fish, they do not evaluate the ecological advantages of increased flows to habitat maintenance and water quality. The reliable annual flows provided by the Shoshone Water Rights, applied to instream use, would provide channel forming and water quality (primarily temperature) benefits that are not being realized under current conditions.

Under the proposed permanent instream flow scenario (Scenario 2, Future with Permanency) with preservation of the Shoshone Water Rights, HHS for fish in the Shoshone Reach would be higher more frequently (and therefore a greater WUA sq. ft./1,000 LF). Flow levels would more often remain within a high suitability range for extended periods and would provide greater flow during the critical late summer and early fall seasons when temperatures and other stressors are at their peak. The assessment's findings indicate that the use of the Shoshone Water Rights for instream flow would preserve and improve the natural environment of the Shoshone Reach up to the highest evaluated discharge of 3,000 cfs. This is demonstrated by Scenario 2 (Future with Permanency) as it would provide the most habitat on an average annual basis when compared to Scenario 1 (Baseline) or Scenario 3 (Future without Permanency). Further, Scenario 2 (Future with Permanency) would provide added habitat during critical late summer and early fall time periods when fish are more likely to be stressed by low flows and elevated temperatures.

The two study sites cover a mosaic of instream habitat characteristics that represent the overall Shoshone Reach. The diverse geomorphic features of both locations create a variety of flow conditions, which enhance habitat complexity, an essential factor for fish survival. The hydraulic connectivity between the sites enables fish to access newly wetted areas and different habitats under varying flow conditions.

At the same time, the Shoshone Water Rights provide benefits that extend beyond their immediate area. The Shoshone Water Rights would preserve flows necessary to support upstream and downstream ecosystems and will improve conditions dramatically within the Shoshone Reach. The Shoshone Water Rights strengthen regional economies by supporting outdoor recreation and tourism, while also playing a role in securing downstream water deliveries. As competition for water resources in the Colorado River Basin continues to intensify, the preservation of the Shoshone Reach Water Rights is a key strategy for balancing environmental and economic needs across the region while also maintaining the ecological integrity of the Shoshone Reach itself.

These water rights, if made permanent through the introduction of an alternate use for instream flow purposes, would preserve and improve the Shoshone Reach's natural environment. Without them, the river could experience rising temperatures, habitat degradation, and declining fish populations. The Shoshone Water Rights are an important factor for the survival and resilience of fish populations, the integrity of aquatic and terrestrial (i.e., riparian) habitats, and the long-term health of the Colorado River. A vital component of all aquatic systems is a connection to requisite resources throughout the year that supports all life-stages and strategy needs (food, clean water, velocity break, feeding zones, spawning habitat, etc.). The Shoshone Water Rights employed for in-stream use would provide a reliable and ecologically meaningful year-round flow that would support all aquatic species in the Shoshone Reach.

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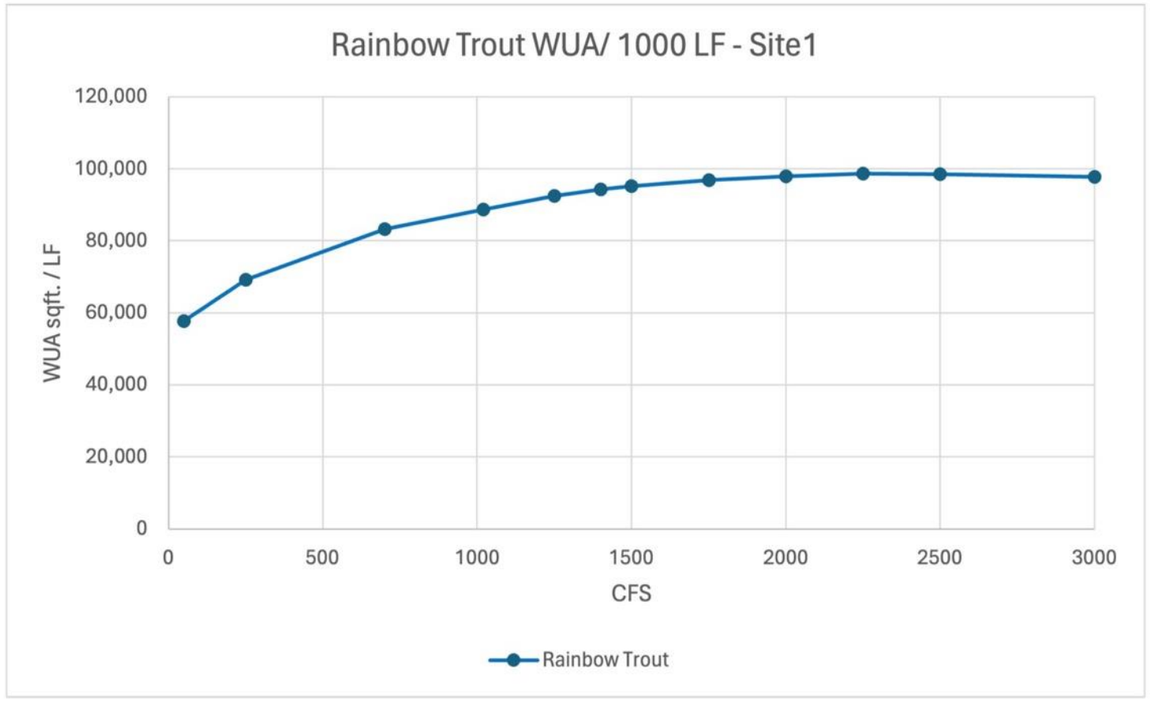
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APPENDIX A - Hydraulic Habitat Suitability Results, Maps and Weighted Useable Area Graph



Study Site 1 Habitat Suitablity

Adult Rainbow Trout



Graph of Weighted Useable Area (WUA Sq. Ft. / LF.) for Adult Rainbow Trout at Site 1 per Discharge (cfs).

Figure A-1: Study Site 1 - Hydraulic Habitat Suitability and WUA Adult Rainbow Trout

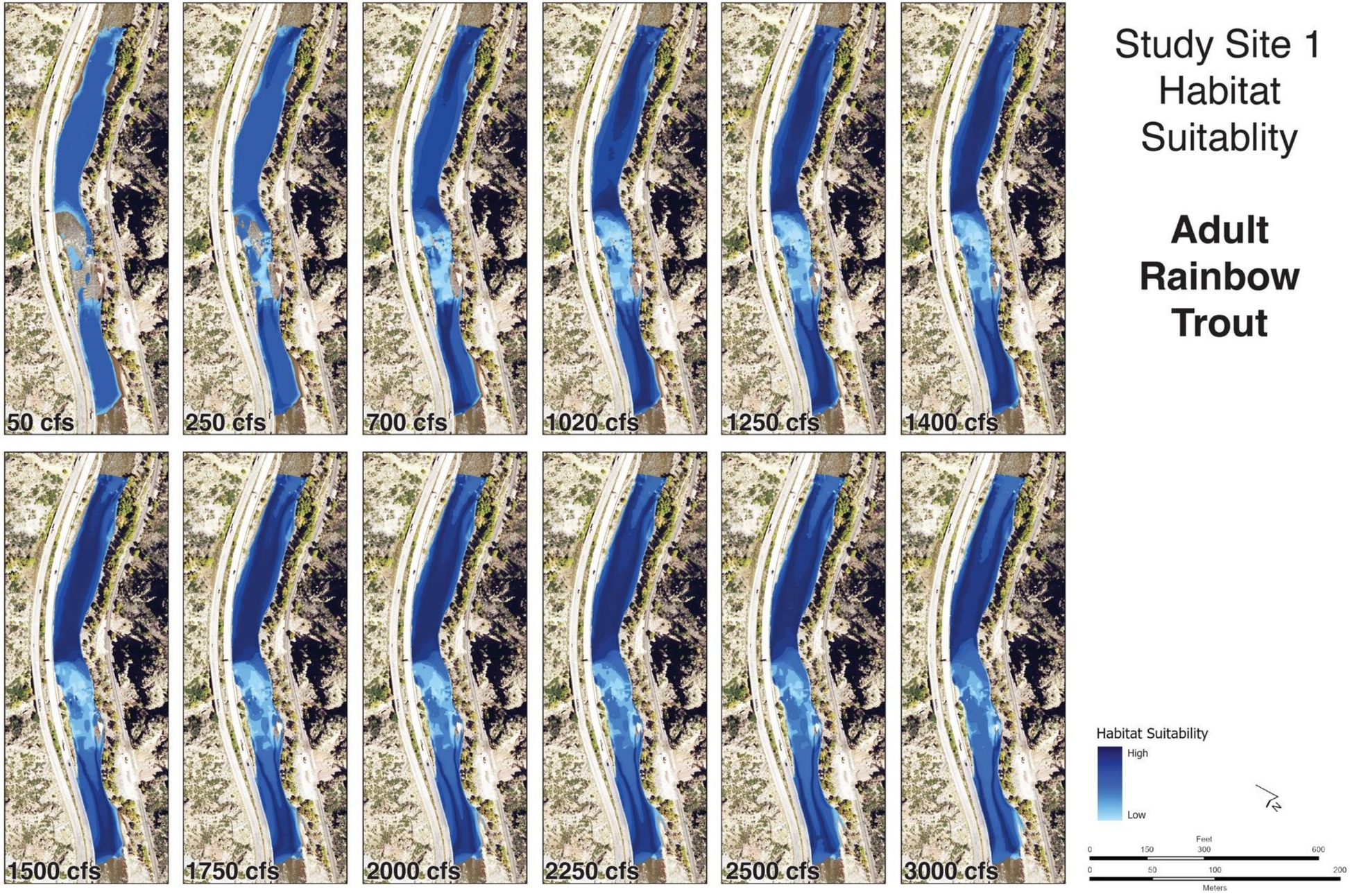
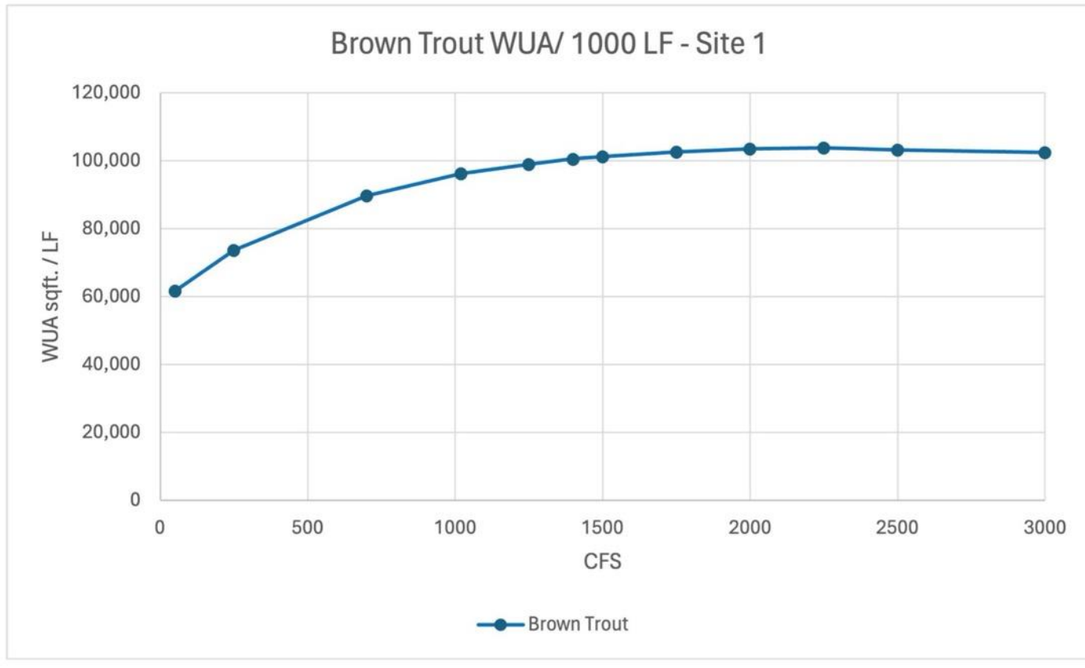


Figure A-2: Study Site 1 - Adult Rainbow Trout HHS Maps per Flow (cfs)



Study Site 1 Habitat Suitablity

Adult Brown Trout



Graph of Weighted Useable Area (WUA Sq. Ft. / LF.) for Adult Brown Trout at Site 1 per Discharge (cfs).

Figure A-3: Study Site 1 - Hydraulic Habitat Suitability and WUA Adult Brown Trout

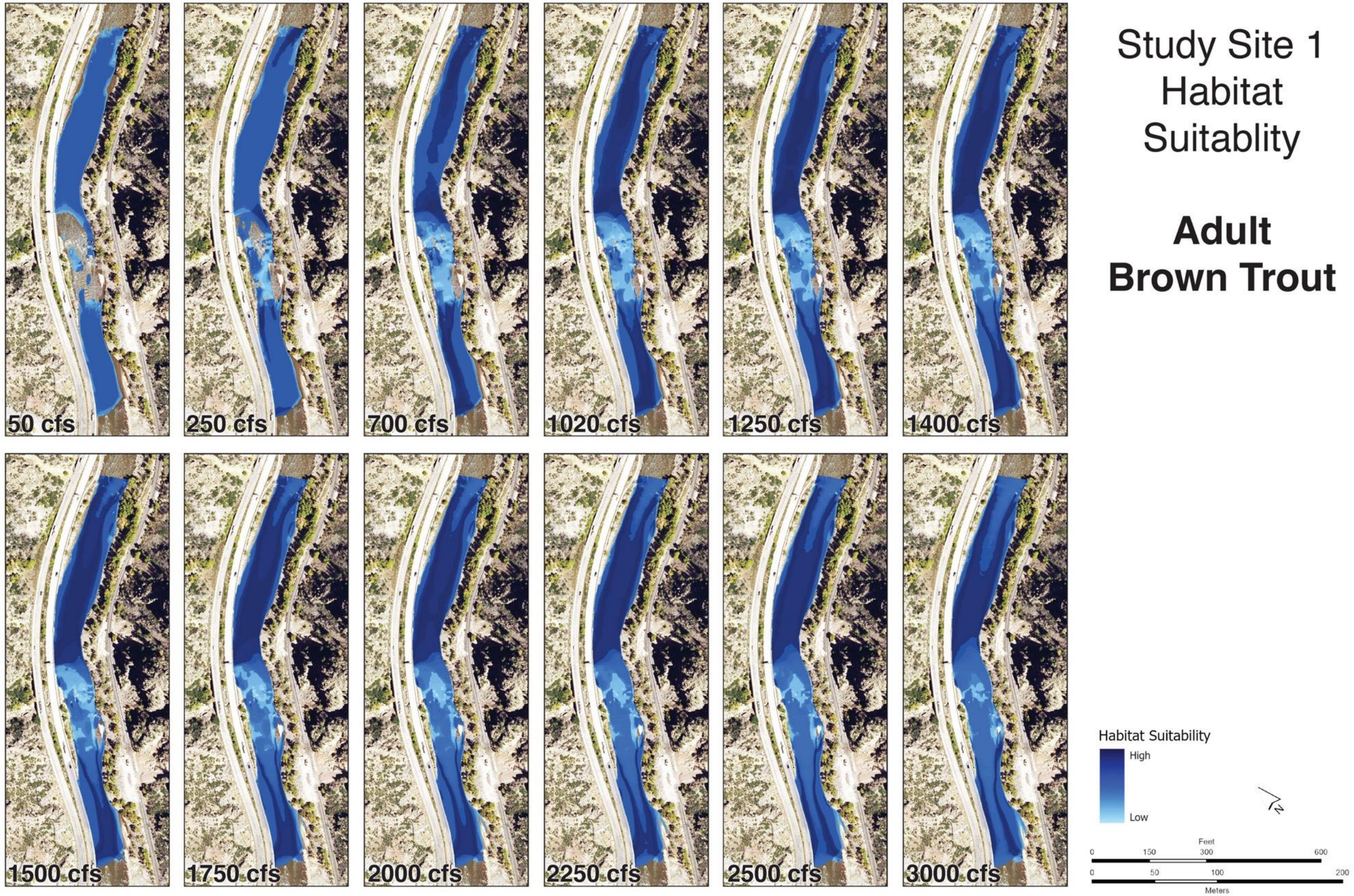
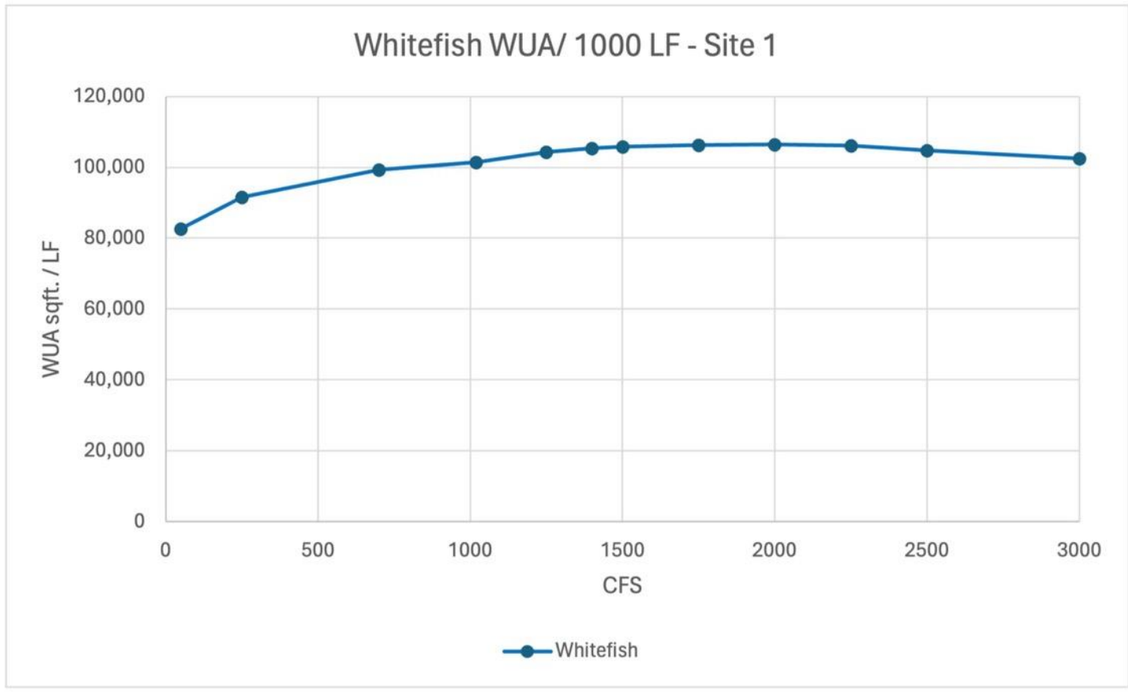


Figure A-4: Study Site 1 - Adult Brown Trout HHS Maps per Flow (cfs)





Graph of Weighted Useable Area (WUA Sq. Ft. / LF.) for Adult Mountain Whitefish at Site 1 per Discharge (cfs).

Figure A-5: Study Site 1 - Hydraulic Habitat Suitability and WUA Adult Mountain Whitefish

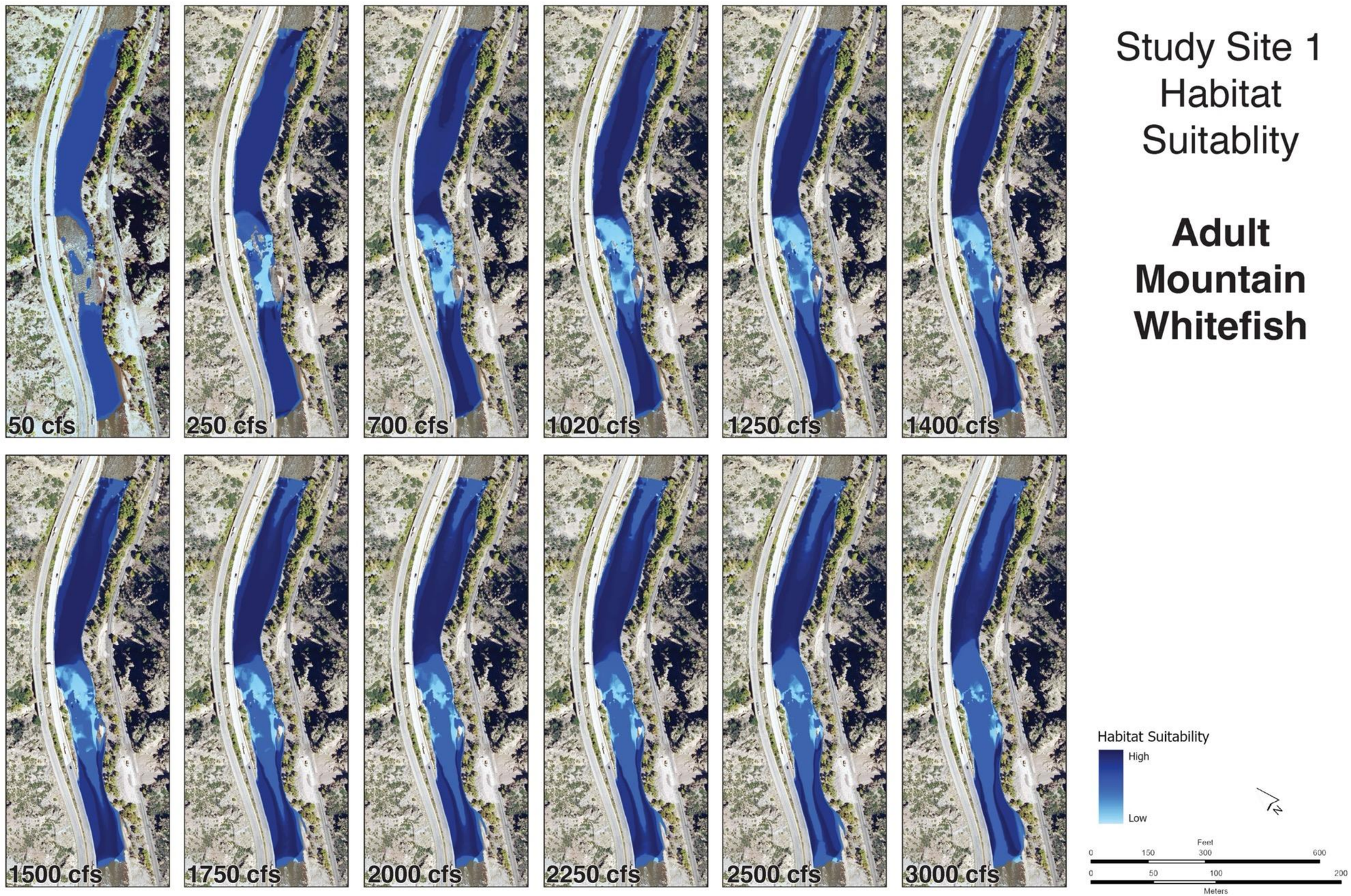
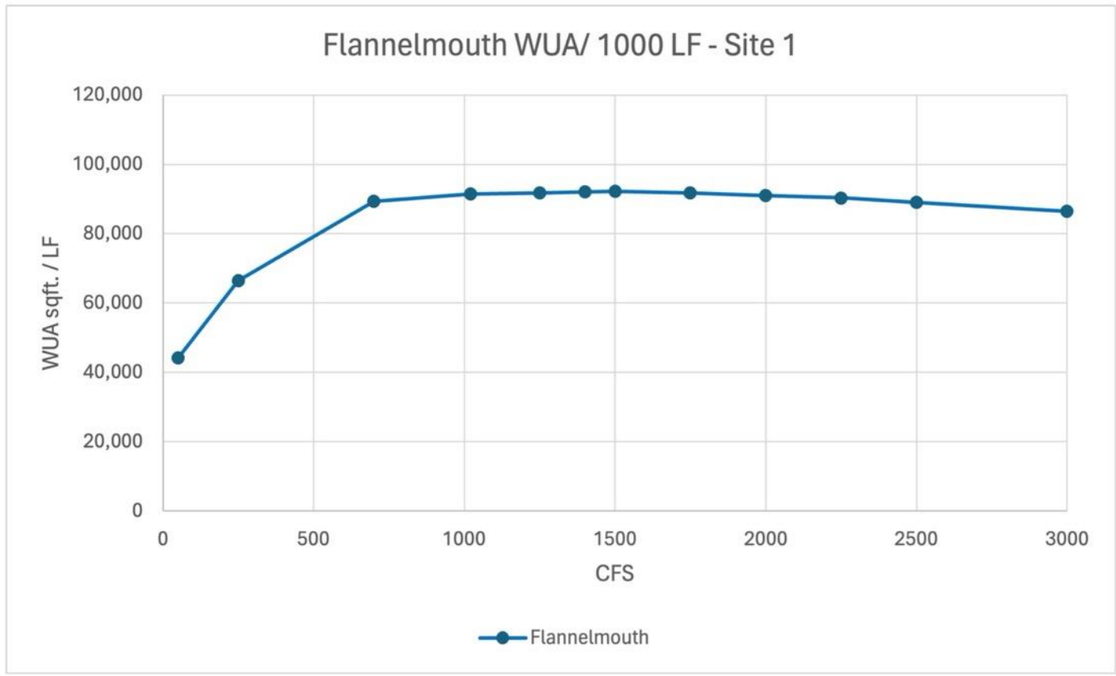


Figure A-6: Study Site 1 - Adult Mountain Whitefish HHS Maps per Flow (cfs)





Graph of Weighted Useable Area (WUA Sq. Ft. / LF.) for Adult Flannelmouth Sucker at Site 1 per Discharge (cfs).

Figure A-7: Study Site 1 - Hydraulic Habitat Suitability and WUA Adult Flannelmouth Sucker

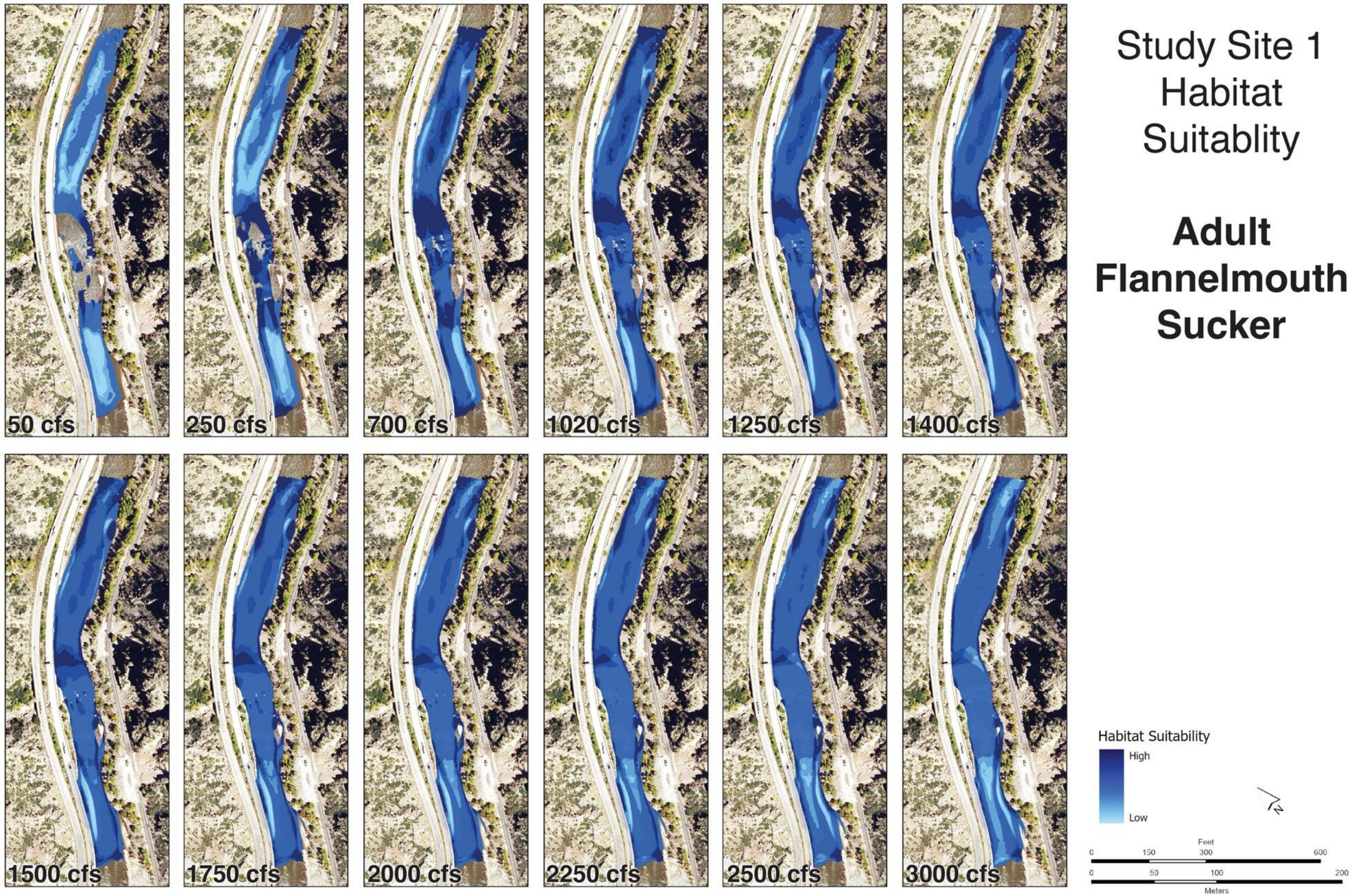
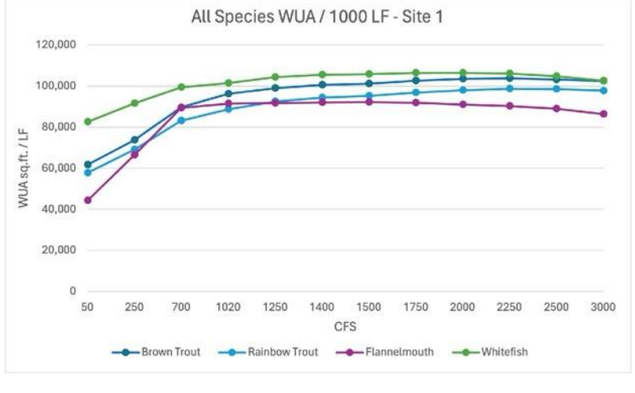
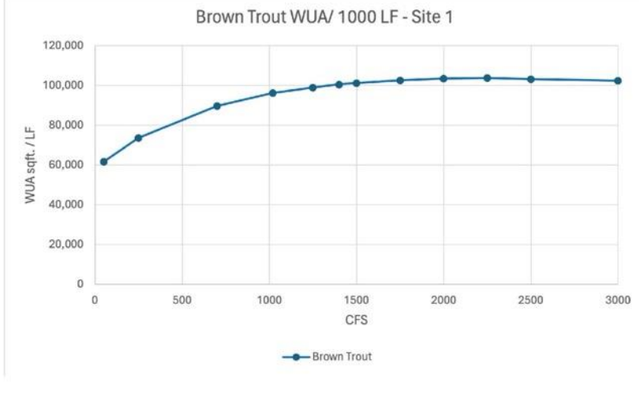
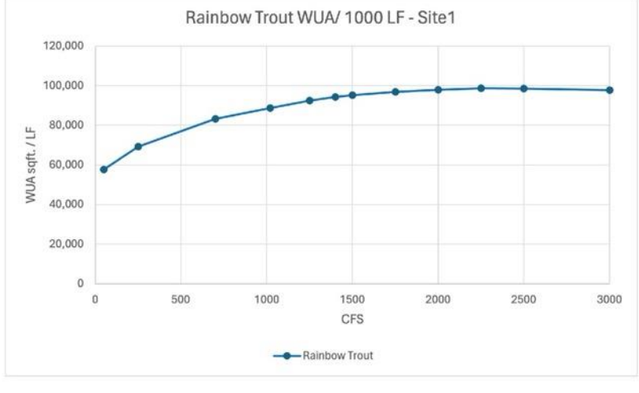


Figure A-8: Study Site 1 - Adult Flannelmouth Sucker HHS Maps per Flow (cfs)

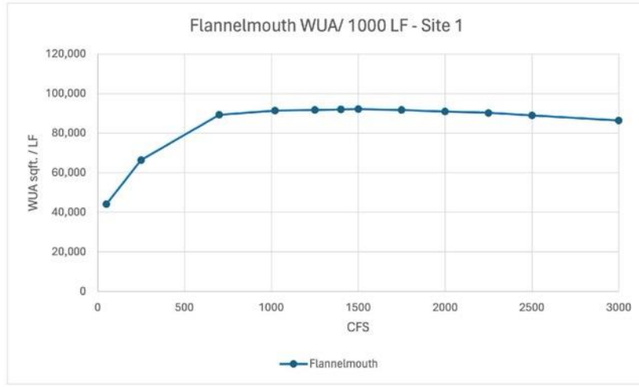
Study Site 1 Habitat Suitablity

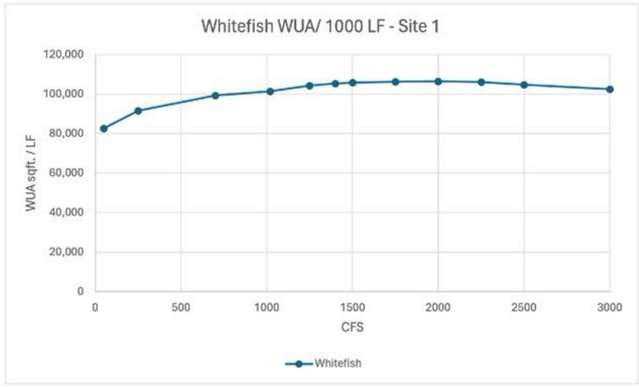












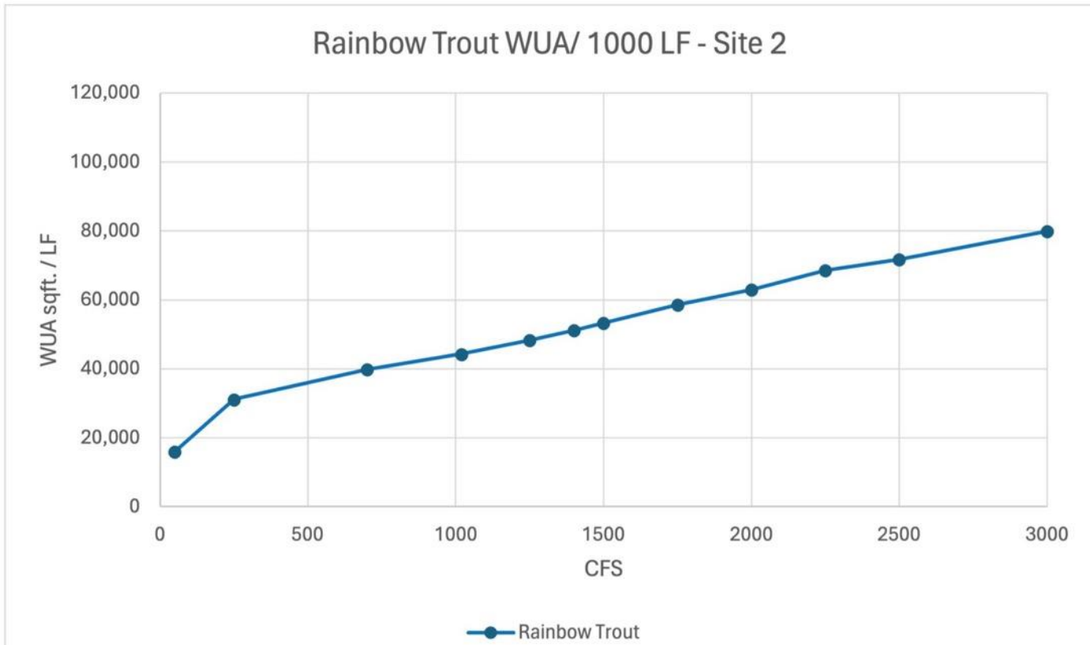
Graphs of Weighted Useable Area (WUA Sq. Ft. / LF.) for all species at Site 1 per Discharge (cfs).

Figure A-9: Study Site 1 - WUA All Species



Study Site 2 Habitat Suitablity

Adult Rainbow Trout



Graph of Weighted Useable Area (WUA Sq. Ft. / LF.) for Adult Rainbow Trout at Site 2 per Discharge (cfs).

Figure A-10: Study Site 2 - Hydraulic Habitat Suitability and WUA Adult Rainbow Trout

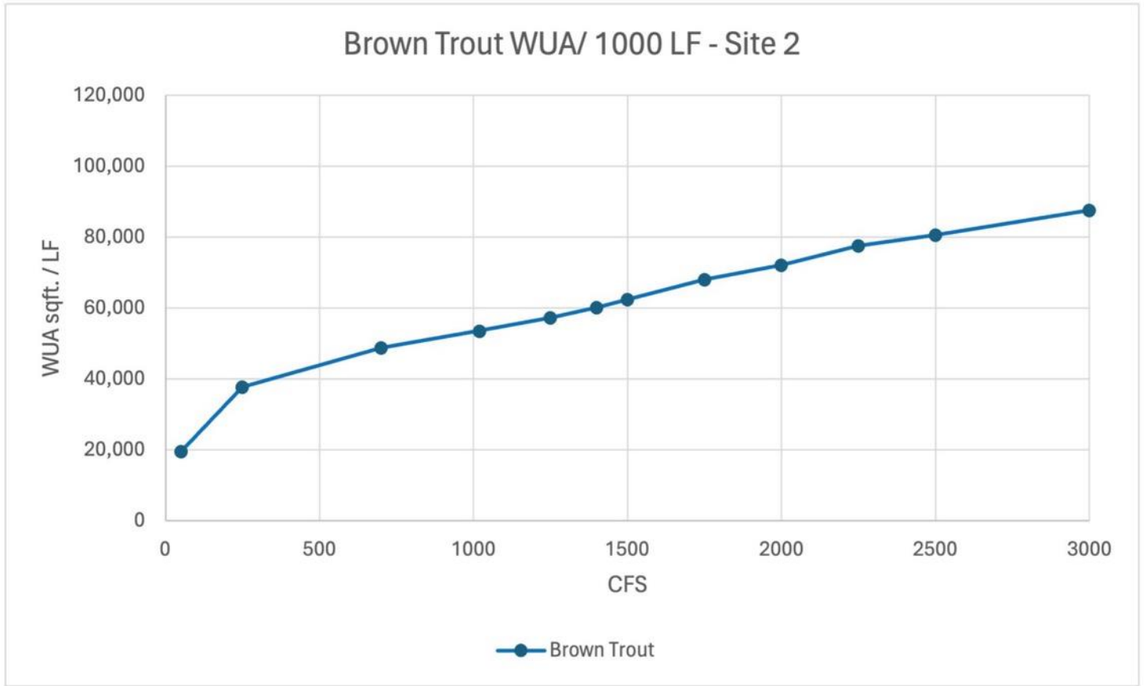


Figure A-11: Study Site 2 - Adult Rainbow Trout HHS Maps per Flow (cfs)



Study Site 2 Habitat Suitablity

Adult Brown Trout



Graph of Weighted Useable Area (WUA Sq. Ft. / LF.) for Adult Brown Trout at Site 2 per Discharge (cfs).

Figure A-12: Study Site 2 - Hydraulic Habitat Suitability and WUA Adult Brown Trout

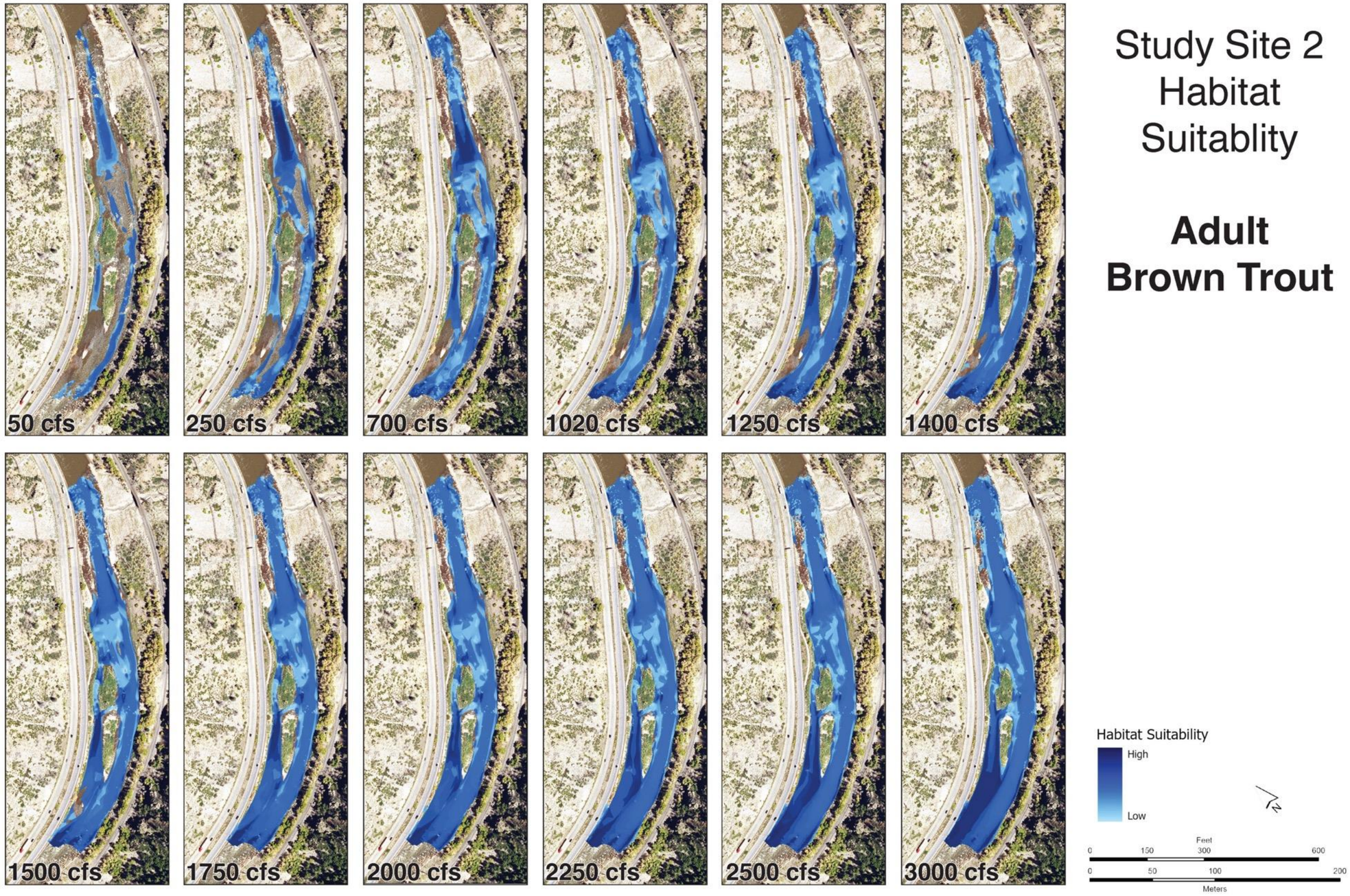
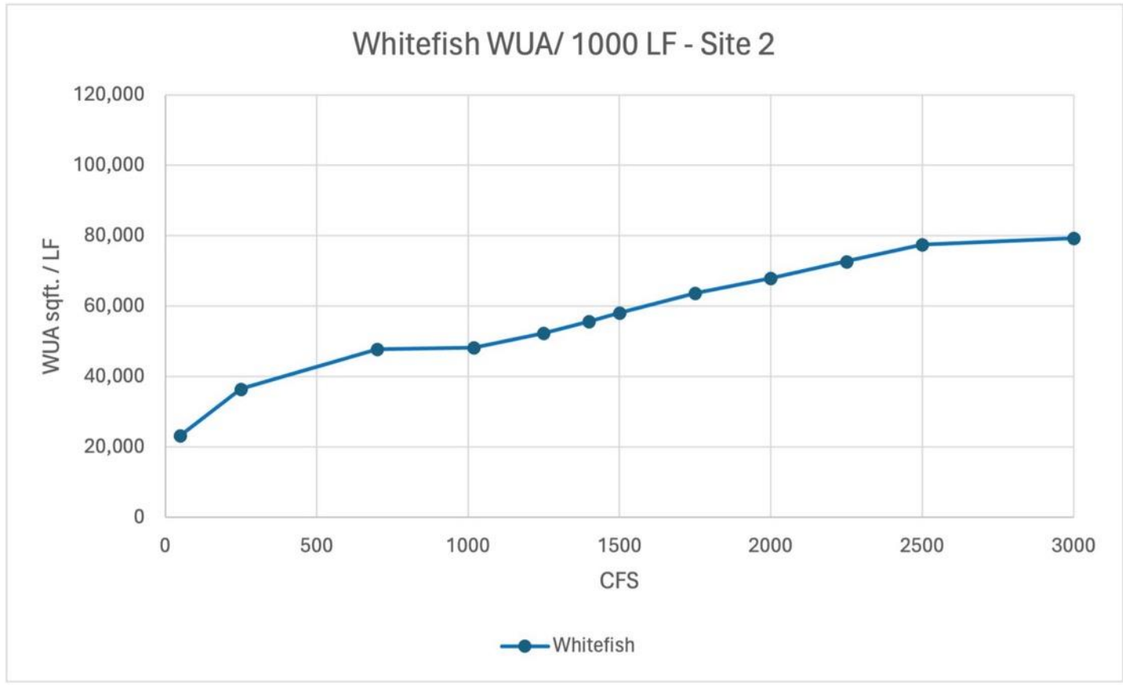


Figure A-13: Study Site 2 - Adult Brown Trout HHS Maps per Flow (cfs)



Study Site 2 Habitat Suitablity

Adult Mountain Whitefish



Graph of Weighted Useable Area (WUA Sq. Ft. / LF.) for Adult Mountain Whitefish at Site 2 per Discharge (cfs).

Figure A-14: Study Site 2 - Hydraulic Habitat Suitability and WUA Adult Mountain Whitefish

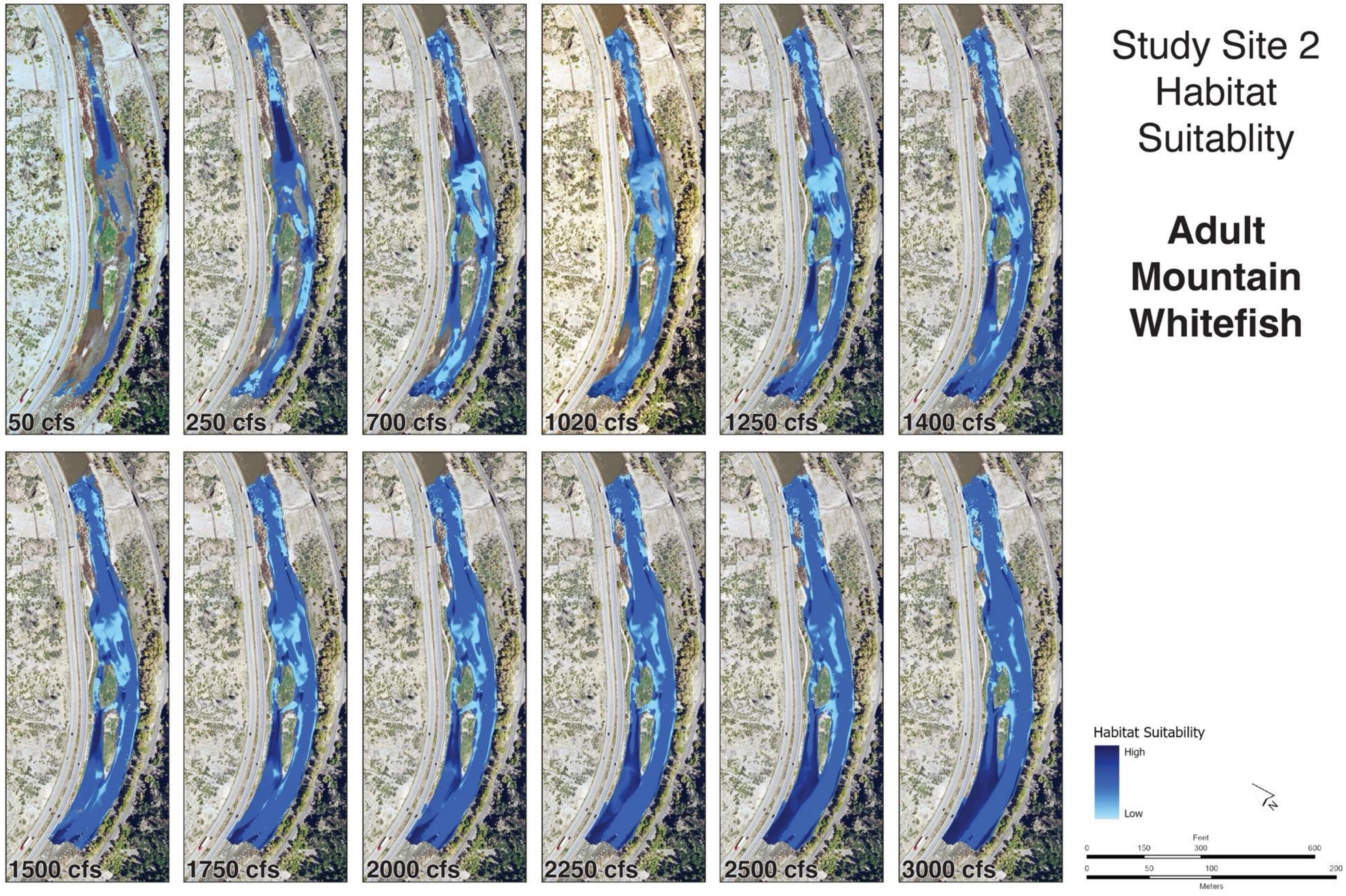
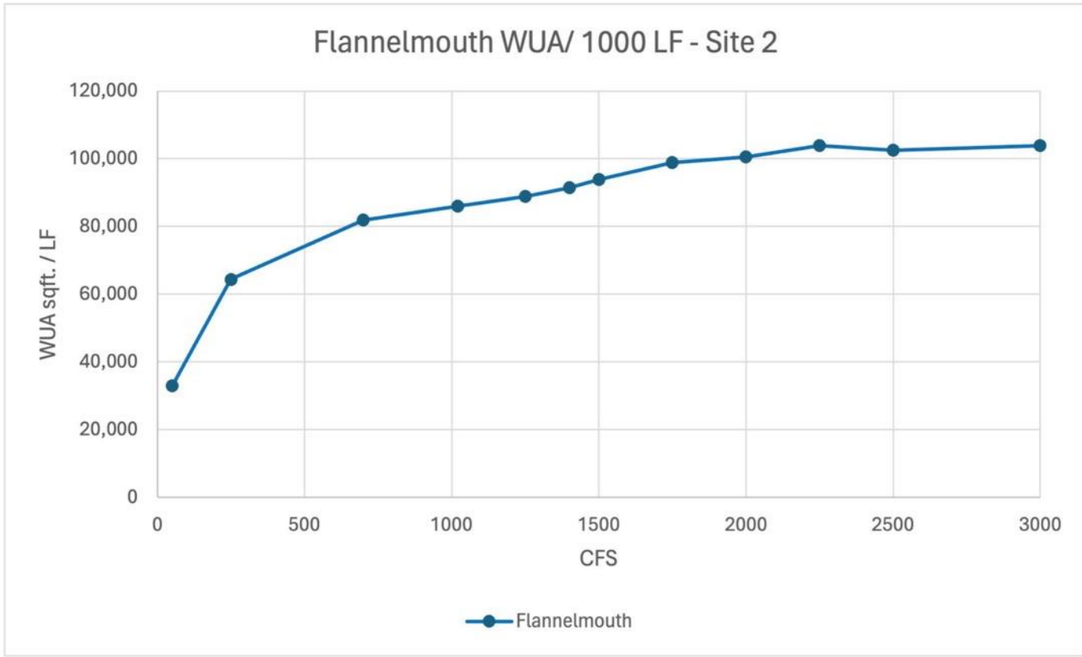


Figure A-15: Study Site 2 - Adult Mountain Whitefish HHS Maps per Flow (cfs)



Study Site 2 Habitat Suitablity

Adult Flannelmouth Sucker



Graph of Weighted Useable Area (WUA Sq. Ft. / LF.) for Adult Flannelmouth Sucker at Site 2 per Discharge (cfs).

Figure A-16: Study Site 2 - Hydraulic Habitat Suitability and WUA Adult Flannelmouth Sucker

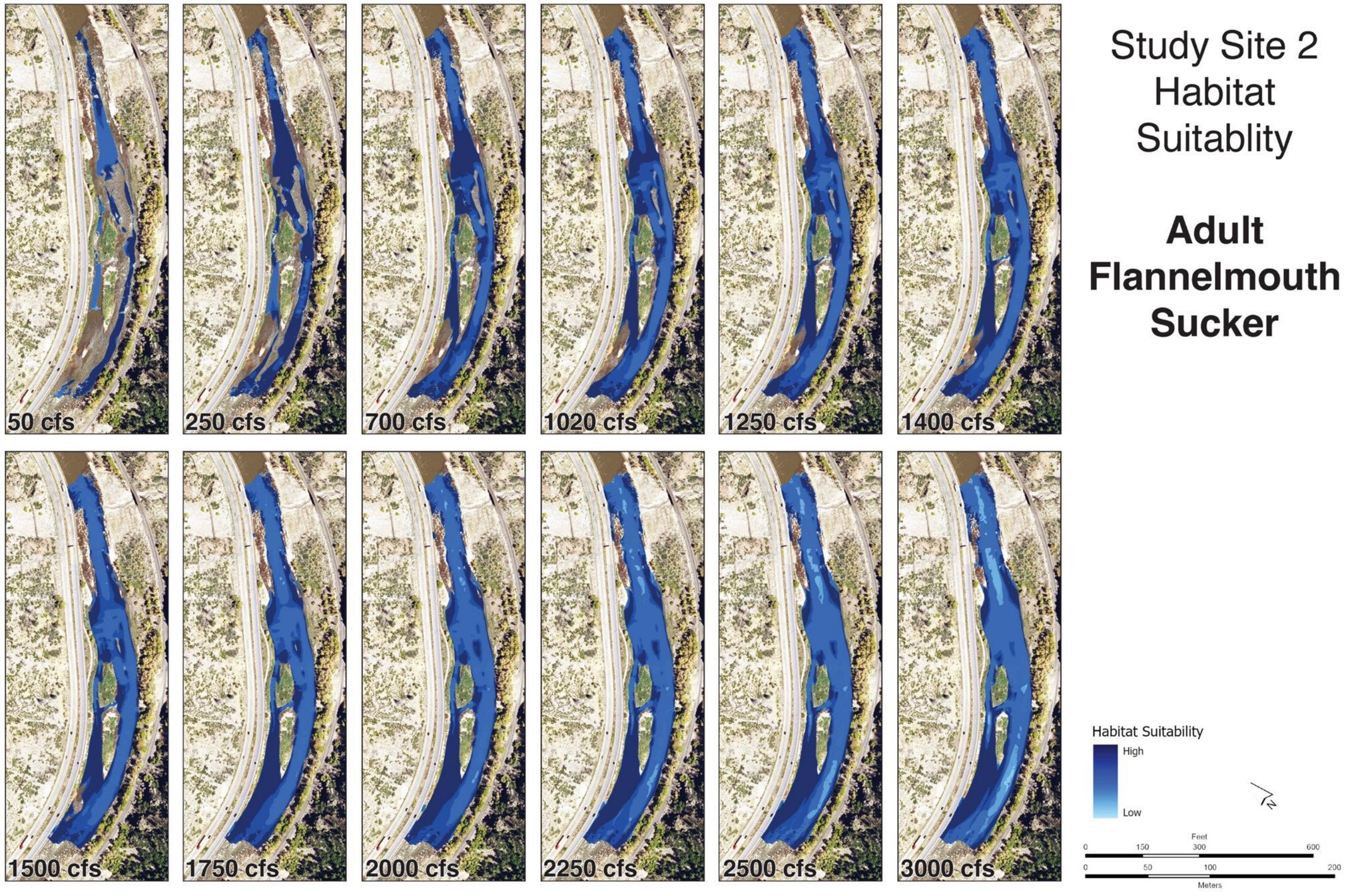
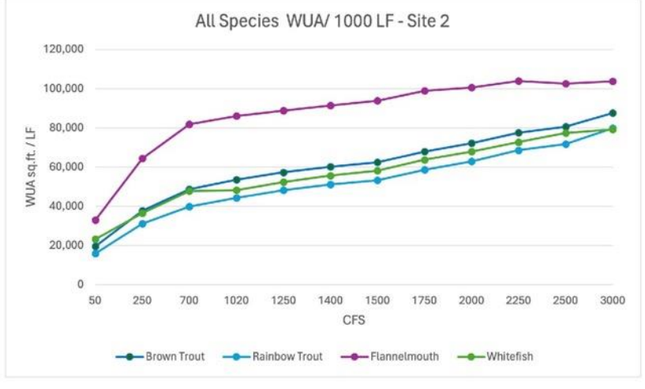
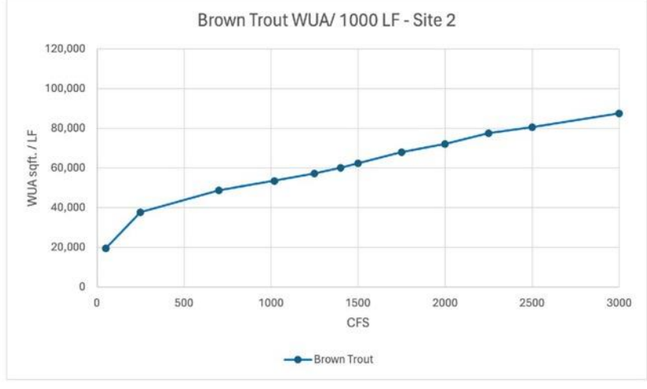
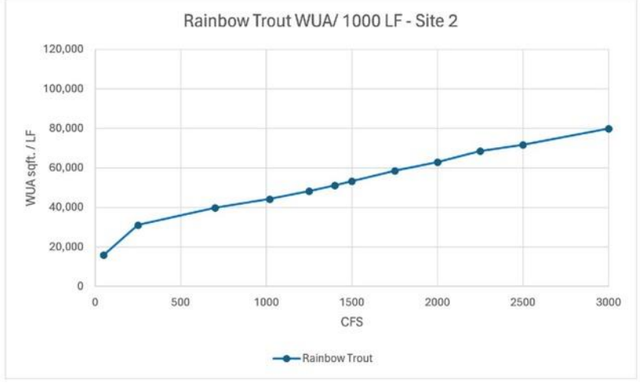


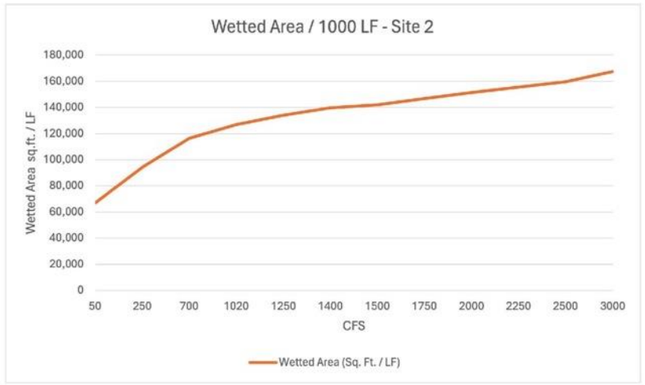
Figure A-17: Study Site 2 - Adult Flannelmouth Sucker HHS Maps per Flow (cfs)

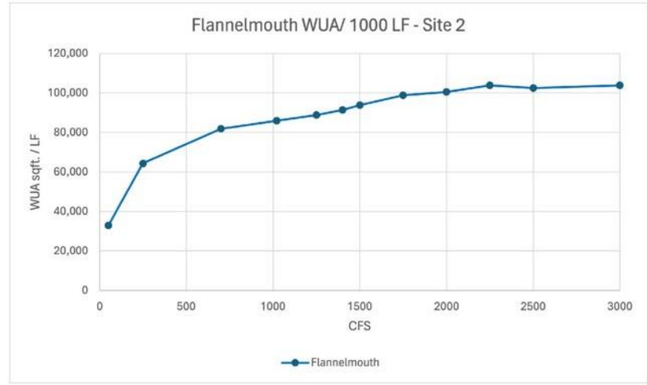
Study Site 2 Habitat Suitablity

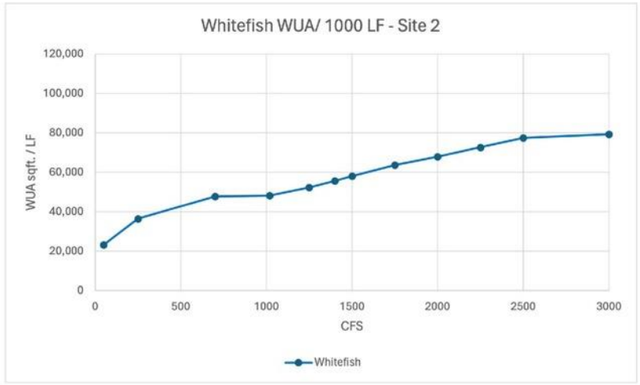








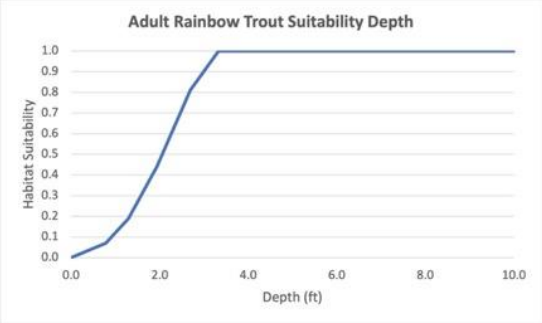




Graphs of Weighted Useable Area (WUA Sq. Ft. / LF.) for all species at Site 2 per Discharge (cfs).

Figure A-18: Study Site 2 - WUA All Species

APPENDIX B – SPECIES Suitability Curves



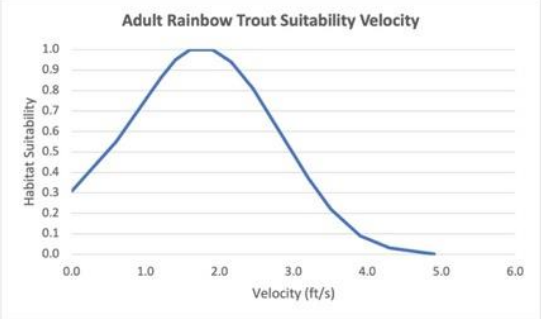
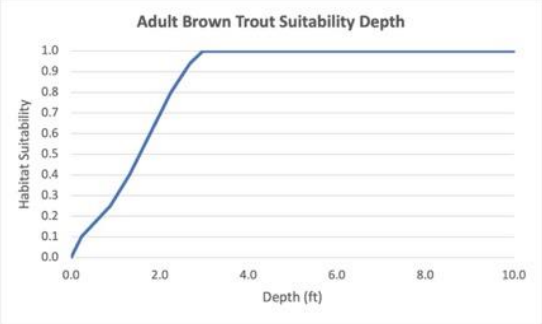


Figure B-1: Adult Rainbow Trout Suitability Curves (Depth and Velocity)



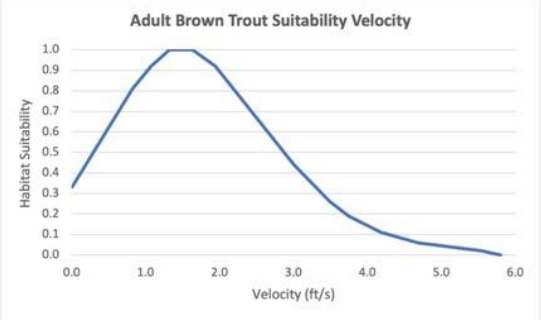
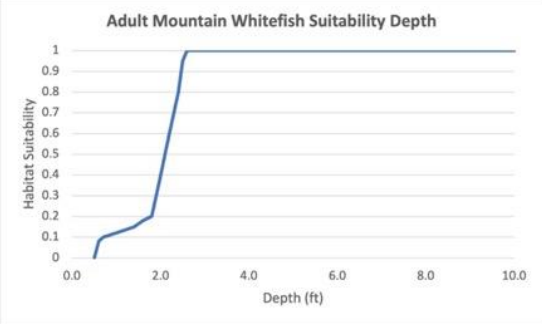


Figure B-2: Adult Brown Trout Suitability Curves (Depth and Velocity)



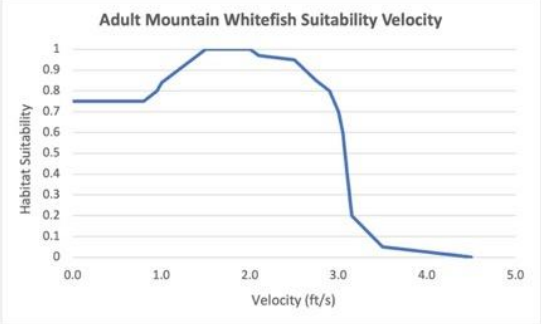
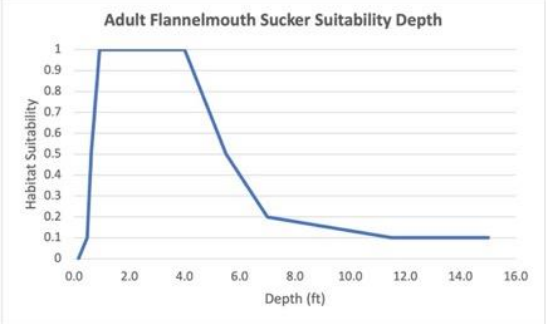


Figure B-3: Adult Mountain Whitefish Suitability Curves (Depth and Velocity)



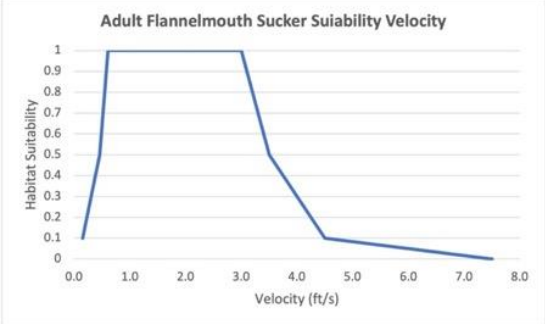


Figure B-4: Adult Flannelmouth Sucker Suitability Curves (Depth and Velocity)

APPENDIX C – HYDRAULIC MODELING AND HYDROGRAPHIC SURVEY REPORTS

Hydraulic Modeling Report – 2023. Prepared by Riverrestoration.org, December 2023.

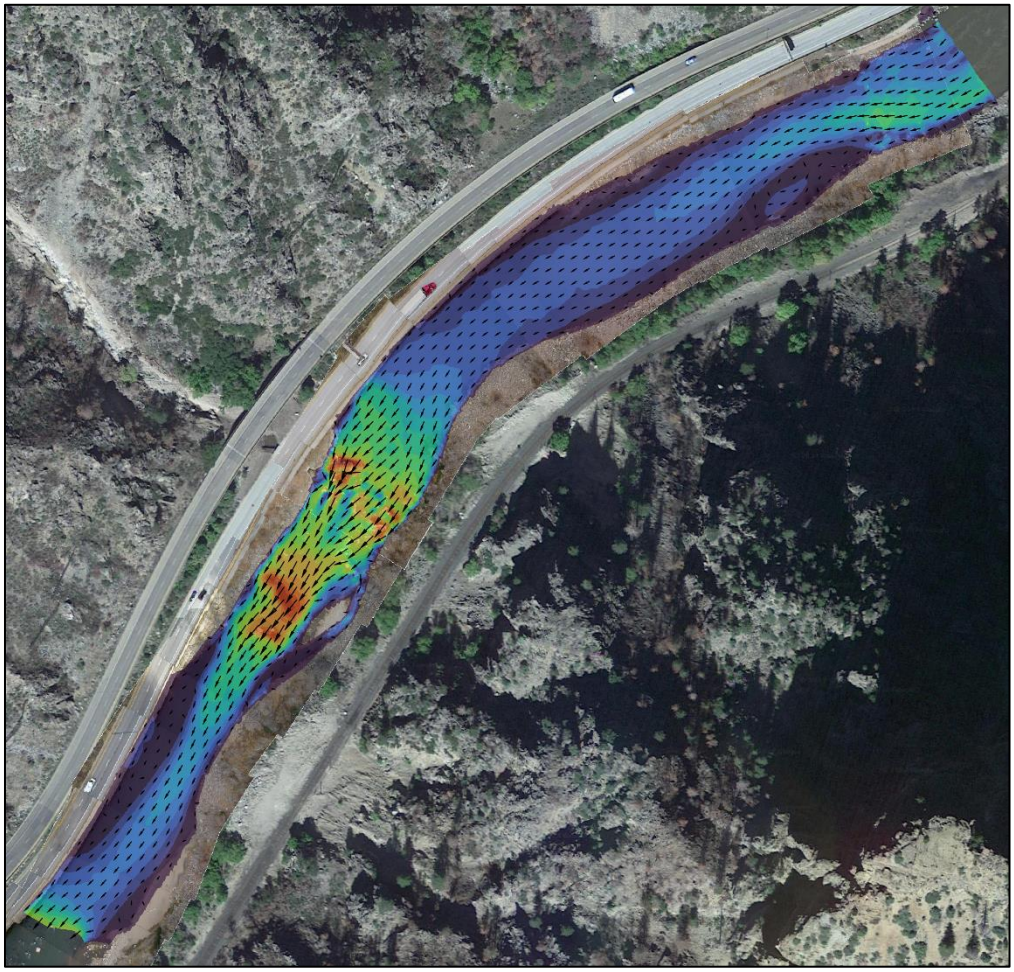
Hydrographic Survey Report – 2023. Prepared by Riverrestoration.org, January 2024.

Hydraulic Modeling Report – 2024. Prepared by Riverrestoration.org, January 2025.

Hydrographic Survey Report – 2024. Prepared by Riverrestoration.org, January 2025.

GLENWOOD CANYON AQUATIC HABITAT STUDY
COLORADO RIVER, COLORADO

HYDRAULIC MODELING REPORT – 2023



PREPARED BY RIVERRESTORATION.ORG, DECEMBER 2023

Corresponding authors: Jason Carey, PE – Project Manager – jason.carey@riverrestoration.org
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RESULTS DATA APPENDICES

GlenwoodCanyon_DEM_ft.tif
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1. INTRODUCTION

A 2 dimensional (2D) hydrodynamic model was used to simulate a variety of low flow conditions for a study reach on the Colorado River in Glenwood Canyon. The model was based on a digital elevation model (DEM) developed from hydrographic survey data collected over an 1854 foot reach (Figure 1). The goal was to provide spatially discrete data and weighted values of water depth, velocity, shear stress, and a Froude value for use in a usable habitat analysis.

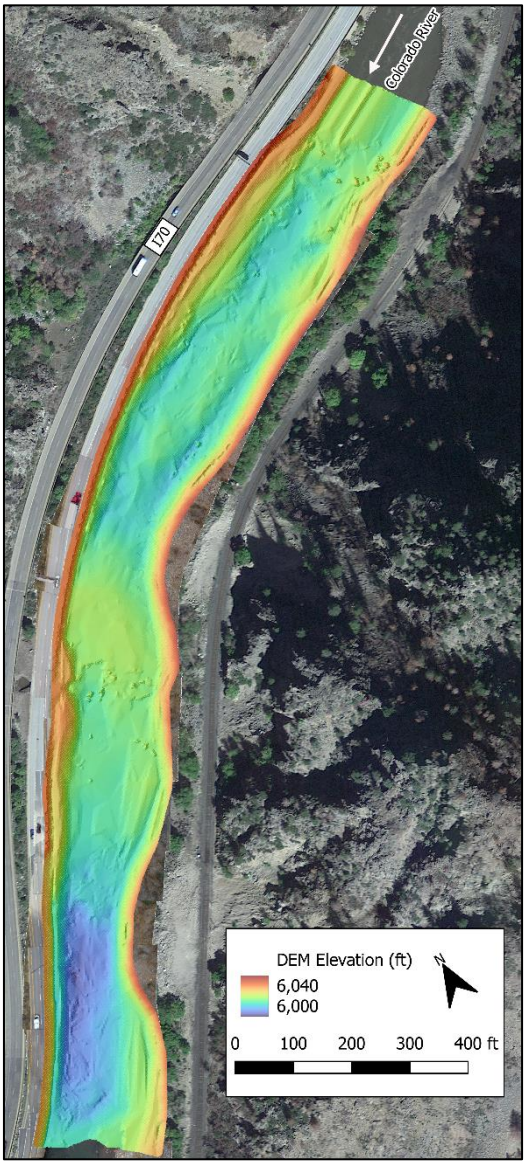


Figure 1. Glenwood Canyon model domain DEM

2. MODELING METHODOLOGY

2.1. Model Overview

Hydrographic survey data (see Glenwood Canyon Survey Report) was used to develop a DEM for the study reach. Point elevations and breaklines were used to characterize bed features like pools, rapids, and individual boulder features. This DEM is available in a geotiff format in the associated data appendices. This DEM was converted into an irregular 2D mesh with a cell sides targeted to a length of 4' within the channel using SMS software. Due to the SMS software interpolating an irregular mesh, a range of cell side lengths were modeled. Both three and 4 sided cells exist in the irregular grid, leading to a range in cell areas. These cells represent the elevations of the bed and provides calculations locations with discrete boundaries for a solver to calculate a depth-averaged result within. Depth-averaged two-dimensional velocity modeling simulates hydraulics in the streamwise and lateral directions, averaging values through the water column in the vertical. SRH-2D is a two-dimensional numerical model widely implemented for hydraulic applications and was used to simulate conditions within the project reach.

The SRH-2D model requires a spatially distributed friction element in addition to elevation for each cell. This can be provided in the form of a Manning's n value layer. For the model, we used spatially discrete Manning's n values based on the bed sediments observed during the survey. The final values for each area can be found in Figure 2, these values were adjusted within a reasonable range during the model calibration process, discussed below.

The upstream end of the 2D mesh was artificially extrapolated 100' upstream. This is visible in Figure 1 where the channel geometry appears stretched. The extra 100' was added to provide an area for the modeled inflow to non-uniformly distribute before entering the area of interest in the model domain. The extrapolated geometry was developed with the upstream cross section of survey data copied to the

upstream location and directly interpolated in between. Results provided from the modeling process used for the habitat analysis excluded all values in this extrapolated area.

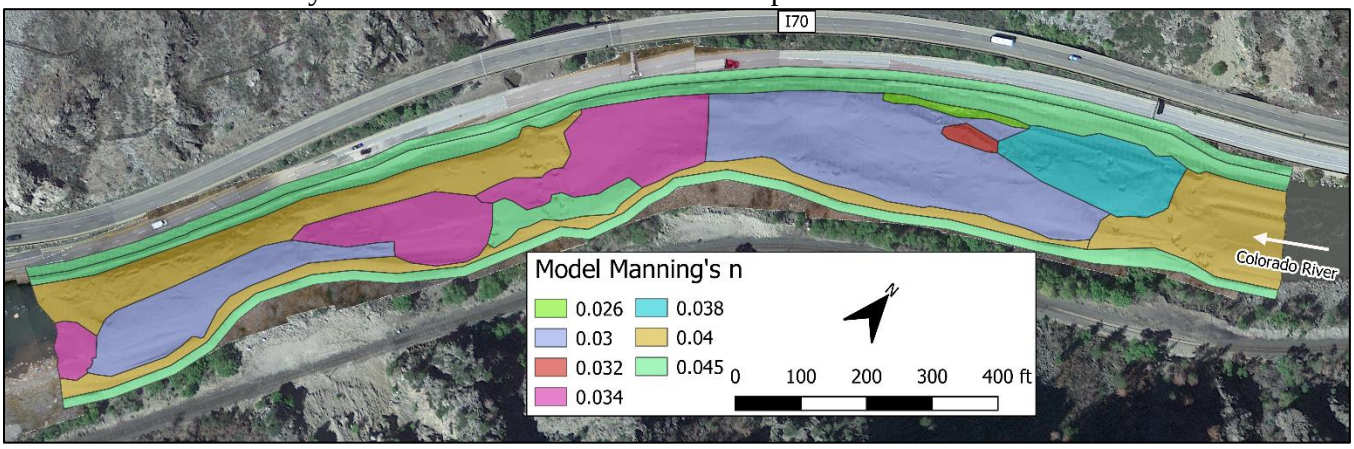


Figure 2. Final spatially distributed Manning's n values used in the SRH-2D hydraulic model

SRH-2D requires an upstream and downstream boundary condition. A steady flow rate was used as the upstream boundary condition for each different flow of interest and the model time was run until a steady state was achieved throughout the model domain. A constant water surface elevation (WSE) was used as the downstream boundary condition for each flow. The downstream boundary in the model domain was set at the crest of a rapid, where the flow exited the pool and passed through the critical state. A known water surface elevation was measured for the survey flow (1020 cfs) and used during the calibration process (discussed below). A 1D critical flow area equation (Eq. 1) based on the geometry of the downstream section of the model was used to calculate the water surface elevation boundary condition for each additional flow of interest. Flows of interest for this study were: 50 cfs, 250 cfs, 700 cfs, 1020 cfs (survey flow), 1250 cfs, 1400 cfs, and 3000 cfs.

Eq. 1 $$Q = \left(\frac{Area^3 * g}{Top\ Width}\right)^{1/2}$$

2.2.Model Calibration

The 2D hydraulic model was calibrated to WSE points captured during the survey flow of 1020 cfs. Calibration consisted of adjusting Manning's n values for different areas of the model within a reasonable range and adjusting the geometry of the DEM at observed control sections that were not sufficiently surveyed for bathymetric data. DEM adjustments were primarily focused on the grade controlling rapid in the middle of the survey area that impacted the large pool upstream and were a challenge to survey in great detail due to safety concerns in the field. The largest adjustment was made on the thalweg on the left side of the channel near the crest of each rapid, where conveyance needed to be increased to match the surveyed upstream water surface slope exiting the pool. After the calibration adjustments were made, the majority of the WSE calibration points were within +/- 0.2' of the model result (Figure 3), which is in line with the expected vertical accuracy of the survey. The majority of the outliers from this range, and the largest outliers, were in the steepest section of the rapid. Here, any given WSE in the model represents a smaller area of the channel. Additionally, less consistent WSE in rapids in the field decreases the accuracy of a given survey value. The large pools and areas of more gradually varying WSE slope all were well matched within the model. Mannings 'n' values were held consistent for all model runs between 50 cfs and 3,000 cfs based on the calibration at 1,020 cfs.

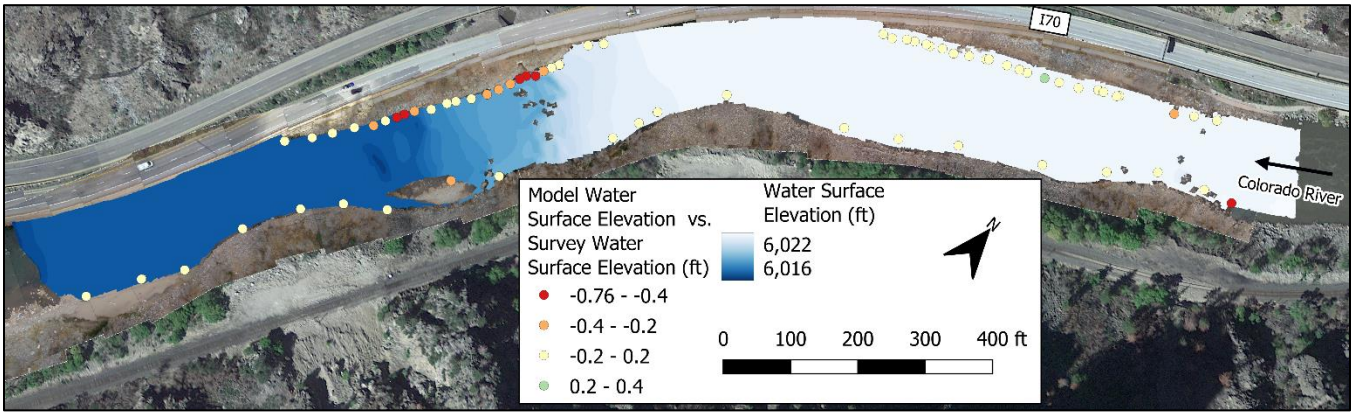


Figure 3. Model Calibration Results

3. RESULTS

3.1. Model Outputs

The model simulations were run until the flowrate into the model came to an equilibrium with the flow rate out of the model and was considered steady state. Results for each were then output for use in the habitat analysis. Results were sampled at the centroid location of each computation cell in the model 2D mesh (Figure 4). These cells represent areas ranging from less than 1 ft^2 to 70 ft^2, with the majority of the cells in the active channel between 5 ft^2 and 15 ft^2. Table 1 lists each of the hydraulic outputs that were sampled at the centroid of each cell.

Table 1. Model Outputs

Output	Unit
Cell Area	ft^2
Centroid X Coordinates	ft
Centroid Y Coordinates	ft
Bed Elevation	ft
Water Surface Elevation	ft
Water Depth	ft
Velocity in X direction	ft/s
Velocity in y direction	ft/s
Velocity Magnitude	ft/s
Froude Number	Dimensionless
Shear Stress	lb./ft^2

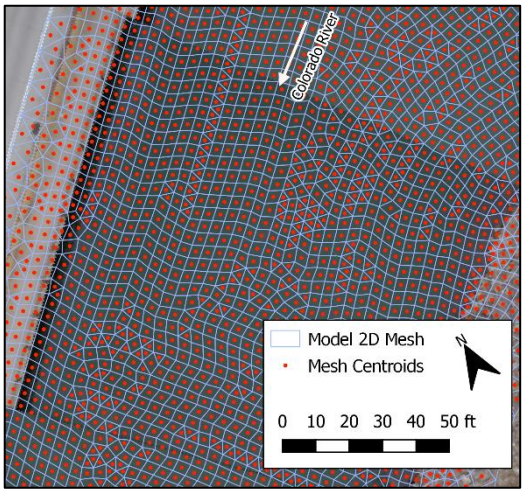


Figure 4. Glenwood Canyon model domain

3.2. Model Results Discussion

The model reach is bound on both sides by steep banks, including areas of vertical concrete in the highway embankment. Across the flow range evaluated the wetted flow area increased 23%. The largest changes in flow area occur around shallow areas of sand deposits near the up and downstream ends of the model as well as in some of the shallow cobble areas of the riffle in the middle of the model. The flow generally increases in velocity and depth as discharge increases (Figure 5). At the lowest modeled flow of 50 cfs

some unwetted areas emerge at the top of the rapid grade control that are larger than just single elevated boulders. At such extreme low flows, it may be reasonable to assume that some of the control section flow would be hyporheic flow between the large bed materials and infiltrate subsurface. The model also represents areas where the channel geometry is overhung by a suspended concrete bike path on the right bank in both pools. The modeled WSE in these areas remains several feet below the path elevations at the highest flow modeled for this analysis, 3000 cfs, but field observations have shown that extreme high flows in the river can reach these vertical obstructions, limiting the applicability of this model to flow levels less than or equal to 3,000 cfs.

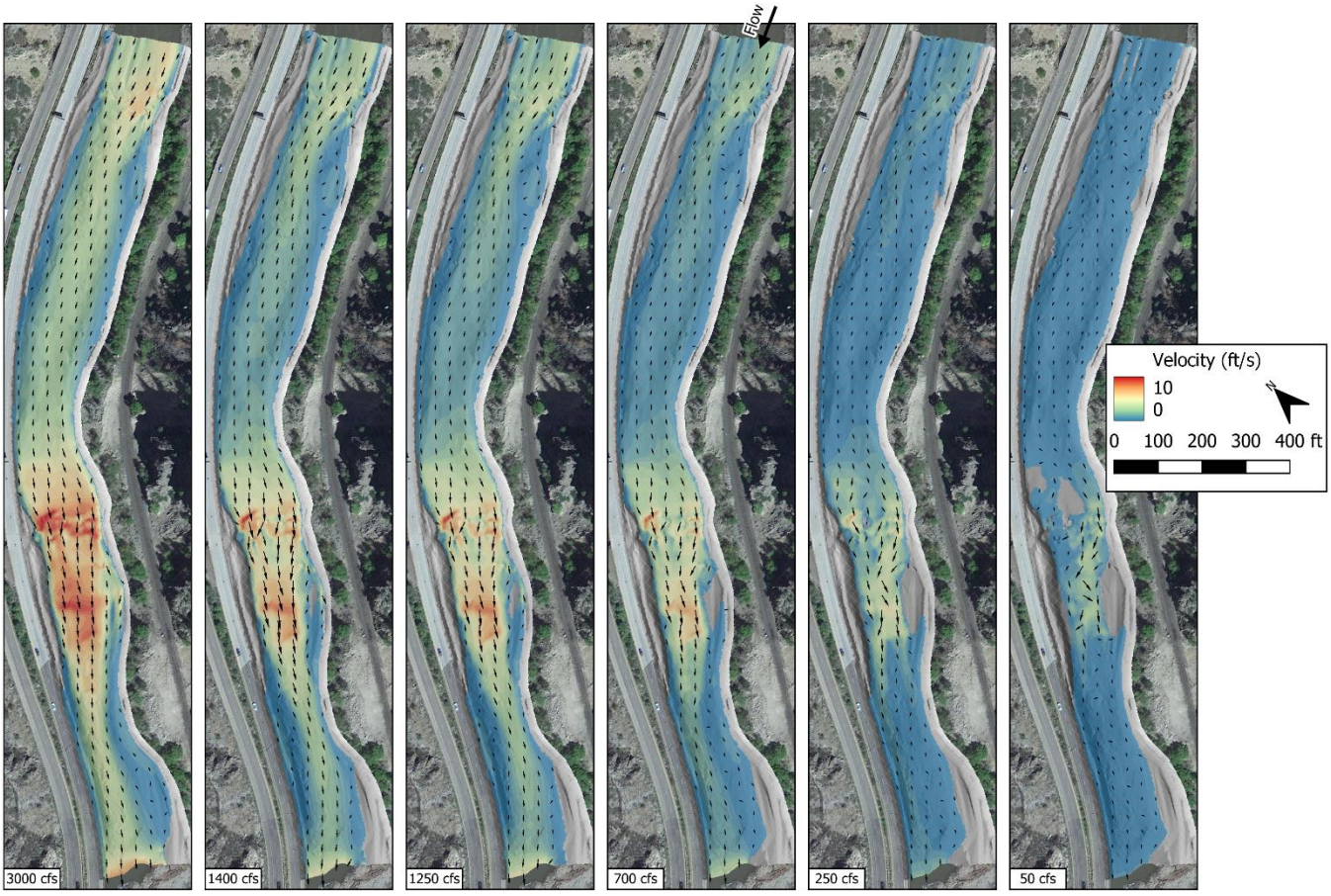


Figure 5. Model results showing velocity at the flows of interest

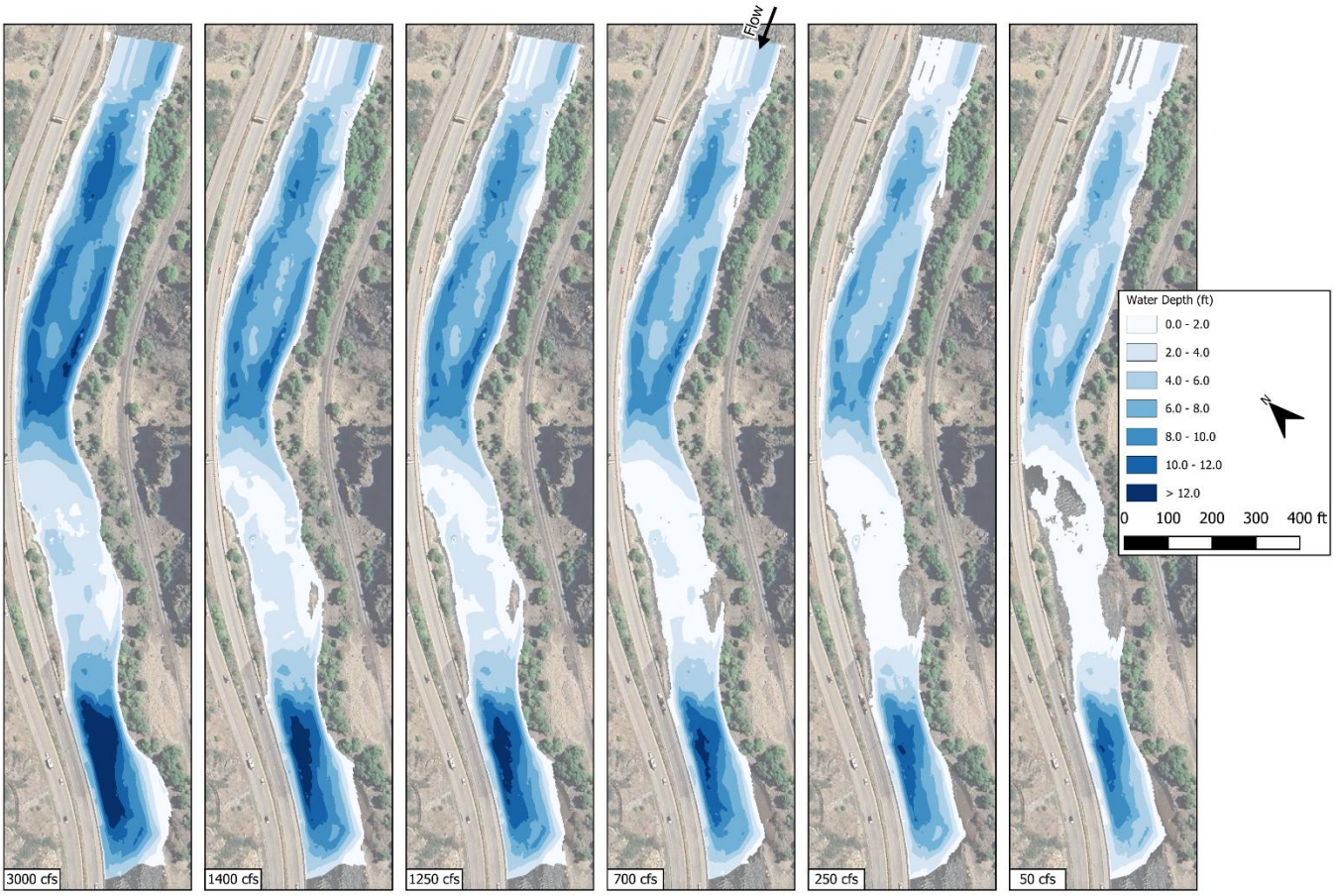


Figure 6. Model results showing depth at the flows of interest

4. SUMMARY

This report explains how survey data collected in Glenwood Canyon were used to create a calibrated 2D hydraulic model. This model was then used to predict hydraulic conditions of the study reach at a range of flows of interest to aquatic habitat at a resolution of approximately 4 ft x 4 ft. The model may have limitations at resolutions less than 4 feet length scale or at flows less than 50 cfs or greater than 3,000 cfs. Results available in the included data appendices can be used in an analysis of the available habitat within the study reach at the specified study flows.

GLENWOOD CANYON AQUATIC HABITAT STUDY
COLORADO RIVER, COLORADO

HYDROGRAPHIC SURVEY REPORT – 2023



PREPARED BY RIVERRESTORATION.ORG, DECEMBER 2023

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GlenwoodCanyon_DEM_ft.tif
SubstrateAreas_Polygons.shp

1. INTRODUCTION AND SURVEY METHODS

A hydrographic survey covering 1854 feet of the Colorado River in Glenwood Canyon was conducted on November 6th and 8th, 2023. The survey extent encompassed two pool sections divided by a boulder/cobble rapid and bounded by a rapid on the downstream end. Survey was conducted in the channel up the ordinary high water mark (OHWM) evident in the field. A combination of wading and boat-based survey was used to cover the areas of various depths and velocities (Figure 1). The survey was performed using a combination of RTK GNSS, Single Beam Echo Sounder (SBES), and total station. The survey was conducted using the NAD83 State Plane Colorado Central coordinate reference system (CRS) in US survey feet, vertical datum of NAVD88, and using the CONUS18 geoid model. Survey control was based on points provided by CDOT and tied in local control monuments via GNSS observations. Instruments utilized included Trimble R780 and R10 GNSS units, a boat mounted Ohmex SonarMite SBES, and a Trimble 5603 DR 200+ total station.

In addition to the bathymetric survey, the bed material was characterized at each topographic survey point throughout the survey reach and high-resolution ortho imagery was captured from 100’ and 200’ AGL throughout the reach.



Figure 1. Survey Area Overview Map



Figure 2. Survey Methods. GNSS rover (left) and boat mounted GNSS integrated SBES (right)

2. SURVEY CONTROL

The survey was based on control provided by CDOT for monuments recovered in the vicinity of the Hanging Lake rest area. Two control monuments were utilized with the coordinates provided in Table 1; Point 2528 was held as the location of the RTK GNSS base station during both days of the survey and point 2541 was used to check the initial base set up with RTK GNSS rovers. Eight additional control monuments were found and tied into the control network using 180 second RTK GNSS observations. These monuments were on the bike path that paralleled the survey reach and consisted of brass survey markers and "X" marks scrawled in the concrete placed by CDOT. These monuments were used for internal survey checks and as the basis for a total station set up and backsight but coordinates in Table 1 should not be considered survey control quality based on the limited GNSS constellation observed at the bottom of the Glenwood Canyon. Single beam sonar sound speed was adjusted in the field to match stadia rod depth measurements and integrated with either a total station prism or a RTK GNSS rover at different times to measure locations.

Table 1. Control Point information. NAD83 State Planes Colorado Central US Survey Feet, NAVD88, Geoid CONUS18. Coordinates are based on RTK GNSS survey holding 2528 and should not be considered survey control quality for future surveys.

Source	Point	Northing	Easting	Elevation	Description
CDOT	2528	1643610.52	2523096.51	6125.178	CDOT 1075--Type 5S IN CONC BIKE PATH
CDOT	2541	1644023.31	2523811.81	6117.827	CDOT 1075--Type 5S IN CONC BIKE PATH
GPS est.	193	1640379.889	2519661.18	6023.026	Brass Marker PT 193
GPS est.	194	1640815.124	2519923.869	6027.73	Brass Marker PT 194
GPS est.	195	1641175.599	2520304.564	6026.45	Brass Marker PT 195
GPS est.	196	1641401.255	2520778.948	6029.373	Brass Marker PT 196
GPS est.	300	1641308.444	2520530.666	6027.274	Concrete Scrawl X
GPS est.	301	1641008.418	2520098.404	6027.054	Concrete Scrawl X
GPS est.	302	1640601.825	2519781.121	6024.546	Concrete Scrawl X
GPS est.	303	1640170.93	2519540.383	6022.625	Concrete Scrawl X

3. SURVEY CONDITIONS

Site survey took place on November 6th and 8th, 2023. November 6th conditions were cold and clear while on November 8th, scattered snow showers fell throughout the day. The project reach is located approximately 8.5 miles downstream of USGS stream gage 09070500 on the Colorado River near Dotsero, CO. Shoshone Power Plant was shut down during survey and no diversions were expected between the gage and the site during data collection efforts. There are no major inflows between the project reach and gage, so the gage is assumed to well represent the project reach flows. Figure 3 shows the range of flows during the survey, as well as the slightly lower flows during the acquisition of aerial imagery.

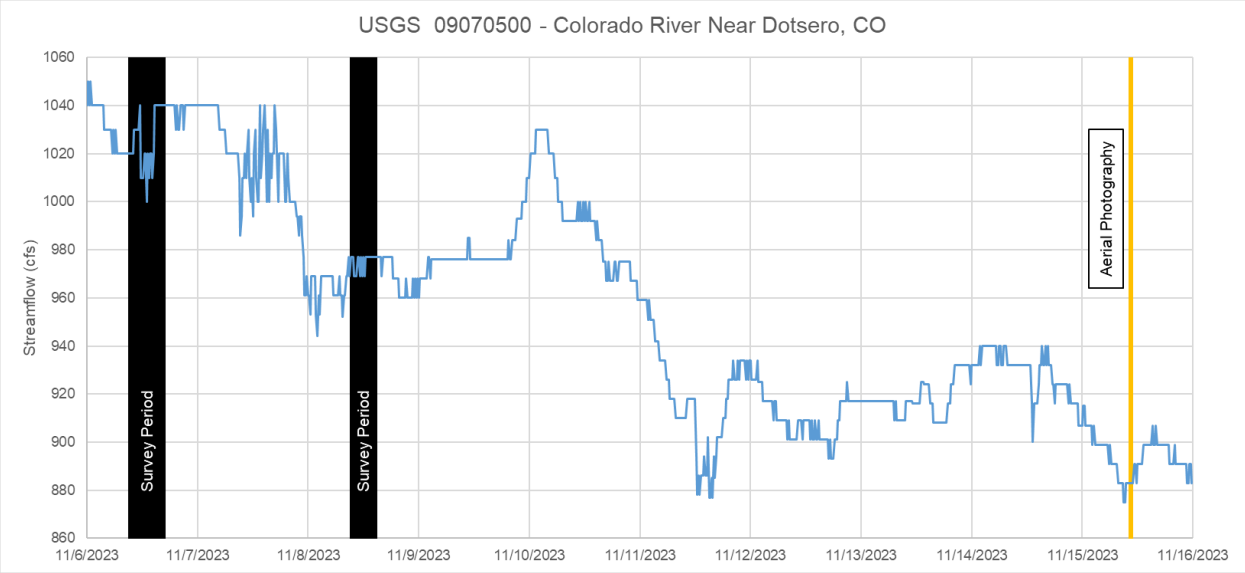


Figure 3. Discharge of Colorado River near Dotsero, Colorado (USGS Gage 09070500) during survey and data aquisition

4. SURVEY RESULTS AND OBSERVATIONS

The survey reach was selected to represent hydraulic characteristics present in the pool/rapid Glenwood Canyon reach of the Colorado River. The survey included two pools divided by one cobble/boulder rapid and was bounded by rapids on the upstream and downstream ends. The rapids generally comprised of large colluvial, and mud and debris flow materials supplied to the main channel from tributaries. Bathymetric and topographic data points were collected to represent bed elevations throughout the survey reach. Information on bed materials including sediment classes and vegetation types were recorded with the points. Areas with depositional sediments and signs of recent maximum high water levels were also recorded, as were water surface elevations (WSE) throughout the reach for the survey flow. There were areas within the survey extent where water was too deep and swift to safely survey on foot or via boat, particularly in some areas around the rapid in the middle of the project reach. Survey was completed to allow for the most accurate interpolation possible in these areas. Additionally, aerial ortho-imagery was collected to help locate larger topographic features such as mid channel boulders.

Survey observations revealed that the bed material varied throughout the study reach. Longitudinal and lateral influences impacted the bed composition. Higher up elevations near the OHWM on each bank consisted of mechanically placed riprap rock materials supporting the highway on river right and railroad on river left (Figure 5). A substantial portion of the river right bank was a vertical concrete wall under a cantilevered bike path with riprap along the right toe (Figure 5). The midchannel consisted of areas of

boulder and large cobbles on the outside of the bend and through the rapids, and large areas of sand deposition on the inside of bends in the pools. Depositional sand included areas of transporting sand over boulders in the upstream pool and also large areas of sand dunes in each pool. A large sandy beach deposit was observed on the inside river left side of the downstream pool. The rapid in the middle of the survey reach and the rapid at the downstream end both consist of large cobble and boulder material (Figure 5) that was delivered from steep tributaries that were impacted by the Grizzly Creek Fire in 2020 and the subsequent debris flows during heavy rain in 2021. The crests of these rapids act as grade controls controlling the water surface elevation of the pools immediately upstream. Sand deposits transition to a lens of alluvially transported large cobble material on the upstream approach of each rapid crest. These cobble materials acted as the hydraulic grade control of each pool at the survey flow. Larger boulders deposited by the tributaries define the main drop in WSE across the rapids. A matrix of small boulders and large cobbles surround the largest boulders with minimal areas of finer depositional material through the rapids until the hydraulic gradient reaches the next pool elevation controlled by the downstream rapid crest and the flow slows. Figure 4 shows the different substrate areas that were identified during the survey overlaid on the final digital elevation model that was created.

Riprap banks throughout the reach were not densely vegetated, but a variety of riparian plant species including willows and cottonwoods were scattered on the banks in pockets around boulders and riprap. Willows, grasses, shrubs, and smaller trees dominated the right bank, while the left bank had more mature cottonwoods.

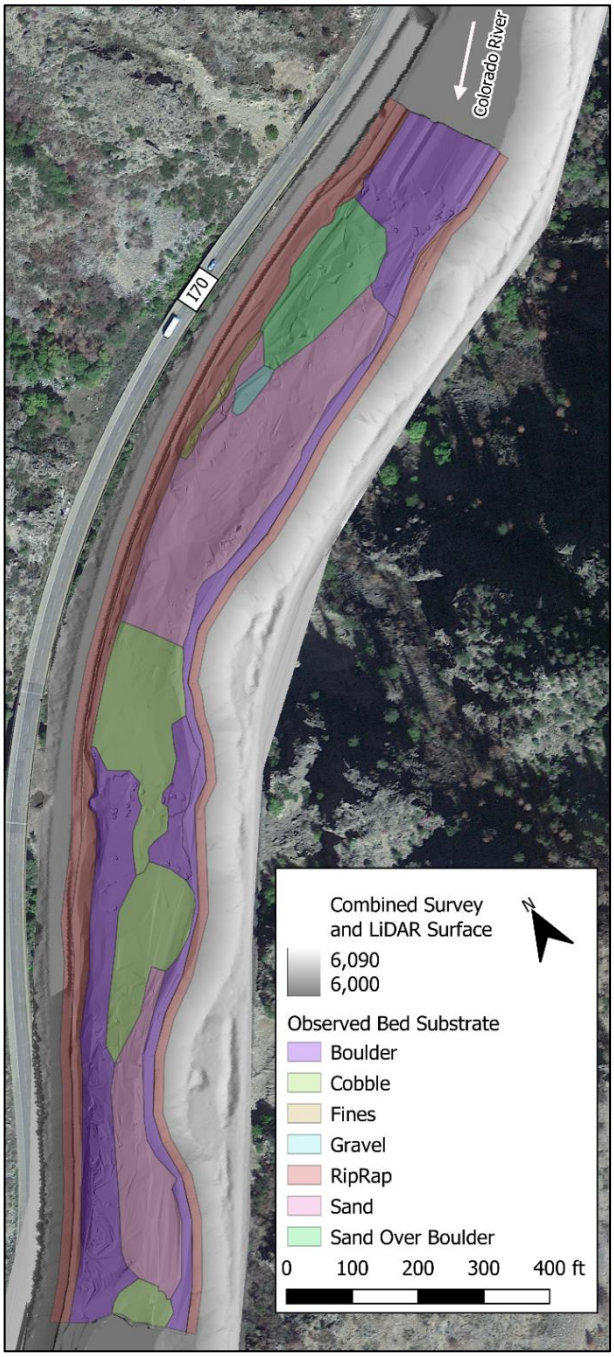


Figure 4. Substrate Areas and DEM



Figure 5. (Left) Looking downstream from the right bank at the rapid in the middle of the survey area. (Right) Aerial oblique drone photo looking downstream from near the upstream end of the survey area. The riprap and concrete nature of the banks can be seen.

5. BASE MAP AND DEM DEVELOPMENT

Survey data were post-processed to remove potential spurious data, mostly in the form of inaccurate SBES depth readings. Interpolation of some topographic data was required in areas that were unsafe to survey, but this was expected from the outset, and the majority of the survey extent was covered by on the ground field survey. A digital elevation model (DEM) was created for the entire surveyed project reach using a triangular irregular network (TIN) to connect surveyed points along with breaklines to represent the existing conditions in the field. Additional breaklines were included to represent boulder clusters and pour overs in rapids based on the collected aerial ortho-images. Elevations for some of these features had to be estimated based on nearby similar elevation features that were surveyed or nearby water surface elevations.

Field survey only took place up to the OHWM. For areas above this elevation, LiDAR data was added to the DEM. This LiDAR DEM data is publicly available data collected on flights in June of 2016 for the Colorado Water Conservation Board (https://coloradohazardmapping.com/lidarDownload). The data is formatted as a geotiff with 3 ft resolution. The LiDAR survey was carried out in the same coordinate reference system as this ground based survey; State Plane Colo. Central, NAD83, NAVD88. The LiDAR survey used the 12B geoid model as opposed to the more recent CONUS18 geoid model, but in the area of interest, this difference is not expected to have an impact. The LiDAR data inserted was well aligned with the surveyed ground elevations and required minimal editing of the DEM to mesh to two surfaces. Because the ground survey went to the elevation of the OHWM, the LiDAR based data inserted at elevations higher than this are not expected to have a meaningful impact on the flow levels of interest for this project.

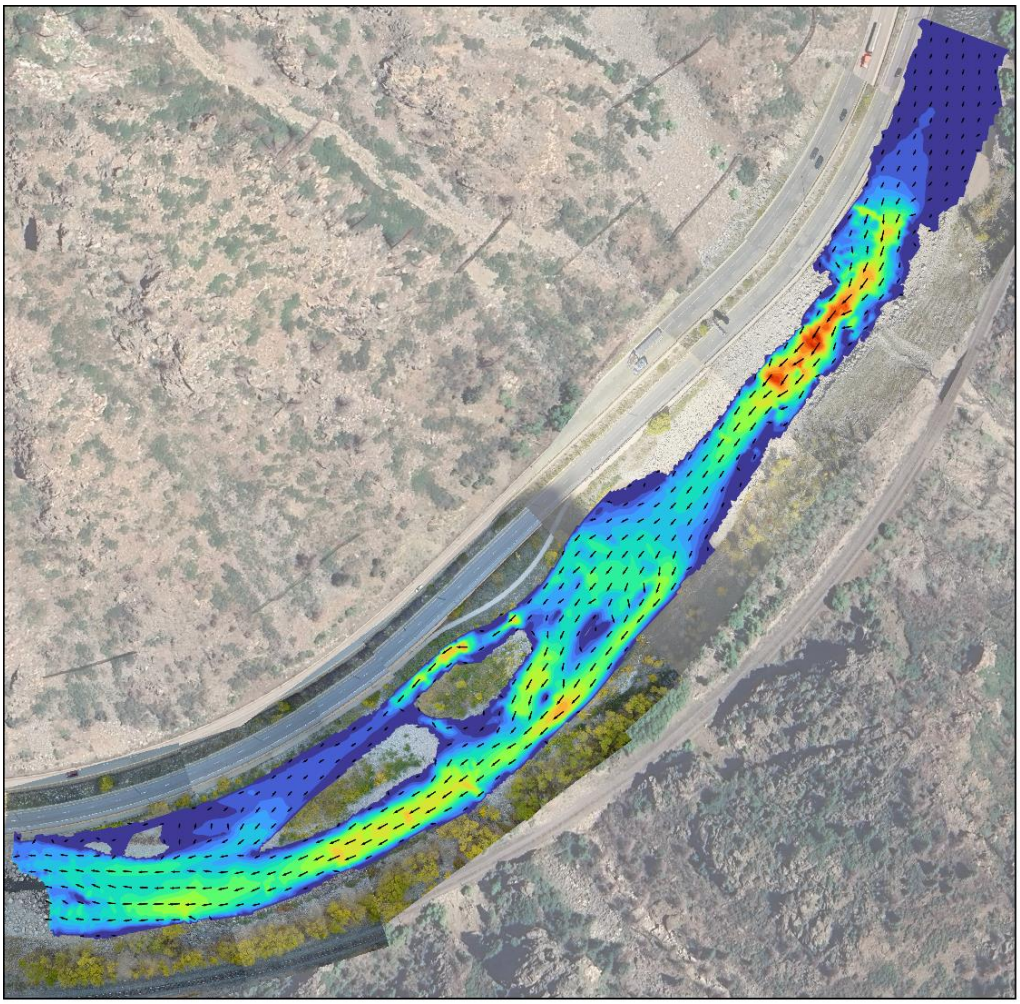
A continuous bathymetric and topographic DEM surface was created using these data described above. This DEM was used in hydraulic modeling efforts, discussed in the Hydraulic Modeling Report.

6. SUMMARY

This survey was successful in collecting sufficient data to develop a detailed DEM of the study reach in Glenwood Canyon. The DEM developed from this survey and the bed material observations were used to model 2D river hydraulics, which is described in the Hydraulic Modeling Report. The data collection described in this report was sufficient for modeling 2D river hydraulics at, or finer than the target resolution for the habitat analysis which was specified as a 25 sqft computational cell size area.

GLENWOOD CANYON AQUATIC HABITAT STUDY
COLORADO RIVER, COLORADO

HYDRAULIC MODELING REPORT – 2024



PREPARED BY RIVERRESTORATION.ORG, JANUARY 2025

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DS_BedElevation.tif
DS_50cfsResults.tif
DS_250cfsResults.tif
DS_700cfsResults.tif
DS_1020cfsResults.tif
DS_1250cfsResults.tif
DS_1400cfsResults.tif
DS_1500cfsResults.tif
DS_1750cfsResults.tif
DS_2000cfsResults.tif
DS_2250cfsResults.tif
DS_2500cfsResults.tif
DS_3000cfsResults.tif

1. INTRODUCTION

A 2 dimensional (2D) hydrodynamic model was used to simulate a variety of low flow conditions for a study reach on the Colorado River in Glenwood Canyon. The model was based on a digital elevation model (DEM) developed from hydrographic survey data collected over an 1,830 foot reach (Figure 1). The goal was to provide spatially discrete data of water depth, velocity, shear stress, and a Froude value for use in a usable habitat analysis.

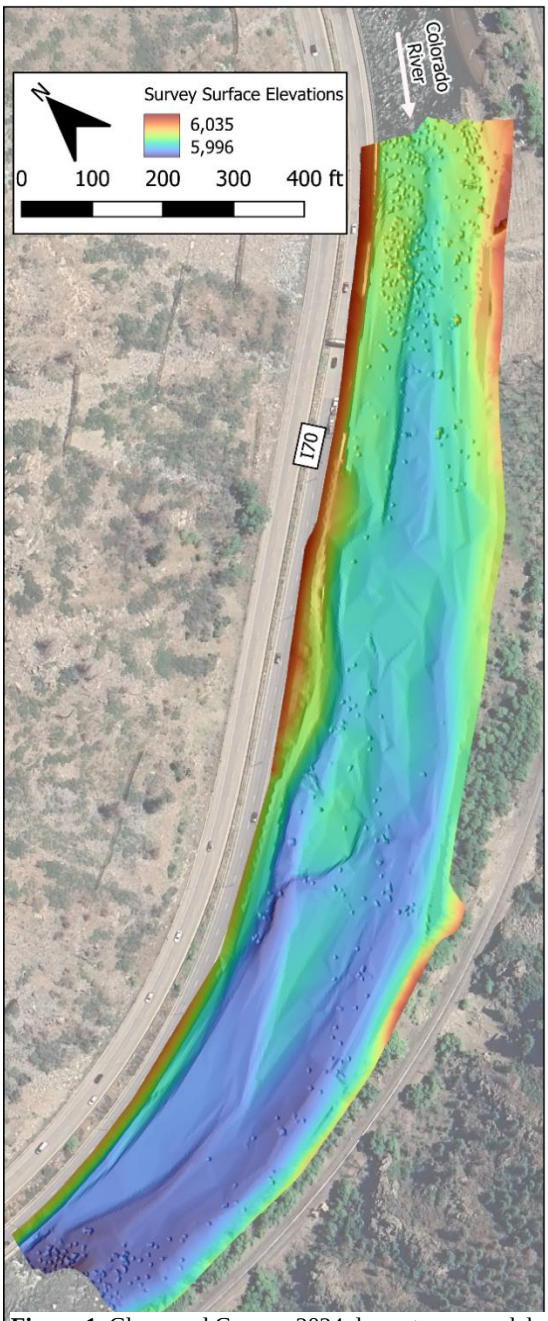


Figure 1. Glenwood Canyon 2024 downstream model domain DEM

2. MODELING METHODOLOGY

Hydrographic survey data (see Glenwood Canyon Survey Report 2024) was used to develop a DEM for the study reach. Point elevations and breaklines were used to characterize bed features like pools, rapids, and individual boulder features. This DEM is available in a geotiff format in the associated data appendices. This DEM was converted into an irregular 2D mesh with a cell sides targeted to a length of 4 feet within the channel using Aquaveo SMS software (Aquaveo, 2015). Due to the SMS software interpolating an irregular mesh, a range of cell side lengths were modeled. Both three and 4 sided cells exist in the irregular grid, leading to a range in cell areas. These cells represent the elevations of the bed and provide calculations locations with discrete boundaries for a solver to calculate a depth-averaged result within. Depth-averaged two-dimensional velocity modeling simulates hydraulics in the streamwise and lateral directions, averaging values through the water column. SRH-2D is a two-dimensional numerical model widely implemented for hydraulic applications and was used here to simulate hydraulic conditions within the project reach (Lai, Yong G. 2009, US Bureau of Reclamation Technical Service Center 2014).

The SRH-2D model requires a spatially distributed friction element in addition to elevation for each cell. This can be provided in the form of a Manning's n value layer. For the model, we used spatially discrete Manning's n values based on the bed sediments observed during the survey. The final values for each area can be found in Figure 2, these values were adjusted within a reasonable range during the model calibration process, discussed below.

In 2023 RiverRestoration completed a modeling effort an 1854 ft reach immediately upstream of the study reach discussed here. The upstream reach represents a deeper pool section of the river. The two reaches combined represent the diverse channel features present in Glenwood Canyon. In the 2023 upstream model, the upper end of the model was artificially extrapolated to allow for the model to non-uniformly distribute flow outside of the area of interest where results were reported. Similarly in the

model presented here the upstream end of the 2D mesh included 300’ of bathymetry that was the downstream end of the model created in 2023 (RiverRestoration 2023). This 300’ was modeled to provide an area for the inflow to non-uniformly distribute before entering the area of interest in the 2024 model domain. Results and figures provided from the modeling process used for the habitat analysis in 2024 excluded all values in the 300’ upstream end.

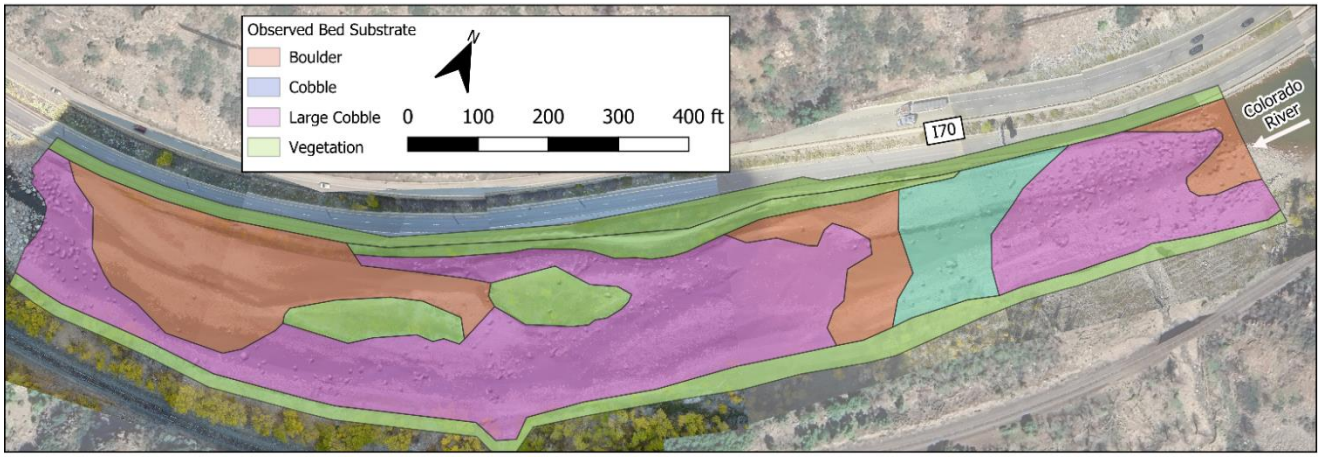


Figure 2. Final spatially distributed Manning’s n values used in the SRH-2D hydraulic model.

SRH-2D requires an upstream and downstream boundary condition. A steady flow rate was used as the upstream boundary condition for each different flow of interest and the model time was run until a steady state was achieved throughout the model domain. A constant water surface elevation (WSE) was used as the downstream boundary condition for each flow rate.

The downstream boundary in the model was set near the crest of the next rapid downstream. However, there did not appear as defined of a grade break as the previous upstream model utilized and near zero flow during and after site survey made locating a critical flow cross section subjective. A 1D flow equation was used to solve for a WSE at each flow of interest. Both a critical flow area and Manning’s equations were considered. Based on the downstream boundary’s position in the river that did not appear to have a sharp drop or constriction of flow and the low elevation values that a critical flow area equation produced, it was determined that Manning’s Equation (Eq.1) would better represent the boundary WSE at different flows. Area (A) and hydraulic radius (R) were solved by changing WSE for the selected cross-section. A bed slope (S) value of 0.0074 was used from survey data. An n value of 0.034 was selected. This value is in line with standard values and was calculated by using the Manning’s equation on a cross section near the upstream end of the study reach similar in character to the downstream boundary where a known WSE for a flow of 1020 cfs was surveyed in 2023.

Eq. 1 $$Q = \frac{1.486}{n} * AR^{2/3} * \sqrt{S}$$

Flows of interest for this study were: 50 cfs, 250 cfs, 700 cfs, 1020 cfs, 1250 cfs, 1400 cfs, 1500cfs, 1750 cfs, 2000 cfs, 2250 cfs, 2500 cfs, and 3000 cfs.

Flows remained near zero between the time of survey and the time of reporting, meaning that the collection of high flow calibration WSE data was not available. Due to this lack of available calibration data, several modeling assumptions were made based on results from the 2023 modeling efforts of the immediate upstream reach, which had 2023 calibration data available and examined the same range of flows using the same baseline resolution for calculations. A one second time step was used for model

calculation. The ke turbulence model was used within the SRH-2D. A small number of WSE calibration points for flows of 1020 cfs and 3250 cfs were available at the upstream end of the model, though these were mostly in the pool section that was excluded from the results since it was included in the domain of previous model reporting from 2023 (RiverRestoration, 2023). These available data were used to make minor adjustments to the upstream end of the DEM and to adjust spatially discrete Manning's n values, however their applicability may be limited due to the 2024 runoff occurring between the WSE measurement and the bed survey used to develop the model. Unknown channel changes may have occurred during 2024 runoff. Adjustments resulted in WSE values that matched to within -0.2' of the observed WSE at 1020 cfs at the upstream end of the reach. Manning's n values within the model were set to correspond with the observed bed sediment areas in Figure 2. Table 1 shows the final Manning's n values. Mannings n values were held consistent for all model runs between 50 cfs and 3,000 cfs.

Table 1. Model Manning's n region values

Observed bed material	Manning's n value assigned
Boulder	0.042
Large Cobble	0.041
Cobble	0.040
Vegetation	0.045

The 2024 reach represents more of a consistent riffle character with smaller pool areas around specific bathymetric grade controls, compared to the upstream 2023 reach. As such, inaccuracies or a lack of resolution in areas of the DEM that will control WSE, or pool levels, are much less likely to propagate through a large area of the model. Additionally, the near zero flow level during survey meant that the topography of the lowest sections of the channel as well the rapidly varying elevations associated with large boulders and the islands could be more accurately and completely captured resulting in a more detailed DEM in 2024.

3. RESULTS

3.1. Model Outputs

The model simulations were run until the flowrate into the model came to an equilibrium with the flow rate out of the model and was considered steady state. Results for each simulation were gridded (rasterized) for use in the habitat analysis. SRH2D integrates the governing equations spatially providing a continuously spatially variable result which was then sampled to a selected 0.25 ft X 0.25 ft resolution raster grid containing 7 data bands for each flow modeled. Table 2 shows the data reported in each data band.

Table 2. Model Result Output Raster Data Bands

Parameter	Unit
Froude Number	Dimensionless
Shear Stress	lb./ft^2
Velocity Magnitude	ft/s
Water Depth	ft
Water Surface Elevation	ft
Velocity in X direction	ft/s
Velocity in y direction	ft/s

3.2.Model Results Discussion

The model reach is bound on both sides by steep banks, including vertical concrete in the highway embankment at the upstream end, a steep railroad embankment on the entire left side, and riprap embankment below the pedestrian path on the right. The flows in the range modeled do not breach any of these higher infrastructure elevations. The model also represents areas where the channel geometry is overhung by a suspended concrete bike path on the right upper right bank. The modeled WSE in these areas remains several feet below the path elevations at the highest flow modeled for this analysis, 3000 cfs, but field observations have shown that snow melt runoff high flows in the river can reach these vertical obstructions, limiting the applicability of this model to flow levels less than or equal to 3,000 cfs.

Within the channel, varying channel elements like boulders, bars and islands lead to changes in the wetted area as flows increase. Across the flow range evaluated, the wetted flow area increased 100%. The largest changes took place in the downstream half of the reach were large depositional bars including the lower, unvegetated, areas of the island bar inundated. Much of this inundation occurred by 1500 cfs with flows growing deeper afterwards. At all flows, the highest velocities and most concentrated flow was found in the upstream rapid. The flow generally increases in velocity and depth as discharge increases (Figure 3 and 4). Depths within the study reach are generally shallower than the results from the upstream reach pools modeled in 2023. Additionally, the deepest areas also are found in the channel thalweg and also have high relative velocities, with the narrow, deep pool on the inside of the island the outlier to this trend.

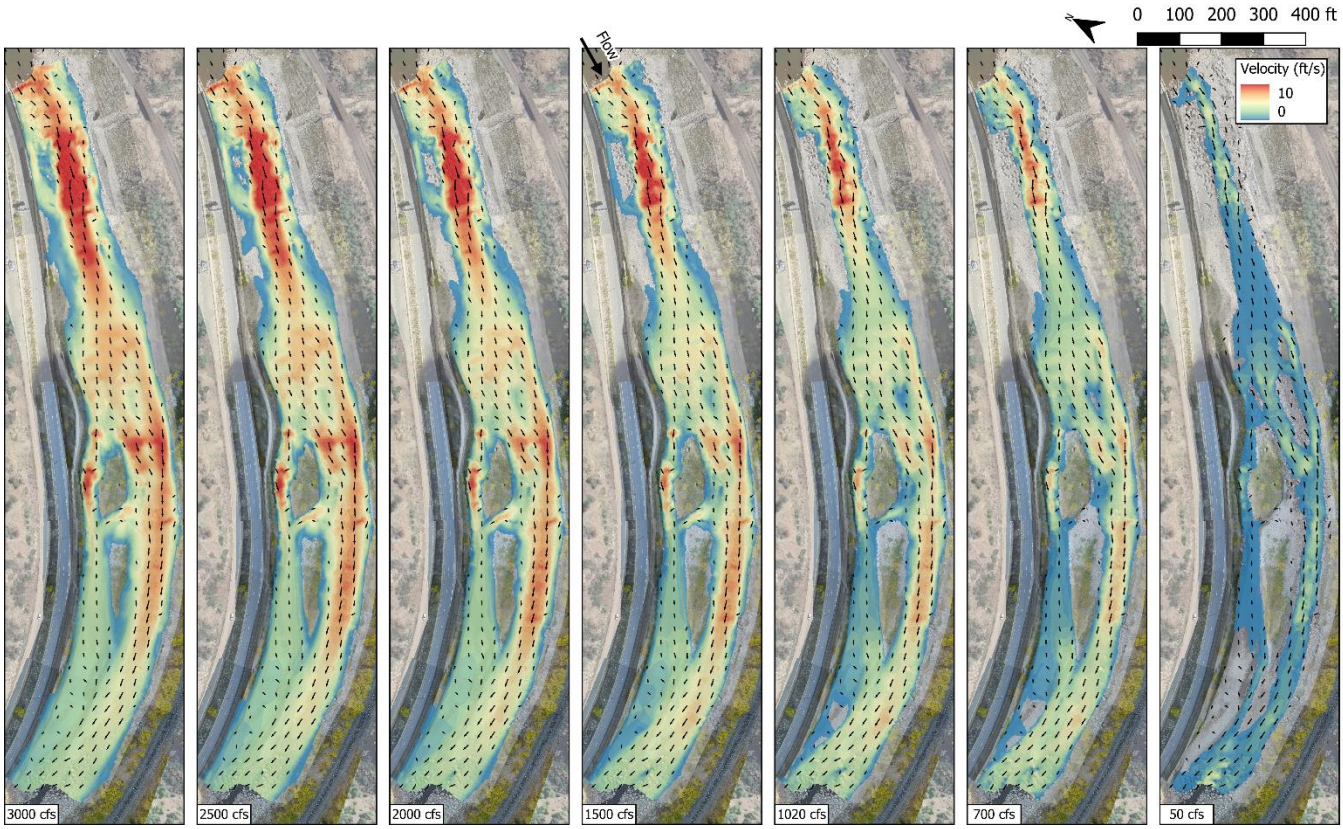


Figure 3. Model results showing velocity at a selection of the flows of interest

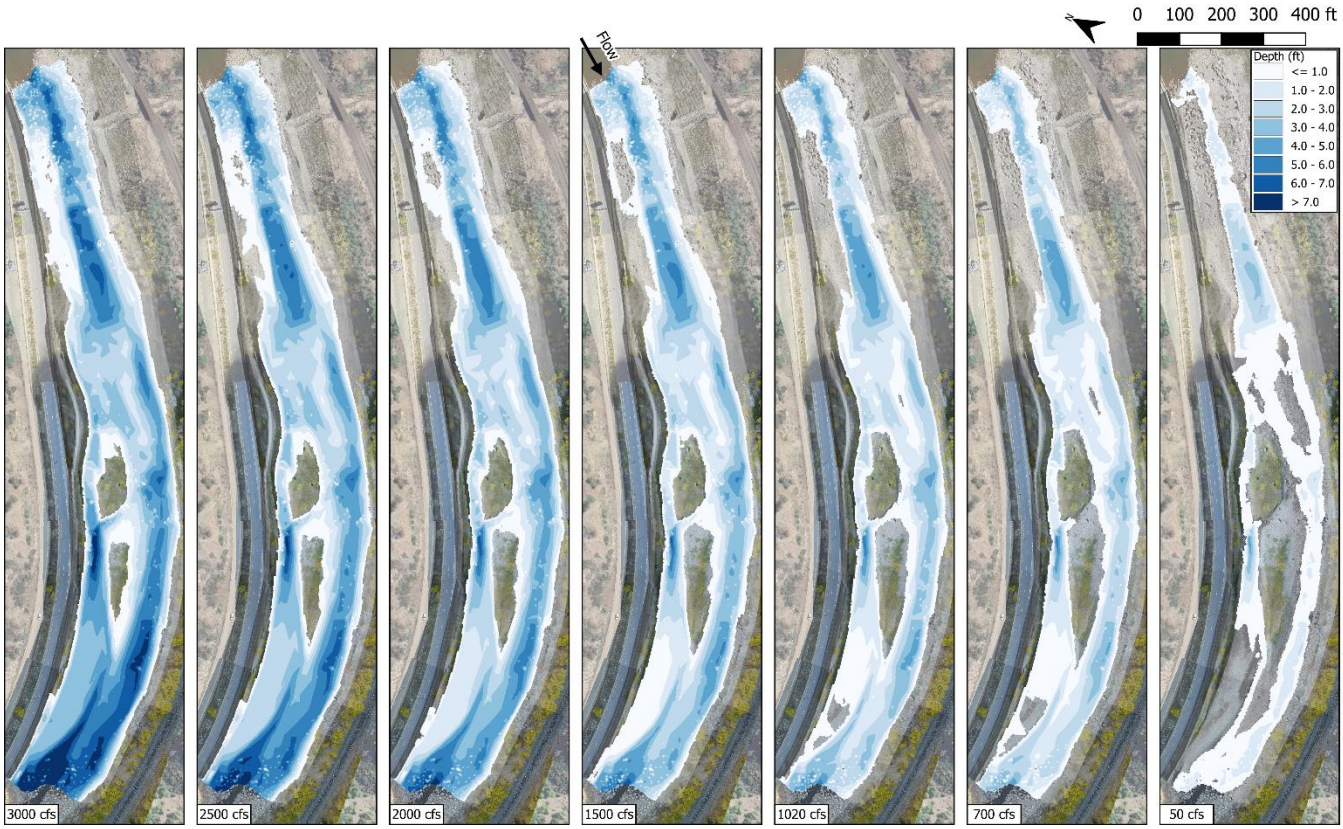


Figure 4. Model results showing depth at a selection of the flows of interest

4. SUMMARY

This report explains how survey data collected in Glenwood Canyon were used to create a 2D hydraulic model. This model was then used to predict hydraulic conditions of the study reach at a range of flows of interest to aquatic habitat at a resolution of approximately 4 ft x 4 ft. The model may have limitations at resolutions less than 4 feet length scale or at flows less than 50 cfs or greater than 3,000 cfs. Results available in the included data appendices can be used in an analysis of the available habitat within the study reach at the specified study flows.

5. REFERENCES

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GLENWOOD CANYON AQUATIC HABITAT STUDY
COLORADO RIVER, COLORADO

HYDROGRAPHIC SURVEY REPORT – 2024



PREPARED BY RIVERRESTORATION.ORG, JANUARY 2025

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RESULTS DATA APPENDICES

GlenwoodCanyon_DEM_ft.tif
SubstrateAreas_Polygons.shp
Sediment Grain Size Distributions .pdfs (multiple)

1. INTRODUCTION AND SURVEY METHODS

A hydrographic survey covering 1830 feet of the Colorado River in Glenwood Canyon was conducted on October 15th and 16th. The survey extent encompassed a boulder/cobble rapid at the upstream end and a pool/riffle/island complex at the downstream end. The upstream end of the survey began at the boulder/cobble rapid of the Devil's Hole Creek confluence, where the previous survey in 2023 ended. The 2023 survey represented a reach characterized by larger pools separated by a defined rapid. Together the 2023 and 2024 reaches represent the diverse types of channel forms found in the Shoshone reach. The survey ended at the beginning of the downstream boulder/cobble rapid of an unnamed gulley confluence. Survey was conducted in the channel up to the ordinary high water mark (OHWM) evident in the field. The survey was performed on foot as there was only minimal flow in the river at the time of survey (Figure 1). The survey was performed using RTK GNSS (Figure 2). The survey was conducted using the NAD83 State Plane Colorado Central coordinate reference system (CRS) in US survey feet, vertical datum of NAVD88, and using the CONUS18 geoid model. Survey control was based on points provided by CDOT and tied in local control monuments via GNSS observations. Instruments utilized included Trimble R12i (rovers) and R10 (base) GNSS units. The base point held during the entire survey was CDOT Point 2528 in Figure 1 and Table 1.

In addition to the bathymetric survey, the bed material was characterized at each topographic survey point throughout the survey reach and high-resolution ortho imagery was captured from 200' and 400' AGL throughout the reach.



Figure 1. 2024 Survey Area Overview Map with low water aerial imagery

2. SURVEY CONTROL

The survey was based on control provided by CDOT for monuments recovered in the vicinity of the Hanging Lake rest area. Two control monuments were utilized with the coordinates provided in Table 1; Point 2528 was held as the location of the RTK GNSS base station during both days of the survey and point 2541 was used to check the initial base set up with RTK GNSS rovers. In November 2023, eight additional control monuments were found and tied into the control network using 180 second RTK GNSS observations. These monuments were on the bike path that paralleled the survey reach and consisted of brass survey markers and "X" marks scrawled in the concrete placed by CDOT. These monuments were used for internal survey checks but coordinates in Table 1 should not be considered survey control quality based on the limited GNSS constellation observed at the bottom of the Glenwood Canyon.



Figure 2. Survey Control Overview Map

Table 1. Control Point information. NAD83 State Planes Colorado Central US Survey Feet, NAVD88, Geoid CONUS18. Coordinates are based on RTK GNSS survey in 2023 holding 2528 and should not be considered survey control quality for future surveys.

Source	Point	Northing	Easting	Elevation	Description
CDOT	2528	1643610.52	2523096.51	6125.178	CDOT 1075--Type 5S IN CONC BIKE PATH
CDOT	2541	1644023.31	2523811.81	6117.827	CDOT 1075--Type 5S IN CONC BIKE PATH
GPS est.	193	1640379.889	2519661.18	6023.026	Brass Marker PT 193
GPS est.	194	1640815.124	2519923.869	6027.73	Brass Marker PT 194
GPS est.	195	1641175.599	2520304.564	6026.45	Brass Marker PT 195
GPS est.	196	1641401.255	2520778.948	6029.373	Brass Marker PT 196
GPS est.	300	1641308.444	2520530.666	6027.274	Concrete Scrawl X
GPS est.	301	1641008.418	2520098.404	6027.054	Concrete Scrawl X
GPS est.	302	1640601.825	2519781.121	6024.546	Concrete Scrawl X
GPS est.	303	1640170.93	2519540.383	6022.625	Concrete Scrawl X

3. SURVEY CONDITIONS

Site survey took place on October 15th and 16th, 2024. Both days were generally mild and clear, with light passing showers. The project reach is located approximately 9 miles downstream of USGS stream gage 09070500 on the Colorado River near Dotsero, CO. During the survey the gage was near 1,200 cfs, however the Shoshone Power Plant was diverting the entire river flow around the project reach. A small amount of flow leaks at the dam cutoff in addition to minor inflow trickles downstream of the dam, meaning there is still a small amount of water in the survey reach. This flow was assumed to be below 10 cfs, but did lead to some deep pool areas remaining.

4. SURVEY RESULTS AND OBSERVATIONS

The survey reach was selected to represent hydraulic characteristics present in the pool/rapid Glenwood Canyon reach of the Colorado River. The survey included one boulder/cobble rapid at the upstream end and an extended riffle/island/pool complex for the majority of the reach. The upstream boundary was a pool included in the original survey and modeling efforts in 2023, and the downstream boundary was the top of the next boulder/cobble riffle going downstream. Bathymetric and topographic data points were collected to represent bed elevations throughout the survey reach (Figure 3). Information on bed materials including sediment classes and vegetation types were recorded with the points. Areas with depositional sediments and signs of recent maximum high water levels were also recorded, as were water surface elevations (WSE) throughout the reach for the extreme low survey flow. Aerial ortho-imagery was collected to help locate and quantify larger topographic features such as mid channel boulders during post processing.

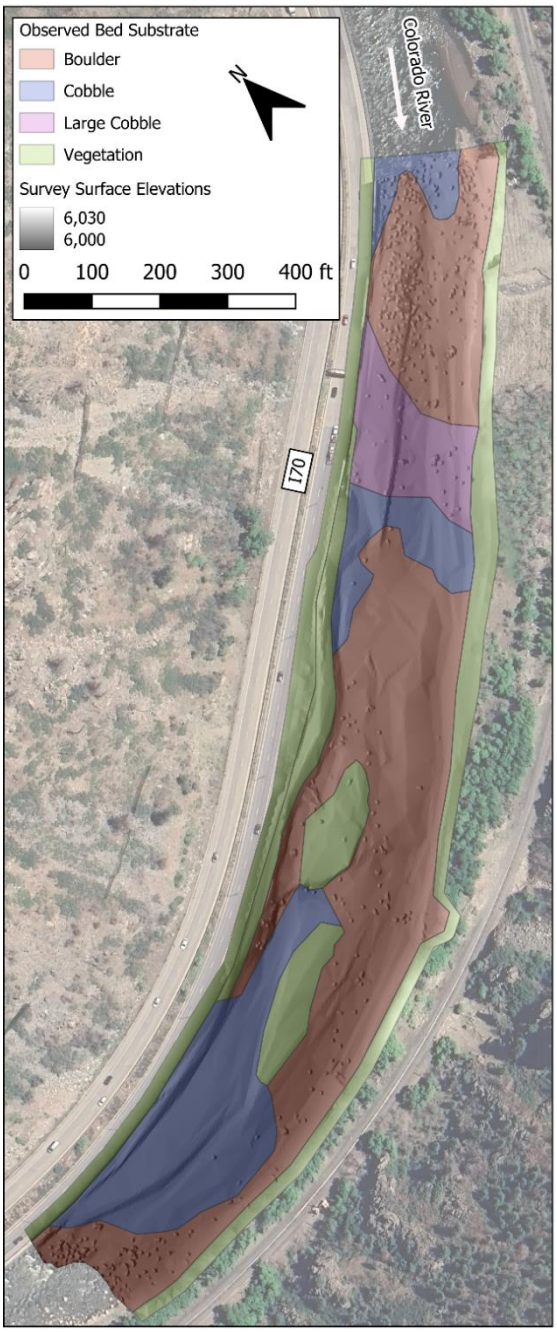


Figure 3. Observed Substrate Areas

The upstream rapid is generally comprised of large colluvial with dozens of boulders ranging from 2'-6' scattered over the top (Figure 4). Much of the material was likely deposited from post-burn flash floods debris flows out of Devil's Hole Creek on the south bank. Many boulders in the rapid were also likely mechanically placed and relocated as part of CDOT or railroad repair and protection efforts. Below the rapid, the bed slope decreases and the remaining reach is dominated by two vegetated islands (Figure 5) near the inside of the bend, a riffle on the outside of the bend, and deeper pools sheltered by the islands on the inside. The majority of the bed through this reach remains coarse and is best described as large cobbles or small boulders, with many larger boulders protruding throughout. Pockets of small material including gravels and sands were found throughout, but generally in proximity to larger boulder features or the islands (Figure 6).

The two islands exist as a part of the same midchannel bar that likely formed downstream of where the riprap right bank extends further into the channel forcing higher flows towards the left bank. The islands are separated by a low portion of the bar were only cobble and boulders are found without vegetation. The upstream island is roughly 2.5’ higher in elevation and has more mature vegetation established including small trees, but the majority of the vegetation are mature willows and the downstream island is only willows and similar riparian shrubs. Both islands consist of the same coarse bed material of cobble and boulders, but the upstream island has more and larger boulders and appears more stable. The downstream island appears to be a part of the more dynamic portion of the larger cobble bar.

The left, outer, channel around the islands has more conveyance, and generally a more consistent bed slope at the time of survey. The right, inner, channel is smaller and at the time of survey had a series of beaver check dams (Figure 7) stepping down the water near the upstream island. The channel along the downstream island consists of a large pool that is controlled by a large cobble deposit near the tail of the island (Figure 8). It is anticipated that these areas may change to have more conveyance during the highest of flows. The downstream end of the survey reach is where the tail end of the mid channel cobble bar and inside cobble deposit transition to another steep boulder rapid consisting of material from a gully on the south side of the river that flashed and crossed the railroad tracks following recent wildfires. Some of this material was similarly mechanically moved and placed into the river.

Higher up elevations near the OHWM on each bank consisted of mechanically placed riprap rock materials supporting the pedestrian path and I70 on river right and railroad on river left. The upper 400 ft portion of the river right bank was a vertical concrete wall under a cantilevered bike path with riprap along the right toe.

Both banks were generally well vegetated despite their coarse riprap material, and a clear edge of vegetation boundary existed through most of the reach indicating periods of consistent flow levels through the reach. Deviations from the vegetated banks included the alluvial fan deposits of Devil’s Hole Creek where only immature vegetation has established, the upper portion of the right bank where the cantilevered path exists, and the left bank near the downstream end of the reach where the channel is closer to the railroad tracks and the bank consists of steeper and looser material. Devil’s Hole Creek tributary channel exhibited some incision which may be ongoing after the 2024 runoff.



Figure 4. Facing downstream at the boulder rapid at the upstream end of survey reach. Devil’s Hole Creek enters from the left. The pool at the upstream end (bottom of the image) is where the survey effort ended in 2023.



Figure 5. Facing downstream at the two vegetated islands on the center channel cobble bar. The outside bend riffle is on the left and the beaver check dams and pool are on the right.



Figure 6. Examples of smaller material within the survey reach. Left - depositional sand on the large cobble bar at the downstream end of the reach. Right – Pocket of gravel and sand behind a large boulder in the outside channel riffle near the islands.



Figure 7. First in the series of small beaver check dams pooling water on the inside of the islands.

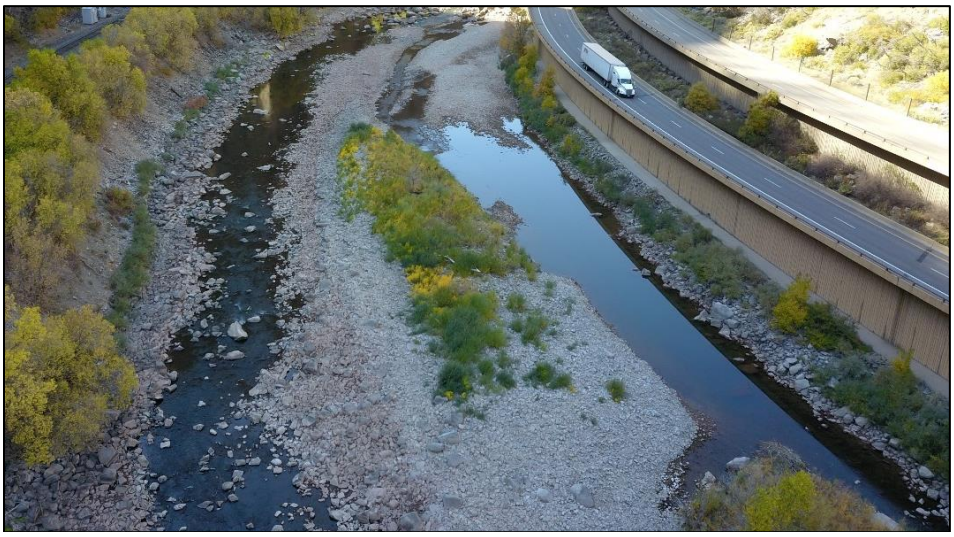


Figure 8. Downstream end of the survey reach. On the left, the outer riffle channel shows larger material and more large boulders that likely originated as colluvium or tributary supply. On the right, the cobble bed pool is currently controlled by the large cobble deposit on the inside of the channel at the downstream end.

5. SEDIMENT SAMPLE SURVEY

Bed materials in the reach were sampled at five locations to quantify the size of typical sediments present, particularly in cobble and gravel areas that may represent better aquatic habitat (Figure 9). Two Wolman pebble counts and three grab samples were completed, the grain size distribution (GSD) of each can be found in the Sediment Grainsize Distribution Appendix. The Wolman pebble counts were performed at the midpoint and downstream end of the main midchannel bar that included the two vegetated islands. These locations represented areas that are frequently inundated and contain fewer large boulder elements. Particle size distributions were similar in both of these locations with most cobbles larger than 4". The sample midway up the bar, between the two vegetated islands, skewed slightly larger, and this area also had more boulders present. A subsurface grab sample was taken in the vicinity of the downstream pebble count and sent to a lab for sieve analysis as it was a much smaller material class (Figure 10). The subsurface GSD had a D_{50} of 10.35 mm and was roughly 1/10 the diameter of the surface pebble count at the D_{10}, D_{50}, and D_{60} benchmarks. This is consistent with expected bed armoring downstream of a dam. The two remaining grabs samples were taken upstream of the islands on the inside of the bend and included both surface and subsurface material. One was taken from a depositional gravel bar above the survey water surface elevation, the other was taken from an apparent trout redd under the water (Figure 11). The trout redd was identified by apparent cleaned and sorted gravels that did not match the condition of the surrounding algae matted or fines veneered bed material. The sample in the redd location contains more coarse gravel and less sand and silt than the nearby gravel bar location. Numerous large trout were observed in the isolated pools during survey. A beaver lodge and beaver activity were also noted during survey.



Figure 9. Sediment sample locations



Figure 10. Sediment sample locations at the far downstream end of the channel center cobble bar. Left – area Wolman pebble count was conducted. Right – subsurface sample location with cobble armor layer removed.



Figure 11. Apparent trout redd sediment sample location. Red circle indicates the redd location.

6. BASE MAP AND DEM DEVELOPMENT

Survey data were post-processed to remove potential spurious data and check for consistency. Interpolation of some topographic data was required in areas where complex topography made detailed survey unsafe, but this was expected from the outset, and the majority of the survey extent was covered by on the ground field survey. A digital elevation model (DEM) was created for the entire surveyed project reach using a triangular irregular network (TIN) to connect surveyed points along with breaklines to represent the existing conditions in the field. Additional breaklines were included to represent boulder clusters based on the collected aerial ortho-images. Elevations for some of these features had to be estimated based on nearby similar elevation features that were surveyed or nearby water surface elevations.

Field survey only took place up to the OHWM. For areas above this elevation, LiDAR data was added to the DEM. This LiDAR DEM data is publicly available data collected on flights in June of 2016 for the Colorado Water Conservation Board (https://coloradohazardmapping.com/lidarDownload). The data is

formatted as a geotiff with 3 ft resolution. The LiDAR survey was carried out in the same coordinate reference system as this ground based survey; State Plane Colo. Central, NAD83, NAVD88. The LiDAR survey used the 12B geoid model as opposed to the more recent CONUS18 geoid model, but in the area of interest, this difference is not expected to have an impact. The LiDAR data inserted was well aligned with the surveyed ground elevations and required minimal editing of the DEM to mesh to two surfaces. Because the ground survey went to the elevation of the OHWM, the LiDAR based data inserted at elevations higher than this are not expected to have a significant error on the flow levels of interest for this project.

A continuous bathymetric and topographic DEM surface was created using these data described above. This DEM was used in hydraulic modeling efforts, discussed in the Hydraulic Modeling Report.

7. SUMMARY

This survey was successful in collecting sufficient data to develop a detailed DEM of the study reach in Glenwood Canyon. The DEM developed from this survey and the bed material observations were used to model 2D river hydraulics, which is described in the Hydraulic Modeling Report. The data collection described in this report was sufficient for modeling 2D river hydraulics at, or finer than the target resolution for the habitat analysis which was specified as a 25 sqft computational cell size area, or a 5 ft x 5 ft cell.

Biological and Recreational Resources Dependent on Colorado River Flows Through Glenwood Canyon

September 2024



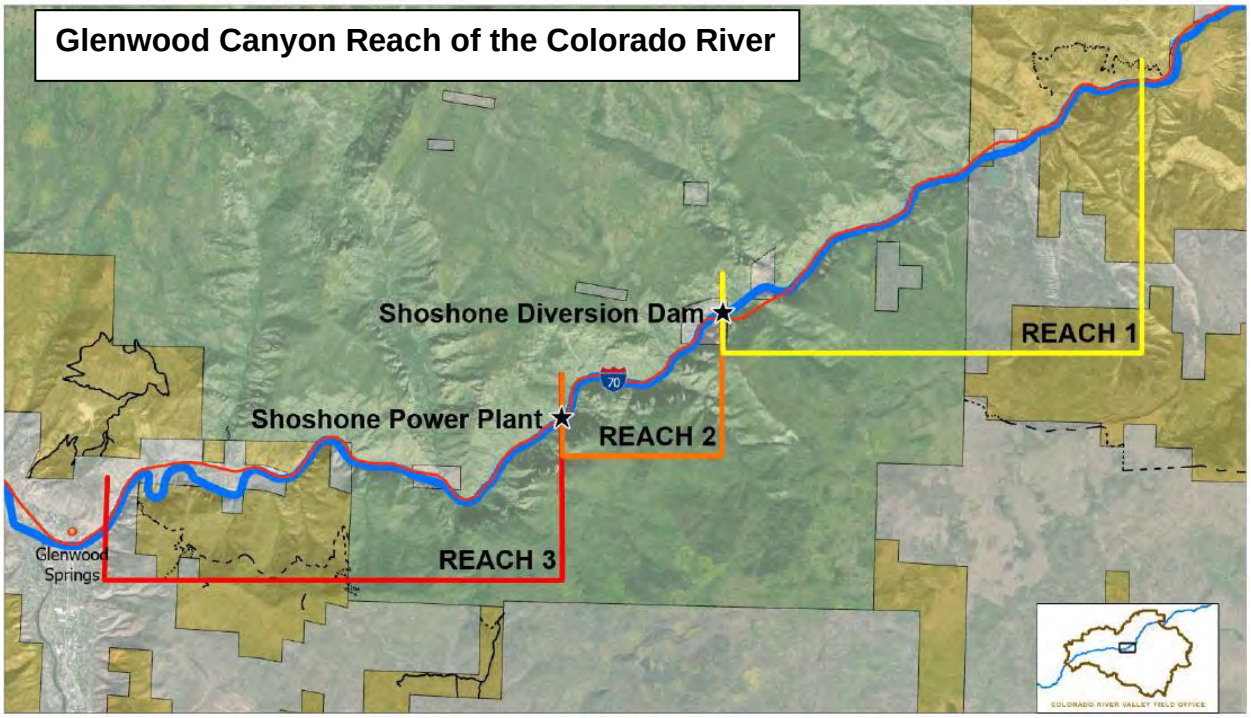
Introduction

This document provides an executive level summary of the natural environment supported by Colorado River flows in Glenwood Canyon, and qualitatively describes the relationship of that natural environment to physical infrastructure and operations of Excel's Energy's Shoshone Power Plant. This document also describes other water-dependent values upstream and downstream from Glenwood Canyon that are highly dependent on consistent flows through Glenwood Canyon. This document does not attempt to quantify natural resource benefits or impacts associated with operation of the Shoshone Power Plant, which would require intensive study of the river channel morphology, hydrology, fish populations, and riparian communities.

This document incorporates biological and recreation information available to the Bureau of Land Management (BLM) and White River National Forest (WRNF), including information from other resource management agencies. Even though this document incorporates information from other agencies, it does not purport to represent any formal position that any agency may take regarding proposed changes to land management or streamflow management in Glenwood Canyon.

Background – Land and Water Management

The Colorado River flows west/southwest through Glenwood Canyon for approximately 18 miles from west of Dotsero, Colorado to Glenwood Springs, Colorado. The river within this reach is naturally confined by a steep and narrow limestone canyon, and further constricted by a four-lane Interstate highway, railroad, and pedestrian bike path. Other infrastructure located within the river corridor includes power lines, two Colorado Department of Transportation (CDOT) rest areas, Excel Energy's Shoshone Hydropower Plant and Dam, the CDOT operations center at Hanging Lake Tunnel, Hanging Lake trailhead, the small community of No Name, and the privately owned Bair Ranch.



Glenwood Canyon is a popular destination for recreation, including but not limited to walking/jogging, biking, whitewater rafting, fishing, and viewing the scenic river corridor and riparian communities. Several small tributaries and two larger streams that contain significant fisheries, Grizzly Creek, and No Name Creek, flow into the Colorado river within this reach. In 2020, the river corridor was impacted by the Grizzly Creek Fire that burned the entire length of the canyon. Rain-induced post-fire debris flow events have impacted the river channel, highway, pedestrian bike path, and the Shoshone Power Plant since the fire.

Despite extensive human modification of the river corridor, the river still supports a regionally significant natural environment that draws many visitors to the canyon. The natural environment supports native and sport fish populations, Rocky Mountain bighorn sheep, and riparian plant communities that are adapted to the ecological constraints within the canyon. Colorado Parks and Wildlife (CPW) periodically monitors fish and big game populations in the canyon but inventories of other biological attributes, including non-game species, have been limited.

The majority of the canyon is National Forest Systems Lands managed by the White River National Forest, and in partnership with CDOT. The BLM manages lesser amounts of lands within the river corridor at each end of Glenwood Canyon. Together the WRNF and BLM emphasize management of visitation and recreation infrastructure while also supporting the ecological function of the Colorado River. In addition to further clarifying the recreational use of the Canyon, the general physical and biological attributes associated with the Canyon are outlined below.



Glenwood Canyon at the Shoshone Dam and Tunnels

In Glenwood Canyon, the Shoshone Hydropower Plant has been in existence for over 100 years and is one of the most senior water rights in the Colorado River watershed within Colorado. This senior water right assures that stream flows make it to the point of diversion when a priority call is made. The hydropower operation consists of three primary components – the Shoshone Dam, which backs up water to the point of diversion, a pipeline from the point of diversion, which operates via gravity flow, and the Shoshone Power Plant, which receives water from the pipeline. When fully operational, the powerplant can place a priority call for two water rights that are diverted to the penstocks of the powerplant, one water right for 1,250 cubic feet per second (cfs) under a 1905 priority and another water right for 158 cfs under a 1940 priority.

In 2016, multiple parties, including the U.S. Bureau of Reclamation, the Colorado Division of Water Resources, water districts, and water users, signed a 40-year agreement referred to as the "Shoshone Outage Protocol."[1] The protocol is designed to maintain the flow regime on the Upper Colorado River, even when the Shoshone Power plant is not calling for water due to operational constraints. The agreement calls for deliveries to the powerplant of 1250 cfs from March 25 to November 10 and 950 cfs from the November 11 to March 24. The agreement includes limits on the volume of water to be delivered to the powerplant each year and it also includes provisions that alter the rate and volume of water delivered to the powerplant during drought conditions.

Wild and Scenic Rivers Management

In 2014, BLM and WRNF amended their respective resource management plans and forest plans to include Wild and Scenic Rivers management prescriptions for Glenwood Canyon and for segments of the Colorado River upstream from Dotsero to Kremmling. Pursuant to study guidance found in the 1968 Wild and Scenic Rivers Act, the agencies determined that the river segments are free flowing (free of impoundments and large diversions), with the exception of the portion of Glenwood Canyon that is occupied by the diversion dam and reservoir associated with the Shoshone Power Plant. The agencies also determined that the river segments support Outstandingly Remarkable Values (ORVs), which are defined as river-related values that are unique or exemplary within the region of comparison. Given those findings, the agencies concluded four river segments are eligible for inclusion in the National Wild and Scenic Rivers System. The river segments analyzed and the ORVs identified are as follows:

Name of Segment	Outstandingly Remarkable Values
Colorado River – Gore Canyon (Segment 4)	Scenic, Recreational (Fishing, Floatboating, and Scenic Driving), Geologic, Wildlife, Historic
Colorado River – Pumphouse to State Bridge (Segment 5)	Scenic, Recreational (Fishing, Floatboating, and Scenic Driving), Geologic, Wildlife, Historic
Colorado River – State Bridge to Dotsero (Segment 6)	Scenic, Recreational (Floatboating, and Scenic Driving), Botanical, Wildlife
Colorado River – Glenwood Canyon (Segment 7)	***Recreational (Whitewater Boating, Scenic Viewing, Hiking), Scenic, Geologic***

As part of the 2014 agency evaluation of whether the river segments are suitable for inclusion in the National Wild and Scenic Rivers System, the agencies received an alternative management plan proposal from the Upper Colorado River Wild and Scenic Stakeholder Group (SG) which is designed to protect and enhance the ORVs. The SG plan was adopted by BLM and WRNF planning decisions on June 25, 2015, with the objective of assisting the two agencies in meeting management requirements under the Wild and Scenic Rivers Act for eligible stream segments on the Colorado River. Specifically, the SG plan was adopted to monitor, protect, and enhance the ORVs identified in BLM and WRNF Eligibility Reports for Segments 4 through 7.

By design, the SG plan focuses on the most highly flow dependent ORVs, specifically recreational float-boating (in segments 4-7) and recreational fishing (in segments 4-6). The

[1] Shoshone Outage Protocol Agreement Number 13XX6C0129 dated June 27, 2016.

intent of adopting the SG plan was that it will complement, and be coordinated with, BLM and WRNF land use authorities and land use decisions, enabling the federal agencies to better fulfill management requirements under the Wild and Scenic Rivers Act. The SG plan offers the benefit of monitoring streamflow through the Wild & Scenic segments, and then supplementing this with coordinated, cooperative, and voluntary water deliveries coordinated by the SG, when available. The intent of the SG plan is to balance permanent protection of the ORVs, certainty for the stakeholders, water project yield, and flexibility for waters users.

It is important to note that the SG Plan[2] relies on the existence of the Shoshone Power Plant water rights as one of its Tier 1 Long-Term Protection Measures:

> *Existing senior water rights*: The Shoshone and Cameo groups of senior water rights generally control the administrative call within the Colorado River Basin. These water rights are located downstream of the subject stream reaches; therefore, an administrative call during dry or average conditions by these water rights can curtail diversions from upstream junior water rights or require the release of water from storage to replace those junior diversions. This administrative call generally results in stream flow through the subject stream segments in amounts greater than would exist in the absence of the administrative call. (Page 36)

Fisheries Summary

The Colorado River within the canyon has three distinct reaches resulting from the presence of Excel Energy facilities: Reach 1 upstream of the Shoshone Dam, Reach 2 from Shoshone Dam to the Shoshone Power Plant outlet, and Reach 3 downstream from the Shoshone Power Plant return flow outlet.

Reach 1, upstream of the dam, is characterized by a flattened/reduced river gradient. The impounded water substantially reduces water velocities, resulting in high sediment deposition above the dam. Aquatic habitat diversity and complexity is reduced due to a lack of riffle-run sequence habitat characteristic of a typical free flowing river. In addition, the dam is a physical barrier to movement of aquatic organisms both upstream and downstream when it is not bypassing river flows and a flow velocity barrier to upstream movement when water is being bypassed. This results in fragmentation of habitat.

Reach 2 encompasses the 2.5 miles of river between the Shoshone Dam and the Shoshone Power Plant return flow outlet. During seasonal low flow periods, the reach is substantially dewatered when the plant is operating. Flows are highly variable throughout the year depending on if the plant is in operation or not. During operations, habitat in the river channel is weakly connected by small inflows of groundwater and tributary streams that fill pools and flow through the large boulder and rock substrate. This reach contains both the lower and higher gradient sections that provide a complexity of habitat when the native flows are allowed to bypass the dam. Habitat persists even during low flow periods, though wetted area in the stream channel is substantially reduced.

Reach 3 begins where native flows are returned to the river during operation of the Shoshone Power Plant and extends downstream to the city of Glenwood Springs. The river regains its natural character with a mix of riffle, run, and deep pool habitats that all contribute to improved channel complexity and diversity.

[2] https://www.upcowildandscenic.com/uploads/1/3/5/3/135388668/amended_and_restated_sg_plan_july_2024.pdf



Shoshone Powerplant

Below is a brief biological summary of the Colorado River within Glenwood Canyon based on fish sampling data, incidental aquatic invertebrate notes, and riparian habitat assessments by BLM and WRNF.

Fishery surveys on the Colorado River are conducted annually by CPW in cooperation with the BLM and WRNF. These surveys include reaches in and near Glenwood Canyon. Based on these surveys, the following fish are considered resident to the Colorado River in Glenwood Canyon:

Sportfish
Brown Trout, Rainbow Trout, Cutthroat Trout, Rainbow-Cutthroat hybrids, and Mountain Whitefish.



Rainbow Trout



Brown Trout



Mountain Whitefish

Native Fishes

Three native species, including Flannelmouth Sucker, Bluehead Sucker, and Roundtail Chub, are referred to the “Three Species” because they are the subject of a multi-state, multi-agency conservation agreement. Other native species include Colorado River Cutthroat Trout, Sculpin, and Speckled Dace.



Flannelmouth Sucker



Roundtail Chub

Invasive/Nonnative Fishes

White Sucker, Longnose Sucker, and Hybrid Suckers

As mentioned previously, the Reach 1 fishery is impacted by the Shoshone Dam, which impounds water, reduces gradient, reduces water velocities, and allows the deposition of fine sediment, resulting in decreased habitat complexity and diversity. The silting in of river substrates and the loss of riffle/run sequences limits macroinvertebrate productivity, native sculpin habitat, and juvenile fish refugia areas. Consequently, fish productivity within the reach is reduced because of limited food supplies. In addition to macroinvertebrate production, riffles and runs provide important fish spawning habitat for desirable native and sport fishes.

Reach 2 is impacted by the hydropower operations via reduced and highly variable flows depending on hydropower plant operational status. When the plant is operating, and during natural seasonal low flow periods, sediment transport is inhibited, wetted habitat is reduced, and channel/flow connectivity is impaired. The highly variable flow rates limit aquatic invertebrate productivity, an important food source for resident fish. Variable flows also can impact fish spawning activities within the reach due to impaired availability of and accessibility to preferred spawning habitat.

In Reach 3, where the natural river flow regime is reestablished, the river harbors a robust sportfish fishery comprised of Brown Trout, Rainbow Trout, and Mountain Whitefish. Despite the threats posed from invasive fish species, native Flannelmouth Sucker and Bluehead Sucker are regularly detected in the Colorado River in and adjacent to Glenwood Canyon, along with Roundtail Chub, Sculpin, and Speckled Dace. The benefits from the hydropower return flows include increased riffle, run, and pool complexes, coupled with abundant large boulders. With flows sufficient for effective sediment transport, this reach contains diverse, high-quality habitat for aquatic species. The resiliency of the aquatic ecosystem is sustained with the greater abundance of riffle habitat that improves macroinvertebrate and resident fish productivity.

Fish species composition is likely similar within the three reaches, but species relative abundance, particularly of fish species that prefer higher gradient and reduced sediment loads (Sculpin, Trout, and Mountain Whitefish), are likely reduced in Reaches 1 and 2 due to the previously mentioned modification of flow rates and channel composition. Species such as Sculpin are particularly sensitive to increases in sediment deposition as they live within the interstitial spaces amongst larger river substrates. Trout and Mountain Whitefish require clean gravel and cobble substrates for spawning and rearing of juveniles.

Importance of Flows to Federally Listed Fishes

In addition to the local fish community, Shoshone water rights help support flows important to four downstream fish species federally listed under the Endangered Species Act: Bonytail, Colorado Pikeminnow, Humpback Chub, and Razorback Sucker. Specifically, flows help support important habitat located in the “15-mile reach” of the Colorado River located from the town of Palisade to the Gunnison River confluence in Grand Junction. This reach is particularly vulnerable to very low flows as substantial water withdrawals occur just above Palisade for agricultural and other uses. This report does not attempt to quantify the timing or magnitude or flows that benefit the 15-mile reach from exercise of the Shoshone water rights.

Shoshone Reach Instream Flow Habitat Data Analysis

Freshwater Consulting, LLC, under contract to the Colorado River Water Conservation District, completed an aquatic habitat analysis for the portion of Glenwood Canyon affected by water diversions to the Shoshone Power Plant.[3] The objectives were to determine the current state of the aquatic habitat and aquatic ecosystem in the Shoshone Reach and determine expected changes to the aquatic habitat and aquatic ecosystem due to hydrologic change if the Shoshone Power Plant water rights were wholly or partially dedicated to instream flow use.

BLM and USFS aquatic resources staff reviewed the report and determined the following:

[3] Shoshone Reach Instream Flow Habitat Data Analysis, Habitat Simulations and Habitat Evaluation of the Colorado River from the Shoshone Diversion to the Shoshone Power Plant Outfall, William J. Miller, PhD, Freshwater Consulting, LLC, August 2024.

- The study utilized broadly accepted scientific procedures for two dimensional hydraulic modeling.

- The habitat suitability criteria used for the fish species of interest, which include multiple species of trout and flannelmouth sucker, appear to be appropriate and incorporate data from multiple river locations in Colorado.

- The study selected cross section and modeling locations with habitat types that are generally representative of Glenwood Canyon, including pools, riffles, rapids and runs.

- The key study conclusions, listed below, appear to be well supported by the habitat modeling results:

    - For older life stages of trout, Mountain Whitefish and Flannelmouth Sucker, the highest habitat availability is at flows that range from 750 cfs to 1,500 cfs.

    - Usable fish habitat gradually declines from 1,500 to 3,000 cfs, but there is still significant habitat available. At higher flow rates, habitat for trout fry decreases significantly.

    - Fish habitat availability quickly declines as flows decrease below 750 cfs.

- The study correctly notes that periphyton, algae, and benthic macroinvertebrates are important food resources for higher trophic levels, and that such resources are significantly impacted by no flow or low flow events caused by diversions to the Shoshone Power Plant.

- The study correctly notes that flow variability, including flood and drought events, are critical for maintaining the overall functioning of aquatic ecosystems, including the riparian communities along the river.

- BLM and USFS concur that any increases in base flows through the reach impacted by Shoshone Power Plant diversions are likely to improve and stabilize aquatic habitat.

Aquatic Invertebrates

A variety of macroinvertebrate species inhabit the Glenwood Canyon. Of primary interest are the EPT taxa (Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Tricoptera (Caddisflies), as the presence and abundance of these taxa reflect the health of aquatic systems. These and other aquatic invertebrates provide important high value food sources for resident fish, birds, and bats and are an important component of the riverscape food web.



Adult Stonefly



Adult Mayfly

Like fish, macroinvertebrate diversity and density, particularly for EPT taxa, are likely higher in Reach 3 below the Shoshone Power Plant where flow is reestablished, because the river contains less fine sediment and increased riffle habitat important for macroinvertebrate productivity. Macroinvertebrate productivity is likely reduced within Reach 2, because of reduced and highly variable flows depending on hydropower operations. Because of the dam, Reach 1 contains very few riffles, and the reduced river gradient allows fine sediments to settle out. A lack of riffle habitat and increased sediment deposition favors sediment tolerant taxa and reduces overall macroinvertebrate densities and diversity within the reach. EPT taxa are particularly sensitive to increased sediment loading and require clean, well oxygenated substrates in which to thrive.

Reduced macroinvertebrate densities can negatively affect the riverscape food web. As with fish, robust macroinvertebrate sampling would be informative regarding perceived differences in species composition and densities within the three reaches.



Rock Covered in Caddisfly Cases

Riparian Vegetation

Riparian vegetation expression is limited within Glenwood Canyon due to several factors, but the most prominent factor is that the reach is within a steep, narrow canyon controlled by bedrock. This geologic context results in a riverscape that contains only a narrow band of alluvial aquifer

on each side of the river that can support riparian vegetation. The canyon contains only short, disjunct reaches supporting significant floodplain acreage. Other factors limiting riparian vegetation extent include confinement from the interstate highway, railroad, bike path, and other previously noted infrastructure.



Glenwood Canyon Riparian Vegetation

Where present, riparian vegetation provides river cover and shading; increased bank armoring and stabilization; habitat for terrestrial insects an important food source for fish, birds, and bats; bird nesting habitat; and scenic and aesthetic values.

Primary riparian vegetation species noted within the canyon include narrowleaf cottonwood, chokecherry, red-osier dogwood, box elder, willow, wild rose, skunkbush, riparian grasses, sedges, and rush. Riparian species composition appears similar within all three reaches, but densities vary throughout the canyon.



Colorado River and Riparian Vegetation – Glenwood Canyon

Despite the natural and human induced constraints limiting the amount and spatial extent of riparian vegetation within the steep canyon, where riparian vegetation exists, it supports scenic attributes, valued ecological functions, and important wildlife habitat. BLM has completed Proper Functioning Condition riparian condition assessments on the lands it manages within Reaches 1 and 3. Given the geological and human induced limitations within the canyon, both BLM-managed riparian segments were found to be in Proper Functioning Condition.

Recreation

Recreation use in Glenwood Canyon and Colorado River segments located upstream between Kremmling and Dotsero relies heavily on flows called by the Shoshone Power Plant water rights. Visitors to these stream reaches are attracted by boatable flows and scenic canyon environments that remain largely in natural condition. Riparian communities along the river provide scenic interest, camping, fishing, and resting locations, as well as habitat for watchable wildlife. In the river segments between Kremmling and Dotsero, certain reaches provide outstanding opportunities for fishing from boat or from shore. In Glenwood Canyon and near Pumphouse and Radium upstream, trail systems parallel the river, providing hikers and bicyclists the opportunity to enjoy wildlife and river corridor views. The Upper Colorado River Scenic Byway also passes through this corridor, providing visitors with scenic driving opportunities.

<u>Kremmling to Dotsero</u>

BLM manages the public lands along with river between Kremmling and Dotsero as the Upper Colorado River Special Recreation Management Area (SRMA). BLM's broad management objectives for the SRMA include delivering personal and social benefits associated with outdoor recreation; protecting fish, wildlife, and plants from public use impacts; generating community stewardship of recreation resource and natural resources; and maintaining tourism employment and revenue for the local economy. BLM achieves these objectives by dividing the river corridor into various management zones and managing each zone for targeted experiences and recreation benefits. To support these objectives, BLM manages nine formal recreation sites between Kremmling and Dotsero, which include facilities such as parking, boat ramps, restrooms, campgrounds, public water supplies, and trailheads.



Private rafting trip taking out at BLM recreation site in Upper Colorado River SRMA.

Visitation to BLM recreation sites is recorded annually in the BLM's Recreation Management Information Systems (RMIS) database. The use at a specific site is captured as "visits" which equates to one person entering onto lands or waters managed by the BLM for the purposes of recreation. A "visitor day" is defined as a visitor spending 12 hours in an area. A family of four camping for three days would count as 12 visitor days. These visitation numbers are derived from multiple methods including records from recreation permits, campground fee envelopes, data from traffic counters, and simple observation. While technically open year-round, visitation to the campgrounds is concentrated in the summer season, generally May through September.

Visitation tracking in RMIS follows the federal fiscal year (FY), which runs from October 1 through September 30 of the following year. Within the SRMA, there were 241,417 visits in FY2020, 242,679 recreational visits in FY2021, and 257,007 visits in FY2022. Visits by recreational users more than doubled over the three-year period and averaged 238,034 visits within the SRMA. This increase in recreational use is consistent with other public lands across Colorado.

Table 1. Estimated Annual Visitation to Upper Colorado River SRMA in Visitor Days

Upper Colorado River SRMA	FY20	FY21	FY22	Average
Kremmling Field Office	149,173	175,203	180,459	168,278
Colorado River Valley Field Office	65,244	67,476	76,548	69,756
Total Annual Visitation	214,417	242,679	257,007	238,034

BLM cooperates with the Upper Colorado River Wild and Scenic Stakeholders Group to collect data concerning the number of visitor days associated with float trips. Between May 1 and September 30, 2022, a total of 42,836 visitor days were logged for commercial outfitters who were taking clients on float boating trips.[4] While the exact percentage of visitor days associated with commercial float trips varies from year to year, the 2022 surveys revealed that approximately 45% of visitor days were associated with commercial float boating trips, while approximately 55% of visitor days were associated with privately-run float boating trips.

[4] Upper Colorado River Wild & Scenic Stakeholders Group – 2022 Annual Monitoring Report.



Visitors experiencing a quiet section of the Colorado River within the SRMA.

Using this data and visitor distribution, BLM estimates there were approximately 53,272 visitor days during 2022 that were associated privately-run boating trips. If visitor days for commercial trips and privately-run boating trips are combined, BLM estimates the number of visitor days for both commercial and private boating trips for 2022 was approximately 96,000.

Much of the visitor use in the SRMA is supported by commercial outfitters, each of whom operates under a Special Recreation Permits issued by BLM. The total number of Special Recreation Permits issued to outfitters for operations within the SRMA is shown in Table 2.

Table 2. BLM Special Recreation Permits for Upper Colorado River SRMA.

Number of Special Recreation Permits	Type of Recreation Use Authorized
2	Kayaking / Canoeing
24	Fishing
50	Rafting / Floating / Rowing

Overall, outdoor recreation types on BLM-administered lands in the Kremmling Field Office and Colorado River Valley Field Office contributes $145.7 million and over 1,100 jobs annually, paying $50.4 million in labor income to Colorado's economy.[5] Public lands play an important role in stimulating the local economy by providing opportunities for recreation. Communities adjacent to public lands can benefit economically from visitors who spend money in hotels, restaurants, gas stations, gift shops, and elsewhere.

[5] BLM 2023. Valuing America's Public Lands 2023. Internet website: https://www.blm.gov/about/data/socioeconomic-impact-report-2023

Glenwood Canyon

WRNF manages the public lands along a majority of the Glenwood Canyon section of the Colorado River. This is the largest canyon on the upper Colorado River with rugged scenic walls rising over 1,300 feet on either side. The 2002 White River National Forest Land and Resource Management Plan provides Management Area direction for this area with a title of *Recreation Rivers-Designated and Eligible* and a theme of *Recreation Rivers are managed to protect and perpetuate eligible and designated recreation river segments*. These areas are managed to protect and perpetuate eligible river segments in their current condition so that their recreation river qualities are not diminished.

WRNF manages the Glenwood Canyon portion of the river as one segment, which starts at the national forest boundary on the eastern end of Glenwood Canyon and extends downstream to the national forest boundary near the west end of Glenwood Canyon. The infrastructure that supports the recreational activities in the canyon includes the Glenwood Canyon Recreation Path, two (2) boat ramps at Shoshone and Grizzly Creek, respectively, and rest areas, trailheads, parking areas, and restrooms at Hanging Lake, Grizzly Creek, and No Name rest areas, with a parking area and restroom at Bair Ranch rest area.



Visitors enjoy one of the many rapids in Glenwood Canyon

Overall visitation on the WRNF managed stretch of the Colorado River, through Glenwood Canyon, is tracked following the federal fiscal year (FY) from October 1 through September 30 of the following year. Estimated visitation includes commercial boater service days along with private boat data collected by WRNF staff at the Shoshone and Grizzly Creek boat ramps throughout the high use summer season, running from late June through late August.

Table 3. Actual and estimated visitation on the Colorado River in Glenwood Canyon based on a 70-day high use season (late June-Late August).

Glenwood Canyon	FY20	FY21	FY22
Commercial	43,089 (actual)	52,131 (actual)	53,687 (actual)
Estimated Private Use	4,138* (estimated 16,092)	1,456** (estimated 6,370)	1,609*** (estimated 3,633)
Total Combined Estimate	59,181	58,501	57,320

*18 days of private data collected,
**16 days of private data collected
***31 days of private data.

In 2018, WRNF conducted an Environmental Assessment to determine the capacity limit for commercial use of the Shoshone Rapids Section of the Colorado River in Glenwood Canyon. Through this process it was determined that 71,500 service days for commercial rafting and 750 service days for commercial kayaking, with a pool of 1,100 service days, and temporary use authorized on a requested basis by institutional type user groups, accounted for a total capacity limit of 73,350. There are currently 68,000 service days allocated to priority special use permit outfitter and guides.

These flow-dependent activities rely heavily on the amount of water in this stretch of the river. Based on input from the outfitters and experience, these commercial operations typically cease when river flows drop below 1,200 cfs. The floating visitor experience diminishes drastically once flows drop below this level.

The Shoshone rapids section of Glenwood Canyon is regionally significant to river recreation, as reliable flows create consistent Class II - IV whitewater conditions for boaters when most other popular rivers in the area have reduced flows, either by natural or controlled means. These dependable flows also contribute to the viability of long-standing outfitter's seasonal business operations and offerings to National Forest visitors.

The total number of outfitter and guide operations or educational institutions that are authorized to operate under a Special Use Permit by USFS to conduct commercial or educational activities on or along this portion of the river are outlined in Table 4.

Table 4. Number and types of 2024 USFS special use permits.

Number of permits	Types of permits	Total Priority Service Days
9	Rafting	66,977
3	Kayak	365
2	Fishing	150
3	Educational Institutions	340

Overall, WRNF directly supports 22,000 jobs with an economic impact of $1.6 billion based on data from 2019 and is considered the most visited national forest in the country.[6] Based on visitation studies conducted on a five-year cycle, forest visitation increased from 12.5 million visits in 2017 to 18.4 million visits in 2022[7]. While 11.5 million of those 2022 visits were from ski areas, the remaining 6.5 million visits were non-ski area visits. The Colorado River and public lands in Glenwood Canyon play a significant role in sustaining the local economy by providing opportunities not only directly related to recreation but also indirectly in the local communities where visitors support numerous local businesses and service providers.



Rafting the Colorado River in Glenwood Canyon.

Summary

The river-related natural environment in Glenwood Canyon has evolved in response to, and is dependent upon, the historical infrastructure and flow regime associated with operation of the Shoshone Power Plant water right. Any significant changes to the historical operation of the water right would result in corresponding changes to the natural environment, especially if the priority call associated with the water right were not exercised, resulting in increased diversions upstream. The Shoshone Outage Protocol[8], an operational agreement signed by Bureau of Reclamation,

[6] FY19 Economic Contributions from National Forests and Grasslands. USDA Forest Service, Ecosystem Management Coordination, Social Science and Economics. 2019.

[7] USDA Forest Service. National Visitor Use Monitoring Data 2017 and 2022.

[8] Shoshone Outage Protocol Agreement Number 13XX6C0129, dated June 27, 2016.

the State of Colorado, multiple local governments, and multiple entities with Colorado River water rights, recognizes the role that the water right plays in preservation of the natural environment in Glenwood Canyon, as well as the natural environment in river locations upstream and downstream. Quantification of the potential impacts associated with modified or terminated operation of the Shoshone Powerplant water right would require a detailed analysis of the historic water right call regime, hydrologic variability, and modeling of the in-channel and riparian habitat in Glenwood Canyon.

Operation of the Shoshone Power Plant water rights also has significant positive impacts both upstream and downstream from the plant. Downstream, operations of the water rights contribute to the flow rates necessary to support threatened and endangered fish species in the 15-Mile Reach near Grand Junction. Upstream, operation of the water rights supports Outstandingly Remarkable Values in three reaches of Colorado River that have been determined to be eligible for designation into the National Wild and Scenic Rivers System. Operation of the water rights also supports economically significant recreation use within BLM's Upper Colorado River SRMA and WRNF Glenwood Canyon Management Areas.

[8]

MEMORANDUM

BBA Water Consultants, Inc.

To: Peter Fleming, Brendon Langenhuizen, Andy Mueller, Jason Turner, Bruce Walters

From: Kristina Wynne, P.H. and John Shuler, P.H.

Subject: Preliminary Shoshone Historical Use Assessment –**DRAFT**

Job: 0808.06

Date: November 8, 2024

The purpose of this memorandum is to present an estimate of the historical use of the Shoshone Power Plant water rights ("Shoshone Water Right(s)"). The analysis of historical use will support the Colorado River Water Conservation District's (the "River District's") efforts to ensure the permanency of these senior non-consumptive water rights by changing their approved use in Colorado Water Court to add an alternate use for instream flow purposes to the already decreed hydropower purposes. The Shoshone Water Rights are among the largest and most senior water rights on the mainstem of the Colorado River. Since the Shoshone Power Plant began operating in 1909, the non-consumptive Shoshone Water Rights have operated nearly continuously in a manner that maximizes power production and subsequently maintains return flows for downstream water rights, including irrigation uses in the Grand Valley, municipal demands along the Colorado River west of Glenwood Canyon, and other non-consumptive uses such as assisting in the maintenance of flows for the Upper Colorado Endangered Fish Recovery Program (the "Fish Recovery Program") in the 15-Mile Reach.

The proposed change of use of the Shoshone Water Rights to include instream flow purposes will require the filing of an application with the Colorado Division 5 Water Court. Such applications are required by statute to be supported by technical determinations of the historical (in this case, non-consumptive) use of the subject water right to ensure that the water right is not expanded, that historical streamflow patterns and return flows are maintained, and that the change of use prevents injury to other water rights. The historical use and yield of the water rights are ultimately determined as part of the Water Court process. Because the River District, Public Service Company of Colorado ("PSCo"), and the Colorado Water Conservation Board ("CWCB")[1] have not yet filed a Water Court application for this change of use, and because various data sources are still being evaluated, a formal technical analysis has not yet been completed. This memorandum and the preliminary yield estimates presented herein are not intended for use in Water Court and may change in the future based upon additional data that may be evaluated or become available, and through ongoing discussions with the CWCB, PSCo, and potential opposers in the case. As with any change of water rights case, the River District seeks the ability to continue to utilize the

[1] Under statute, the CWCB is the only water user in the State of Colorado authorized to use water rights for instream flows and natural lake levels to preserve or improve the natural environment. Therefore, the CWCB will be a co-applicant with the River District and Public Service Company of Colorado when a Water Court application for a change of the Shoshone Water Rights is filed.

full Shoshone Water Rights at their decreed rates when legally and physically available, consistent with the historical use over a representative study period.

Background

The Shoshone Power Plant is located on the Colorado River in Glenwood Canyon just upstream of the City of Glenwood Springs, Colorado. The Shoshone Water Rights are diverted at an on-channel diversion dam ("Shoshone Dam") that extends across the Colorado River, approximately eight miles downstream of the USGS stream gage located near Dotsero, Colorado (USGS Gage 09070500, the "Dotsero Gage"). Water is diverted at the Shoshone Dam into an approximately 2.5-mile concrete-lined tunnel to the power plant where it is delivered to twin penstocks before dropping a total of 167 feet through two turbines to generate electricity at the Shoshone Power Plant. As part of the facility's normal operations to sluice sediment to prevent damage to the Shoshone Power Plant turbines and other infrastructure, some water is typically released from the tunnel at various locations. These uses are not consumed but must be diverted to optimize power generation at the Shoshone Power Plant, as discussed below. These diverted amounts return to the Colorado River un-depleted. The remaining water delivered to the penstocks and through the turbines to produce electricity is also not consumed, and therefore, all of the water diverted at the Shoshone Dam and delivered through the plant returns to the Colorado River at the Shoshone Power Plant outfall.

The Shoshone Power Plant is currently owned and operated by PSCo. In December 2023, the River District and PSCo entered into a purchase and sale agreement ("PSA") for the Shoshone Water Rights. As described in the PSA, the River District, in coordination with the CWCB, seeks to permanently protect the Shoshone Water Rights by changing the decreed use of the water rights to include instream flow purposes in the reach between the Shoshone Dam and the Shoshone Power plant outfall. By adding an alternate beneficial use for instream flow purposes to the Shoshone Water Rights, the rights will continue to utilize their administrative priority dates while maintaining the historical flow regime of the Colorado River within the State of Colorado.

Shoshone Water Rights

The Shoshone Water Rights include two separate absolute water rights associated with the Shoshone Power Plant. The more senior, original Shoshone Water Right was decreed for 1,250 cubic feet per second ("cfs") in Eagle County Civil Action No. 466 with a priority date of December 5, 1905. The entire 1,250 cfs was later made absolute in Eagle County Civil Action No. 553. The plant's capacity and consequent demand for water later increased by 158 cfs to a total of 1,408 cfs in 1929. The junior Shoshone Water Right was decreed for 158 cfs in Eagle County Civil Action No. 1123 and is administered with a priority date of May 31, 1940. The total decreed amount of the two water rights is 1,408 cfs, which has historically been diverted at the full rate for at least a portion of nearly every year. The combined decreed uses for the senior and junior Shoshone Water Rights are for power production purposes which are non-consumptive. The Shoshone Water Rights are more particularly described in Table 1, below.

Table 1. Shoshone Power Plant Water Rights

Case No.	Amount (cfs)	App. Date	Adj. Date	Previous Adj. Date	Priority Admin No.	Use
CA-466, CA-553	1,250	1/7/1902	12/9/1907	12/5/1905	20427.18999	Power manufacturing, mining, milling, traction, heating and lighting purposes
CA1123	158	5/15/1929	2/7/1956	5/31/1940	33023.28989	Manufacturing and generation of electrical energy

While records dating back to the initial diversion of the Shoshone Water Rights are not available, records available from the Colorado Division of Water Resources ("DWR") indicate that the Shoshone Water Rights may have placed calls since at least the mid-1960s. Calls for the Shoshone Water Rights have been and are currently administered by the DWR at the Dotsero Gage, located approximately eight miles upstream from the Shoshone Dam and approximately 10.5 miles upstream from the Shoshone Power Plant.

Plant History

Construction of the Shoshone Power Plant began in 1906, and it first operated in 1909. The tunnel at the Shoshone Power Plant can carry up to 1,408 cfs, which supplies water to two turbines at the Shoshone Power Plant which are capable of producing a combined 15,000 kW of electricity. Based on our discussions with current and past Shoshone Power Plant operators and PSCo water resources staff, we understand that unless the turbines, the plant, or the tunnel were shut down for maintenance, inspections, or for some other unforeseen circumstance, the plant was always diverting water and producing energy to the greatest extent possible. In other words, there has consistently been demand for the full amount of power that the plant can produce, in part due to the fact that the Shoshone Power Plant is a relatively small contributor to the larger energy grid. As such, over its operational lifespan, the delivery of power produced at the Shoshone Power Plant has not required reductions associated with a drop in demand at any time. Repairs to the turbines have historically been made using the same or similar parts throughout the life of the plant resulting in relatively consistent capacities, efficiencies, and operations over time.

For the majority of its 115-year history, the Shoshone Power Plant has operated constantly and exercised the Shoshone Water Rights to produce power, with routine partial shutdowns for maintenance. Review of available maintenance records from PSCo will occur prior to finalizing any historical use yield analysis. We understand from discussions with present and former PSCo staff that at least since the early 1980s, routine maintenance typically occurred from one to three months during the winter when streamflow is low, and the operators could minimize lost power

production. During that time, maintenance of the turbines was reportedly achieved by shutting down one turbine while keeping the other turbine online.

Based on DWR records which date back to the mid-1970s, and Historic Users Pool ("HUP") Annual Reports, which records span 1998-2014, the Shoshone Power Plant operated consistently with minor shutdowns (most often related to planned maintenance) until approximately 2002 when PSCo voluntarily reduced its call from 1,408 cfs to 1,000 cfs to allow upstream junior water rights to divert or store water from June 13, 2002 through June 26, 2002. This informal "Shoshone Call Relaxation" was again implemented in 2003, when PSCo voluntarily reduced the Shoshone Water Rights call to 704 cfs in the winter and spring despite the fact that there was physically available flow to divert at a greater rate for a portion of this period and there was demand for the power at the full capacity of the plant.[2] A formal call reduction agreement between PSCo and the Board of Water Commissioners for the City and County of Denver ("Denver Water") was signed in 2007.

In addition to the negotiated and voluntary call reduction agreements described above, the frequency of days during which the Shoshone Power Plant was not operational and unable to exercise the Shoshone Water Rights significantly increased after 2003, mostly due to natural phenomena or unforeseen circumstances beyond the control of PSCo and for which it worked diligently to make repairs necessary to get the plant back online and continue to meet the power demand. These major outages include but are not limited to the following events:

- 2004: PSCo conducted a major automation of the power plant's operations, which required the plant to be offline between mid-March and mid-July.

- 2007-2008: A major penstock rupture on June 20, 2007 resulted in the plant being offline until April 25, 2008. Operational issues following the penstock failure and repair persisted through water year 2008.

- 2010: Unscheduled maintenance was required due to a generator fire in late 2009.

- 2012: The plant operated with only one turbine to reduce the head at the Shoshone Dam to reduce seepage and other issues at the dam.

- 2013: Denver Water call relaxation agreement was in effect.

- 2020: The plant was shut down during the spring of 2020 due to a flood that required the replacement of the turbine exciters. The Grizzly Creek Fire started on August 10, 2020 and closed Glenwood Canyon for 13 days. The Shoshone Power Plant was offline following

[2] The 2003 informal "Shoshone Call Relaxation" was conducted in accordance with the March 21, 2003 "Agreement Concerning Proposed Operation of the Shoshone Power Call" between the River District and the City and County of Denver, acting by and through its Board of Water Commissioners.

the highway closure because powerlines destroyed during the fire had to be repaired or replaced.

- 2021: The plant was partially or fully offline for much of 2021 for reasons that included a large debris flow between the Shoshone Dam and the Shoshone Power Plant. Rock debris was stuck in the diversion tunnel.

- 2022: The plant shut down due to specialized turbine and casing inspections.

- 2023-2024: The plant shut down due to hazardous rockfall at the Shoshone Power Plant site and safety concerns for on-site staff and facilities. During the extended outage, the runner in Turbine A was sent off-site for significant repairs and refurbishment.

As shown in Table 2 below, reported days of full outages were much more frequent after 2004, indicating that the post-2003 period is not representative of the long-term historical use of the Shoshone Water Rights and the consistent operation of the plant due largely to extreme circumstances beyond the control of the plant operators.

Table 2: Summary of Days of Full Outage at the Shoshone Power Plant[3]

Period	Total Days of Full Outage	Average Annual Days of Full Outage
1975-2003 (29 years)	89	3
2004-2022 (19 years)	1,493[4]	77

Available Data Sources

There are two readily available data sources associated with the administration, diversion, and deliveries attributable to the Shoshone Water Rights: (1) records available from the DWR's Colorado Decision Support System ("CDSS") database which are characterized as "diversion records," and (2) administrative flow calculations quantified at the Dotsero Gage, where the Shoshone Water Rights are administered, as made available by the DWR through the Division Engineer's Office for Colorado Water Division 5. The CDSS records and administrative flow data are described in more detail below.

CDSS Records

Daily records for the Shoshone Power Plant from 1975 to present are available from the CDSS database. However, records for some periods are missing or appear to be repeated for many days

[3] Full daily outage based on days with reported zero or no data in CDSS records.

[4] Value based upon CDSS records. PSCo data suggests that there may have been up to approximately 30 days, primarily in November 2013, when the plant was operational to some degree. However, CDSS records report zero.

or months in a row. While these data entries are represented as "diversion records," these records are not based on the measurement of diversions or deliveries to the Shoshone Power Plant during this period. Rather, we understand that these records are based on power production records kept by the plant operators which were then converted to a flow rate based on a typical hydropower equation and an assumed unit efficiency of 81%. Generating unit efficiency was measured and variable unit efficiency curves were developed in the 1930s but were not used to develop the records that are currently available from the CDSS database.

Like most diversion structures and water rights uses, all the water diverted at the Shoshone Dam upstream of the plant and delivered through the tunnel is necessary for optimum operation of the Shoshone Power Plant even though not all the water diverted runs through the turbines to produce power. Analogous to other losses that are inherently included in and necessary for the operation of a reasonably efficient system and utilization of a water right, water is released through various tunnel "adits" or outlets. The Shoshone Power Plant operators open low level valves in the tunnel at several adits to clear sediment from the tunnel before the water reaches the penstocks in order to protect the turbine runners and other power plant infrastructure from damage and excessive wear. Based on discussions with operators at the plant, water may be released through the adits for many weeks at a time and releases may equal up to several hundred cfs. While water released through the adits returns directly to the Colorado River and is not run through the turbines, it is necessary for these amounts to be diverted to allow power to be generated in the safe operation of the power plant.

Because the CDSS records are based only on power produced at the Shoshone Power Plant, the additional water that was required to be diverted to enable the beneficial purposes at the plant is not included in the record. As a result, the CDSS records are more reflective of historical deliveries to the turbines than historical diversions from the river. The CDSS records underestimate the total amount of water actually available and diverted at the dam and subsequently delivered through the tunnel. Therefore, reliance on the CDSS records alone may not adequately protect the return flows historically available to downstream junior water rights because the CDSS records do not include water that was necessarily diverted to achieve the end beneficial use and that was returned to the river without directly producing power.

An additional consideration of the CDSS records is that at times they include reservoir water released for downstream users to fill any remaining tunnel capacity. The Shoshone Power Plant historically diverted and created power using the physically available flow, up to the plant's capacity, and the CDSS records inherently include at least some water that was released from upstream storage and bound for downstream use, such as support for the Fish Recovery Program in the 15-Mile Reach. This water, often referred to as "virtual pipeline water" or "shepherded water," is water that the Shoshone Power Plant may physically divert but that it does not have the right to call for. Diversion of shepherded water at the Shoshone Power Plant was allowed by the Division Engineer, as the Shoshone Water Rights are used for non-consumptive power generation and the water diverted would still be available for downstream users. Although the shepherded water cannot be "called" for by the Shoshone Water Rights, the diversion and beneficial use of that water demonstrates that except for periods of reduced use or non-use described above, the Shoshone Power Plant has a constant demand for 1,408 cfs.

Administrative Flow Data

While the Shoshone Power Plant may divert water on a year-round basis through the plant up to its capacity at any time, the ability for the Shoshone Water Rights to place a call has historically been administered by the Division 5 Engineer's Office ("DEO") based on the available "administrative flow" or "natural flow" at the Dotsero Gage. The administrative flow is determined by the DEO based on information from the U.S. Bureau of Reclamation ("USBR") and other users to account for upstream reservoir releases that must be shepherded to users below the Shoshone Power Plant including, but not limited to, contract water and HUP water released from Green Mountain Reservoir for use in the Grand Valley and water released for the Fish Recovery Program from Lake Granby, Wolford Mountain Reservoir, or other upstream sources. The DEO is charged with ensuring that this shepherded water is delivered past downstream intervening diversions to the final place of use. The administrative flow is therefore equal to the measured streamflow at the Dotsero Gage less the shepherded water. Because releases of contract water, HUP water, and water from other upstream sources generally only occur during the late summer months, the administrative flow is generally equal to the measured flow at the Dotsero Gage except from July through October.

The administrative flow has been formally considered and enforced as part of the DEO's administration of the Colorado River since 1998, following the start of the Fish Recovery Program releases on the Upper Colorado River in 1997. Based upon preliminary review of USBR Colorado River operations records and other DWR records, it appears that contract releases made above the Shoshone Power Plant and bound for users below the plant were minimal prior to 1998. Administrative flow calculations were made available by the DEO from 2017-2022. All administrative flow records prior to that period (back to 1998) were calculated based on the same sources of data and the same processes used by the DEO.

We understand that, until the mid-1980s, the administrative practice of the DWR and/or USBR may have been to limit the administration of the Shoshone Water Rights call to 1,250 cfs under the senior Shoshone Water Right. However, based on conversations with PSCo administrators and plant operators, in addition to streamflow records available pre-1998, there was always a demand for the full 1,408 cfs when such water was legally and physically available. Moreover, written call records from the 1980s indicate that plant operators at the Shoshone Power Plant routinely requested that DWR administer the entire 1,408 cfs when demands were not being met at the power plant. Therefore, for purposes of this analysis, we assumed that the administrative flow prior to 1998 is equal to the measured flow at the Dotsero Gage, limited to 1,408 cfs.

There was always demand for power generated at the Shoshone Power Plant and therefore the administrative flow could always be utilized so long as the power plant was operating at capacity and provided such water was legally and physically available. The administrative flow includes all water necessary to operate the plant to generate electricity including water released from the tunnel via the adits for sediment sluicing and other uses consistent with reasonably efficient operations. Consequently, the administrative flow is the best representation of the actual historical use of the Shoshone Water Rights and also more accurately reflects the historical impact to upstream water users during times when the plant was operating. Moreover, the administrative flow also includes

100% of the return flows from the historical exercise of the Shoshone Water Rights, which will be required to be maintained in a change of water right to prevent injury to downstream users. Because the administrative flow is most representative of historical conditions at the Shoshone Dam, it is also the most appropriate basis for determining the amount of water available for the alternate instream flow use within the proposed instream flow reach.

Additional Data and Records

For purposes of the analysis described in this memorandum, we relied on records available on DWR's CDSS database and administrative flow data recorded at the Dotsero Gage. Moving forward, the analysis of historical use described in this memorandum may be supplemented as additional information and data is discovered.

Preliminary Yield Analysis

In any change of use in Colorado Water Court, the historical use of the subject water right must be quantified based on the actual historical beneficial use of the water right for its decreed purposes to prevent the expansion of the water right and prevent injury to other water rights holders upstream and downstream. As described above, and for purposes of this analysis, the administrative flow is more representative of historical conditions than the "delivery" records available from the CDSS database.

Study Period

While the CDSS records are not the most representative data to reflect what flow rate was diverted under the Shoshone Water Rights, these records are available on a daily basis back to 1975 and indicate when the plant was operating, and that water was being used for its decreed purposes. The CDSS records, along with notes regarding the operations at the plant and calls by the Shoshone Water Rights, also show that the ability to operate the plant and divert water to the fullest extent was reduced after 2003. As described above, this was due to various reasons that were beyond the control of PSCo and, therefore, the post-2003 period is not reflective of the long-term historical exercise of the Shoshone Water Rights. Pursuant to Colorado law (e.g., CRS § 37-92-305(3)(d)), the entire study period of available data need not be considered in a change case provided that the selected study period is sufficiently long to show the true historical use of the water right to be changed.

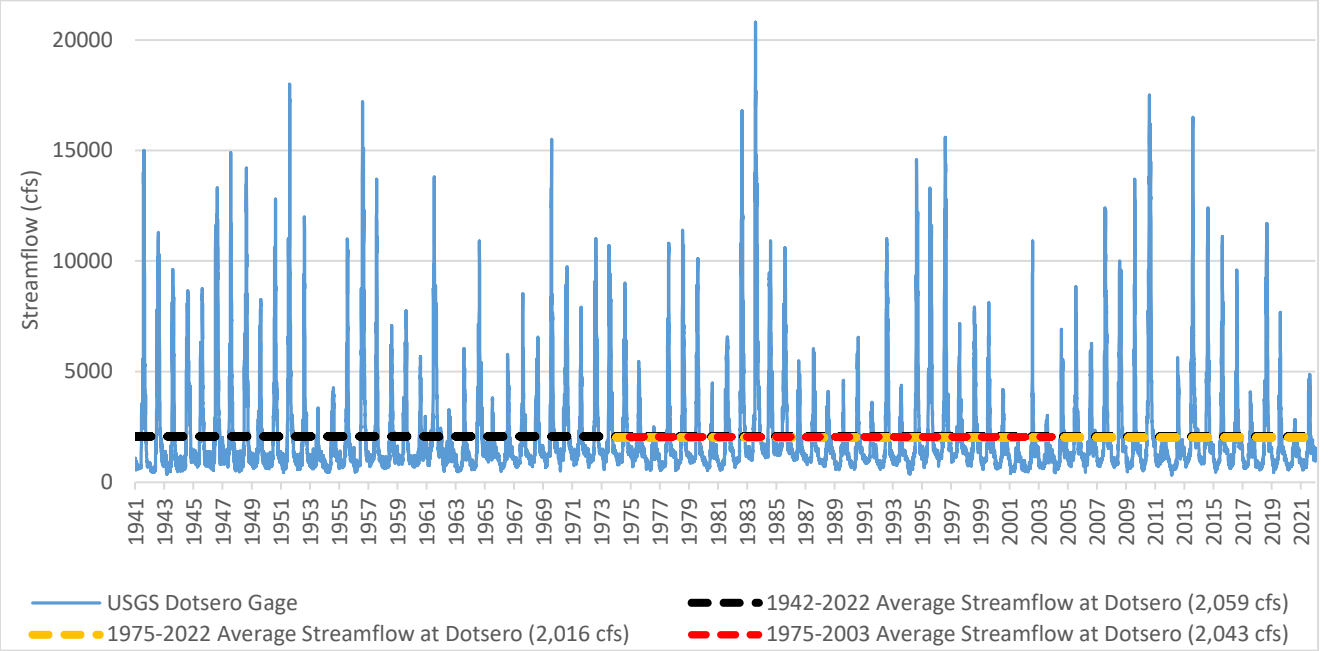
In other words, "quantification of the historical consumptive use of a water right must be based on an analysis of the actual historical use of the water right for its decreed purposes during a representative study period that includes wet years, dry years, and average years. The representative study period:

> (I) Must not include undecreed use of the subject water right; and
>
> (II) Need not include every year of the entire history of the subject water right."

Section 37-92-305(3)(d), C.R.S.

For the determination of the yield of the Shoshone Water Rights presented herein, a 1975 through 2003 water year study period was selected. This period represents years during which information regarding the operation of the plant is available and is reflective of a period of consistent operations at the plant and the exercise of the Shoshone Water Rights. The 29-year period of record also contains periods of wet, dry, and average hydrologic years, similar to years before and after the study period, as demonstrated below in Figure 1.

Figure 1 – Hydrograph of total Dotsero Gage streamflow with averages for different study periods to show that 1975-2003 study period is hydrologically representative.



Dotsero Gage data are available with minimal data gaps from 1942 to present. As shown in Figure 1, the entire period of record and the 1975-2003 period of record both include periods of wet, dry, and average streamflow years. Despite fluctuations in streamflow over the years, the average streamflow from 1942 to present is nearly identical to the average streamflow during the 1975-2003 study period (less than 1% difference). Similarly, the 1975-2022 average streamflow is approximately equal to the previous study periods (within approximately 2%). This indicates that any variance in average annual yield of diversions of the Shoshone Water Rights and plant operations after 2003 is not due to significant changes in physical supply available at Dotsero. Water diverted at the Shoshone Dam has historically fluctuated with the hydrograph given the nature of the operations, limited to the Shoshone Water Rights flow rate and the capacity of the plant.

Historical Use Quantification

Any change of a water right must ensure that the proposed changed use of the water right is not expanded and that historical streamflow patterns and return flows are maintained. This is most typically done through the imposition of decreed volumetric limits (which may be multi-year or annual averages) and return flow obligations. Volumetric limits can be determined by quantifying

the average historical use of a water right over a representative study period and may then be applied as a decreed limit to the future changed uses over a period of time consistent with the study period. Incorporating a running-average volumetric limitation based on a longer period of time allows a water right to operate with some flexibility and fluctuations in response to variable hydrology, just as it operated in the past, but prevents the expansion of the water right by limiting the running average annual diversion to the long-term historical average. Because the Shoshone Water Rights are non-consumptive water rights, maintaining the historical pattern of use will also maintain the historical return flows.

Therefore, we quantified the average annual yield of the Shoshone Water Rights for the representative study period of 1975-2003 by converting the daily administrative flow from 1998-2003 and the Dotsero Gage flow from 1975-1997 (limited to 1,408 cfs) to acre-feet ("ac-ft") of water beneficially used and then summed the daily values over each month of the selected study period (i.e., 1975-2003). The monthly averages from 1975-2003 were then summed to determine an average annual historical yield.

To best reflect the historical exercise of the Shoshone Water Rights, and to maintain the historical streamflow patterns and return flows relied upon by downstream water users, it was necessary to make the following reasonable adjustments and assumptions regarding the administrative flow:

- As described above, the administrative flow record was estimated using methods confirmed by the DEO and DWR-provided data back to 1998. Information regarding any water shepherded past the Dotsero Gage is limited, though the volumes and daily flow rates of shepherded water would have been minimal and occurred only during the irrigation season. Therefore, for purposes of this analysis, we assumed that prior to 1998, the administrative flow is equal to the flow at the Dotsero Gage, with additional limitations described below.

- Daily flows included in the yield analysis are limited to the lesser of the administrative flow and the total 1,408 cfs available under the Shoshone Water Rights.

- While the administrative flow was determined for all days in the 1975-2003 study period, the Shoshone Water Rights could not take advantage of and beneficially use the flow during periods of outage at the plant. Therefore, days of full outage were excluded from the calculation of total yield. As shown in Table 2, during the 1975-2003 study period, there were 89 days of full outage, based upon days with no data or days with zero diversions in the CDSS records. Data which specifically indicate the periods of partial outages are not available and therefore no corresponding adjustments have been made to this analysis.

- During the 1975-2003 study period, the power plant operated consistently, with only brief periods of partial outage to address routine maintenance issues according to PSCo staff.

Utilizing the data described above, with the appropriate adjustments, our preliminary calculation of average annual yield for the 29-year study period of 1975-2003 is equal to 844,644 ac-ft. This value, when applied on a rolling 29-year average basis (i.e., not an annual volumetric limit) is an appropriate volumetric limit for the changed use of the Shoshone Water Rights. For purposes of comparison, the preliminary average annual yield presented here is less than the measured Dotsero

Gage flow (limited to 1,408 cfs). As shown in Table 3, the preliminary average annual yield is also significantly less than if the historical use was assumed to be the total Shoshone Water Rights of 1,408 cfs or the senior right of 1,250 cfs.

Table 3: Average Annual Yield Comparison for Study Period 1975-2003

Data Source	Average annual yield (ac-ft)
Calculated Administrative Flow	844,644
Measured Dotsero Streamflow (limited to 1,408 cfs)	857,696
1,408 cfs year-round	1,019,360
1,250 cfs year-round	904,972

It is important to note that the historical use of the Shoshone Water Rights fluctuated with historical hydrology. Additionally, the maximum administrative flow rate diverted at the plant over the 1975-2003 study period was equal to 1,408 cfs at least once in each month throughout the entire period of study (i.e., the administrative flow was equal to 1,408 cfs in at least one January, one February, etc. over the entire study period). Thus, the full decreed rate of flow should be available for both continued hydropower production and for instream flow use based on the actual historical diversion and use of the Shoshone Water Rights for their originally decreed purposes. However, because the full decreed rate was not continuously available on a daily basis in all months, the future use of the Shoshone Water Rights will be limited to the 29-year running average annual volume of use in order to prevent an expansion of the water right.

The yield estimate based upon the adjusted administrative flow record from 1975-2003 is reflective of a period of continuous exercise of the Shoshone Water Rights at the Shoshone Power Plant and the conditions on the mainstem of the Colorado River. Unlike the CDSS records, the administrative flow includes all water diverted that was necessary to generate power at the plant as well as the water that was returned to downstream users to prevent injury to vested water rights.

Conclusion

Under the PSA, the River District seeks to acquire the Shoshone Water Rights for the purpose of changing the decreed use of the water rights to include an alternate beneficial use by the CWCB for instream flow purposes. The change of use must be reflective of the historical beneficial use of the Shoshone Water Rights for the decreed non-consumptive uses and will require the continuation of historical streamflow patterns and return flows to the Colorado River that has occurred in conjunction with the consistent exercise of the Shoshone Water Rights.

For purposes of this analysis, adjusted administrative flows at the Dotsero Gage were used to determine the yield of the Shoshone Water Rights which is equal to a running 29-year annual average of 844,644 ac-ft during the 1975-2003 study period. This study period is representative of consistent operations of the Shoshone Power Plant and exercise of the Shoshone Water Rights and

excludes periods of extended unplanned outages that were outside of PSCo's control such as the 2007 penstock rupture, wildfire and subsequent debris flows in Glenwood Canyon, and other events. In addition, this historical average yield value is conservative because it does not include the virtual pipeline/shepherded water that was historically used by the Shoshone Power Plant to produce power. The yield analysis presented here is not only representative of the operation and beneficial use of the water rights necessary for hydropower production but also maintains the return flows resulting from diversions of these nonconsumptive water rights and preserves the historical streamflow regime on the Colorado River.

Ultimately, the historical yield of the water rights that may be changed for instream flow purposes will be determined through the Colorado Water Court process. Thus, the analysis of historical use described in this memorandum may be revised as additional information and data is discovered.

JOINT MEMORANDUM

TO: United States Bureau of Reclamation

FROM: Bruce C. Walters, Colorado River Water Conservation District

Kirsten M. Kurath, on behalf of the Orchard Mesa Irrigation District and the Grand Valley Water Users Association

Frederick G. Aldrich, on behalf of the Grand Valley Irrigation Company

RE: The Shoshone Water Rights, the Orchard Mesa Check Case, and Green Mountain Reservoir's Historic Users Pool "Surplus" Releases to the 15-Mile Reach

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The Colorado River Water Conservation District and a coalition of West Slope governments, municipalities, and major water entities seek to secure the permanent protection of the river flow regime created by the historical exercise of the "Shoshone Water Rights" as part of the Shoshone Water Rights Preservation Project.[1] Ensuring the continuation of this critical flow regime also protects a number of associated benefits downstream of the Shoshone Power Plant, including the availability of water to the 15-Mile Reach in the Grand Valley.

The Shoshone Water Rights are a foundational component of the administration of the upper Colorado River, from the headwaters in Grand County, Colorado, downstream to the Colorado-Utah state line. Maintenance of the historical exercise of the Shoshone Water Rights is critical to the annual determination by a group of water users in the Grand Valley to decare a "surplus" of water stored in Green Mountain Reservoir's Historic Users Pool ("HUP Surplus"). In most years, the HUP Surplus provides the single largest source of upstream storage available for release to supplement low flows in the 15-Mile Reach,[2] thereby supporting the substantial benefits to the 15-Mile Reach of the Colorado River Programmatic Biological Opinion. The continued maintenance of the historical flow regime created by the exercise and administration of the Shoshone Water Rights will ensure that the call attributable to the senior "Cameo" group of water rights in the Grand Valley (the "Cameo Call") is reduced in amount and duration, reducing the amount of time that the Cameo Call "sweeps" the river just above the 15-Mile Reach and increasing the times during which there will be HUP Surplus available to benefit the 15 Mile Reach.

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[1] As defined in the Check Case Stipulation, "Shoshone [Water] Rights" means the water rights decreed for and associated with the Shoshone Hydroelectric Power Plant, adjudicated for 1,250 c.f.s. on December 19, 1907, with an appropriation date of January 7, 1902, and adjudicated for 158 c.f.s. on February 7, 1956, with an appropriation date of May 15, 1929. *See* Stipulation, p. 3, ¶ 1.

[2] The "15-Mile Reach" is the reach of the Colorado River which extends, from the point at which the tailrace common to the Grand Valley Power Plant (and now the Vinelands Power Plant) and the OMID pumping plant returns to the Colorado River below the GVIC diversion dam, downstream to the confluence of the Colorado River and Gunnison River. *See* Stipulation, p. 2, ¶ 1.

History and Background.

In 1991, the Orchard Mesa Irrigation District ("OMID"), the Grand Valley Water Users Association ("GVWUA"), and the United States of America ("United States") jointly filed a water court application in Case No. 91CW247, District Court, Water Division No. 5 (the "Check Case"). In the application, the co-applicants requested approval of an absolute water right associated with the historical operation of an appropriative right of exchange for the structure commonly referred to as the Orchard Mesa Check (the "Check"). *See* Decree, ¶¶ 6, 7.7. The Check provides a mechanism by which the water that is used by OMID, GVWUA and the United States to generate power and by OMID to lift water to a canal system on Orchard Mesa can be directed back upstream of the Grand Valley Irrigation Company's ("GVIC's") diversion dam. *Id.*

Operationally, the exchange first involves the diversion of water out of the Colorado River at the Grand Valley Project's diversion dam (the "Roller Dam").[3] *Id.* at ¶ 7.1. Once that water is diverted by GVWUA at the Roller Dam, it is then delivered through the Government Highline Canal and into the Orchard Mesa Power Canal for delivery to OMID's pumping plant and/or the Grand Valley/Vinelands Power Plant. *Id.* at ¶¶ 7.2–7.6. Once used for power and pumping purposes, the return flow is conveyed from an afterbay to a point upstream via the Check channel into the Colorado River just above GVIC's diversion dam, where the water may then be diverted by GVIC. *See* Figure 1.[4] The federal facilities, rights, and interests involved in the case are fundamental to the operation of the Check and the annual determination of whether a HUP Surplus exists.

The Check Case Stipulation.

In addition to formally adjudicating the long-standing Check exchange operation, the Check Case addressed several interrelated issues on a critically important stretch of the Colorado River for the four Colorado River Endangered Fish Species.

The 1996 Check Case Stipulation (the "Stipulation")—which was expressly incorporated into the Decree—provides that the co-applicants (including the United States and GVIC) agree to: (1) reduce the overall demand of the Cameo group of water rights from 2,260 c.f.s. to 1,950 c.f.s., and (2) annually make a declaration as to whether a HUP Surplus exists for supplementing low flows in the 15-Mile Reach. More particularly, because Check operations can reduce the amount of water released from the 66,000 acre-feet HUP on an annual basis, the Stipulation also implements the Green Mountain Reservoir HUP Operating Criteria (the "Operating Criteria," Decree, Ex. D),

[3] The Roller Dam is located on the Colorado River just above Plateau Creek and is operated by GVWUA in conjunction with the Bureau. Some of the water diverted by the Roller Dam is also delivered to GVWUA, Palisade Irrigation District, and Mesa County Irrigation District via the Government Highline Canal.

[4] With respect to Figure 1, the Check channel is referred to as the "bypass channel." In addition, although Figure 1 shows 310 c.f.s. going to the Vinelands Power Plant in this graphic, the United States' power right is decreed for 400 c.f.s. during the irrigation season and there are certain conditions when the full 400 c.f.s. water right can be diverted to the power plant.

which criteria contemplates the existence of "HUP Surplus" water (i.e., the volume of water, if any, in excess of the amount of water necessary to meet the demands of HUP beneficiaries). Under the Operating Criteria, HUP Surplus water is delivered to the 15-Mile Reach through non-consumptive use contracts with Grand Valley entities.

As it relates to the Shoshone Water Rights, the Stipulation sets forth terms and conditions under which the co-applicants and GVIC agree to forgo placing an administrative call against upstream HUP beneficiaries provided the following three conditions are met:

(1) The Check structure is physically operable;
(2) There is at least 66,000 acre-feet of water available in Green Mountain Reservoir for the benefit of HUP beneficiaries when Green Mountain Reservoir ceases to be in-priority for its initial fill (i.e., at the end of the reservoir's fill season); and
(3) The Shoshone Water Rights continue to be exercised in "a manner substantially consistent with their historical operations[.]"

See Stipulation, pp. 5–6, ¶¶ 3.b., 3.b.(1) –3.b.(3).

Thus, per the Stipulation, if any one of the three conditions are not met during the period extending from April 1 through October 31, then the Operating Criteria *and* the Stipulation's non-curtailment provisions with respect to HUP beneficiaries may be declared inoperative by the concurrence of any of the three Co-Applicants and GVIC. *Id.* at p. 6, ¶ 3.b.(5). The Stipulation provides that the immediate impact of an "inoperative" declaration is that "no water in the HUP shall be deemed to be surplus to the needs of the HUP beneficiaries." *Id.* In other words, if the third condition in the Stipulation is not satisfied (i.e., the Shoshone Water Rights are no longer exercised in "a manner substantially consistent with their historical operations"), then the HUP Surplus could not be relied on as the single largest source of stored water available to supplement low flows in the 15-Mile Reach.

Conclusion.

The permanent protection of the river flow regime created by the historical exercise of the Shoshone Water Rights is necessary to continue the critical benefits to the 15-Mile Reach created by the operation of all the terms of the Check Case. Any failure to operate the Shoshone Water Rights "in a manner substantially consistent with historical operations," could trigger a potential loss of the benefits that the HUP Surplus provides to all Colorado River water users within the state.

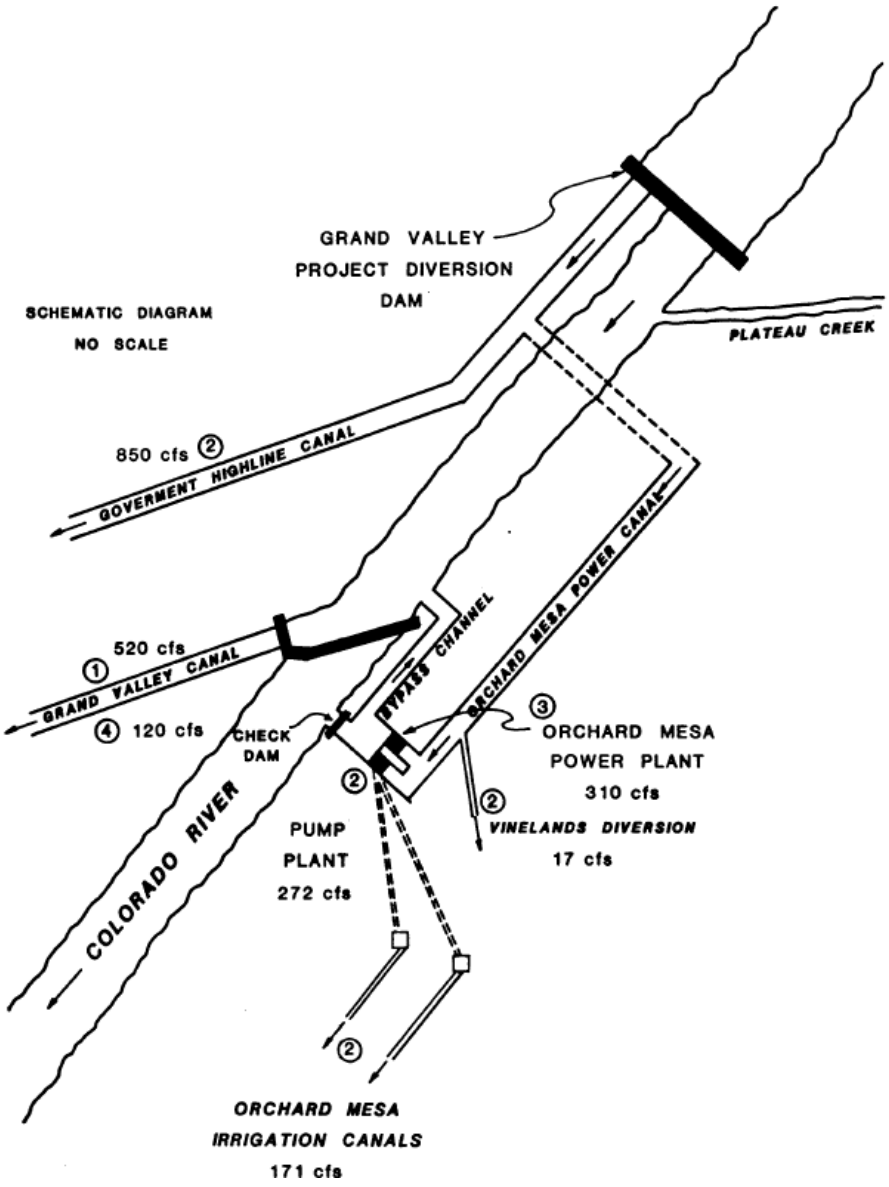


Figure 1: "Proposed Solution to the Orchard Mesa 'Check' Problem," prepared by the Colorado River Water Conservation District in cooperation with the Grand Junction Projects Office, U.S. Bureau of Reclamation, Case No. 91CW247, District Court, Water Division 5 (October 7, 1988).

PURCHASE AND SALE AGREEMENT

THIS PURCHASE AND SALE AGREEMENT (this "**Agreement**") is made as of the **Effective Date** by and between Colorado River Water Conservation District, a political subdivision of the state of Colorado (the "**River District**") and Public Service Company of Colorado, a Colorado corporation ("**PSCo**"). PSCo and the River District may be hereinafter referred to individually as a "**Party**," and together as the "**Parties**." All capitalized terms used but not immediately thereafter defined shall have the meanings ascribed thereto elsewhere in this Agreement.

RECITALS

A. PSCo owns the Shoshone Water Rights (defined below in Article 2), which are diverted at the Shoshone Dam, located in Glenwood Canyon, Colorado, and used for non-consumptive hydro-power generation at the Shoshone Hydroelectric Generation Station ("**Power Plant**"). Water delivered to the Power Plant is discharged and returned directly into the Colorado River at the outfall of the Power Plant.

B. Operation of the Shoshone Water Rights for hydropower purposes for over 100 years has had the added benefits of maintaining administrative stability of water rights in the Colorado River basin, , helping Colorado to meet the recovery requirements of endangered fish species under the federal Endangered Species Act, contributing significant flows to the interstate Colorado River System, and providing stream flows necessary to meet municipal, agricultural, environmental and recreation needs on Colorado's western slope.

C. The River District represents western slope interests that desire to maintain in perpetuity the operation of the Shoshone Water Rights in a manner consistent with their historical operation in order to preserve the benefits described above.

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the parties agree as follows:

ARTICLE 1. BASIC TERMS

1.1	Effective Date:	January 1, 2024
1.2	Seller:	PUBLIC SERVICE COMPANY OF COLORADO, a Colorado Corporation
1.3	Buyer:	COLORADO RIVER WATER CONSERVATION DISTRICT, a political subdivision of the state of Colorado
1.4	Subject Property:	The Shoshone Water Rights, as more particularly described in Article 2, below.
1.5	Purchase Price:	NINETY-EIGHT MILLION FIVE HUNDRED THOUSAND DOLLARS ($98,500,00.000).

1.6	Transaction Costs:	Five Hundred Thousand Dollars ($500,000.00), as more particularly defined in Article 3, below.
1.7	Due Diligence Period:	The period beginning on the Effective Date and ending on May 15, 2024.
1.8	Closing Date:	Thirty (30) days following the satisfaction of the Closing Conditions.
1.9	Exhibits:	Exhibit A: Escrow Agreement Exhibit B: PSCo's Due Diligence Deliveries Exhibit C: Special Warranty Deed Exhibit D: Lease of Shoshone Water Rights Exhibit E: Promissory Note Exhibit F: Deed of Trust

ARTICLE 2. PROPERTY DEFINED

2.1 **Shoshone Water Rights**. As used in this Agreement, the property being conveyed is the following described water rights:

(a) The Shoshone Power Plant senior water right decreed as the Glenwood Power Canal and Pipeline water right on Dec. 9, 1907, in Civil Action No. 0466, Eagle County District Court, in the amount of 1,250 cfs with an appropriation date of Jan. 7, 1902, for power, mining, milling, manufacturing, lighting and heating and traction purposes, and as further decreed by the Eagle County District Court on Feb. 27, 1911, in Civil Action No. 553; and

(b) The Shoshone Power Plant junior water right decreed as the Shoshone Hydro Plant Diversion No. 2 on Feb. 7, 1956 in Civil Action No. 1123, Eagle County District Court, in the amount of 158 cfs with an appropriation date of May 15, 1929, for manufacturing and generation of electrical energy.

together, (the "**Shoshone Water Rights**").

ARTICLE 3. PURCHASE & SALE

3.1 **Agreement of Purchase and Sale**. Subject to the terms and conditions of this Agreement, PSCo agrees to convey to River District, and River District agrees to purchase from PSCo the Shoshone Water Rights for the Purchase Price. The River District's payment of the Purchase Price to PSCo shall be as follows:

(a) Deposit. Not later than ten (10) business days following the Effective Date, River District shall deliver FIVE HUNDRED THOUSAND and 00/100 DOLLARS ($500,000.00), by wire transfer or bank or cashier's check, at its election (the "**Initial Deposit**") to the escrow holder defined below (the "**Escrow Holder**"). The Initial Deposit shall be deposited with and held by Escrow Holder as a deposit against the Purchase Price in accordance with the terms and provisions of this Agreement, and shall be credited against the Purchase Price if the transaction closes. All interest accruing on the Initial Deposit shall accrue to PSCo and be applied

against the Purchase Price at Closing. In the event this Agreement is terminated pursuant to the terms of this Agreement, the Escrow Holder shall distribute the Initial Deposit and interest accrued thereon in a manner consistent with Section 4.5, below.

(b) Escrow Holder. The Escrow Holder shall be First American Title Insurance Company, 1380 17th Street, Denver, CO 80202, Attn: Nichole Segura, Vice President, Commercial Escrow Officer. Upon execution of this Agreement, the Parties shall execute an escrow agreement as reasonably requested by the Escrow Holder, subject to PSCo's and River District's review and approval, not to be unreasonably withheld (the "**Escrow Agreement**"), substantially in the form of Exhibit A attached hereto. Escrow Holder shall hold and dispose of the Deposit in accordance with the terms of this Agreement and the Escrow Agreement.

(c) Transaction Costs. In addition to the Purchase Price, the River District shall pay PSCo FIVE HUNDRED THOUSAND and 00/100 DOLLARS ($500,000.00) (the "**Transaction Cost Prepayment**") as prepayment for PSCo's legal and consulting fees and costs incurred in negotiating this Agreement, negotiating associated agreements with the River District, Colorado Water Conservation Board and Denver Water; participating in filing and prosecuting a change application in Water Court, and participation in other negotiations, agency or regulatory approval processes, including the Colorado Public Utilities Commission, or other actions related to this transaction ("**Transaction Costs**"). The River District shall pay the Transaction Cost Prepayment no later than ten (10) days following the Effective Date by delivering the same directly to PSCo by wire transfer pursuant to instructions provided by PSCo. The Transaction Cost Prepayment to PSCo shall not be refundable in any amount to River District, except upon early termination of this Agreement and shall not be applied or credited against the Purchase Price at Closing. If the total Transaction Costs exceed the Transaction Cost Prepayment, the River District shall pay the difference at Closing (the "**Final Transaction Costs**"). Prior to Closing, at least every sixty (60) days, PSCo shall provide an up-to-date accounting of the Transaction Costs incurred by PSCo which will identify the billing entity, the total billed by such entity, and a brief description of the work performed. Before any funds may be transferred to PSCo as contemplated by this paragraph, PSCo must provide a signed W-9 to the River District, be set up as a vendor in the River District's billing/accounting system, provide its wiring instructions to the River District, and participate in a wire confirmation call with the River District.

(d) Closing Payment.

1. On the day of the Closing, SEVENTY-EIGHT MILLION FIVE HUNDRED THOUSAND and 00/100 DOLLARS ($78,500,000.00) of the Purchase Price, as adjusted by the Initial Deposit, and any interest accrued thereon, shall be paid in cash to PSCo by wire transfer (the "**Closing Payment"**). Notwithstanding the foregoing, the River District may, in its sole option and discretion, choose to pay more than the Closing Payment at Closing.

2. The balance of the Purchase Price, if any, after payment of the Closing Payment, and any other amounts tendered by the River District at Closing pursuant to Section 3.1(d)1. above, shall be paid to PSCo over ten (10) years in equal annual installment due on or before April 30 each year, as set forth in the promissory note (the "**Promissory Note**") attached hereto as Exhibit E and

incorporated herein by reference. The Promissory Note and Deed of Trust attached assumes the remaining balance will be TWENTY MILLION and 00/100 DOLLARS ($20,000,000.00) and the Parties agree to adjust the principal sum stated on the Promissory Note and Deed of Trust to reflect the actual balance of the Purchase Price prior to its execution. If the River District tenders the entire Purchase Price at Closing, the Promissory Note and Deed of Trust will not be required to close the transaction contemplated by this Agreement.

ARTICLE 4. DUE DILIGENCE AND CONDITIONS PRECEDENT TO CLOSING

4.1 PSCo's Due Diligence Deliveries. PSCo shall deliver or make available to River District, within fourteen (14) business days after the Effective Date, complete, legible copies of the items described in Exhibit B attached to this Agreement to the extent such items are in the possession or control of PSCo (collectively, "**PSCo's Due Diligence Deliveries**"). The Due Diligence Deliveries shall be considered to be Common Interest Information pursuant to the Common Interest, Confidentiality and Joint Defense Agreement executed by the Parties as of March 15, 2023 (the "**JDA**"). In the event that the Closing hereunder shall not occur for any reason whatsoever, River District shall promptly return PSCo's Due Diligence Deliveries to PSCo and shall destroy all copies and abstracts thereof.

4.2 Right of Inspection.

(a) During the Due Diligence Period and prior to Closing, River District shall, at its own cost and expense, have the right to review all aspects of the Shoshone Water Rights and conduct such inspections as it determines are necessary for completion of the transaction. River District shall schedule and coordinate all physical inspections of the Shoshone Water Rights and/or the Power Plant with PSCo and shall give PSCo at least seven (7) days' prior notice thereof. The River District, and its authorized agents and employees, must be escorted by a badged PSCo representative at all times while the River District is at the Power Plant or on other PSCo-owned property. The River District, and its authorized agents and employees, must observe PSCo's safety and security policies at all times while at the Power Plant or on other PSCo-owned property. PSCo shall reasonably cooperate with River District's inspections (including without limitation River District's interviews with PSCo personnel) so long as such cooperation is at no material expense to PSCo. River District shall not, in connection with its investigations, unreasonably interfere with Power Plant operations.

(b) To the extent allowed by applicable law, the River District shall indemnify, defend and hold PSCo harmless from and against all costs, expenses, damages, liabilities, liens or claims, including, without limitation, attorneys' fees and court costs, directly related to any entry on property associated with the Power Plant or Shoshone Water Rights by the River District, its agents, employees or contractors in the course of performing inspections, tests and/or inquiries provided for under this Agreement, or resulting from any conditions on such property created by River District's entry and testing (but not including any claims resulting from the discovery or disclosure of pre-existing physical or environmental conditions or any claims resulting solely from the gross negligence or willful misconduct of PSCo or its agents, representatives, employees or contractors). The foregoing indemnity shall survive the Closing Date or earlier termination of this Agreement.

4.3 Due Diligence Review; Approval. River District shall promptly commence, and shall diligently and in good faith pursue, its due diligence reviews hereunder within the Due Diligence Period. If, prior to the expiration of the Due Diligence Period, based upon such review, examination or inspection, River District determines in its sole and absolute discretion that it no longer intends to acquire the Shoshone Water Rights, the River District shall promptly notify PSCo of such determination in writing ("**Disapproval Notice**") whereupon this Agreement, and the obligations of the Parties to purchase and sell the Shoshone Water Rights, shall terminate, except those provisions that expressly survive the termination hereof, and the Initial Deposit shall be returned to the River District. If River District fails to deliver the Disapproval Notice to PSCo on or before the expiration of the Due Diligence Period, River District shall be deemed to have approved of all of the foregoing matters, and the transaction shall proceed to Closing, subject to completion of the Closing Conditions described in Section 4.4, below. In the event River District fails to deliver the Disapproval Notice on or before the expiration of the Due Diligence Period, River District shall be deemed to have accepted the condition of the Shoshone Water Rights in their "AS IS, WHERE IS" and "WITH ALL FAULTS" condition subject to the representations and warranties expressly made by PSCo in this Agreement.

4.4 Conditions Precedent to Obligations of River District and PSCo to Close. In addition to the River District's approval of its due diligence review as provided in Section 4.3, PSCo and River District agree that the Parties' obligation to complete the transaction hereunder shall be subject to the satisfaction or mutually agreed upon waiver of the following conditions at or prior to Closing (the "**Closing Conditions**"):

(a) Negotiate Use of the Shoshone Water Rights by CWCB for Instream Flow Purposes. The Parties agree to use their best efforts to mutually negotiate an agreement between the PSCo, the River District, and the Colorado Water Conservation Board ("**CWCB**") to enable the Shoshone Water Rights to be used for instream flow purposes when they are not being used for power generation purposes (the "**Instream Flow Agreement**"). The Instream Flow Agreement shall be executed prior to filing the Change Application described in Section 4.4(c), below, *provided however* that the Instream Flow Agreement will be effective as of the Closing Date of this Agreement, and will be held in escrow by the Parties pending delivery at Closing. The Instream Flow Agreement with the CWCB shall include the following provisions:

1. Use of the Shoshone Water Rights by the CWCB shall be subject to the lease of said water rights after Closing by the River District, as lessor, to PSCo, as lessee, for continued hydroelectric generation purposes (the "**Lease**").

2. PSCo's continued use of the Shoshone Water Rights pursuant to the Lease shall have precedence over use of the said water rights for instream flow purposes.

3. The use of the Shoshone Water Rights by the CWCB shall be conditioned upon the Closing of this Agreement and the issuance of a final Water Court Decree (as defined in Section 4.4(c) below), which changes the use of the Shoshone Water Rights to include instream flow purposes.

(b) Negotiate with Certain Potential Water Court Objectors. As described in subsection (c), below, the Parties intend to file a joint application to change the Shoshone Water Rights to include instream flow uses as an additional decreed use. Prior to filing such application, the Parties agree to use their best efforts to identify third parties who would likely file statements of opposition to the Change Application, and to enter into negotiations with said third parties to address their concerns with the goal of eliminating or minimizing objections to the Change Application. Closing is not specifically dependent on the Parties' success in reaching an agreement or stipulation with any of the potential water court objectors.

(c) Obtain Decree for Change of Shoshone Water Rights. The Parties and the CWCB will file an application with the Water Court, Water Division 5, seeking to change the Shoshone Water Rights to add instream flow uses as an additional decreed use (the "**Change Application**"). The Parties agree to prosecute the Change Application with diligence with the goal of obtaining a final decree (the "**Water Court Decree**"), with all rights of appeal exhausted or expired, by June 30, 2026; provided, however, that the deadline for completion of litigation may be extended by the Parties by mutual agreement to address unforeseen circumstances in completing the litigation. Should PSCo, in its sole and absolute discretion, determine that the adjudication of the Change Application would negatively impact the Shoshone Water Rights, impair PSCo's ability to continue hydroelectric generation at the Power Plant, or otherwise impair significant PSCo business interests, PSCo may withdraw the Change Application and terminate this Agreement. Should the River District, in its sole and absolute discretion, determine that the adjudication of the Change Application would prevent the acquisition of these rights from providing the intended benefit, the River District may withdraw the Change Application and terminate this Agreement.

Should either Party make a determination to withdraw the Change Application in accordance with this subparagraph (c), such Party shall provide notice of its intent to withdraw to the other Party, and the Parties shall then have sixty (60) days (the "**Review Period**") from the date of such notice during which the Parties shall discuss the concerns of the issuing Party and attempt to resolve those concerns and prevent withdrawal of the Change Application and termination of this Agreement. If the Parties are unable to resolve the issuing Party's concerns within the Review Period, the Party who issued the notice may withdraw from the Change Application and terminate this Agreement.

(d) Negotiate Amendment of Shoshone Relaxation Agreement with Denver Water. Effective January 1, 2007, PSCo entered into that certain Agreement Concerning Reduction of Shoshone Call (the "**Relaxation Agreement**") with the City and County of Denver, acting by and through its Board of Water Commissioners ("**Denver Water**"). The Parties to this Agreement will seek to negotiate the following amendments to the Relaxation Agreement with Denver Water (the "**Amendment to the Relaxation Agreement**"), to be effective upon Closing of this Agreement:

1. Modify the term of the Relaxation Agreement to be perpetual instead of terminating on February 28, 2032;

2. Allow all or part of the Relaxation Agreement to be assigned by PSCo to the River District if PSCo permanently ceases operation of the Power Plant;

3. Remove or modify the bidding rights granted to Denver in paragraph 13 of the Relaxation Agreement;

4. Include new provisions that would provide for the Relaxation Agreement to continue to operate in a manner that replicates historical Power Plant outages for regular maintenance activities if Power Plant operations permanently cease and the Shoshone Water Rights are used solely for instream flow purposes.

(e) Approval of the Public Utility Commission. PSCo shall obtain any final, non-appealable, approvals and decisions from the Colorado Public Utilities Commission ("**PUC**") legally required to effectuate the transaction contemplated by this Agreement (the "**PUC Decision**"), which must be fully acceptable to PSCo, and shall not impose any unsatisfactory conditions nor revise the terms and conditions of this Agreement, PSCo's tariffs, or any related agreements in any material respect. PSCo shall commence the approval process with the PUC upon satisfaction of Section 4.4(a), (c) and (d) and receipt from the River District of evidence that the River District has sufficient funds to make the Closing Payment. The Parties shall cooperate to seek such PUC Decision, including, without limitation, preparing responses to any information requests, providing any testimony or witnesses, and filing any supporting briefs or affidavits as may be useful and helpful to obtain regulatory approval. PSCo agrees to pursue the PUC Decision with diligence with the goal of obtaining the same by twelve (12) months from the date of PSCo's first public filing in the PUC approval process; provided, however, that the deadline for obtaining the PUC Decision may be extended by the Parties by mutual agreement to address unforeseen circumstances in completing the PUC approval process. PSCo, in its sole and absolute discretion, shall have the right to file any application for rehearing, reargument, and reconsideration with the PUC or to appeal any decision of the PUC to the courts.

(f) River District Financing. River District shall have available sufficient funds to make the Closing Payment to PSCo, and evidence of the same must be submitted to PSCo prior to commencing the PUC process outlined in subsection (e) immediately above. The Parties recognize that the River District anticipates a portion of the Closing Payment will be paid using funding from governmental funding sources (i.e. municipal, county, state, or federal governments or agencies, including but not limited to the River District) and that evidence of available sufficient funds from governmental sources in this paragraph shall include funds that are appropriated and/or otherwise committed by the governmental entity or entities toward the purchase of the Shoshone Water Rights.

(g) Release of PSCo Corporate Indenture. Following expiration of the Due Diligence Period, PSCo shall make application for a release of the Shoshone Water Rights from the lien of PSCo's corporate indenture ("**Indenture Release**"). In the event the Indenture Release is not issued, for any reason, on or before Closing, PSCo may, at PSCo's option, extend the Closing Date by written notice to River District for up to six (6) successive thirty (30) day periods or until such Indenture Release is issued.

(h) Waiver of Closing Conditions. The conditions set forth in Section 4.4(a) through (g) are for the mutual benefit of River District and PSCo. Unless stated otherwise therein, to the extent that one or more of the Closing Conditions have not been satisfied, the Parties may only waive such Closing Condition by mutual agreement in writing.

4.5 Termination.

(a) Except as may otherwise be indicated, if any of the conditions expressly set forth in Sections 4.4(a)-(f) have not been satisfied, extended or waived by mutual agreement of the Parties by December 31, 2027, or in the event of termination pursuant to Section 5.2(c), this Agreement may be terminated, with both Parties consenting to and acknowledging such termination in writing, and the terms hereof shall be of no further force and effect, except those provisions that expressly survive the termination hereof. In the event of termination in accordance with this Section 4.5(a), the Initial Deposit, and any accrued interest thereon, shall be released to PSCo.

(b) In the event of termination pursuant to Section 4.3, Section 4.4(g), and Section 5.1(h), the Initial Deposit, and any accrued interest thereon, shall be released to the River District.

(c) If this Agreement is terminated pursuant to a termination right expressly set forth in this Section 4.5, then:

1. within ten (10) business days following such termination and to the extent not otherwise prohibited by applicable law, River District shall deliver to PSCo all of the PSCo Due Diligence Deliveries it holds in non-electronic form or shall certify the destruction of same;

2. any documents deposited with Escrow Holder by River District shall be returned to River District, and any documents deposited with Escrow Holder by PSCo shall be returned to PSCo;

3. the Parties shall equally share any cancellation fee of the Escrow Holder;

4. the Parties shall withdraw the Change Application if it is pending, with a preference to withdraw the Change Application without prejudice;

5. PSCo shall withdraw the PUC application if it is pending;

6. if the Instream Flow Agreement has been finalized, the Parties and CWCB shall terminate such agreement;

7. if the Amendment to the Relaxation Agreement has been finalized, the Parties and Denver Water shall terminate such agreement;

8. the Parties shall execute all documents necessary to direct the Escrow Holder to release the Initial Deposit, in accordance with Sections 4.5(a) and 4.5(b) above; and

9. neither Party shall have any further obligations to the other hereunder, except for those obligations and indemnities which are expressly made to survive the termination.

(d) If the transaction contemplated by this Agreement is terminated prior to the Closing Date, PSCo, within ninety (90) days after the termination, shall provide an accounting of its actual Transaction Costs as of the date of termination to the River District and

1. if the actual Transaction Costs have not exceeded the Transaction Cost Prepayment, PSCo shall within that ninety (90) day period return to the River District any unapplied balance of the Transaction Cost Prepayment; or

2. if the actual Transaction Costs have exceeded the Transaction Cost Prepayment, the River District shall within that ninety (90) day period pay to PSCo the amount of the Transaction Costs which have exceeded the Transaction Cost Prepayment.

Before any funds may be transferred to the River District as contemplated by this paragraph, the River District must provide a signed W-9 to PSCo, be set up as a vendor in PSCo's billing/accounting system, provide its wiring instructions to PSCo, and participate in a wire confirmation call with PSCo.

(e) Pre-Closing Default. EXCEPT FOR THE RELEASE OF THE INITIAL DEPOSIT TO PSCO WHERE SPECIFIED HEREIN AND THE PAYMENT OF INCURRED TRANSACTION COSTS TO PSCO, SUBJECT TO ACCOUNTING IN THE EVENT OF TERMINATION, THE PARTIES HEREBY SPECIFICALLY WAIVE ANY SPECIAL, CONSEQUENTIAL, PUNITIVE, SPECULATIVE OR DIRECT DAMAGES AND ANY RIGHT EITHER PARTY MAY HAVE TO SPECIFIC PERFORMANCE IN THE EVENT OF A TERMINATION PURSUANT TO THIS SECTION 4.5.

ARTICLE 5. REPRESENTATIONS, WARRANTIES, AND COVENANTS

5.1 PSCo's Representations and Warranties. PSCo represents and warrants to River District as of the Effective Date and again as of Closing as follows:

(a) PSCo is a Colorado corporation, duly organized and validly existing and in good standing under the laws of the State of Colorado.

(b) This Agreement and all documents executed by PSCo that are to be delivered to River District at the Closing are, or at the time of Closing will be, duly authorized, executed and delivered by PSCo and are, or at the time of Closing will be, legal, valid and binding obligations of PSCo.

(c) To the best of PSCo's knowledge as of the Effective Date, PSCo has received no notice from any governmental authority with jurisdiction over the Shoshone Water Rights of any current violation of any laws or regulations applicable to the Shoshone Water Rights.

(d) To the best of PSCo's knowledge, there is no material litigation pending or threatened against PSCo that arises out of the ownership of the Shoshone Water Rights.

(e) To the best of PSCo's knowledge, no condemnation or other eminent domain proceedings are pending or threatened against the Shoshone Water Rights.

(f) PSCo is not and has never been a "foreign person" within the meaning of Section 1445 of the Internal Revenue Code of 1986, as amended, and any applicable regulations promulgated thereunder. Neither PSCo nor, to PSCo's knowledge, any of its affiliates or their respective partners, members, shareholders or other equity owners is a person or entity with whom U.S. Persons or entities are restricted from doing business under regulation s of the Office of Foreign Asset Control ("OFAC") of the Department of the Treasury or under any statute, executive order, or other governmental action.

(g) To the best of PSCo's knowledge, PSCo has not received any written notice that the Shoshone Water Rights are in breach of any "Environmental Requirements," meaning all laws, ordinances, statutes, codes, rules, regulations, agreements, judgments, orders, and decrees, now or hereafter enacted, promulgated or amended, of the United States, the State of Colorado, local governmental entities or any other political subdivision or agency exercising jurisdiction over the owner of the Shoshone Water Rights, the Shoshone Water Rights, or the use of the Shoshone Water Rights, relating to pollution, the protection or regulation of human health, natural resources, or the environment, or the emission, discharge, release or threatened release of pollutants, contaminants, chemicals of industrial, toxic or hazardous substances or waste or hazardous materials into the environment (including, without limitation, ambient air, surface water, ground water or land or soil).

(h) **To the extent that PSCo becomes aware after the Effective Date and prior to the Closing that any of the representations and warranties set forth in this Section 5.1, are no longer true and correct, PSCo shall promptly, and in any event prior to the Closing, provide River District with written notice thereof and explain in reasonable detail the facts giving rise to the change. Unless PSCo elects to cause and does cause the representation or warranty to again become true or correct prior to Closing, River District shall have the right to terminate the Agreement based any changes in the representations set forth in Section 5.1.**

The representations and warranties of PSCo set forth in Section 5.1, as updated as of the Closing Date in accordance with the terms of this Agreement, shall survive Closing for a period of six (6) months (the "**Survival Period**"), and upon expiration thereof shall be of no further force or effect except to the extent that, with respect to any particular alleged breach, River District gives PSCo written notice so as to be received by PSCo on or before the expiration of the Survival Period of such alleged breach with sufficient detail summarizing the nature of such alleged breach (a "**Claim Notice**") and files an action against PSCo with respect thereto within sixty (60) days of the date of such Claim Notice. Notwithstanding anything to the contrary contained herein, PSCo shall have no liability to the River District for the breach of any representation or warranty made in this Agreement or in PSCo's closing documents unless the loss resulting from PSCo's breach of its representations and warranties exceeds, in the aggregate, Twenty-Five Thousand Dollars ($25,000.00), in which event PSCo shall be liable for each dollar of damages resulting from the breach or breaches of its representations and warranties, but in no event shall PSCo's total liability for any such breach or breaches exceed, in the aggregate, five percent (5%) of the Purchase Price (the "**Cap**"); provided, however, that the Cap shall not apply to any claims made by River District due to any PSCo fraud. In no event shall any claim for a breach of any representation or warranty of PSCo be actionable or payable if the breach in question results from or is based on a condition, state of facts or other matter which was actually known by River District or any of River District's

employees, without any duty of inquiry, prior to Closing. PSCo shall indemnify and defend River District, its directors, officers, employees, agents, successors and assigns from and against any claim, loss, liability or expense, including reasonable attorneys' fees that, during the Survival Period, arise out of or result from the breach by PSCo of any of the foregoing representations or warranties.

With the sole exception of the representations and warranties set forth in this Agreement or in the closing documents executed by PSCo at Closing ("**PSCo Closing Documents**"), the agreement between River District and PSCo for the sale of the Shoshone Water Rights is made without representation or warranty of any kind by PSCo. With the sole exception of the representations and warranties set forth in this Agreement or in the PSCo Closing Documents, PSCo makes no representation or warranty of any kind with regard to the quality or quantity of the Shoshone Water Rights or the physical condition of any infrastructure associated therewith, with regard to any restrictions, requirements, costs or constraints that may be associated with the Shoshone Water Rights, or with regard to the suitability of the Shoshone Water Rights for River District's purposes, it being the parties' express understanding and agreement that River District shall fully inspect the Shoshone Water Rights and all aspects thereof during the Due Diligence Period and prior to Closing, and that River District will rely solely upon its own inspection in determining the physical condition and other features of the Shoshone Water Rights, any restrictions, requirements, costs or constraints that may be associated with the Shoshone Water Rights, and whether the Shoshone Water Rights are suitable for River District's intended purposes. With the sole exception of the representations and warranties set forth in this Agreement or in the PSCo Closing Documents, River District will acquire the Shoshone Water Rights in an "AS IS" and "WITH ALL FAULTS" condition. Without limiting the generality of the foregoing, except to the extent the representations and warranties set forth in this Agreement or in the PSCo Closing Documents are not true and correct, River District, for itself and its successors and assigns, releases PSCo and PSCo's agents, employees, managers, members, brokers, contractors and representatives from, and waives any and all causes of action or claims against any of such persons for, (a) any and all liability attributable to any physical condition of Shoshone Water Rights, including, without limitation, the presence of any hazardous materials; and (b) any and all liability resulting from the failure of the Shoshone Water Rights to comply with any applicable laws, including, without limitation, any environmental laws. Wherever herein a representation is made based upon the knowledge of, or notice to, PSCo, such knowledge or notice, is limited to the actual knowledge without duty of inquiry of, or notice received by Donald Hartinger, Director, Plant Operations, and Patrick Martinez, Sr. Manager, Operations, all of Xcel Energy Services Inc., provided nothing in this Agreement will be deemed to be a representation made by any named individual other than in their respective representative capacity, and the River District hereby expressly releases such individuals from any and all personal liability arising out of this Agreement or the representations made herein.

5.2 River District's Representations and Warranties. River District hereby represents and warrants to PSCo as of the Effective Date and again as of Closing as follows:

(a) River District is a body corporate and politic and a political subdivision of the state of Colorado duly organized and validly existing under the laws of the state of Colorado, with full right, power and authority to take title to the Shoshone Water Rights and to enter into and otherwise perform and comply with the terms of this Agreement.

(b) This Agreement and all documents executed by River District that are to be delivered to PSCo at the Closing are, or at the time of Closing, will be duly authorized, executed and delivered by River District and are, or at the time of Closing will be legal, valid and binding obligations of River District.

(c) To the extent that River District becomes aware after the Effective Date and prior to the Closing that any of the representations and warranties set forth in Section 5.2 are no longer true and correct, River District shall promptly, and in any event prior to the Closing, provide PSCo with written notice thereof and explain in reasonable detail the facts giving rise to the change. Unless River District elects to cause and does cause the representation or warranty to again become true or correct prior to Closing, PSCo shall have the right to terminate the Agreement based on any material change in the representations set forth in Section 5.2.

(d) The representations and warranties of River District set forth in Section 5.2 as updated as of the Closing in accordance with the terms of this Agreement, shall survive Closing for a period of six (6) months.

5.3 PSCo's Covenants. Between the Effective Date and the Closing or earlier termination of this Agreement, or for such other time period as set forth below, PSCo covenants and agrees as follows:

(a) PSCo shall operate and maintain the Shoshone Water Rights in substantially the same manner in which PSCo is currently operating the Shoshone Water Rights, subject to outages at the Power Plant due to necessary maintenance and repairs.

(b) Except for the existing lien of PSCo's corporate Indenture, PSCo shall not sell, mortgage, pledge, transfer or dispose of the Shoshone Water Rights, or any interest therein, except as contemplated as a condition of this Agreement. PSCo shall not create any new encumbrances on, or limitations on the exercise of, the Shoshone Water Rights.

(c) PSCo will not directly or indirectly solicit, actively encourage, initiate, entertain, substantively review, or participate in any negotiations or discussions with any other person or entity with respect to any offer or proposal to sell or finance the Shoshone Water Rights or any part thereof.

ARTICLE 6. CLOSING

6.1 Date and Location. The closing of this transaction (the "**Closing**") shall occur at a mutually agreeable time and place as the Parties and Escrow Holder may mutually agree to in writing, but not later than sixty (60) days following issuance of the PUC Decision and the expiration of all periods of appeal of such decision without contest (the "**Closing Date**").

6.2 Transactions at Closing.

(a) On or before the Closing Date, PSCo shall deliver or cause to be delivered to the Escrow Holder, with appropriate instructions for recording and disbursement consistent with this Agreement, the following documents duly executed and acknowledged where appropriate:

1. The Special Warranty Deed substantially in the form of Exhibit C.

2. The Lease to PSCo substantially in the form attached as Exhibit D.

3. The Indenture Release.

4. A Certificate of non-foreign status pursuant to Section 1445 of the Internal Revenue Code of 1986, as amended, together with any Certificates required pursuant to Colorado law.

5. The Amendment to the Relaxation Agreement.

6. The PUC Decision.

7. A W-9 Form.

8. Such other documents as may be reasonably necessary and appropriate to complete the Closing as contemplated herein.

(b) On or before the Closing Date, River District shall deliver or cause to be delivered to the Escrow Holder, with appropriate instructions for recording and disbursement consistent with this Agreement, the following documents to be duly executed an acknowledged where appropriate:

1. An executed Promissory Note substantially in the form attached as Exhibit E.

2. A Deed of Trust substantially in the form attached as Exhibit F.

3. The Lease.

4. The Instream Flow Agreement.

5. The Water Court Decree.

6. A W-9 Form.

7. Such other documents as may be reasonably necessary and appropriate to complete the Closing contemplate herein.

8. The Closing Payment.

9. The Final Transaction Costs, if any.

(c) Each Party shall, at Closing or from time-to-time prior to Closing, execute and deliver such further instruments, affidavits, and documents as the other Party or the Escrow Holder may reasonably request to effectuate the intent of this Agreement or as required by applicable law.

(d) The Escrow Holder shall record and/or distribute the Closing Documents and shall release the Initial Deposit, the Closing Payment, and Final Transaction Costs to PSCo.

(e) River District shall pay for the cost of recording of all deeds. The Parties shall each pay for one-half (1/2) of the cost of recording any of the other Closing Documents. The Parties shall each pay one-half (1/2) of the Escrow Holder costs. Except as provided in Section 3.1(c) above, each Party shall pay its own attorneys' fees.

ARTICLE 7. GAINS ON SALE

The River District recognizes and agrees that any decision on how PSCo allocates or uses the gains on sale, if any, from the transaction contemplated by this Agreement (the "**Gains**") is a business decision within the discretion of PSCo. In addition to the foregoing, the Parties recognize and agree that the allocation or use of the Gains may be limited by the PUC Decision.

PSCo and the River District share an interest in the ecological and environmental health of the Colorado River. The Parties also share an interest in the benefits of emerging and next-generation utility projects, and PSCo plans to pursue these types of projects across Colorado. Should PSCo identify a project located in the western Colorado region served by the River District which advances these shared interests, and which provides a benefit to PSCo's ratepayers across the State of Colorado, and should PSCo decide to allocate, use or invest any of the Gains to finance such a project, the Parties agree to work together to promote such projects.

Notwithstanding the foregoing, the River District will not make any public statements in opposition to PSCo's business decisions on how to allocate or use the Gains in accordance with Section 4.4(e).

ARTICLE 8. POST-CLOSING DEFAULTS AND REMEDIES

8.1 Events of Default. After Closing, each of the following shall constitute an "**Event of Default**":

(a) Default by either Party in the due and punctual performance of any of its covenants, conditions, agreements, payments or other provisions contained in this Agreement on its part to be performed, if such default continues for thirty (30) days after written notice specifying such default and requiring the same to be remedied is given by the non-defaulting Party; provided that if such default cannot be cured within such thirty (30) days, and during such period corrective action has commenced to remedy such default and subsequently is diligently pursued to the completion of such performance, an Event of Default shall not be deemed to have occurred until one hundred and twenty (120) days after written notice has been delivered.

(b) Subject to any of the survival provisions of Sections 5.1 and 5.2 (Survival), any of the representations or warranties made by a Party shall prove to have been materially incorrect under the circumstances when made.

8.2 Remedies, Generally. Upon the occurrence and continuation of an Event of Default, the following remedies shall be available to the Parties:

(a) Except as provided in Section 8.2(b) below, if an Event of Default by PSCo, River District may in its sole discretion:

1. Waive such default or condition; or

2. If the Event of Default by PSCo is not cured as provided in Section 8.1, above, River District shall have the right to damages, EXCEPT THAT RIVER DISTRICT SPECIFICALLY WAIVES ANY SPECIAL, CONSEQUENTIAL, PUNITIVE, SPECULATIVE OR INDIRECT DAMAGES.

(b) If the Event of Default consists of a default by River District under Section 8.1, above, PSCo may in its sole discretion:

1. Waive such default or condition; or

2. If the Event of Default by River District is not cured as provided in Section 8.1, above, PSCo shall have the right to damages, EXCEPT THAT PSCo SPECIFICALLY WAIVES ANY SPECIAL, CONSEQUENTIAL, PUNITIVE, SPECULATIVE OR INDIRECT DAMAGES.

ARTICLE 9. NOTICES

Any notice, demand, claim or other written instrument required or permitted to be given pursuant to this Agreement shall be in writing signed by the Party giving such notice and shall be sent by electronic mail, hand messenger delivery, overnight courier service or certified mail (receipt requested) to the other Party at the addresses set forth below and shall be deemed to have been duly given by delivery to the respective addresses provided below, or such other address changed by the recipient by notice consistent with this Article: (i) on the date and at the time of delivery if delivered personally to the Party to whom notice is given at such address; (ii) on the date and at the time of delivery or refusal of acceptance of delivery if delivered or attempted to be delivered by an overnight courier service to the Party to whom notice is given as such address; (iii) on the date of delivery or attempted delivery shown on the registered or certified mail, return receipt requested, postage prepaid and properly addressed to such address; (iv) if an email address is specified, on the date and at the time shown on the sent email message if sent to the e-mail address specified below:

If to PSCo: Public Service Company of Colorado
Attn: Environmental Services - Water Resources
1800 Larimer Street, Suite 1300
Denver, CO 80202

With Copy to: Public Service Company of Colorado
Attn: Director, Community Relations
1800 Larimer Street, Suite 1400
Denver, CO 80202

and:	Xcel Energy Attn: Frances A. Folin, Esq. 1800 Larimer Street, 14th Floor Denver, CO 80202 Frances.A.Folin@xcelenergy.com
and:	Welborn Sullivan Meck & Tooley, P.C. 1401 Lawrence Street, Suite 1800 Denver, CO 80202 Attn: Carolyn Burr, Esq.; James M. Noble, Esq. cburr@wsmtlaw.com jnoble@wsmtlaw.com
If to River District:	Andy Mueller, Esq. General Manager Colorado River Water Conservation District 201 Centennial St., #200 Glenwood Springs, CO 81601 amueller@crwcd.org
With Copy to:	Peter Fleming, Esq. General Counsel Colorado River Water Conservation District 201 Centennial St., #200 Glenwood Springs, CO 81601 pfleming@crwcd.org
If to Escrow Holder:	First American Title Insurance Company 1380 17th Street Denver, CO 80202 Attn: Nichole Segura, Vice President 303.876.1112 nsegura@firstam.com

ARTICLE 10. MISCELLANEOUS

10.1 No Third-Party Beneficiary: No Waiver of Governmental Immunity. This Agreement shall not create any duty of care or liability with respect to any person or entity not a Party to this Agreement, or waive any of the privileges or immunities River District or its officers, employees, successors and assigns may present pursuant to law, including, but not limited to, the Colorado Governmental Immunity Act, C.R.S. 24-10-101, et seq., as amended.

10.2 Limits on Governmental Immunity. River District represents that, pursuant to C.R.S. Section 24-10-106, its governmental immunity is limited to claims for injury that lie in tort or could lie in tort. Under existing law, River District is not entitled to raise the defense of

sovereign immunity in connection with any legal proceeding to enforce or collect upon contractual obligations, including this Agreement, or any amendments or exhibits to this Agreement, including the payment of any amounts due thereunder, provided however that no term or condition of this Agreement shall be construed or interpreted as a waiver, express or implied, of any of the privileges or immunities River District, its officers, employees, successors or assigns may present pursuant to law, including but not limited to the Colorado Governmental Immunity Act, C.R.S. Section 24-10-101 et seq., as amended.

10.3 Mediation. If any dispute arises under this Agreement (including as to whether either Party has breached this Agreement or whether an Event of Default has occurred), then either Party may require that the other engage in nonbinding dispute resolution processes upon delivery of a written notice (a "**Dispute Notice**") setting forth the disputed matter. Upon receipt by the other party of such Dispute Notice, the Parties shall use commercially reasonable efforts to negotiate a resolution of the dispute for a period of sixty (60) days (the "**Dispute Resolution Period**") which may include mediation using a mediator chosen by the Parties. During the Dispute Resolution Period, no Party may bring a claim or commence legal action related to or in connection with the matter set forth in the Dispute Notice until the Dispute Resolution Period ends. This section shall not alter any date in this Agreement, unless the Parties agree otherwise in writing.

10.4 Time. Except as otherwise provided in this Agreement, time is of the essence as to each provision of this Agreement and the performance of each Party's obligations hereunder.

10.5 Attorneys' Fees. If any legal action or other proceeding is commenced to enforce or interpret any provision of this Agreement, the prevailing Party (defined below) shall be awarded its attorneys' fees and expenses, in addition to any other relief granted. The phrase "**Prevailing Party**" shall include the Party who receives substantially the relief desired whether by dismissal, summary judgment, judgment or otherwise. This provision shall survive the termination of this Agreement.

10.6 No Waiver. No waiver by any party of the performance or satisfaction of any covenant or condition shall be valid unless in writing and shall not be considered to be a waiver by such party of any other covenant or condition hereunder. Any failure of a Party to enforce any of the provisions of this Agreement or to require compliance with any of its terms at any time during the pendency of this Agreement shall in no way affect the validity of this Agreement, or any part hereof, and shall not be deemed a waiver of the right of such Party thereafter to enforce any and each such provision.

10.7 Entire Agreement. This Agreement contains the entire agreement between the Parties. This Agreement may only be modified by mutual written agreement duly authorized and executed by the Parties.

10.8 Survival. The provisions of this Section and Sections 3.1(d), 4.2, 4.3, 5.1, 5.2, and 10.5 shall survive the Closing or any earlier termination of this Agreement.

10.9 Publicity. Neither PSCo nor River District shall issue any public announcement referencing the Purchase Price or the other economic terms of this Agreement without the prior

written consent of the other. The Parties agree to work cooperatively and in good faith to jointly prepare all public announcements involving this Agreement.

10.10 Assignment. River District may not assign or otherwise transfer this Agreement or any of its rights or obligations hereunder without first obtaining PSCo's prior consent and approval thereto.

10.11 Governing Law and Construction. This Agreement, including any instrument or agreement required hereunder, and all matters arising out of or in connection with this Agreement (whether in contract, tort or otherwise) shall be construed in accordance with and governed by the laws of the State of Colorado without giving effect to any conflict of law principles that would require the application of the laws of another jurisdiction. The Parties hereby agree that the normal rule of construction to the effect that any ambiguities are to be resolved against the drafting party shall not be employed in the interpretation of this Agreement or any amendments or exhibits hereto.

10.12 Venue. All actions or proceedings arising out of or relating to this Agreement and any dispute shall be litigated in the District Court in Garfield County, Colorado. Each Party accepts for itself, generally and unconditionally, the exclusive jurisdiction and venue of the aforesaid court, submits itself to the personal jurisdiction of such courts and waives any defense of forum non conveniens or any similar defense. Each Party hereby waives its respective right to a trial by jury for any claim or cause of action based upon or arising out of or related to this Agreement in any action, proceeding, or other litigation of any type brought by any Party against any other Party, whether with respect to contract claims, tort claims, or otherwise. Each Party agrees that any such claim or cause of action will be tried by a court trial without a jury.

10.13 Joint Effort. Preparation of this Agreement has been a joint effort of the Parties and the resulting document shall not be construed more severely against one Party than against the other Party.

10.14 Days. In the event any time period set forth in this Agreement commences, expires or is determined from a date which falls on a Saturday, Sunday, legal holiday of the State of Colorado, the date of such commencement, performance, expiration or determination shall automatically be extended to the next business day. As used in this Agreement "business day" means any day except any Saturday, Sunday, any day which is a Federal or State of Colorado legal holiday, or any day on which banking institutions in the State of Colorado are authorized or required by law or other governmental action to close.

10.15 Counterparts; Electronic Signatures. This Agreement may be executed in any number of multiple counterparts, each of which shall be deemed to be an original copy and all of which shall constitute one agreement, binding on all parties hereto. PDF or DocuSign signatures shall be sufficient to bind the Parties.

10.16 Integrated Agreement. This Agreement, including all exhibits referenced herein, constitutes the complete, unseverable, unitary, integrated agreement between PSCo and River District concerning the subject matter hereof. The parties hereto acknowledge that they negotiated this Agreement, including all exhibits, as a single transaction and would not have entered into any

portion of the Agreement without the rights and obligations conferred by the Agreement as a whole. In the event of a conflict between the terms of this Agreement and any exhibits, the terms of this Agreement shall control unless such exhibit specifically identifies the Section(s) of this Agreement that will be superseded.

10.17 Approval.

(a) THE OBLIGATIONS OF THE RIVER DISTRICT ARE EXPRESSLY CONTINGENT UPON THE APPROVAL OF THIS AGREEMENT BY THE BOARD OF DIRECTORS OF THE RIVER DISTRICT.

(b) The River District's Board will not publish notice of its intent to consider this Agreement for approval, in accordance with Colorado law, until receiving written confirmation of final approval of this Agreement by the Board of Directors of PSCo and its parent company. Upon confirmation of the River District's Board's approval of this Agreement at a public meeting, each Party shall execute and deliver the Agreement to the other. The Parties may elect and mutually agree to a time and place for in-person execution of this Agreement.

10.18 Requirement of Good Faith and Reasonable Judgment. Unless otherwise expressly provided in this Agreement, all decisions to be made by a Party or jointly by the Parties shall be interpreted to require the exercise of each Party's reasonable judgment, acting in good faith, in rendering such decision.

10.19 Severability. In case any one or more of the provisions contained in this Agreement for any reason is held to be invalid or unenforceable, the invalidity or unenforceability will not affect any other provision of this Agreement, which will be construed as if the invalid or unenforceable provision had not been contained in this Agreement and, in lieu of each invalid or unenforceable provision, there will be added automatically as a part of this Agreement a provision as similar in terms to the invalid or unenforceable provision as may be possible and be valid and enforceable.

10.20 No Warranty of Tax Treatment. Each party is relying solely on itself and its own tax advisors regarding the tax treatment of the transactions contemplated under this Agreement.

10.21 Cooperation. At the request of the other Party, each Party, on its own behalf, covenants that it shall reasonably cooperate with the other Party, at no cost to the cooperating Party, except as provided in Section 3.1(d), in negotiating with other parties, or obtaining governmental approvals which are required to implement the Agreement.

[Signatures on Next Page]

IN WITNESS WHEREOF, the parties hereto have duly executed this Agreement as of the Effective Date.

Public Service Company of Colorado, a Colorado Corporation:

By: _____

Name: Robert S. Kenney

Title: President, Public Service Company of Colorado

Colorado River Water Conservation District, a political subdivision of the State of Colorado

By: _____

Name: Kathy Chandler-Henry

Title: President, Colorado River Water Conservation District

EXHIBIT A

ESCROW AGREEMENT

See attached.



1380 17th Street
Denver, CO 80202

ESCROW INSTRUCTIONS

File # _____

First American Title Insurance Company ("Escrow Agent"), hereby agrees to act as the escrow agent for funds deposited with it by the other parties to this Escrow Agreement ("the Agreement") under the terms and conditions set forth herein.

1. Colorado River Water Conservation District, a political subdivision of the state of Colorado ("Purchaser"), hereby deposits, in escrow with Escrow Agent, funds in the amount of FIVE HUNDRED THOUSAND and 00/100 DOLLARS ($500,000.00) (the "Escrowed Funds").

2. Escrow Agent is authorized to hold the Escrowed Funds in a segregated deposit account. The segregated deposit account [*check one:* _X__ shall _____ shall not] be an interest-bearing deposit account.

3. If Public Service Company of Colorado, a Colorado corporation ("Seller") and Purchaser do not jointly and timely authorize the closing of the transaction contemplated by that certain Purchase and Sale Agreement dated effective as of January 1, 2024 by and between Seller and Purchaser (the "PSA"), or if the PSA is terminated by either party pursuant to the terms thereof, Escrow Agent is instructed to follow the terms of the PSA with respect to the Escrowed Funds. Additionally, Escrow Agent shall obtain the written permission of both parties hereto prior to disbursing the Escrowed Funds. In doing so, Escrow Agent shall be relieved of any further responsibility or liability in connection with this Agreement or the Escrowed Funds.

4. The parties hereto agree that Escrow Agent has not yet made a search of the public records with respect to the transaction contemplated under the PSA, nor has Escrow Agent any documents deposited with Escrow Agent for validity, execution or their effect upon title, if any.

5. The parties agree to pay Escrow Agent any and all fees incurred pursuant to this Agreement or with respect to the escrowed funds and/or documents.

6. The parties hereto agree to hold Escrow Agent harmless, from and against any and all liabilities, losses, damages, expenses and charges, including but not limited to, attorney's fees and expenses of litigation, including those necessary to enforce this indemnification paragraph, which may be sustained or incurred by Escrow Agent and its agents under, or arising directly or indirectly out of such any claim, action, proceeding, or judgment arising from the escrowed documents and/or funds. In the event of a dispute between the parties to this Agreement, Escrow Agent shall be permitted in its sole discretion: (a) not to act unless pursuant to an order of a court, or (b) to file a complaint in interpleader and deposit the documents and/or funds with the court, less all out-of-pocket fees and expenses incurred by Escrow Agent, including attorneys' fees. Upon so acting under 6(a) or (b), Escrow Agent shall be released and forever discharged of all liability under the terms of this Agreement or with respect to the documents and/or funds escrowed.

7. Escrow Agent shall not be personally liable for any act it may do or omit to do hereunder as such agent, while acting in good faith and in the exercise of its own best judgment, and any act done or omitted by it pursuant to the advice of its own attorneys shall be conclusive evidence of such good faith. Escrow Agent shall not be under any duty or obligation to ascertain the identity, authority or rights of the parties executing or delivering or purporting to execute or deliver these instructions or any documents or papers or payments deposited or called for hereunder, and assumes no responsibility or liability for the validity or sufficiency of these instructions or any documents or papers or payments deposited or called for hereunder.

8. The Agreement may be supplemented, altered, amended, modified or revoked by writing only, signed by all of the parties hereto.

Dated effective: January 1, 2024.

Purchaser:

COLORADO RIVER WATER CONSERVATION DISTRICT, a political subdivision of the state of Colorado

By: _____
Name: Kathy Chandler-Henry
Title: President, Colorado River Water Conservation District

Escrow Agent:

FIRST AMERICAN TITLE INSURANCE COMPANY

By: _____
Name: _____
Title: _____

Seller:

PUBLIC SERVICE COMPANY OF COLORADO, a Colorado corporation

By: _____
Name: Robert S. Kenney
Title: President, Public Service Company of Colorado

EXHIBIT B

PSCo's DUE DILIGENCE DELIVERIES

Pursuant to Section 4.1 of the Agreement, PSCo shall provide any of the following documents in possession of PSCo, its agents, contractors, agents and/or attorneys to the River District within 14 days after the Effective Date of the Agreement:

1. Any and all title work, title opinions, correspondence, court documents related to the existence, title, ownership, conveyance, of title related to the Shoshone Water Rights.

2. Any and all documents related to historical diversion of the Water Rights.

3. Any official correspondence or notices from any and all government officials or agencies related to the diversion, beneficial use, or existence of the Shoshone Water Rights.

4. Any public document or correspondence from third parties related to the diversion, beneficial use or existence of the Shoshone Water Rights and/or the validity of the ability or right of the Shoshone Water Rights to call out junior water rights.

5. Any valuation, appraisal or assessment of the value of the Shoshone Water Rights.

EXHIBIT C

SPECIAL WARRANTY DEED

See attached.

SPECIAL WARRANTY DEED
(Grant of Water Rights)

THIS SPECIAL WARRANTY DEED, dated this ___ day of _____, 202_, is from Public Service Company of Colorado, a Colorado corporation ("Grantor"), whose address is 1800 Larimer Street, Suite 1300, Denver, Colorado 80202, to the Colorado River Water Conservation District ("Grantee"), a political subdivision of the State of Colorado, whose address is 201 Centennial Street, Suite 200, Glenwood Springs, Colorado 81601.

WITNESSETH, that Grantor, for and in consideration of the sum of Ten Dollars ($10.00) and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged does grant, sell, transfer, convey, and assign unto Grantee, its successors, and assigns, all of Grantor's right, title, and interest in and to the following water rights:

(a) The water right decreed as the Glenwood Power Canal and Pipe Line water right on December 9, 1907, in Civil Action No. 466, Eagle County District Court, in the amount of 1,250 cubic feet per second with an appropriation date of January 7, 1902, for power, mining, milling, manufacturing, lighting and heating and traction purposes, and as further decreed by the Eagle County District Court on February 27, 1911, in Civil Action No. 553; and

(b) The water right decreed as the Shoshone Hydro Plant Diversion No. 2 First Enlargement on February 7, 1956 in Civil Action No. 1123, Eagle County District Court, in the amount of 158 cubic feet per second with an appropriation date of May 15, 1929, for manufacturing and generation of electrical energy,

TOGETHER with all and singular the hereditaments and appurtenances thereto belonging, or in anywise pertaining, and the reversion and reversions, remainder and remainders, and all the estate, right, interest, claim and demand whatsoever of the Grantor, in law or equity, of, in, and to the above-described water rights. (the "Shoshone Water Rights").

TO HAVE AND TO HOLD, the Shoshone Water Rights, together with any and all rights incident thereto, forever, and all the estate, right, title and interest of Grantor in the Shoshone Water Rights unto the Grantee. Grantor further represents that it has the authority to convey to Grantee all rights described herein. Grantor, for itself, its successors and assigns, covenants and agrees that it will warrant title and forever defend the Shoshone Water Rights in the quiet and peaceable possession of Grantee, its successors and assigns, against all and every person or persons claiming the whole or any part thereof, by, through, or under the Grantor.

[signature page follows]

SPECIAL WARRANTY DEED
(Grant of Water Right)

IN WITNESS WHEREOF, Grantor has executed this Special Warranty Deed on the date set forth above.

GRANTOR

_____
Robert S. Kenney, President
Public Service Company of Colorado

NOTARIZATION

STATE OF COLORADO)
) ss.
COUNTY OF _____)

The foregoing instrument was acknowledged before me on the _____ day of _____ by as President of the Public Service Company of Colorado.

Witness my hand and official seal. My Commission Expires: _____

_____
Notary Public

EXHIBIT D

LEASE OF SHOSHONE WATER RIGHTS

See attached.

WATER LEASE

This WATER LEASE ("Lease") is entered into this ____ day of _____ (the "**Effective Date**"), by and between the COLORADO RIVER WATER CONSERVATION DISTRICT, a political subdivision of the state of Colorado ("**River District**"), and PUBLIC SERVICE COMPANY OF COLORADO, a Colorado corporation ("**PSCo**").

RECITALS

WHEREAS, River District owns the following water rights, which were conveyed to it by PSCo pursuant to the Special Warranty Deed dated _____, 202_, and are diverted at the Shoshone Dam, located in Glenwood Canyon, Colorado, and historically used for non-consumptive hydro-power generation at the Shoshone Hydroelectric Generation Station ("**Power Plant**").

(a) The Power Plant senior water right decreed as the Glenwood Power Canal and Pipeline water right on Dec. 9, 1907, in Civil Action No. 0466, Eagle County District Court, in the amount of 1,250 cfs with an appropriation date of Jan. 7, 1902, for power, mining, milling, manufacturing, lighting and heating and traction purposes, and as further decreed by the Eagle County District Court on Feb. 27, 1911, in Civil Action No. 553; and

(b) The Power Plant junior water right decreed as the Shoshone Hydro Plant Diversion No. 2 on Feb. 7, 1956 in Civil Action No. 1123, Eagle County District Court, in the amount of 158 cfs with an appropriation date of May 15, 1929, for manufacturing and generation of electrical energy.

together, (the "**Shoshone Water Rights**"); and

WHEREAS, PSCo desires to lease the Shoshone Water Rights from River District for continued use at the Power Plant for as long as the Power Plant is being operated to produce hydroelectric power; and

WHEREAS, River District is willing to lease the Shoshone Water Rights to PSCo for use at the Power Plant;

NOW THEREFORE, for good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, River District and PSCo agree as follows.

LEASE

1. Water Rights Lease. River District hereby leases to PSCo, and PSCo hereby leases from the River District, the above-described Shoshone Water Rights for use at the Power Plant for hydroelectric generation purposes.

2. Term of Lease. The term of this Lease begins on the Effective Date and terminates upon permanent abandonment and/or decommissioning by PSCo of Power Plant operations for hydroelectric generation purposes (the "**Term**"). Any temporary suspension of operations at the

Power Plant due to operational considerations, maintenance, replacement, repairs or for other reasons shall not constitute permanent abandonment or decommissioning. Notwithstanding the foregoing, PSCo may terminate this Lease during the Term for any reason by delivering one (1) year's advance written notice to River District. Additionally, refer to Paragraph 12 for provisions relating to termination for cause.

3. Annual Lease Fee. PSCo shall pay to River District annual rent in the amount of ten dollars ($10.00) (the "**Annual Lease Fee**") on or before January 15 of each calendar year during the Term. For any Annual Lease Fee payment not already prepaid by PSCo, the River District will provide an invoice of the Annual Lease Fee to PSCo by December 31 of each calendar year prior to the due date of the Annual Lease Fee payment. PSCo may, in its discretion, prepay the Annual Lease Fee for more than one year of the Lease at any point during the Term. River District acknowledges that it has received a payment of $500.00 from PSCo as of the Effective Date, representing payment of the Annual Lease Fee in advance for fifty (50) years through 20__.

4. Use of Water Rights.

a. PSCo shall use the water delivered pursuant to the Shoshone Water Rights only for power generation purposes at the Power Plant, consistent with the Shoshone Water Rights decrees. PSCo shall not use the Shoshone Water Rights for any other uses or at any other location. PSCo shall take and use the water delivered pursuant to the Shoshone Water Rights to the fullest extent practical, and shall undertake no action that could be construed as abandonment of the Shoshone Water Rights. At times when PSCo is operating the Power Plant, delivery of the Shoshone Water Rights to the Power Plant shall take precedence over any other use of the Shoshone Water Rights.

b. At times when the Power Plant is temporarily not operating or is not fully operating due to maintenance or repair issues, or due to other business considerations, the Shoshone Water Rights may be made available to the Colorado Water Conservation Board pursuant to the terms of the Instream Flow Agreement dated _____, 202_, between the River District, PSCo and the CWCB, and the decree entered in Division 5 Case No. ___CW____. PSCo shall provide advance written notice to River District at least thirty (30) days prior to any scheduled shutdown of Power Plant operations, and shall provide notice as soon as reasonably possible of any unscheduled shutdown of Power Plant operations. Such notice, whether for scheduled or unscheduled shutdown of Power Plant operations shall also provide River District notice of the anticipated amount of time that the Power Plant will be shutdown or partially shutdown.

5. Power Plant Operations. PSCo shall conduct Power Plant operations, including but not limited to replacing, reconstructing, upgrading, adding to, improving, or altering the Power Plant, in its sole discretion, so long as the same does not change the point of diversion, flow rate, and non-consumption of the Shoshone Water Rights through the Power Plant. If PSCo determines to decommission and/or permanently suspend operations of the Power Plant it will provide written notice to River District at least six (6) months before operations at the Power Plant permanently cease and this Lease shall automatically terminate as of the date of completion of decommissioning by PSCo and/or permanent abandonment of the Power Plant.

6. Restriction on Sublease and Assignment. Upon thirty (30) days advanced written notice to the River District, PSCo may assign this Lease only to a successive owner or operator of the Power Plant for power generation purposes. Otherwise PSCo shall not rent, sublet, transfer or convey the right to use the Shoshone Water Rights.

7. No Vested Interest in Shares or Joint Venture. River District grants no interest in the Shoshone Water Rights to PSCo other than as explicitly set forth in this Lease. PSCo shall make no claim to any rights, title, or interest in the Shoshone Water Rights other than as explicitly set forth in this Lease. This Lease does not create a partnership or joint venture of any kind between the parties. River District shall not be entitled to any claim based on revenue generated by PSCo by use of the Shoshone Water Rights at the Power Plant. Likewise, PSCo shall bear the entirety of any loss, cost, or expense incurred through its use of the Shoshone Water Rights at the Power Plant, including but not limited to the cost or expense related to any federal "headwaters benefit" charge. River District shall have no obligation express or implied to maintain, operate and or have any role in the decommissioning of the plant and or repair, replacement or removal of any infrastructure owned and/or operated by PSCo. PSCo hereby indemnifies and holds harmless the River District from any and all obligations, financial or otherwise related to the repair, replacement, removal of infrastructure arising from PSCo's operation or decommissioning of the Power Plant or its associated infrastructure including but not limited to the current or future Shoshone dam.

8. No Guarantee of Yield. PSCo is entitled to receive the amount of water yielded by the Shoshone Water Rights by operation of the decrees therefore and administration of the same by the Colorado Division of Water Resources. River District makes no warranty, guarantee, or representation of any kind regarding the quality or physical yield of water to be delivered pursuant to the Shoshone Water Rights. PSCo shall not hold River District liable for any failure in delivery of the water pursuant to the Shoshone Water Rights, including, but not limited to, that caused by force of nature or failure of water supply infrastructure, except if such failure is a result of the exercise of the Shoshone Water Rights by the CWCB.

9. Maintenance of Infrastructure and Power Plant. During the Term, PSCo shall be responsible for the maintenance, construction, repair, operation, replacement, reconstruction, inspection, and improvement of:

a. the infrastructure and other personal property necessary to deliver water pursuant to the Shoshone Water Rights at PSCo's own cost and expense. PSCo shall undertake the foregoing as may be necessary to keep the infrastructure and other personal property in good working condition during the Term of this Lease, as reasonably practicable in PSCo's discretion.

b. the Power Plant at PSCo's own cost and expense. PSCo may, in its sole discretion, conduct any of the foregoing at any time during the Term of this Lease so long as the Shoshone Water Rights' use, and point of diversion remain unchanged by PSCo's activities.

Any temporary shutdowns, suspensions, or reductions in operation of the Power Plant due to any of the foregoing activities shall not constitute a default pursuant to Paragraph 12 of this Lease.

10. Environmental Indemnity. Except to the extent that the same arise from any use of the Shoshone Water Rights by the River District, or any third party, or the River District's obligations under this Lease, PSCo hereby agrees to indemnify, defend, and hold harmless the River District and its agents, affiliates, officers, directors and employees of and from any and all liability, claims, demands, actions, and causes of action whatsoever (including without limitation reasonable attorneys' fees and expenses, and costs and expenses reasonably incurred in investigating, preparing or defending against any litigation or claim, action, suit, proceeding or demand of any kind or character) arising out of or related to the use of the Shoshone Water Rights in the Power Plant and the (1) alleged contamination by any hazardous substance, pollutant or contaminant, or petroleum or any fraction thereof of the Shoshone Water Rights, or (2) alleged injury or threat of injury to human health or safety or to the environment, or (3) alleged noncompliance with any with any federal, state, and local environmental statutes, regulations, ordinances, and any permits, approvals, or judicial or administrative orders issued thereunder, giving rise to liability under any federal, state or local environmental statutes or ordinances, including without limitation the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. 9601 et seq., as amended from time to time, or under any common law claim, including claims for personal injury or property damage or for injunctive relief of any kind.

11. Notice. All notices to be given under this Lease shall be (1) sent by certified or registered mail, return receipt requested, (2) hand-delivered at the addresses set forth below, or (3) by electronic mail requiring confirmation of receipt. Either party shall provide written notice to the other party if the appropriate contact information changes.

If to PSCo:	Public Service Company of Colorado Attn: Water Resources 1800 Larimer Street, Suite 1300 Denver, CO 80202
With Copy to:	Public Service Company of Colorado Attn: Director, Community Relations 1800 Larimer Street, Suite 1100 Denver, CO 80202
And:	Xcel Energy Attn: Legal Dept. – Real Estate 1800 Larimer Street, 14th Floor Denver, CO 80202
and:	Welborn Sullivan Meck & Tooley, P.C. 1401 Lawrence Street, Suite 1800 Denver, CO 80202 Attn: Carolyn Burr, Esq.; James M. Noble, Esq. cburr@wsmtlaw.com jnoble@wsmtlaw.com

If to River District: Andy Mueller, Esq.
General Manager
Colorado River Water Conservation District
201 Centennial St., #200
Glenwood Springs, CO 81601
amueller@crwcd.org

With Copy to: Peter Fleming, Esq.
General Counsel
Colorado River Water Conservation District
201 Centennial St., #200
Glenwood Springs, CO 81601
pfleming@crwcd.org

12. Default and Remedies.

a. If either River District or PSCo fails to comply with a term or condition herein, such failure constitutes a default of this Lease. The non-defaulting party may declare the default by providing written notice to the defaulting party in accordance with Paragraph 11 above. Upon receipt of this notice of default, the defaulting party will have thirty (30) days within which to cure the default.

b. If, in the sole discretion of the non-defaulting party, the default has not been cured, a cure has not commenced, or the defaulting-party has ceased to pursue the cure with diligence during such 30-day cure period, or after any written extension thereof mutually agreed upon by the parties, the non-defaulting party may treat the Lease as continuing and the non-defaulting party shall have the right to injunctive relief, specific performance or damages, or both, and to avail itself of any other remedy at law or equity. The failure of either party to declare a default or material breach does not establish a precedent or constitute an implied waiver of any subsequent breach of the terms and conditions in this Lease.

c. In the event either party is unable to perform its obligations under the terms of this Lease because of acts of God, strikes, stoppage of labor, riot, fire, flood, rock or mud slides, acts of war, insurrection, accident, order of any court, equipment or transportation failure or damage reasonably beyond its control, or other causes reasonably beyond its control, such party shall not be liable for damages to the other for any damages resulting from such failure to perform or otherwise from such causes.

d. All of the rights and remedies set forth in this Paragraph 12 shall be cumulative. In any action to enforce or construe the terms of this Lease, the substantially prevailing party shall recover all legal and related court costs, including all reasonable attorneys' fees and expert witness fees, costs and expenses.

13. No Third Party Beneficiaries. Nothing in this Lease, express or implied, is intended to confer any rights or remedies upon any parties other than PSCo and River District, or their respective permissible successors in interest.

14. Recovery of Costs and Fees. In addition to any remedies otherwise available, a party that is successful in a legal action commenced against the other due to a default or material breach of this Lease may recover from the defaulting party reasonable costs and attorneys' fees incurred during the course of such legal action.

15. Governing Law and Venue. This Lease shall be governed by and enforced in accordance with the laws of the State of Colorado. Proper venue for any action arising out of this Lease is the District Court for Garfield County, Colorado, or the Division 5 Water Court for the State of Colorado.

16. Severability. In the event a provision of this Lease is held invalid or unenforceable by a court of competent jurisdiction, such holding will not invalidate any other provision herein, and the remainder of the Lease should be interpreted in accordance with the intent of the parties.

17. Integration. This Lease constitutes a complete integration of the understanding and Lease between River District and PSCo with respect to the subject matter herein. No representations, negotiations, or warranties, express or implied, exist between River District and PSCo except as explicitly set forth in this Lease. This Lease may only be modified in a written form duly authorized, approved, and executed by River District and PSCo.

18. Counterparts. This Lease may be executed in counterparts, each of which shall be deemed an original, and all of which together shall constitute one and the same instrument. Executed copies of this Lease may be delivered by electronic means. The parties agree to accept and be bound by signatures hereto delivered by electronic means.

19. Recording. PSCo shall not record this Lease in the real property records of any jurisdiction. This Lease is not intended to run with the land as a covenant burdening real property.

[signature page follows]

IN WITNESS WHEREOF, the undersigned parties have executed this Water Lease on the date first set forth above.

Public Service Company of Colorado, a Colorado Corporation

By: _____
Name: _____
Title: _____

Colorado River Water Conservation District, a political subdivision of the state of Colorado

By: _____
Name: _____
Title: _____

EXHIBIT E

PROMISSORY NOTE

See attached.

PROMISSORY NOTE

$20,000,000.00 (Twenty Million Dollars) _____, 20__

FOR VALUE RECEIVED, the Colorado River Water Conservation District, a political subdivision of the state of Colorado ("**Borrower**") promises to pay to Public Service Company of Colorado, a Colorado corporation ("**Lender**") the principal sum of TWENTY MILLION and No/100 DOLLARS ($20,000,000.00) (the "**Principal Amount**"), with interest on the unpaid balance thereof at the Effective Rate (hereinafter defined) in effect from time to time.

1. All sums owing hereunder are payable in lawful money of the United States of America, in immediately available funds.

2. For the purposes of this promissory note (this "**Note**"), the "**Effective Rate**" shall mean the Secured Overnight Financing Rate in effect on the date of this Note on a per annum basis. The Effective Rate is identified on the payment schedule attached hereto as Schedule 1 (the "**Payment Schedule**").

3. The outstanding principal balance of this Note, together with all accrued and unpaid interest, shall be due and payable in annual installments calculated based on a 10-year amortization. The annual installment payments shall begin on the April 30, _____ and shall continue to be due on or before the 30th day of each subsequent April until the principal amount is paid in full, and shall be paid to Lender in accordance with the Payment Schedule.

4. Payment by Borrower shall be made to Lender by wire or electronic funds transfer per the instructions provided by Lender, or at such other place as may be designated by written notice to Borrower by Lender.

5. Payments will be applied first to any late fees, then to accrued interest, and the remainder, if any, to the then-outstanding Principal Amount. Any reductions of the Principal Amount may not be re-borrowed.

6. Any remaining Principal Amount, and any accrued interest thereon, that has not been paid in full on or before April 30, 20___ ("**Maturity Date**") shall be due and payable on the Maturity Date.

7. The River District may prepay the then-outstanding amount of this Note, along with any outstanding interest, at any time without penalty or premium.

8. If any payment required by this Note is not paid when due the indebtedness shall bear interest at the rate of Effective Rate plus 5% per annum until such payment is made. Further, if any payment is not paid within 30 days of its due date, Borrower shall pay Lender a late payment charge of 10% of the amount of such annual payment. Should the Borrower fail to pay any payment due pursuant to this Note within sixty (60) days, Lender shall be entitled to accelerate the entire remaining principal amount then outstanding and all accrued interest and penalties thereon.

9. Nothing in this Note is intended or shall be construed to create a multiple fiscal year financial obligation or debt of the Borrower. Where activities or payment obligations provided in

this Note extend beyond the then-current fiscal year, continued payments, expenditures, or appropriations are contingent on the approval of the Board of Directors of the Borrower.

10. The indebtedness evidenced by this Promissory Note is secured by a Deed of Trust, of even date herewith, and, until released, the Deed of Trust contains additional rights of Lender. Such rights may cause acceleration of the indebtedness evidenced by this Promissory Note. Reference is made to said Deed of Trust for such additional terms. Said Deed of Trust grants rights in certain property located in the County of Garfield, State of Colorado, described as follows (the "**Property**"):

(a) The Shoshone Power Plant senior water right decreed as the Glenwood Power Canal and Pipeline water right on Dec. 9, 1907, in Civil Action No. 0466, Eagle County District Court, in the amount of 1,250 cfs with an appropriation date of Jan. 7, 1902, for power, mining, milling, manufacturing, lighting and heating and traction purposes, and as further decreed by the Eagle County District Court on Feb. 27, 1911, in Civil Action No. 553; and

(b) The Shoshone Power Plant junior water right decreed as the Shoshone Hydro Plant Diversion No. 2 on Feb. 7, 1956 in Civil Action No. 1123, Eagle County District Court, in the amount of 158 cfs with an appropriation date of May 15, 1929, for manufacturing and generation of electrical energy.

11. Any notice, demand, claim or other written instrument required or permitted to be given pursuant to this Promissory Note shall be in writing signed by the Party giving such notice and shall be sent by electronic mail, hand messenger delivery, overnight courier service or certified mail (receipt requested) to the other Party at the addresses set forth below and shall be deemed to have been duly given by delivery to the respective addresses provided below, or such other address changed by the recipient by notice consistent with this paragraph: (i) on the date and at the time of delivery if delivered personally to the Party to whom notice is given at such address; (ii) on the date and at the time of delivery or refusal of acceptance of delivery if delivered or attempted to be delivered by an overnight courier service to the Party to whom notice is given as such address; (iii) on the date of delivery or attempted delivery shown on the registered or certified mail, return receipt requested, postage prepaid and properly addressed to such address; (iv) if an email address is specified, on the date and at the time shown on the sent email message if sent to the e-mail address specified below:

If to Lender:	Public Service Company of Colorado 1800 Larimer Street, Suite 1100 Denver, CO 80202 Attn: Director, Environmental Services
with a copy to:	Frances A. Folin, Esq. Xcel Energy Services Inc. 1800 Larimer Street, 14th Floor Denver, CO 80202 303-294-2222 Frances.A.Folin@xcelenergy.com

and:	Welborn, Sullivan, Meck & Tooley, P.C. 1401 Lawrence Street, Suite 1800 Denver, Colorado 80202 Attn: Carolyn Burr, Esq., James M. Noble, Esq. (303) 830-2500 cburr@wsmtlaw.com, jnoble@wsmtlaw.com
If to Borrower:	Andy Mueller, Esq. General Manager Colorado River Water Conservation District 201 Centennial St., #200 Glenwood Springs, CO 81601 970-945-8522 amueller@crwcd.org
with a copy to:	Peter Fleming, Esq. General Counsel Colorado River Water Conservation District 201 Centennial St., #200 Glenwood Springs, CO 81601 970-945-8522 pfleming@crwcd.org

12. A waiver of any term of this Note or the Deed of Trust or of any of the obligations secured thereby must be made in writing and shall be limited to the express written terms of such waiver. In the event of any inconsistencies between the terms of this Note and the terms of any other document related to the loan evidenced by this Note, the terms of this Note shall prevail.

13. This Note shall be construed and enforced in accordance with the laws of the State of Colorado.

14. The provisions of this Note may be amended or revised only by an instrument in writing signed by the Borrower and Lender.

BORROWER:

Colorado River Water Conservation District,
a political subdivision of the State of Colorado

By: _____

Schedule 1
(Payment Schedule)

[insert amortization/payment schedule prior to closing]

EXHIBIT F

DEED OF TRUST

See attached.

Following recording return to:
Public Service Company of Colorado
c/o Xcel Energy
Attn: Legal Dept. – Real Estate
1800 Larimer Street, 14th Floor
Denver, Colorado 80202

DEED OF TRUST

THIS DEED OF TRUST is made this _____ day of _____, 20____, by the COLORADO RIVER WATER CONSERVATION DISTRICT, a political subdivision of the State of Colorado ("Trustor"), whose address is 201 Centennial Street, Suite 200, Glenwood Springs, Colorado 81601, in favor of the PUBLIC TRUSTEE OF GARFIELD COUNTY, COLORADO ("Trustee"), for the benefit of PUBLIC SERVICE COMPANY OF COLORADO, a Colorado corporation ("Beneficiary"), whose address is 1800 Larimer Street, Suite 1100, Denver, Colorado 80202.

1. **Property in Trust**. Trustor, in consideration of the indebtedness herein recited and the trust herein created, hereby grants and conveys to Trustee, for the benefit of Beneficiary, in trust, with power of sale, all of Trustor's right, title, and interest in the following legally described property located in the COUNTY OF GARFIELD, STATE OF COLORADO (the "Property"):

(a) The Shoshone Power Plant senior water right decreed as the Glenwood Power Canal and Pipeline water right on Dec. 9, 1907, in Civil Action No. 0466, Eagle County District Court, in the amount of 1,250 cfs with an appropriation date of Jan. 7, 1902, for power, mining, milling, manufacturing, lighting and heating and traction purposes, and as further decreed by the Eagle County District Court on Feb. 27, 1911, in Civil Action No. 553; and

(b) The Shoshone Power Plant junior water right decreed as the Shoshone Hydro Plant Diversion No. 2 on Feb. 7, 1956, in Civil Action No. 1123, Eagle County District Court, in the amount of 158 cfs with an appropriation date of May 15, 1929, for manufacturing and generation of electrical energy.

2. **Note; Obligations Secured**. This Deed of Trust is given to secure to Beneficiary:

(a) the repayment of the indebtedness evidenced by Trustor's promissory note ("Note"), dated as of _____, in the principal sum of TWENTY MILLION and 00/100 DOLLARS (U.S. $20,000,000.00), with interest as specified in the Note;

(b) the payment of all other sums as specified in the Note disbursed by Beneficiary in accordance with this Deed of Trust to protect the security of this Deed of Trust; and

(c) the performance of the covenants and agreements of Trustor herein contained.

If not sooner paid, the entire principal amount outstanding and accrued interest thereon shall be due and payable on _____.

3. **Title**. Trustor covenants that Trustor has taken no action to alienate and/or convey the title to the Property received from Beneficiary via Special Warranty deed dated the same date as this Deed of Trust.

4. **Payment of Principal and Interest**. Trustor shall promptly pay when due the principal of and interest on the indebtedness evidenced by the Note, and any late charges or other charges as provided in the Note, and shall perform all of Trustor's other covenants contained in the Note.

5. **Application of Payments**. All payments received by Beneficiary under the terms hereof shall be applied by Beneficiary first in payment of amounts due pursuant to §8 (Protection of Beneficiary's Security), and the balance in accordance with the terms and conditions of the Note.

6. **Prior Mortgages and Deeds of Trust; Charges; Liens**. Trustor represents and warrants that there are no prior deeds of trust, charges or liens on the Property.

7. **Preservation and Maintenance of Property**. Trustor shall not commit waste or permit impairment or deterioration of the Property and shall comply with the provisions of any lease if this Deed of Trust is on a leasehold. Trustor shall perform all of Trustor's obligations under any declarations, covenants, by-laws, rules, court decrees, or other documents governing the use or ownership of the Property.

8. **Protection of Beneficiary's Security**. If Trustor fails to perform the covenants and agreements contained in this Deed of Trust, or if a default occurs in a prior lien, or if any action or proceeding is commenced which materially affects Beneficiary's interest in the Property, then Beneficiary, at Beneficiary's option, with notice to Trustor if required by law, may make such appearances, disburse such sums, and take such action as is necessary to protect Beneficiary's interest, including, but not limited to:

(a) any general or special taxes or ditch or water assessments levied or accruing against the Property;

(b) the premiums on any insurance necessary to protect any improvements comprising a part of the Property;

(c) sums due on any prior lien or encumbrance on the Property;

(d) if the Property is a leasehold or is subject to a lease, all sums due under such lease;

(e) the reasonable costs and expenses of defending, protecting, and maintaining the Property and Beneficiary's interest in the Property, including repair and maintenance costs and expenses, costs and expenses of protecting and securing the Property, receiver's fees and expenses, inspection fees, appraisal fees, court costs, attorney fees and costs, and fees and costs of an attorney in the employment of Beneficiary or holder of the certificate of purchase;

(f) all other costs and expenses allowable by the evidence of debt or this Deed of Trust; and

(g) such other costs and expenses which may be authorized by a court of competent jurisdiction.

Trustor hereby assigns to Beneficiary any right Trustor may have by reason of any prior encumbrance on the Property or by law or otherwise to cure any default under said prior encumbrance.

Any amounts disbursed by Beneficiary pursuant to this §8, with interest thereon, shall become additional indebtedness of Trustor secured by this Deed of Trust. Such amounts shall be payable upon notice from Beneficiary to Trustor requesting payment thereof, and Beneficiary may bring suit to collect any amounts so disbursed plus interest specified in the Note. Nothing contained in this §8 shall require Beneficiary to incur any expense or take any action hereunder.

9. **Condemnation**. The proceeds of any award or claim for damages, direct or consequential, in connection with any condemnation or other taking of the Property, or part thereof, or for conveyance in lieu of condemnation, are hereby assigned and shall be paid to Beneficiary as herein provided. In the event of a total taking of the Property, the proceeds shall be applied to the sums secured by this Deed of Trust, with the excess, if any, paid to Trustor.

In the event of a partial taking of the Property, the proceeds remaining after taking out any part of the award due any prior lien holder (net award) shall be divided between Beneficiary and Trustor, in the same ratio as the amount of the sums secured by this Deed of Trust immediately prior to the date of taking bears to Trustor's equity in the Property immediately prior to the date of taking. Trustor's equity in the Property means the fair market value of the Property less the amount of sums secured by both this Deed of Trust and all prior liens (except taxes) that are to receive any of the award, all at the value immediately prior to the date of taking.

If the Property is abandoned by Trustor or if, after notice by Beneficiary to Trustor that the condemnor offers to make an award or settle a claim for damages, Trustor fails to respond to Beneficiary within 30 days after the date such notice is given, Beneficiary is authorized to collect and apply the proceeds, at Beneficiary's option, either to restoration or repair of the Property or to the sums secured by this Deed of Trust.

Any such application of proceeds to principal shall not extend or postpone the due date of the installments referred to in §4 (Payment of Principal and Interest) nor change the amount of such installments.

10. **Trustor not Released**. Extension of the time for payment or modification of amortization of the sums secured by this Deed of Trust granted by Beneficiary to any successor in interest of Trustor shall not operate to release, in any manner, the liability of the original Trustor, nor Trustor's successors in interest, from the original terms of this Deed of Trust. Beneficiary shall not be required to commence proceedings against such successor or refuse to extend time for payment or otherwise modify amortization of the sums secured by this Deed of Trust by reason of any demand made by the original Trustor nor Trustor's successors in interest.

11. **Forbearance by Beneficiary Not a Waiver**. Any forbearance by Beneficiary in exercising any right or remedy hereunder, or otherwise afforded by law, shall not be a waiver or preclude the exercise of any such right or remedy.

12. **Remedies Cumulative**. Each remedy provided in the Note and this Deed of Trust is distinct from and cumulative to all other rights or remedies under the Note and this Deed of Trust or afforded by law or equity, and may be exercised concurrently, independently or successively.

13. **Successors and Assigns Bound**; **Joint and Several Liability; Captions.** The covenants and agreements herein contained shall bind, and the rights hereunder shall inure to, the respective successors and assigns of Beneficiary and Trustor, subject to the provisions of §21 (Transfer of the Property; Assumption). All covenants and agreements of Trustor shall be joint and several. The captions and headings of the sections in this Deed of Trust are for convenience only and are not to be used to interpret or define the provisions hereof.

14. **Notice**. Except for any notice required by law to be given in another manner, (a) any notice to Trustor provided for in this Deed of Trust shall be in writing and shall be given and be effective upon (1) delivery to Trustor or (2) mailing such notice by first class U.S. mail, addressed to Trustor at Trustor's address stated herein or at such other address as Trustor may designate by notice to Beneficiary as provided herein, and (b) any notice to Beneficiary shall be in writing and shall be given and be effective upon (1) delivery to Beneficiary or (2) mailing such notice by first class U.S. mail, to Beneficiary's address stated herein or to such other address as Beneficiary may designate by notice to Trustor as provided herein. Any notice provided for in this Deed of Trust shall be deemed to have been given to Trustor or Beneficiary when given in any manner designated herein.

15. **Governing Law; Severability**. The Note and this Deed of Trust shall be governed by the laws of the State of Colorado. In the event that any provision or clause of this Deed of Trust or the Note conflicts with the law, such conflict shall not affect other provisions of this Deed of Trust or the Note which can be given effect without the conflicting provision, and to this end the provisions of the Deed of Trust and Note are declared to be severable.

16. **Acceleration; Foreclosure; Other Remedies**. Except as provided in §21 (Transfer of the Property; Assumption), upon Trustor's breach of any covenant or agreement of Trustor in this Deed of Trust, at Beneficiary's option, all of the sums secured by this Deed of Trust shall be immediately due and payable (Acceleration). To exercise this option, Beneficiary may invoke the power of sale, may commence and maintain an action to foreclose this instrument and in such event Borrower specifically waives the defense of laches and any applicable statutes of limitation, and/or may exercise any other remedies permitted by law. Beneficiary shall be entitled to collect all reasonable costs and expenses incurred in pursuing the remedies provided in this Deed of Trust, including, but not limited to, reasonable attorney's fees.

If Beneficiary invokes the power of sale, Beneficiary shall give written notice to Trustee of such election. Trustee shall give such notice to Trustor of Trustor's rights as is provided by law. Trustee shall record a copy of such notice and shall cause publication of the legal notice as required by law in a newspaper of general circulation in each county in which the Property is situated, and shall

mail copies of such notice of sale to Trustor and other persons as prescribed by law. After the lapse of such time as may be required by law, Trustee, without demand on Trustor, shall sell the Property at public auction to the highest bidder for cash at the time and place (which may be on the Property or any part thereof as permitted by law) in one or more parcels as Trustee may think best and in such order as Trustee may determine. Beneficiary or Beneficiary's designee may purchase the Property at any sale. It shall not be obligatory upon the purchaser at any such sale to see to the application of the purchase money.

Trustee shall apply the proceeds of the sale in the following order: (a) to all reasonable costs and expenses of the sale, including, but not limited to, reasonable Trustee's and attorney's fees and costs of title evidence; (b) to all sums secured by this Deed of Trust; and (c) the excess, if any, to the person or persons legally entitled thereto.

17. **Trustor's Right to Cure Default**. Whenever foreclosure is commenced for nonpayment of any sums due hereunder, the owners of the Property or parties liable hereon shall be entitled to cure said defaults by paying all delinquent principal and interest payments due as of the date of cure, costs, expenses, late charges, attorney's fees and other fees all in the manner provided by law. Upon such payment, this Deed of Trust and the obligations secured hereby shall remain in full force and effect as though no Acceleration had occurred, and the foreclosure proceedings shall be discontinued.

18. **Appointment of Receiver; Beneficiary in Possession**. Beneficiary or the holder of the Trustee's certificate of purchase shall be entitled to a receiver for the Property after Acceleration under §16 (Acceleration; Foreclosure; Other Remedies), and shall also be so entitled during the time covered by foreclosure proceedings and the period of redemption, if any; and shall be entitled thereto as a matter of right without regard to the solvency or insolvency of Trustor or of the then owner of the Property, and without regard to the value thereof. Such receiver may be appointed by any Court of competent jurisdiction upon ex parte application and without notice; notice being hereby expressly waived.

Upon Acceleration under §16 (Acceleration; Foreclosure; Other Remedies) or abandonment of the Property, Beneficiary, in person, by agent or by judicially-appointed receiver, shall be entitled to enter upon, take possession of and manage the Property and to collect the rents of the Property including those past due. All rents collected by Beneficiary or the receiver shall be applied, first to payment of the costs of preservation and management of the Property, second to payments due upon prior liens, and then to the sums secured by this Deed of Trust. Beneficiary and the receiver shall be liable to account only for those rents actually received.

19. **Release**. Upon payment of all sums secured by this Deed of Trust, Beneficiary shall cause Trustee to release this Deed of Trust and shall produce for Trustee the Note. Trustor shall pay all costs of recordation and shall pay the statutory Trustee's fees. If Beneficiary shall not produce the Note as aforesaid, then Beneficiary, upon notice in accordance with §14 (Notice) from Trustor to Beneficiary, shall obtain, at Beneficiary's expense, and file any lost instrument bond required by Trustee or pay the cost thereof to affect the release of this Deed of Trust.

20. **Waiver of Exemptions**. Trustor hereby waives all right of homestead and any other exemption in the Property under state or federal law presently existing or hereafter enacted.

21. **Transfer of the Property; Assumption**. The following events shall be referred to herein as a "Transfer": (i) a transfer or conveyance of title (or any portion thereof, legal or equitable) of the Property (or any part thereof or interest therein); (ii) the execution of a contract or agreement creating a right to title (or any portion thereof, legal or equitable) in the Property (or any part thereof or interest therein); (iii) or an agreement granting a possessory right in the Property (or any portion thereof), in excess of 3 years; (iv) a sale or transfer of, or the execution of a contract or agreement creating a right to acquire or receive, more than fifty percent (50%) of the controlling interest or more than fifty percent (50%) of the beneficial interest in Trustor and (v) the reorganization, liquidation or dissolution of Trustor. Not to be included as a Transfer are the creation of a lien or encumbrance subordinate to this Deed of Trust, or an agreement with, or transfer to, the Colorado Water Conservation Board regarding the use of the Property for instream flow purposes.

At the election of Beneficiary, in the event of each and every Transfer:

(a) All sums secured by this Deed of Trust shall become immediately due and payable (Acceleration).

(b) If a Transfer occurs and should Beneficiary not exercise Beneficiary's option pursuant to this §21 to Accelerate, Transferee shall be deemed to have assumed all of the obligations of Trustor under this Deed of Trust including all sums secured hereby whether or not the instrument evidencing such conveyance, contract or grant expressly so provides. This covenant shall run with the Property and remain in full force and effect until said sums are paid in full. Beneficiary may without notice to Trustor deal with Transferee in the same manner as with Trustor with reference to said sums including the payment or credit to Transferee of undisbursed reserve Funds on payment in full of said sums, without in any way altering or discharging Trustor's liability hereunder for the obligations hereby secured.

(c) Should Beneficiary not elect to Accelerate upon the occurrence of such Transfer then, subject to §21(b) above, the mere fact of a lapse of time or the acceptance of payment subsequent to any of such events, whether or not Beneficiary had actual or constructive notice of such Transfer, shall not be deemed a waiver of Beneficiary's right to make such election nor shall Beneficiary be estopped therefrom by virtue thereof. The issuance on behalf of Beneficiary of a routine statement showing the status of the loan, whether or not Beneficiary had actual or constructive notice of such Transfer, shall not be a waiver or estoppel of Beneficiary's said rights.

22. **Trustor's Copy**. Trustor acknowledges receipt of a copy of the Note and this Deed of Trust.

[signature page follows]

EXECUTED BY TRUSTOR as of the date first stated above:

TRUSTOR:

COLORADO RIVER WATER CONSERVATION DISTRICT,
a political subdivision of the State of Colorado

By: _____
Andrew A. Mueller, Secretary/General Manager

By: _____
Kathy Chandler-Henry, CRWCD Board President

STATE OF COLORADO)
)ss.
COUNTY OF _____)

The foregoing instrument was acknowledged before me this ____ day of _____, 20___, by Andrew A. Mueller, Secretary/General Manager, and Kathy Chandler-Henry, Board President of the Colorado River Water Conservation District, a political subdivision of the State of Colorado.

Witness my hand and official seal.

My commission expires: _____

_____
Notary Public

MEMORANDUM – DRAFT – SUBJECT TO REVISION

To: Colorado River District Staff and Counsel
From: Hydros Consulting, Inc.
Subject: Shoshone Power Plant Water Rights Yield Assessment
Date: September 11, 2024

Summary

The Colorado River District (River District) asked Hydros Consulting, Inc. (Hydros) to provide technical assistance in quantifying the yield or "pull" of the water rights associated with the Shoshone Power Plant (Shoshone), with the goal of understanding the impact of the Shoshone water rights on flows through the "15-Mile Reach"[1] near Palisade, Colorado and at the Colorado-Utah state line. To perform this analysis, Hydros used the State of Colorado's StateMod water allocation and accounting model to assess impacts to river flows both with and without the Shoshone water rights being utilized. Notwithstanding the foregoing, this analysis is not intended to serve as an analysis of the historical use of the Shoshone water rights with respect to any proceeding in water court for a change in type of use for the Shoshone water rights. Instead, this analysis is provided to demonstrate the benefits of the Shoshone water rights on flows through the 15-Mile Reach.

The analysis indicates that continued exercise of the Shoshone water rights will result in significant benefits to the Colorado River through the 15-Mile Reach to the Colorado-Utah state line, and abandonment or disuse of those rights would dramatically reduce flows, particularly in drier years. Assuming full use of the Shoshone water rights, and continued growth of demands for consumptive uses in the upper mainstem Colorado River, the net annual benefit of the Shoshone call could be more than 80,000 acre-feet of water to the 15-Mile Reach in dry years. The benefit is even more pronounced during critically dry months when the Shoshone water rights are fully utilized. As shown in Table 7, flows in these critically dry months are as much as 29% higher (approximately 140 cfs) on average when the Shoshone water rights are being fully utilized. The benefits of continued exercise of the Shoshone water rights are not limited to critically dry periods, and an *average* flow increase of 6% - 9% (equal to approximately 78 cfs to 96 cfs) is expected across the driest 50% of *all* simulated monthly flows compared to flows without Shoshone.

This report first provides a background of the Shoshone water rights and the importance of the administration of those water rights on the Colorado River. Next, this report describes

[1] See, for example: https://coloradowatertrust.org/project/15-mile-reach.

the methodologies used to quantify the yield of the Shoshone water rights. Finally, a description of the various scenarios used to compare model runs with and without the Shoshone water rights and the results of those models are presented.

Background

The Shoshone Power Plant is a run-of-river hydroelectric power plant located on the Colorado River approximately nine miles east of Glenwood Springs, Colorado. The power plant has been in operation since the early 1900s and utilizes two water rights as described in Table 1. Together, the water rights total 1,408 cubic feet per second (cfs). As a run-of-river operation, the Shoshone hydroelectric plant has no consumptive use and no immediately identifiable impact on the river, other than a small forebay and reduced flows through a short section of Glenwood Canyon. The power plant's broader impact on the river, however, is at times significant. The Shoshone Call[2] will often limit the ability of junior users upstream of the power plant to divert water or will force those users to provide replacement water to offset their depletions. The beneficial effect of the Shoshone Call to river flows is also felt downstream of the power plant, as all of the water diverted through the plant's penstocks returns to the Colorado River and continues downstream, where it is available for diversion by other water users.

Table 1: Shoshone Power Plant Water Rights.

Water Right	Amount [cfs]
Adjudication Date 12/9/1907; Admin. No.: 20427.18999	1,250
Adjudication Date 2/7/1956; Admin. No.: 33023.28989	158

The River District is interested in acquiring the Shoshone water rights from Public Service Company of Colorado (PSCo). Model results demonstrate that protecting the Shoshone water rights would benefit flows through the 15-Mile Reach, which is critical habitat for endangered warm-water fish species. The River District and west slope water users have a number of operating agreements, leases, and other mechanisms in place to ensure that critical flows are maintained through the 15-Mile Reach.[3] Failure to maintain these flows could lead to non-compliance with the Programmatic Biological Opinion and Record of Decision (PBO) regarding endangered fish species in the Colorado River basin. As with most western rivers, critically low flows are often associated with particularly dry hydrologic years, and with late summer and early fall months in *most* years, when demands are at their highest and the river is returning to baseflow conditions after the snowmelt runoff.

[2] Unless stated otherwise, "Shoshone Call" in this report refers to the full 1,408 cfs junior + senior call
[3] See, for example: https://www.usbr.gov/gp/ecao/10825_final_ea_fonsi.pdf

Without active diversions of the Shoshone water rights, the impacts to the river in the future could be even greater. Growth of both transmountain diversions (TMDs) and in-basin uses by junior water users would likely result in additional reduction to river flows absent the Shoshone water rights being exercised.

Between 1975 and 2020, the Shoshone Power Plant diverted an annual average of approximately 668,000 acre-feet/year, according to State records on Colorado's Decision Support System (CDSS) website. Figure 1 below shows the average monthly diversions (1975-2020) as reported by the State of Colorado via CDSS (https://dwr.state.co.us/Tools/Structures/5300584). These average monthly values are shown in comparison to the monthly volumes *if the Shoshone water rights were being met 100% of the time*.[4] Natural hydrologic shortages, particularly during winter months, will often prohibit Shoshone from realizing those full diversion amounts, even if they are calling for their full decreed amounts. Shoshone's diversions are non-consumptive, and the Shoshone water rights are senior to many upstream diversions for consumptive uses. As a result, the Shoshone Call has historically resulted in increased flows in the Colorado River above and below the Shoshone Power Plant.

[4] The CDSS records are based on an equation relating power generation to flow through the turbine. It is believed these records may underestimate the actual volume of water delivered to and through the Shoshone powerplant due to rating curve discrepancies, system losses, and other factors. If historical diversions are in fact greater than reported through CDSS, we expect the benefit from continued use of the Shoshone Rights to increase. Water availability, particularly during fall and winter months, will often limit how much water Shoshone can actually divert.

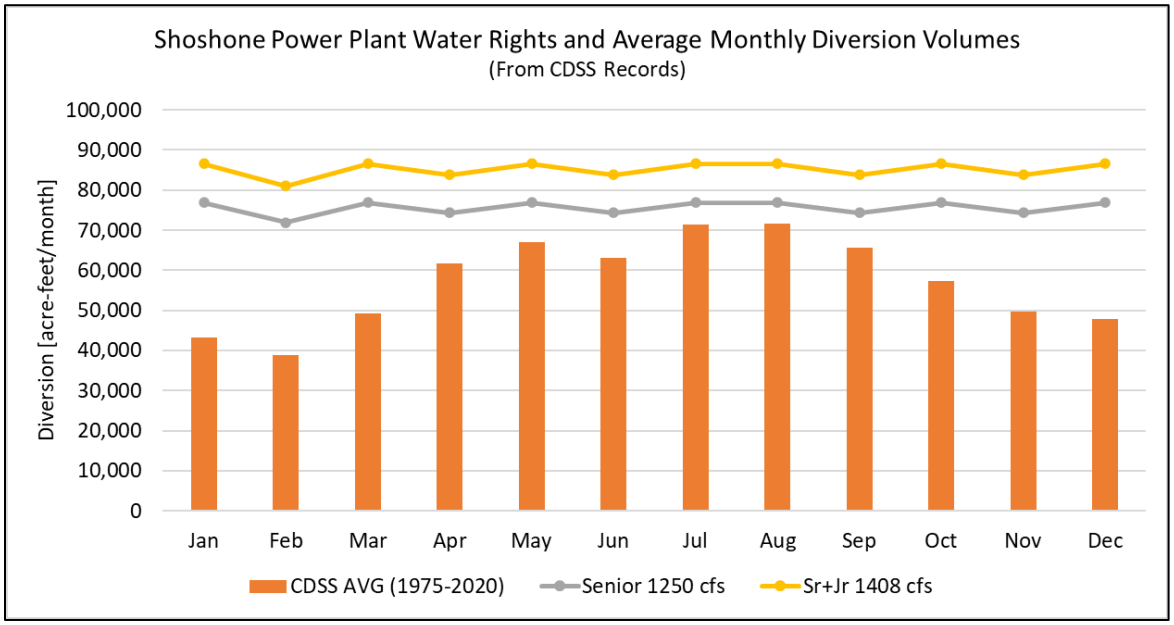


Figure 1: CDSS Shoshone Power Plant Average Monthly Diversions (1975-2020) and Maximum Decreed Diversion Rates.

Methodology

StateMod is a water rights administration and accounting model that simulates priority administration of Colorado water rights and operating protocols such as diversions to storage, releases, exchanges, and augmentation. It is often used to evaluate water availability for new water rights, or to evaluate potential impacts from changes in use of existing water rights. StateMod can simulate changes in diversions, releases, and other basin-wide water operations by senior and junior water rights both upstream and downstream of the Shoshone Power Plant if the exercise of the Shoshone water rights is modified. Of particular interest to this analysis are major downstream water rights such as the Grand Valley Project and Grand Valley Canal diversions, commonly referred to collectively as the "Cameo Call" diversions, and environmental flows through the 15-Mile Reach. The interaction between the Cameo Call and the Shoshone water rights is discussed in detail in Appendix C.

Using the Baseline model from the State of Colorado's 2015 release of the Upper Colorado River Basin StateMod model (cm2015B[5]) with updates made as part of the Phase IV Risk Study (Hydros, 2023)[6], Hydros evaluated the Shoshone water rights by performing a series of analyses comparing model runs with and without the Shoshone water rights active[7]. In addition to a "No Shoshone Call" scenario, several other scenarios were developed in which Shoshone's water rights were active at different levels of demand. Using this modeling approach, the difference in model results between the activated and deactivated runs are used to illustrate the impact of the Shoshone water rights.

Scenario Descriptions

For this analysis, we compare four Shoshone operating policies together with both current and estimated future basin-wide demands. Analysis of results focuses on the "Stress-Test Period"[8] (water years 1988-2013)[9] as this includes several critically dry periods, particularly during the late 1980s, 2002-2005, and 2012-2013. Unique characteristics that

[5] Obtained on 4/7/2022 from: https://cdss.colorado.gov/software/statemod
[6] Technical Appendices A and B of the Phase IV Risk Study Report describe these modifications in detail. The purpose of the modifications was to enhance accuracy of simulation for the structures in the model that simulate the aggregated operations of numerous smaller diversions from tributaries, which is described in Appendix A, and to represent future incremental development of transmountain diversions and other demands to represent future conditions, which is described in Appendix B.
[7] This analysis uses the publicly available version of StateMod simulating on a monthly timestep. The CWCB is currently developing a daily version of the mainstem Colorado River model in StateMod.
[8] The "Stress Test" hydrology concept has been used extensively in Colorado River Basin planning efforts such as the Drought Contingency Plan (DCP) and other planning studies. The use of this period as the period of focus in this study should not be construed as a representative study period of the historical exercise of the Shoshone water rights for evaluation of the proposed change of use.
[9] Water years start October 1st of the prior year and continue through September 30 of the year identified.

define each scenario include the demands assumed for Shoshone, the demands assumed for other water users in the basin, and whether a reduction in the Shoshone Call based upon a "call relaxation" agreement with Xcel (Xcel, 2007) is applied. The assumptions for each scenario are listed in Table 2.

Table 2. Scenario Definitions.

Scenario	Shoshone Demands	Basin-Wide Demands	Call Relaxation
Zero Shoshone Current	Zero[1]	Current[2]	None
Zero Shoshone Future	Zero	Future[3]	None
Senior Current	Senior[4]	Current	None
Senior Future	Senior	Future	None
Max Current	Maximum[5]	Current	None
Max Future	Maximum	Future	None
Senior Current w/ Relaxation Agreement	Senior	Current	3-year[6]
Senior Future w/ Relaxation Agreement	Senior	Future	3-year
Max Current w/ Relaxation Agreement	Maximum	Current	3-year
Max Future w/ Relaxation Agreement	Maximum	Future	3-year

1) Scenarios with Zero demands for Shoshone are used to quantify the impact on river flows if the Shoshone water rights were abandoned or not exercised. This is the "worst case" scenario for river flows.
2) "Current" basin-wide demands apply to all water users other than Shoshone, and are the demands used in the CM2015B Baseline StateMod model of the Upper Colorado.
3) "Future" basin-wide demands apply to all water users other than Shoshone, and are the demands developed to represent future conditions identified in the Phase III Risk Study
4) "Senior" demands for Shoshone are based on only the senior diversion right of 1,250 cfs, totaling approximately 906,000 acre-feet per year.
5) "Maximum" demands for Shoshone assume full use of all decreed water rights for Shoshone, totaling approximately 1,019,000 acre-feet per year. These demands are used to estimate upper bounds on the impact of the Shoshone call (see Figure 1)
6) "3-year" Xcel Call Reduction scenarios apply the Call Relaxation in 2003, 2004, and 2013. 2003 and 2013 were years when the reduction historically occurred, and although not historically a call reduction year, Shoshone was not physically able to divert for part of 2004 so it is included here to mimic that historical reduction in demand.

Call Relaxation Agreement Background

In 2007, the City and County of Denver's Board of Water Commissions and Xcel Energy entered into an agreement (2007 Agreement) to "relax" the Shoshone Call in years when the NRCS and Colorado River Basin Forecast Center predict that the April - July flow of the Colorado River at the Kremmling gage will be less than or equal to 85% of average (other requirements to trigger the call relaxation, including projections of defined storage content within Denver's system, also apply, see 2007 Xcel Call Reduction [Xcel, 2007]). When the conditions for a "Call Relaxation" are met, Xcel will reduce the Shoshone Call

to a senior water right call of 704 cfs during the period of March 14th – May 20th (inclusive). 704 cfs is exactly half of the total decreed rate of 1,408 cfs diversion for the plant and represents the use of just one of the two turbines in the plant (see Table 1). A similar agreement was previously entered in 2003 (Xcel, 2003). Because the 2007 agreement is the most recent agreement, the terms of the 2007 Agreement are applied in this analysis for any year that includes a Call Relaxation. This agreement allows Denver Water and other junior water users to refill reservoirs and/or divert water through trans-basin or in-basin diversions during the pre-runoff period in exceedingly dry years when Shoshone would otherwise place an administrative call on those rights.

To simulate Call Relaxation under the 2007 Agreement, Hydros conducted model runs where the monthly demands in the Maximum Current and Maximum Future demand scenarios were reduced for the months of March, April, and May. To do this, the monthly diversion volumes were converted to a daily flow rate (assuming a uniform distribution for each month) and diversions for the period of March 14th - May 20th were limited to 704 cfs. The resulting reduction in demand is shown below in Figure 2. The daily diversion rates were then aggregated back to monthly volumes for use in the model (Table 3). The Call Relaxation scenarios were evaluated to determine incremental impacts from Call Relaxation under the 2007 Agreement during very dry years. For this analysis, we assume that the call reduction would occur in 2003, 2004, and 2013.[10]

[10] 2003 and 2013 were years when the reduction historically occurred. The Shoshone Power Plant was not physically able to divert for part of 2004 due to infrastructure maintenance issues.

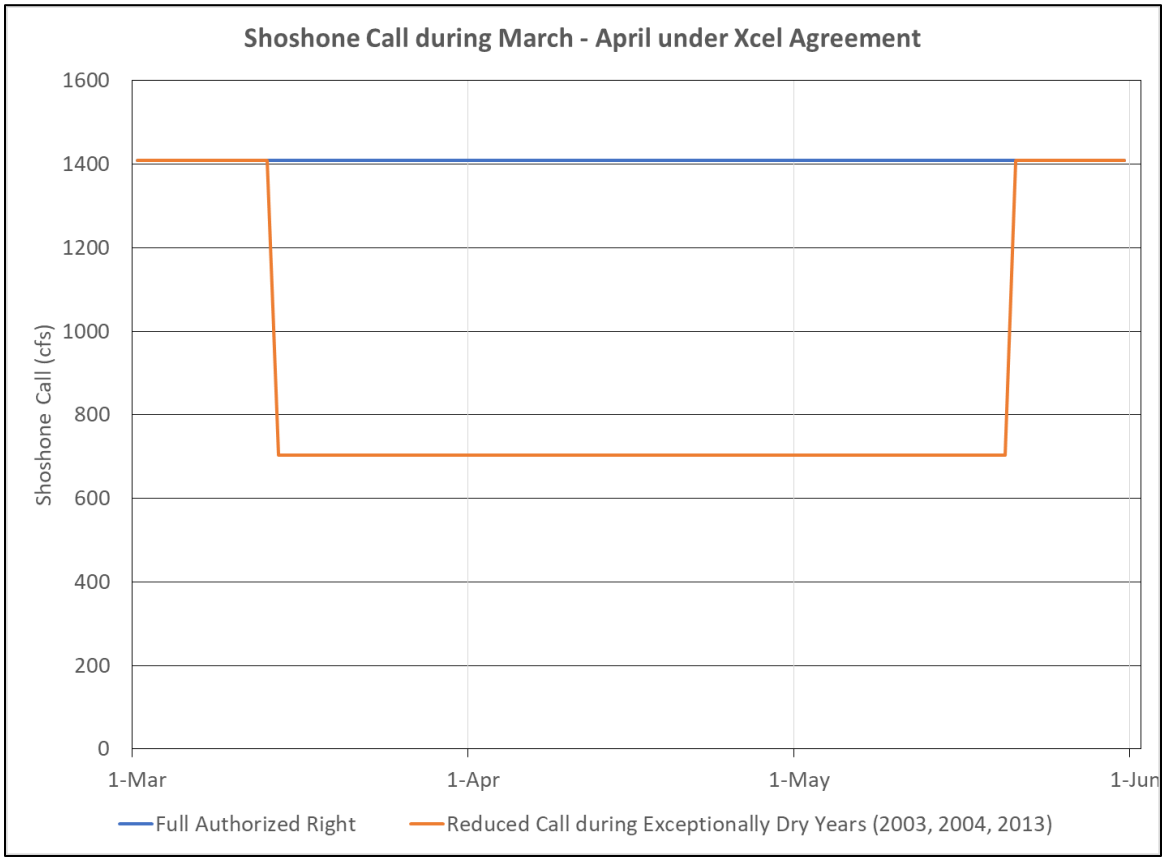


Figure 2: Demands with Call Relaxation applied to full use of both Shoshone rights.

Table 3: Change in Modeled Monthly Shoshone Call Volume (Demand) under the Call Relaxation Agreement.[11]

Monthly Volumes	Full Use (AF)	Call Relaxation (AF)
March	86,576	61,441
April	83,783	41,892
May	86,576	58,648

Results

The following section provides a summary of results for the scenarios described above. Results focus on the Stress Test period of 1988-2013. Flows at both the Colorado-Utah state line and in the 15-Mile Reach were evaluated for each scenario, both as timeseries and via statistical analysis. Although some differences between impacts to the 15-Mile Reach and the state line were evident, the two locations had similar outcomes when comparing scenarios. As a result, and to simplify the discussion, the following summary

[11] Note that the relaxation agreement represents a change in demand (call) from Shoshone and the volumes shown would only be realized if water supply and river administrative conditions permit.

focuses on impacts in the 15-Mile Reach. In the following discussion of results, "yield" or "benefit" means the expected additional flow resulting from the Shoshone Power Plant and Call actively calling its decreed rights compared to expected changes in river flows without any active calls attributable to the Shoshone water rights.

The 15-Mile Reach is critical habitat for two threatened and two endangered warm-water fish species.[12] Flow recommendations have been developed by the U.S. Fish and Wildlife Service (USFWS) as part of the Programmatic EIS for the 15-Mile Reach. USFWS identified a minimum flow target of 810 cfs for dry hydrologic years for the months August-October. This is equivalent to approximately 50,000 acre-feet per month.

We examine the benefits of the Shoshone Call in two ways: first, we evaluate three example years to understand how the Shoshone Call impacts annual flow volumes in dry, average, and wet years; second, we look specifically at very low flow periods (months) in the 15-Mile Reach, to better understand how some of the most significant benefits of the Shoshone water rights are realized during times of critically low flows in this reach.

Appendix B to this report outlines the monthly distribution of yields in more detail and includes both quantifications of the typical variation in yields by month of the year. Appendix C describes the administrative conditions and operational mechanisms that lead to increased 15-Mile Reach flows during late-summer months.

Annual Examples

Antecedent conditions from one year to the next can cause significant differences in reservoir storage across scenarios with different administrative regimes or user demands. Varying levels of low initial storage between scenarios can distort or obscure the actual impacts of the Shoshone Call in the year of interest, particularly when comparing results across scenarios and multiple years. Wet, dry, and average example years were chosen based on having wet antecedent conditions in order to minimize differences between model scenarios caused by impacts of prior year drawdown in storage by junior water rights.

A table of annual results from the stress-test period (1988-2013) is attached in Appendix A as Table A-1. As shown in Table A-1, the example years are not necessarily the years with the highest yield within a particular hydrologic category. For example, we use 2010 as a typical average year. However, 1994 (another average year) has a simulated yield that is more than twice as large as 2010. Although the yield in 1994 is much larger than 2010,

[12] See https://coloradoriverrecovery.org

2010 is considered to be more representative of yields in an average hydrologic year due to a longer period of wet antecedent conditions leading up to that year.

Wet Year Example

1998 was chosen as the example year to represent wet conditions due to flows exceeding the 1988-2013 average by 33%, and due to antecedent conditions being wet or average for the prior 7 years. Yields for each scenario are tabulated in Table 4, where the yields for the scenarios with Call Relaxation under the 2007 Agreement are omitted due to the Call Relaxation not being active in the example year:

Table 4. Wet Year (1998) Example Yields.

Scenario	15-Mile Reach Yield (AF)
Senior Current	3,107
Senior Future	13,028
Max Current	13,359
Max Future	27,273

Average Year Example

2010 was chosen as the example year to represent average conditions, due to flows being within 4% of the 1988-2013 average, and due to antecedent conditions being wet or average for the prior 5 years. Yields for each scenario are tabulated in Table 5, where the yields for the scenarios with Call Relaxation under the 2007 Agreement are omitted due to the Call Relaxation not being active in the example year.

Table 5. Average Year (2010) Example Yields.

Scenario	15-Mile Reach Yield (AF)
Senior Current	5,376
Senior Future	22,608
Max Current	9,823
Max Future	27,324

Dry Year Example

2012 was chosen as the example year to represent dry conditions, due to flows being 48% below the 1988-2013 average, and due to antecedent conditions being wet or average for the prior 7 years. Yields for each scenario are tabulated in Table 6, where the yields for the scenarios with Call Relaxation under the 2007 Agreement are omitted due to the Call Relaxation not being active in the example year.

Table 6. Dry Year (2012) Example Yields.

Scenario	15-Mile Reach Yield (AF)
Senior Current	41,184
Senior Future	55,080
Max Current	69,580
Max Future	86,143

Annual Examples Summary

The wet, average, and dry year examples above all show a net benefit from maintenance of the Shoshone Call. These examples include both the senior (1,250 cfs) and maximum (1,408 cfs) calls for the Shoshone water rights, as well as current and future basin demands. A few obvious trends are apparent from the results:

1. There is generally a larger benefit to flows through the 15-Mile Reach in dry years as compared to wet years. This benefit is magnified when considering that the years with the highest volumetric yield are generally also the years with the lowest total annual flows to begin with.
2. Fully exercising both the senior and junior Shoshone water rights results in larger yields, meaning the junior water right provides additional value in contributing flows to the 15-Mile Reach.
3. The benefit of maintaining the Shoshone Call will increase with time, as additional upstream junior rights are developed or are more fully exercised. The Shoshone Call will be an important "backstop" to protect flows through the 15-Mile Reach as those junior rights are fully utilized.

Monthly Flow Impacts

A second analysis of the results focuses on monthly flow volumes during the Stress Test period (1988-2013), and in particular on very low flow months in which the minimum flow targets for the 15-Mile Reach are not met. Under the "No Shoshone Call" StateMod run with current basin-wide demands, approximately 15% (46 of 312 months) of *all months* since 1988 would fail to meet the late irrigation season minimum flow target of 50,000 acre-feet per month. Of these 46 months, 30 are in the August-October period (the others include 8 Aprils, 1 May, 2 Junes, and 5 Julys). Table 7 below illustrates the *average* increase in flow under the Shoshone Call during these 46 critically dry months. Table 7 includes results under both current and forecasted future Upper Colorado basin demands across the four Shoshone Call scenarios outlined in Table 2.

Under current basin demands and full exercise of the Shoshone water rights, average flows during these critically dry months are 23% higher than flows with no Shoshone Call. Assuming an increment of future growth by both TMDs and in-basin uses, the benefit of the continued exercise of Shoshone water rights results in 29% more flow on average in these critically dry months. In some instances, the monthly flows with the Shoshone Call active *more than double* the expected flow through the 15-Mile Reach under a no-call scenario. The 2007 agreement for Call Relaxation has a relatively minor impact on the critically dry months' results in the 15-Mile Reach, because the agreement is only active in certain spring conditions, and most of the critical low-flow months are in the late summer and early fall.

Table 7. Increase in flow through the 15-Mile Reach during months with less than 50,000 acre-feet of water in the 1988-2013 simulation period. Increases are shown as monthly average flow and percent increase above flows modeled in the "No Shoshone Call" scenario.

Average Monthly Flow Increase (cfs, %) 1988-2013 (Months < 50,000 AF)				
Basin Demand Level	Senior Shoshone Right 1,250 cfs	Senior Shoshone Right 1,250 cfs w/ Relaxation	Max Shoshone Call 1,408 cfs	Max Shoshone Call 1,408 cfs w/ Relaxation
Current	93 (18 %)	90 (18 %)	118 (23 %)	115 (22 %)
Future	123 (25 %)	120 (25 %)	140 (29 %)	127 (26 %)

The benefits of the Shoshone water rights are not limited to just the driest months. Table 8 shows the expected benefit in the driest quarter (25%) of all months in the 1988-2013 simulation period. While the average benefit across all these months is somewhat less than in the very driest of months, there is still a significant increase in average flow. Even considering the driest half of all the monthly flows in the simulation period (Table 9), there is a clear benefit from continued operation of the Shoshone water rights.

Table 8. Increase in flow through the 15-Mile Reach during the driest 25% of months in the 1988-2013 simulation period. Increases are shown as monthly average flow and percent increase over flows in the "No Shoshone Call" scenario.

Average Monthly Flow Increase (cfs, %) 1988-2013 (Driest 25% of Months)				
Basin Demand Level	Senior Shoshone Right 1,250 cfs	Senior Shoshone Right 1,250 cfs w/ Relaxation	Max Shoshone Call 1,408 cfs	Max Shoshone Call 1,408 cfs w/ Relaxation
Current	88 (12 %)	81 (11 %)	121 (16 %)	114 (15 %)
Future	119 (17 %)	114 (16 %)	147 (21 %)	136 (20 %)

Table 9. Increase in flow through the 15-Mile Reach during the driest half (50%) of months in the 1988-2013 simulation period. Increases are shown as monthly average flow and percent increase above flows modeled in the "No Shoshone Call" scenario.

Average Monthly Flow Increase (cfs, %) 1988-2013 (Driest 50% of Months)				
Basin Demand Level	Senior Shoshone Right 1,250 cfs	Senior Shoshone Right 1,250 cfs w/ Relaxation	Max Shoshone Call 1,408 cfs	Max Shoshone Call 1,408 cfs w/ Relaxation
Current	49 (4 %)	45 (4 %)	70 (6 %)	67 (6 %)
Future	76 (7 %)	73 (7 %)	97 (9 %)	88 (8 %)

Conclusions

This analysis of the Shoshone water rights indicates that abandonment or lack of enforcement of the water rights would have a significant detrimental effect on flows through the 15-Mile Reach of the Colorado River and likely would result in reduced flows at the Colorado-Utah state line. The impact of the Shoshone Call is particularly significant during dry years, such as in 2012, when the 15-Mile Reach would suffer a loss of approximately 41,000-86,000 acre-feet per year if the Shoshone water rights were no longer administered against upstream juniors.

This existing benefit of the Shoshone Call is critical to the continued success of the 15-Mile Reach PBO. If the Shoshone water rights were not exercised in the future, this would likely result in the further inability to satisfy the 15-Mile Reach PBO minimum target flows. Furthermore, the benefit of the Shoshone water rights is not only seen during these critical dry years. In average and wet years, flows in the 15-Mile Reach would be as much as 27,000 acre-feet lower (per year) without continued exercise of the Shoshone Water rights.

Of equal importance to the overall increase in annual flows through the 15-Mile Reach is the significant benefit to flows seen during late summer and early fall months, particularly in dry years, when the river is typically at its lowest. During these months, the Shoshone Call can double the monthly flow compared to flows without a Shoshone Call, and when averaged across all of the critically dry months, the Shoshone Call increases the monthly flows by 18% - 26% under the Senior Current and Future Max scenarios, respectively.

Future Work

As of early September 2024, the Colorado Water Conservation Board is working on an updated version of the Upper Colorado River Basin StateMod Model. This updated model will include revisions to operating rules, as well as a daily timestep version of the model. While that model was not publicly available when this analysis was performed, this memo will be updated *if warranted* after that model is made public.

References

Hydros, 2023. Colorado River Risk Study Phase IV Draft Report. Prepared for the Colorado River District and the Southwestern Water Conservation District.

Xcel, 2003. Agreement Concerning Proposed Operation of the Shoshone Power Call. Agreement between the City and County of Denver, acting by and through its Board of Water Commissioners, and the Colorado River Water Conservation District.

Xcel, 2007. Agreement Concerning Reduction of Shoshone Call. Agreement between the City and County of Denver, acting by and through its Board of Water Commissioners, and Public Service Company of Colorado d/b/a Xcel Energy.

Appendix A: Increases inflow (aka "yield") attributed to the Shoshone Call.

Table A-1. 15-Mile Reach Yields for Each Year in All Scenarios

Year	Hydrology	Future Development Yield* (AF)				Current Development Yield* (AF)			
		Senior	Senior-	Max	Max-Relaxation	Senior	Senior-	Max	Max-
1988	Average	20,708	20,708	20,986	20,986	3,407	3,407	-	-
1989	Dry	28,262	28,262	30,325	30,325	-	-	2,109	2,109
1990	Dry	51,330	51,330	50,386	50,386	18,267	18,267	42,655	42,655
1991	Average	35,394	35,394	33,374	33,374	38,505	38,505	19,770	19,770
1992	Average	32,442	32,442	41,387	41,387	15,995	15,995	18,658	18,658
1993	Wet		-	-	-	-	-	-	-
1994	Average	50,013	50,013	63,986	63,986	19,169	19,169	39,451	39,451
1995	Wet		-	-	-	-	-	-	-
1996	Wet		-	-	-	1,745	1,745	-	-
1997	Wet		-	-	-	-	-	-	-
1998	**Wet**	**13,028**	**13,028**	**27,273**	**27,273**	**3,107**	**3,107**	**13,359**	**13,359**
1999	Average	16,551	16,551	4,310	4,310	5,197	5,197	-	-
2000	Average		9,644	18,427	18,427	1,604	1,604	2,723	2,723
2001	Dry	48,552	48,552	59,162	59,162	27,086	27,086	30,354	30,354
2002	Dry	53,552	53,552	54,837	54,837	36,204	36,204	39,351	39,351
2003	Dry	32,060	25,699	43,610	12,703	22,834	17,318	24,549	19,031
2004	Dry	68,408	42,649	72,176	15,334	54,538	33,620	61,151	40,394
2005	Average	29,034	39,894	28,914	59,250	2,423	4,606	7,556	10,179
2006	Average	13,374	13,228	25,755	23,528	-	-	6,157	5,911
2007	Average		-	13,016	12,948	-	-	-	-
2008	Wet		-	-	-	-	-	-	-
2009	Wet	11,523	11,521	21,762	21,723	-	-	-	-
2010	**Average**	**22,608**	**22,611**	**27,324**	**27,328**	**5,376**	**5,374**	**9,823**	**9,821**
2011	Wet		-	-	-	-	-	-	-
2012	**Dry**	**55,080**	**55,083**	**86,143**	**86,294**	**41,184**	**41,183**	**69,580**	**69,580**
2013	Dry	20,429	5,926	22,192	-	5,419	-	7,213	-

**Yield is defined here as being necessarily greater than zero, because Shoshone's call does not directly result in reductions in flow. Differences in reservoir operations between scenarios can cause reductions in flow greater in magnitude than Shoshone's actual yield, resulting in zero apparent yield.*

Appendix B – Monthly Yield Analysis

This appendix provides a more detailed review of simulated monthly increases (yields) to the 15-Mile Reach than is provided in the main body of the report. Whereas the main body of the report contains results across all scenarios showing the annual yields, this appendix focuses on the Max-Relaxation scenarios[13] under both current and future demand levels. The Max-Relaxation scenarios have distributions of monthly yields similar to the other scenarios in most years but exhibit reductions in overall yield to the 15-Mile Reach during Call Relaxation periods when compared to the Max-Relaxation scenarios, which do not include the 2007 Agreement. This appendix reviews the simulated patterns of monthly yields under the Max-Relaxation scenarios, followed by an illustration of the amount of 15-Mile Reach flows attributable to the Shoshone Call. As additional background information, Appendix C provides an overview of the operational mechanisms at Cameo (OMID Power Canal, Check Structure, and GVC operations) together with a more detailed explanation of how the exercise of the Shoshone water rights can increase flows in the 15-Mile Reach even when a Cameo Call is active.

Simulated Patterns of Monthly Yield – Magnitude and Frequency

Magnitude

The patterns of monthly yield to the 15-Mile Reach due to utilization of the Shoshone call are similar for both Current and Future demand levels. Figure 3 depicts the average amount of additional daily flow by month when full utilization of the Shoshone Call yields additional water to the 15-Mile Reach. Regardless of which demand set is used in the Max-Relaxation scenario, the pattern of monthly yields is similar, with the highest yields occurring in early spring – particularly April - and in the late summer months of August – October.

Additional flows in the 15-Mile Reach in months outside the irrigation season, such as in February and March, tend to result from changes in reservoir storage carryover from previous years, together with differing administrative regimes that can limit the amount of storable water[14]. The yields in those months typically result from reservoirs having to

[13] The Max-Relaxation scenario assumes full use of the Shoshone water rights (1,408 cfs call) and implementation of a Call Relaxation under the 2007 Agreement, which is simulated to occur in this analysis in 2003, 2004, and 2013)

[14] These changes may be due to both increased releases to offset other depletions and decreased ability to store water in priority. This phenomenon is seen in many years and is particularly evident in dry years, such as in 2001. In February and March of 2001, in both the Current and Future scenarios, Williams Fork Reservoir gains storage each month if the Shoshone Call is not active and loses storage each month if the Shoshone Call is active. The increase in flow at the 15-Mile Reach due to the different administrative regime at Williams Fork Reservoir in February and March with the Shoshone call on is about 88 cfs in 2001. However, the difference in river administration with and without the Shoshone Call does not impact

bypass inflows that – absent a Shoshone call – would be storable under their more junior storage rights. The pronounced increase in April is due to both changes in the ability of upstream reservoirs to fill, coupled with early-season irrigators either being curtailed or required to release additional augmentation water from storage.

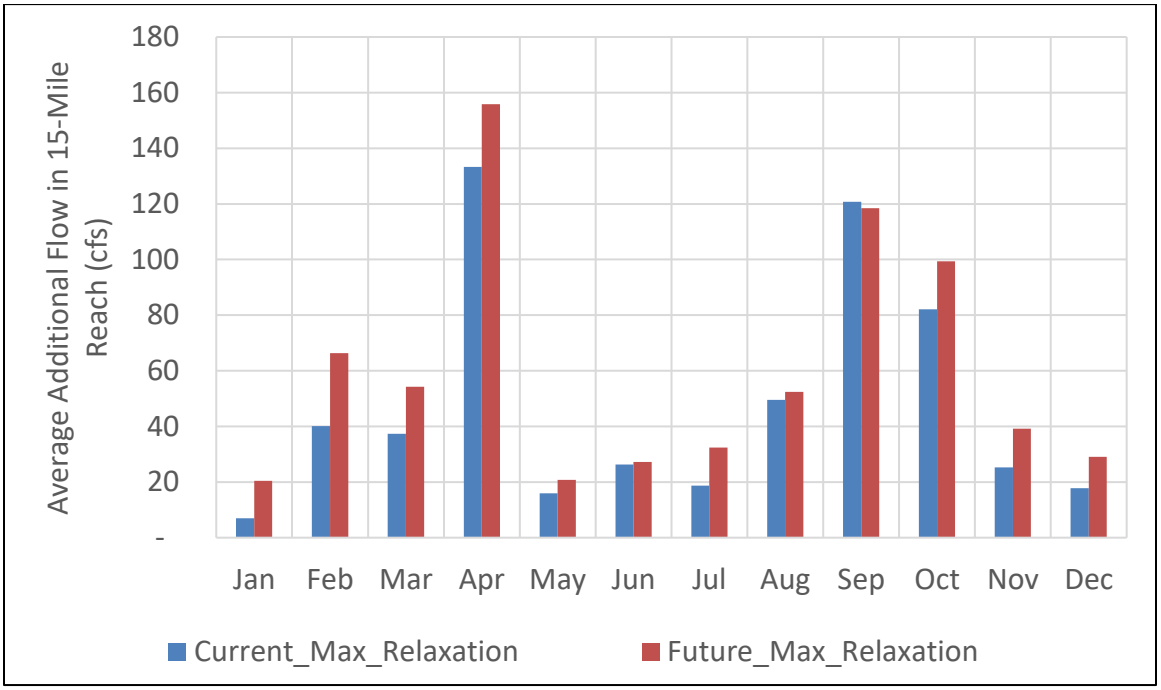


Figure 3. 1988-2013 Average Monthly Yield Magnitude Patterns - Current and Future Max Relaxation Scenarios

Frequency

In addition to increased flows during spring and late summer, the *frequency* of increased flows is also highest in these months. Table 10 illustrates expected frequency (likelihood) by month of increased 15-Mile Reach flows with the Shoshone Call active. The frequency shown is percentage of years over the 1988-2013 study period in which a given month saw increased flows.

Williams Fork Reservoir every year. Similarly, changes in storage at other reservoirs may exhibit different behavior in any given year due to the complexities of each reservoir's operational response to the presence or absence of a Shoshone Call, and this impact may persist over multiple years.

Table 10. Monthly Yield Frequency - Current and Future Max Relaxation Scenarios

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Current	27%	73%	69%	69%	12%	12%	15%	46%	88%	77%	46%	35%
Future	46%	92%	73%	77%	19%	12%	23%	54%	81%	85%	54%	54%

The monthly pattern of yield *frequency* is similar to the monthly pattern of yield *magnitude*, with the exception of the winter months (December through March). The four winter months show higher frequency of yield but a lower magnitude of yield, due to reduced natural flows in the winter and the lack of any substantial irrigation demands, including the Cameo Call, during this period.

PBO Comparison

Differences between these scenarios can also be evaluated against flow recommendations from the Upper Colorado River PBO.[15] Table 2 of the PBO is repeated here for reference:

[15] https://coloradoriverrecovery.org/uc/wp-content/uploads/sites/2/2021/09/FinalPBO.pdf

Table 11. (Table 2 from Upper Colorado River Programmatic Biologic Opinion)

Table 2. Recommended mean monthly flows for the top of the 15-Mile Reach in cubic feet per second. Rate is the percent of years recommended for identified flows based on winter snowpack levels. For example, in the wettest 25 percent of years, flows in June should average at least 15,660 cfs; stated another way, this recommendation should be met in 5 of every 20 years. During low-water years, June flows should average no less than 6,850 cfs, and such a minimum should occur at a rate of no more than 4 in 20 years (20 percent). Table from Osmundson et al. 1995.

Rate	25 percent	25 percent	30 percent	20 percent
Exceedance	25 percent	50 percent	80 percent	100 percent
JAN	1,630	1,630	1,630	1,240
FEB	1,630	1,630	1,630	1,240
MAR	1,630	1,630	1,630	1,240
APR	3,210	2,440	2,260	1,860
MAY	10,720	9,380	7,710	7,260
JUN	15,660	14,250	11,350	6,850
JUL	7,060	5,370	3,150	1,480
AUG	1,630	1,630	1,240	810
SEP	1,630	1,630	1,240	810
OCT	1,630	1,630	1,240	810
NOV	1,630	1,630	1,630	1,240
DEC	1,630	1,630	1,630	1,240

As noted in the inset table caption, PBO recommendations for very low-flow years are listed in cfs in the far right column by month. From a fisheries-benefit perspective, those low-flow targets ideally would have an 80% exceedance (i.e., only 4 years out of 20 would see flows corresponding to the right-most monthly targets). Figure 4 and Figure 5 compare the frequency of meeting the recommended flow targets for the months of April and September across the scenarios.

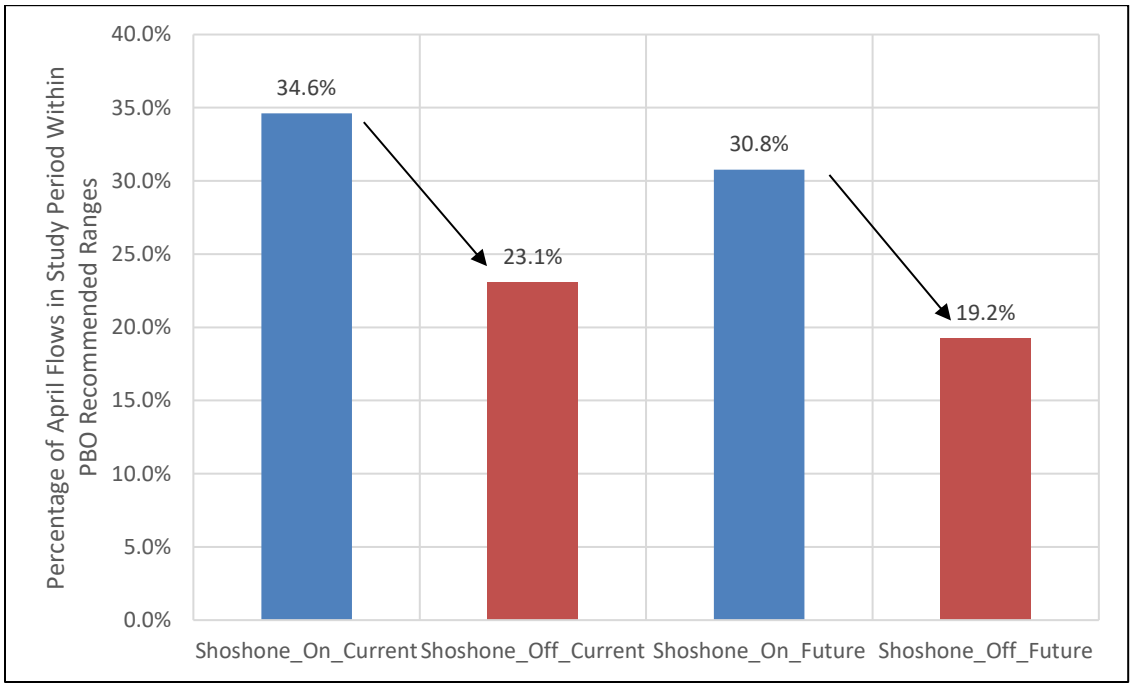


Figure 4. Frequency of April Flows meeting the Lowest PBO Recommended Range *(Shoshone On Scenario is Max w/ Relaxation).*

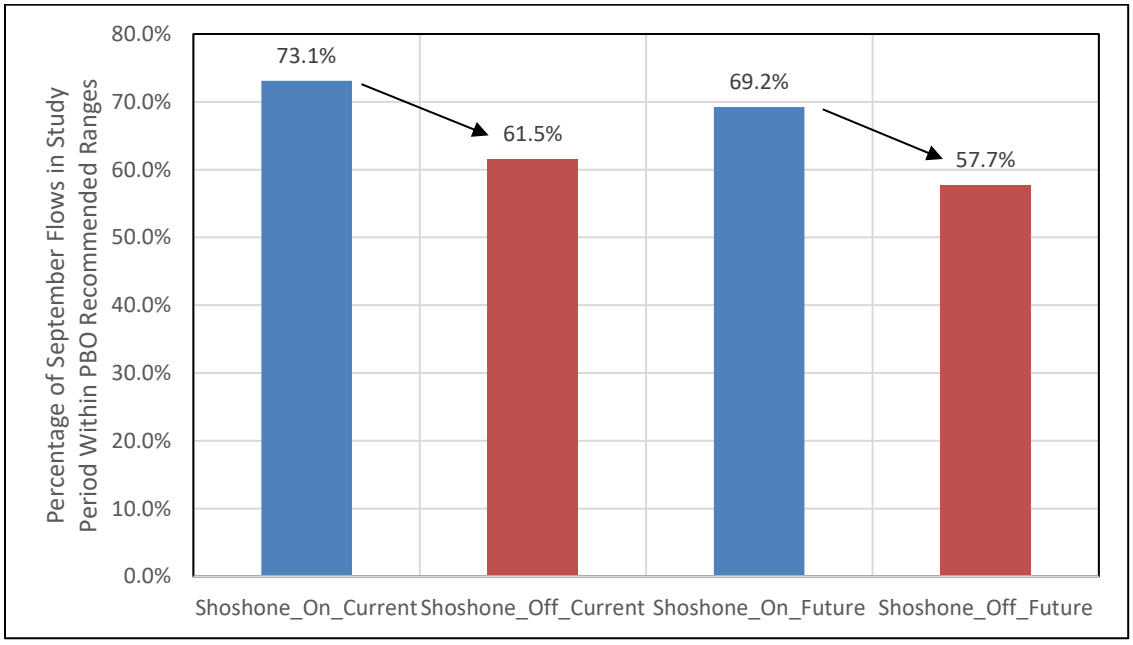


Figure 5. Frequency of September Flows meeting the Lowest PBO Recommended Range *(Shoshone On Scenario is Max w/ Relaxation).*

Notably, there is a significant *decrease* in the frequency of meeting the PBO recommendations when the Shoshone Call is *off*. While having the Shoshone Call active does not by itself meet all desired flow targets for the 15-Mile Reach, its absence would result in significant reductions in PBO target flow compliance rates.

Summary of Late-Summer Benefits

The increase in flows in August-October are of particular interest, because generally lower natural flow conditions—combined with upstream diversions that are often being fully utilized during late summer—tend to negatively impact flows, and hence endangered species, in the 15-Mile Reach. Despite having the lowest monthly flow target (810 cfs), flows in August-October meet that target just 72% of the time during the simulation period. The contribution of the Shoshone Call to flows in the 15-Mile Reach is significant, particularly in critically dry periods.

Model results indicate that when average flows in the 15-Mile reach are less than 810 cfs, the Shoshone Call is responsible for 22% (on average) of that flow, and in some months as much as 50% of the flow (Figure 6).

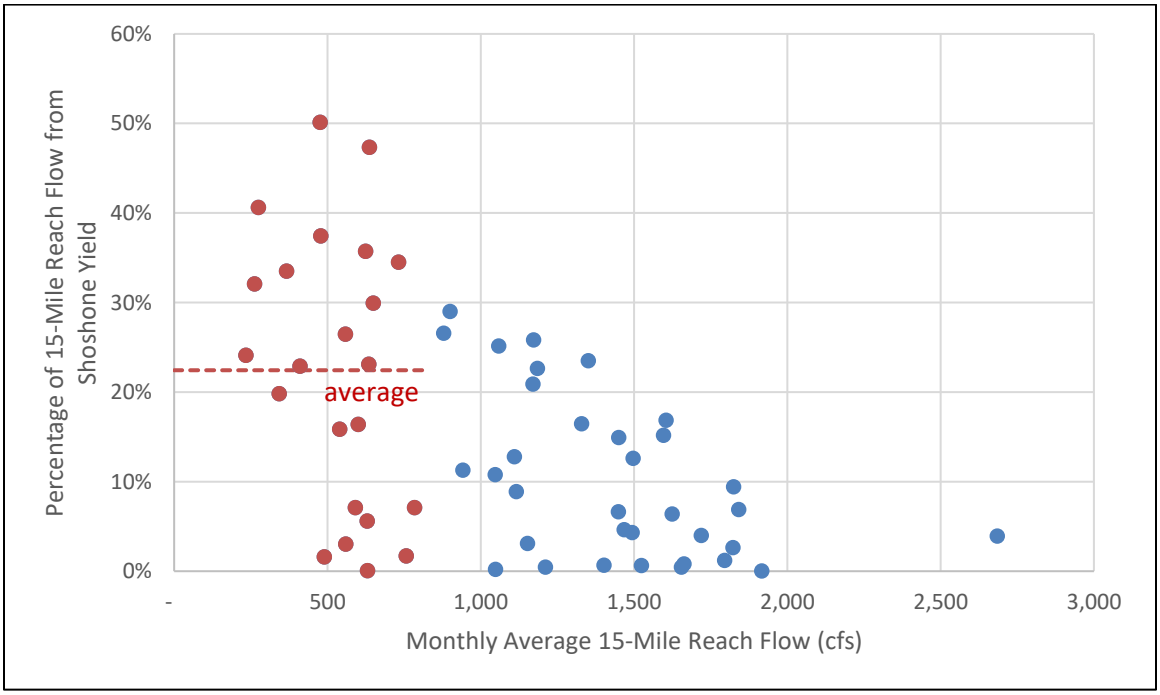


Figure 6. Relationship Between Monthly Average Flow and the Percentage of Flow Resulting from Shoshone's Call - Aug-Oct, Future Max Relaxation Scenarios.

Summary of Monthly Yield Analysis

The analysis presented in Appendix B illustrates several key benefits of the Shoshone Call to the 15-Mile Reach, including:

1. Increases in monthly flows through the 15-Mile Reach year-round, with the highest flow increases in early spring (February – April) and late summer (August – October).
2. The *frequency* of increased flows is also generally highest during the early spring and late summer months. Approximately 4 out of 5 years see some amount of increased flows in September and October (Table 10).
3. The benefits accruing to the 15-Mile Reach are particularly significant during the months with the lowest flows in the driest years. The likelihood of meeting the PBO recommended flow minimums increases across all scenarios when the Shoshone Call is on (Figures 4 and 5).
4. During critically dry (<810 cfs) months, the Shoshone Call contributes *on average* 22% of the flow in the 15-Mile Reach, and as much as 50% of the flow.

Appendix C: Dissecting the Cameo Calls – How Shoshone Contributes to the 15-Mile Reach in Late-Summer

This appendix is being provided in response to comments received during review of this report and associated presentations. The appendix provides additional details as to the mechanisms that result in additional flows to the 15-Mile Reach during months in which a Cameo Call may typically be active. The Cameo Call is a generic term that describes an administrative call for water placed by either the Grand Valley Project's Government Highline Canal or the Grand Valley Canal, both of which are directly upstream of the 15-Mile Reach and both of which have relatively senior water rights in the basin (although the most senior Cameo water rights are junior to Shoshone's senior water right). StateMod results indicate that having Shoshone active has a meaningful impact to the 15-Mile Reach. However, StateMod is somewhat limited in its ability to tease out details of how the Shoshone and Cameo calls interact, particularly over sub-monthly time periods. Examination of historical river administration records can be used to validate these conclusions.

Mechanisms that benefit 15-Mile Reach flows include:

1. Delayed Onset of the Cameo Call: A Shoshone Call brings additional water downstream, which delays and shortens the duration of the Cameo Call. This additional flow is the result of increased curtailment and/or release of larger volumes of augmentation water by junior users upstream of Shoshone.
2. Reduced Need for Recovery Program Flow Releases: A Shoshone Call reduces the need for Recovery Program supplemental releases by increasing flows past Cameo into the 15-Mile Reach. This reduces the need for releases from "fish water"[16] storage accounts during certain times and allows for increased flexibility in providing flow augmentation releases during late summer months.
3. Operation of the OMID Check Dam during a Cameo Call: Efficient operation of the OMID Power Plant and Pump Turbine often results in only partial operation of the Check Dam. This enables more efficient power production and results in water bypassing the Check Dam and returning to the river at the head of the 15-Mile Reach.

Each of these is discussed in more detail below.

1. Delayed Onset of Cameo Call

Historically, the Cameo Call is the controlling call on the river during the late summer months of August through October. In the absence of a Shoshone Call, it is likely that the

[16] "Fish Water" refers to releases from upstream reservoirs make specifically to benefit flows in the 15-Mile Reach. These releases are shepherded past the Cameo diverters for the benefit of the Endangered Fish.

Cameo Call would be initiated even earlier in the year, as the runoff peak ends and the river returns to a baseflow condition. Under an assumed full utilization of the Shoshone Call, the need for a Cameo Call is pushed later in the summer and may be eliminated altogether.

An example of the effect that the Shoshone Call has in delaying the Cameo Call can be seen in CDSS administrative data from August and September of 2019. The Shoshone junior call was first placed on 8/23/2019. The senior Shoshone call was then placed on 8/28/2019 with the swing right at CBT's 8/1/1935 priority. As Administrative Flows[17] continued to fall, the swing right was adjusted to the Moffat Tunnel (7/9/1934) priority on 8/30, and finally to the Shoshone Priority (12/5/1905) on 9/2/2019. Although Shoshone was calling throughout September, the gradual reduction of mainstem and tributary inflows pushed the natural flow of the river low enough that by 9/25/2019, a Cameo Call was necessary at the 8/3/1934 priority of the Grand Valley Project.

In analyzing this historical sequence of calls, it is reasonable to conclude that absent the Shoshone Call, a Cameo Call would have been placed much earlier in September. In this example, the Shoshone Call likely delayed the onset of the Cameo Call by 3 or 4 weeks. Regardless of how much Administrative Flow was in the river over and above the Cameo diverters' demands, the lack of a Cameo Call during this period indicates that the Shoshone Call resulted in water in excess of the Cameo diverters' needs passing into the 15-Mile Reach. Absent the Shoshone Call, it is likely that the Cameo Call would have started weeks earlier and there would have been less water in the 15-Mile Reach. Delaying the onset of the Cameo Call by making the Shoshone Call permanent will result in additional flows into the 15-Mile Reach.

Sources of Water

The Senior Shoshone Call is administered under a 1905 priority and is approximately seven years senior to the senior Cameo Call, which is administered at a 1912 priority. Differences in the administrative dates and volume of the two calls impacts water users upstream of Shoshone. In general, the more senior Shoshone Call will force junior rights upstream to either provide additional augmentation water or curtail their uses.

To the extent that there was a swing call on one of the junior rights above Shoshone, exercising the Shoshone call over the Cameo call would increase that user's required offset, or would shift the swing to another user. Regardless, delaying or preventing a Cameo Call through continued utilization of the Shoshone rights will result in longer periods of flows

[17] In general terms, the "Administrative Flow" equals the measured flow at the Dotsero Gage minus shepherded reservoir release water, including "fish water" that has been bypassed or released from upstream storage and is shepherded past other diversions in order to supplement flows in the 15-Mile Reach

at Cameo in excess of diversion demands, and result in more water being bypassed into the 15-Mile Reach.

2. Enhanced Flexibility of Recovery Program Releases

As previously discussed in the main body of this report, modeling results indicate a reduction in flows in the 15-Mile Reach during late summer months without Shoshone actively calling. However, when the Shoshone Call is active, average 15-Mile Reach flows increase, particularly during critically dry months and years.[18] StateMod currently does not simulate changes to "fish water" releases that might result from changes to Shoshone operations. However, it is clear that having additional flows in the 15-Mile Reach by virtue of the Shoshone Call increases the likelihood of meeting PBO flow targets (See Figures 4 and 5) and will allow for greater flexibility in utilizing the various environmental pools to make releases to benefit the endangered fish populations in that reach.

3. Operation of OMID Check Dam during a Cameo Call

The existence of a Shoshone call does not guarantee that there will not be a Cameo call, although it does reduce the likelihood and delay the onset. During periods when both Cameo and Shoshone are calling, there can still be benefits to the 15-Mile Reach as compared to river conditions without a Shoshone Call.

Figure 7 presents a simplified schematic of the diversion infrastructure at Cameo that is useful in understanding how water moves through that system.[19] The Orchard Mesa Irrigation District (OMID) diverts part of the flow of the Government Highline Canal into the OMID Power Canal. Tailwater from the OMID power plant and pump turbine are regulated by a Check Dam which can be operated to deliver water upstream through the bypass channel for diversion by the GVIC into the Grand Valley Canal. If the Check Dam is only partially closed, the portion of water not delivered back to GVIC is returned to the river just below the GVIC canal, at the head of the 15-Mile Reach.

OMID operates the Check Dam when flows available to meet the Cameo Call are at or below 1,950 cfs, thereby enabling power generation and deliveries to OMID without injuring the senior GVIC rights (see Figure 7). However, checking flows into the bypass channel at a rate greater than 100 cfs results in decreased power production due to a reduction in hydraulic head caused by pooling of the power and pumping plant tailwater. Thus, the Check Dam does not always redirect all the OMID Power Canal return flow water upstream to the GVIC diversion dam. Often, the Check operates only partially or not

[18] See Figures 3-5.
[19] This schematic is taken from a report by Paul Calder dated July 12, 1993 entitled "Orchard Mesa Irrigation District Operation of the 'Check'".

at all – even when a Cameo Call is in effect. Water not checked back into the bypass channel accrues to the 15-Mile Reach.

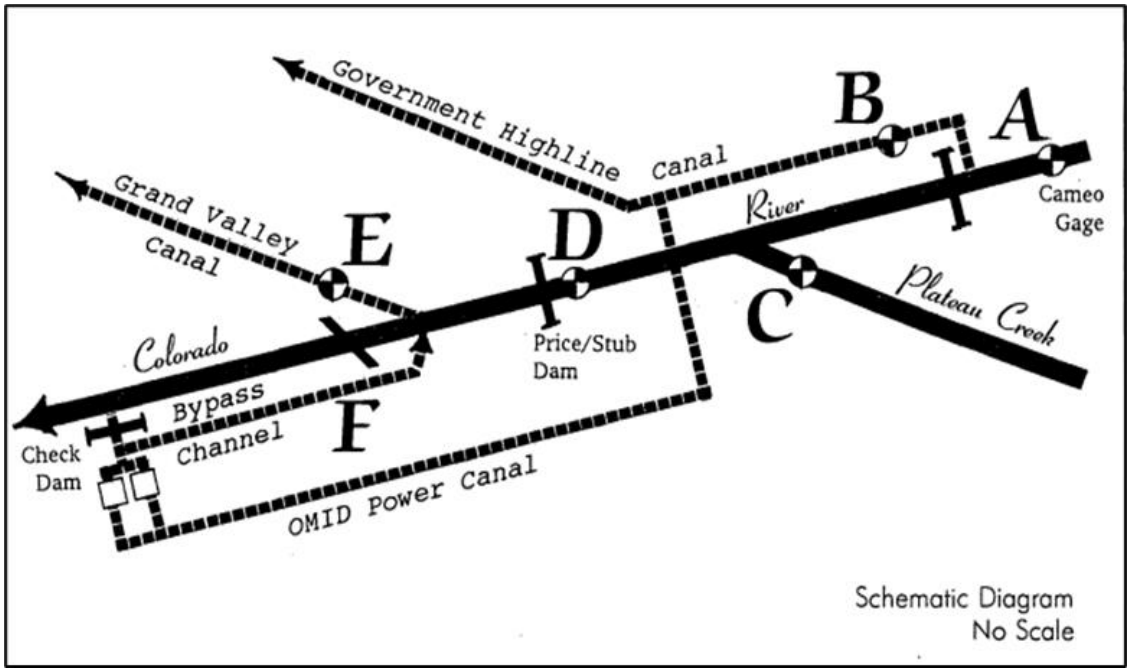


Figure 7. Schematic Diagram of Cameo Diversions.

Historical Example

Historical flows in the 15-Mile Reach were evaluated during periods when Shoshone was calling. The full set of data required for this assessment is available beginning in 2012, which was a year where infrastructure issues prevented full exercise of the Shoshone water rights. Figure 8 shows the period from July-October of that year when the senior Cameo Call was active, and how the Check Dam and the OMID power plant were operated in tandem during that time. In the figure, the "check structure" line represents flows delivered back to the river via the bypass channel to ensure GVIC's demand is met. The difference in flow between the two lines represents—at a minimum—the amount of water entering the 15-Mile Reach. If GVIC is not diverting 100% of the flow at its headgate, additional water will arrive at the 15-Mile Reach as it passes the GVIC diversion dam.

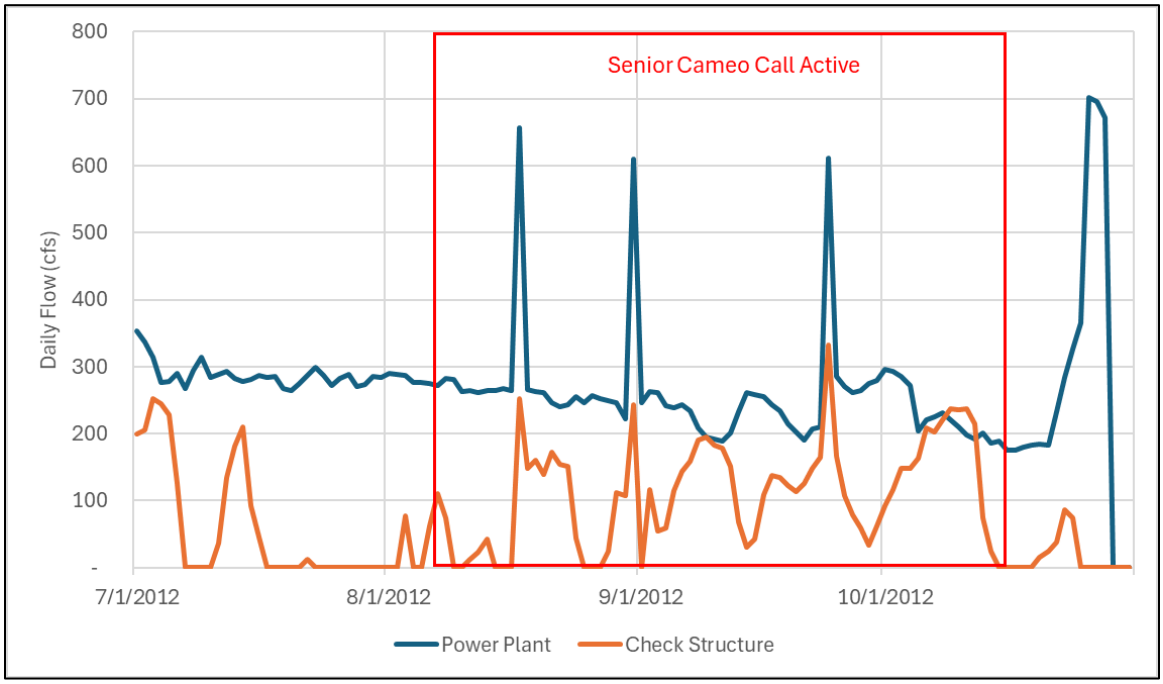


Figure 8. Historical Observed Power Plant Diversions and Checked Flow, 2012.

A portion of the difference in flow between the lines showing the OMID power plant and Check Dam usage corresponds to "Fish Water" that was released from upstream storage and is intended to supplement flow in the 15-Mile Reach. These deliveries are NOT subject to a Cameo Call, are often routed through the OMID power plant, would not be checked back into the bypass channel, and would be released into the river at the head of the 15-Mile Reach. Not all of the water represented by the difference between the two lines is "Fish Water". Periods during which this additional flow accrues to the river below GVIC represent instances where calls from the Cameo water rights have been met, and any additional flows from upstream would accrue to the 15-Mile Reach. Had the senior Shoshone Call been in place during these times, there are upstream diversions junior to Shoshone but senior to Cameo that would have been called out, and the additional yield from their curtailment (or associated replacement water released from storage) would have accrued to the 15-Mile Reach.

DRAFT

TO: Colorado River District Staff and Counsel
FROM: Hydros Consulting, Inc.
SUBJECT: Addendum to September 11, 2024, Shoshone Power Plant Water Rights Yield Assessment
DATE: November 7, 2024

This memo is being provided as an addendum (Addendum) to the September 11, 2024 memo "Shoshone Power Plant Water Rights Yield Assessment" from Hydros Consulting to the River District. On September 18, 2024, a new version of the Upper Colorado River Basin Model (UCRM) and Baseline Data Set was released to the public by the Colorado Water Conservation Board (CWCB). The updated version of the UCRM can be run using either monthly or daily timesteps. A summary of the significant changes made to the 2015 version of the UCRM is provided in a memo from the State's modeling contractor (herein "WWG Memo") from Erin Wilson (Wilson Water Group) to Brian Macpherson (CWCB) dated September 16, 2024.[1]

This Addendum provides a summary of additional analyses conducted using the daily timestep version of the new UCRM and addresses comments raised by organizations reviewing the original analysis. Like the original September 11, 2024, memo, the analysis presented in this Addendum is not intended to quantify the historical use of the Shoshone water rights.

Background

The daily timestep model provides an opportunity to more precisely analyze the effects of the proposed Shoshone water rights on stream flow and revisit the analysis of the impacts to Colorado River flow if the Shoshone water rights were eventually abandoned or otherwise not exercised. However, because the daily UCRM has yet to undergo any formal vetting process, the daily UCRM outputs are likely less accurate than what would occur under real-time conditions. [2]

[1] https://dnrftp.state.co.us/CDSS/ModelFiles/StateMod/Shoshone_StateMod_Baseline_9-26-2024.zip

[2] Note that this daily model was not calibrated to daily or monthly flows or operational data, and only generally approximates actual patterns of daily water user demands. It also does not reflect the reality of multi-day travel times when making reservoir releases or administering water rights. As such, the daily UCRM will tend to allocate water more precisely, but possibly less accurately, than would occur in reality.

For purposes of this Addendum, three different Shoshone water rights[3] operation scenarios were evaluated:

1. The "Baseline" model as provided by CWCB, representing the current conditions in the basin;
2. A "Zero Shoshone" scenario, which simply sets the Shoshone demand to zero; and
3. A "Max Shoshone" scenario, which assumes a Shoshone demand of 1,408 cubic feet per second (cfs) year-round, subject to reduction as discussed below.

In both the Baseline and Max Shoshone scenarios, the years 2003 and 2013 are simulated using the Public Service Company/Denver Water Relaxation Agreement demands for the Shoshone water rights. Thus, the "Max Shoshone" scenario is comparable to the "Max with Relaxation" scenarios from the September 11, 2024, Hydros memo. These three Shoshone scenarios are combined with two sets of basin-wide user demands, representing "Current Conditions" (i.e., users other than Shoshone unadjusted from the "Baseline"), and "Future Conditions," which approximate the increment of consumptive use allowed under the 15-Mile Reach Programmatic Biological Opinion (PBO).[4]

Impacts to Reclamation Projects and Associated Water Deliveries

Following release of the September 11, 2024, Hydros report which utilized the 2015 monthly UCRM, some water users expressed a desire for additional analyses of potential impacts, if any, the proposed "Shoshone Permanency" approach would have on Reclamation's project operations, including reservoir storage and water deliveries.

As stated in the WWG Memo, the Baseline model represents current demands, infrastructure, and administration, and "*can be used as the basis against which to compare a simulation that includes a new use or operation*." (WWG Memo, page 1). Given this intended use, and to address the questions raised with respect to impacts on other users, the Baseline model results were compared to a simulation of basin conditions under a "Max Shoshone" scenario in which a year-round demand of 1,408 cfs was assumed for the Shoshone Power Plant.

[3] Unless otherwise noted, the use of "Shoshone" when referring to operational scenarios and model results generally refers to the demands placed by, and exercise of, the Shoshone water rights.

[4] The PBO allows for 120,000 acre-feet of additional depletions in the Colorado River above its confluence with the Gunnison River. The updated UCRM Baseline demands are approximately 50,000 acre-feet more than the 2015 UCRM Baseline demand data. Thus, the Future Conditions demand dataset used in this Addendum targets an additional 70,000 acre-feet of demands. The depletions resulting from these demands increase by approximately 105,000 acre-feet on average due to shortages in some years.

In the Baseline scenario, Shoshone's water rights demands vary between 704 cfs and 1,408 cfs depending on the season, assumptions about outages at the Shoshone Power Plant, and implementation of call relaxation in 2003 and 2013. In order to assess the possibility that the impact of the Shoshone Call[5] might change in the future as basin-wide development increases, the daily UCRM under Baseline and Max Shoshone scenarios is simulated under both Current Conditions and Future Conditions for basin-wide demands. Since the objective of this analysis is to understand more about the impact and importance of the Shoshone Call, and not to assess the impacts of other development in the basin, comparisons here focus on differences between Baseline and Max Shoshone scenarios (as opposed to comparing the Max Shoshone scenario under Current and Future demand conditions).

Colorado – Big Thompson Project (C-BT) and Frying Pan – Arkansas (Fry-Ark) Storage

The Baseline and Max Shoshone scenarios produce almost identical results for storage in Granby Reservoir, Green Mountain Reservoir, and Ruedi Reservoir when minimum, average, or maximum storages are compared at a given level of basin-wide development. Table 1 presents a comparison of storage in units of thousands of acre-feet (KAF), where the largest difference resulting from Shoshone Max versus Baseline is the 0.1 KAF difference in average storage for Granby Reservoir. For reference, results for the "Zero Shoshone" scenarios are also presented in Table 1.

Table 1. C-BT and Fry-Ark Storage Comparison (units of KAF)

Scenario		Granby			Green Mountain			Ruedi		
		Min	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**
Current Conditions	**Baseline**	74.4	332.8	539.7	48.6	95.9	154.6	52.0	83.6	102.4
	Max	74.4	332.8	539.7	48.6	95.9	154.6	52.0	83.6	102.4
	Zero	76.1	337.3	539.7	57.9	100.3	154.6	52.0	83.2	102.4
Future Conditions	**Baseline**	74.3	279.2	539.7	48.5	93.4	154.6	52.0	83.6	102.4
	Max	74.3	279.1	539.7	48.5	93.4	154.6	52.0	83.6	102.4
	Zero	73.6	282.4	539.7	57.6	97.4	154.6	52.0	83.1	102.4

There is no appreciable difference in simulated storages between the Baseline and Max Shoshone scenarios. There are differences, however, between those two scenarios and the Zero Shoshone scenario, which exhibits higher average storage levels for reservoirs upstream of the Shoshone Power Plant (Granby and Green Mountain Reservoirs), The

[5] For purposes of this Addendum and the September 11, 2024, memo, the "Shoshone Call" means the historical administration of the 1,408 cfs attributable to the junior and senior priorities under the Shoshone water rights.

decrease in average storage at Ruedi Reservoir without the Shoshone Call occurs because administration of the Shoshone Call tends to prevent calls from Grand Valley water users that would impact Ruedi Reservoir. The differences in minimum and average storage levels in Granby Reservoir and Green Mountain Reservoir are due to changes in the timing of drawdown and refill of those facilities under the different scenarios.

Reclamation and Other Major Trans-Mountain Diversions (TMDs)

C-BT (Adams Tunnel) and Fry-Ark Project (Boustead Tunnel) deliveries to the East Slope are largely unaffected by Shoshone's operations, when Baseline and Max Shoshone scenarios are compared to each other, similar to the impacts noted for project storage. There are also significant amounts of Colorado River water diverted for municipal and other uses for Front Range communities through the Homestake, Twin Lakes, Roberts, and Moffat Tunnels. None of these uses experience any appreciable reduction in their supplies between the Baseline and Max Shoshone scenarios as illustrated in Table 2:

Table 2. Major Trans-Mountain Diversions Average Annual Diversions (units of KAF)

Scenario		Adams Tunnel	Boustead Tunnel	Homestake Tunnel	Twin Lakes Tunnel	Moffat Tunnel	Roberts Tunnel
Current Conditions	**Baseline**	242.4	48.0	26.3	40.8	53.2	75.5
	Max	242.4	48.0	26.3	40.8	53.2	75.5
	Zero	242.7	47.8	26.7	40.7	53.5	75.5
Future Conditions	**Baseline**	254.4	48.0	28.7	40.8	60.2	96.6
	Max	254.4	48.0	28.7	40.8	60.2	96.6
	Zero	255.3	47.8	32.0	40.7	60.7	96.6

Grand Valley Project

Reclamation's Grand Valley Project delivers water to the Grand Valley Water Users Association (GVWUA), Orchard Mesa Irrigation District (OMID), and Vinelands Hydropower Plant (Vinelands). Diversions to these water users are unchanged when comparing the Baseline, Max Shoshone, and Zero Shoshone scenarios under both Current and Future Conditions (the maximum difference is 0.02%, less than one acre-foot). The Grand Valley Project water users do not see increased demands under Future Conditions, and their water rights are senior enough not to be impacted by changes to Shoshone operations.

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Recovery Program Storage

While the Shoshone demands are different between the Baseline and Max Shoshone scenarios, the outcome of the modeling is nearly identical under these two scenarios. These results are not unexpected, because physical water supply limits water availability for large periods of time when Shoshone is typically calling for water.[6] In many periods, especially during winter months, regardless of whether Shoshone is calling for 900 cfs, 1,250 cfs, or 1,408 cfs, there is often not enough water to fully satisfy the Shoshone Call.

The UCRM tracks the use of the various user pools in each reservoir, so evaluation of impacts to specific user accounts is possible. One group of reservoir accounts of particular interest in this analysis are the "fish pool" accounts for the Upper Colorado River Recovery Program that store water for subsequent release to benefit threatened and endangered fish in the 15-Mile Reach. To address the possibility that the Max Shoshone scenario might negatively impact the fish pool accounts, combined storage in the fish pool accounts was evaluated and compared to the Baseline scenario. *Figure 1* presents the combined storage in the fish pool accounts in Ruedi, Wolford Mountain, and Granby Reservoirs under Current Conditions demands. Although the time series are not identical for each reservoir, as evident during the lowest drawdowns in some years, the average storage differs by less than 10 acre-feet (less than 0.1%).

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[6] Previous versions of the UCRM utilized average monthly state-recorded *diversions, which are calculated using a constant turbine efficiency at the Shoshone Power Plant*, as the basis for Shoshone water rights' demands. This assumption underestimated Shoshone water rights' actual *demand* for water and artificially limited the power plant's ability to divert water for power production during times when the amount of water available for diversion exceeded the long-term average.

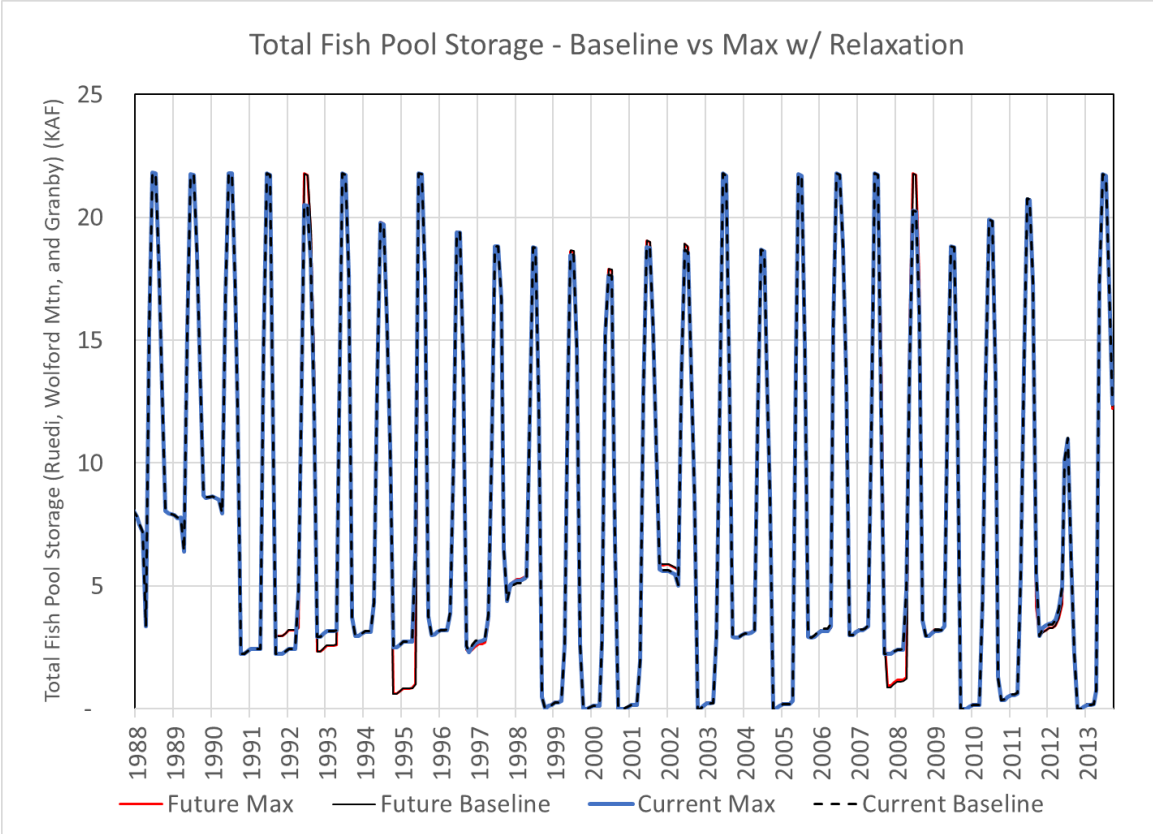


Figure 1. Total Fish Pool Storage - Baseline vs Max w/ Relaxation. The differences in minimum storage are so small as to be difficult to discern on this graph, except for some minimum storage values when Current and Future Conditions are compared.

Benefits to the 15-Mile Reach

Analysis of impacts to the 15-Mile Reach includes simulation of the Max Shoshone and Zero Shoshone scenarios under both Current Conditions and Future Conditions in the daily timestep version of the UCRM.

Summary: Results from this daily modeling analysis confirm the conclusions from the original Hydros yields assessment memo (September 11, 2024) using the monthly UCRM. Shoshone has a significant benefit to flows in the 15-Mile Reach, and the timing of that benefit is well aligned with the objectives of the Endangered Fish Recovery Program. The timing of the Shoshone call and the resulting benefits to the 15-Mile Reach are greatest during dry years, and in all years during the lowest flow months of August – October, when fish flow targets are most difficult to meet.

Based on outputs from the Baseline model, the Shoshone water rights are actively calling 62% - 64% of the time during the 1988-2013 period of simulation, under Current Conditions and Future Conditions, respectively. Absent the continued exercise and

administration of the Shoshone water rights, flows through the 15-Mile Reach would be reduced by an annual average of 24.2 KAF under Current Conditions and 26.9 KAF under Future Conditions.[7] Importantly, 68% - 76% of that flow reduction would occur during the critical low-flow months of August through October. These results are shown in Table 4,[8] which presents the expected annual and August-October benefits to the 15-Mile Reach due to Shoshone Permanency under both Current and Future Conditions. The maximum benefit to the 15-Mile reach in a single year is 41.9 KAF under Current Conditions and 56.0 KAF under Future Conditions. Maximum benefits to the 15-Mile Reach during August-October of a single year are 38.7 KAF and 33.8 KAF for Current and Future Conditions, respectively.

Table 4. Summary of Baseline Model Flow Benefit in the 15-Mile Reach attributable to ongoing exercise of the Shoshone water rights.

Basin-Wide Development	Average Annual Increase (KAF)	Average August-October Increase (KAF)	Increase occurring during August-October (% of Total Annual Increase)
Current Conditions	24.2	18.5	76%
Future Conditions	26.9	18.2	68%

Table 5 provides a breakdown of the benefits by year type for both Current and Future Conditions scenarios. The Shoshone water rights contribute a higher percentage of the total flow through the 15-Mile Reach during the period extending from August through October in dry years than in wet years, although the total volumes are similar. The average increase in daily flow attributable to continued exercise of the Shoshone water rights for Current and Future Conditions during August – October over the 1988-2013 period is approximately 100 cfs.

[7] The "available flow" data from the Shoshone node in the daily UCRM is used to identify the days in the simulation period during which Shoshone water rights are actively calling. If there is no "available flow" at that node, it means that the Shoshone water rights are calling out upstream juniors and/or forcing them to provide replacement water for any depletions. All comparative results presented for the 15-Mile Reach are evaluated during periods that Shoshone water rights are calling under the Baseline scenario.

[8] Results for the August-October summary statistics shown in Table 4 are for the calendar years 1988-2012. Using calendar years instead of water years allows continuity when computing results statistics over the August-October period. The difference in simulated annual average benefit between 1988-2013 water years and 1988-2012 calendar years is less than 1%. The model simulation ends in September 2013 (the end of the 2013 water year), so calendar year 2013 data are incomplete and not included in the annual summary results that include August-October, such as Table 4 and Table 5.

Table 5. Benefit of Shoshone Call on flows through the 15-Mile Reach by year type under the Baseline scenario. Both annual average and August-October average values are shown.

Hydrologic Condition	Current Conditions			Future Conditions		
	Average Annual Benefit (KAF)	Average August-October Benefit (KAF)	Aug-Oct Benefit (% of total flow in those months)	Average Annual Benefit (KAF)	Average August-October Benefit (KAF)	Aug-Oct Benefit (% of total flow in those months)
Dry	33.1	14.9	15%	36.8	15.0	17%
Average	22.6	20.0	12%	24.9	18.7	12%
Wet	18.3	19.6	7%	20.9	20.4	8%

Delaying the Cameo Call[9]

The September 11, 2024, Hydros memo compared monthly results to historical data from the CWCB's CDSS website and concluded that the utilization of the Shoshone water rights impacts the "Cameo Call" by delaying the administration of junior rights to satisfy that call. Results from the daily timestep version of the UCRM confirm this finding.

In the Baseline scenario with Current Conditions, the Cameo Call is on for 1,041 days during the 1988-2013 simulation period. In comparison, the Cameo Call is on for 1,340 days in the Zero Shoshone scenario, a 29% increase in calling days over the Baseline scenario. The Future Conditions results also show a 29% increase in calling days, from 1,108 to 1,429, resulting from the removal of the Shoshone call. Minimizing the frequency of the Cameo Call is significant for the 15-Mile Reach. Every day that Cameo is not calling indicates that there is flow in the river in excess of the Cameo diverters' needs, and that water will flow past those diverters and into the 15-Mile Reach.

Monthly Results

In the September 11, 2024, Hydros memo, Appendix B discusses monthly distributions of yield, and changes in frequency of flows meeting PBO-recommendations. The qualitative results from that analysis are generally unchanged when similar evaluations are carried out with 2024 UCRM results. Figure 2 presents the average increase in flows by month for periods when the Shoshone water rights are actively calling. These results are consistent with the monthly pattern of benefits seen in the 2015 UCRM results, with

[9] "Cameo Call" is a generic term that describes an administrative call for water placed by either the Grand Valley Project's Government Highline Canal or the Grand Valley Canal, both of which are directly upstream of the 15-Mile Reach and both of which have relatively senior water rights in the basin (although the most senior Cameo water rights are junior to Shoshone's senior water right).

the most significant benefits in the early spring and late summer months. While the magnitude of yields in May and June for the 2024 UCRM is larger than the similar results from the 2015 UCRM, the frequency of yields (i.e., number of days of benefits) in those months is lower.

Another important monthly result that is similar to the 2024 UCRM's daily results is the expected reduction in flows during September under the Zero Shoshone scenario that meet PBO-recommendations (a minimum flow of 810 cfs). Figure 3 presents the comparison of days within the recommended flow range in September across Current Conditions and Future Conditions for the Baseline Shoshone scenario versus the Zero Shoshone scenario. There is a greater decrease in flows meeting the 15-Mile Reach PBO targets under the 2024 UCRM compared to the 2015 UCRM, when comparing the Zero Shoshone scenario to the Baseline, which is likely the result of the 2024 UCRM's ability to evaluate flows on a daily basis.

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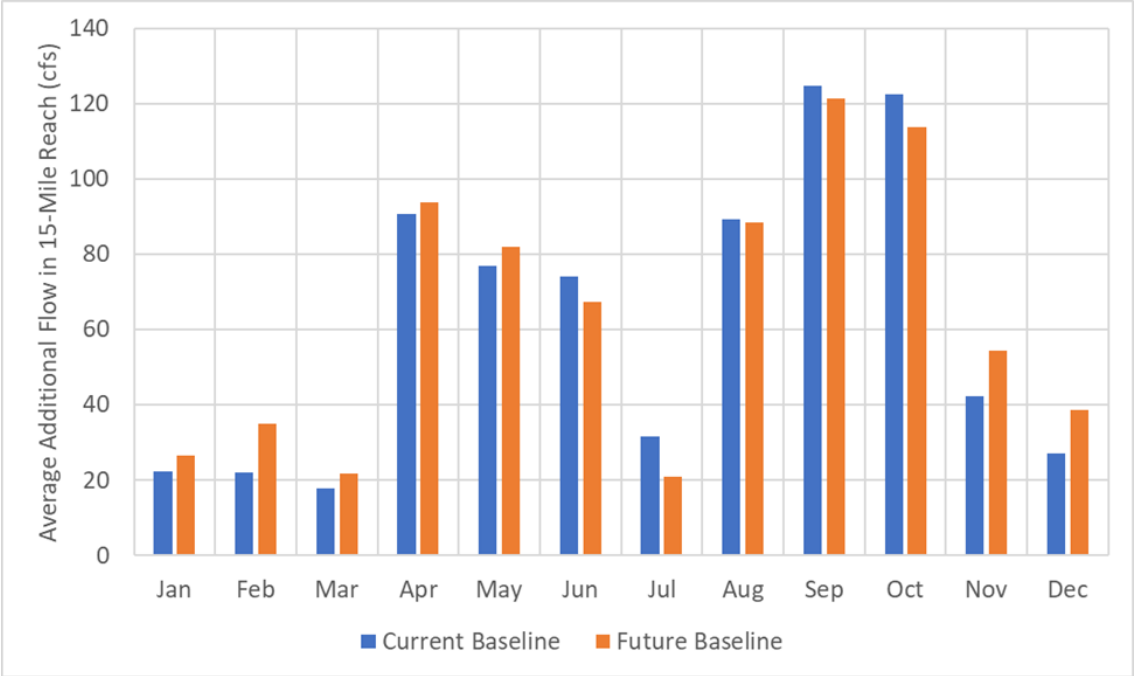


Figure 2. Monthly Distribution of 15Mile Reach Yield - 2024 UCRM

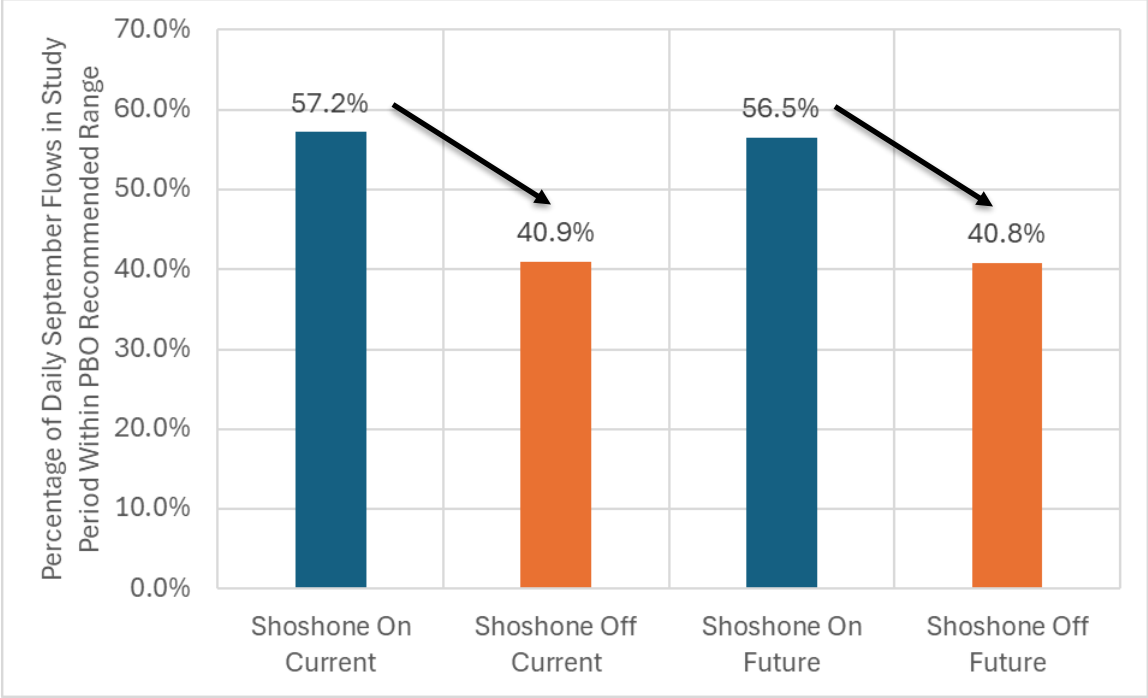


Figure 3. Decrease in Frequency in September Flows within PBO-Recommended Range without Shoshone Permanency

15-Mile Reach Discussion

Benefits to the 15-Mile Reach occur more uniformly across the different year types in the daily UCRM compared to the results from the monthly 2015 version of the UCRM, but still show the greatest benefit during dry (i.e., drought) years.

As expected, and consistent with the results presented in the September 11, 2024, memo, the benefit of Shoshone Permanency to the 15-Mile Reach is magnified when evaluating the Future Conditions scenarios. Results from those scenarios further illustrate the benefit that the Shoshone water rights have in limiting the impact of future growth in consumptive uses on flows through the 15-Mile Reach. As was noted in the original September 11, 2024, Hydros memo, and confirmed again here, the greatest benefit to the 15-Mile Reach, as a percentage of flow attributable to the Shoshone Call, is seen during the driest years and during the low-flow months of August, September, and October.

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Conclusions

This Addendum presents analyses using the recently released daily timestep version of the CWCB's 2024 UCRM. This Addendum addresses specific questions raised by interested parties regarding potential impacts to existing projects and to flows in the 15-Mile Reach, which are critical to the success of the Upper Colorado River Endangered Fish Recovery Program. The Addendum also provides a point of comparison between the results presented previously, as shown in Table 5, which presents annual and dry year yields across various versions of the model that have been used to assess yield.

Table 5. Comparison of benefits of continued exercise of the Shoshone water rights on flows through the 15-Mile Reach across model versions and scenarios.

Model + Scenario	**Annual Benefit, All Years (KAF)**	**Annual Benefit, Dry Years (KAF)**
2015 Monthly Model ***Max w/ Relaxation - Current***	14.0	30.4
2024 Daily Model ***Max w/ Relaxation - Current***	24.0	32.8
2015 Monthly Model ***Max w/ Relaxation - Future***	25.5	38.6
2024 Daily Model ***Max w/ Relaxation - Future***	26.8	36.6
2024 Daily Model ***Baseline - Current***	24.2	33.1
2024 Daily Model ***Baseline - Future***	26.9	36.8

The results presented in this Addendum reaffirm the benefit of the Shoshone Call under both Baseline and Max Shoshone scenarios, particularly during dry years, in keeping additional water in the 15-Mile Reach when compared to river conditions absent utilization of the Shoshone water rights. Results indicate that full use of the Shoshone water rights does not negatively impact Reclamation projects when compared to the Baseline scenario, nor does it impact the water users that benefit from and/or provide water in support of those federal projects. Also notable is the similarity between the Baseline and Max with Relaxation results for the 2024 daily UCRM, which further validates the use of the Max with Relaxation scenario yields in the original analysis.

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COLORADO RIVER DISTRICT

PROTECTING WESTERN COLORADO WATER SINCE 1937

MEMORANDUM

TO: **PETER C. FLEMING, GENERAL COUNSEL**
JASON TURNER, DEPUTY GENERAL COUNSEL
BRUCE WALTERS, ASSOCIATE COUNSEL

FROM: **RAQUEL FLINKER, SENIOR WATER RESOURCES ENGINEER/ PROJECT MANAGER**
BRENDON LANGENHUIZEN, DIRECTOR OF TECHNICAL ADVOCACY

SUBJECT: **SHOSHONE WATER RIGHTS ANALYSIS ON DECREED INSTREAM FLOW REACHES IN THE COLORADO RIVER WATERSHED**

DATE: **APRIL 30, 2025**

The Shoshone Hydroelectric Power Plant (the "Shoshone Power Plant") has two of the largest and most senior non-consumptive-use water rights on the mainstem of the Upper Colorado River. These water rights include the 1905 senior Shoshone Water Right in the amount of 1,250 cubic feet per second ("cfs") and the 1940 junior Shoshone Water Right in the amount of 158 cfs (together, the "Shoshone Water Rights"). The exercise of the Shoshone Water Rights results in an influential "pull" of water down the mainstem of the Colorado River, including through several significant tributaries, which helps to maintain flows both upstream and downstream of the Shoshone Power Plant. To satisfy an administrative call placed under the Shoshone Water Rights, upstream junior water rights are curtailed or are required to provide replacement releases from upstream reservoirs.

The State of Colorado has approximately 350 decreed instream flow ("ISF(s)") water rights on the Colorado River upstream of the Shoshone Power Plant (*see* Figure 1), and over 120 ISF water rights located downstream of the Shoshone Power Plant, including those on tributaries to the Colorado River. River District staff carried out the following analysis to evaluate the benefits that the exercise and administration of the Shoshone Water Rights have on these existing decreed ISF reaches. Representative ISFs located upstream and downstream of the Shoshone Power Plant were selected to better understand how the Shoshone Permanency Project is expected to help protect the identified ISFs. The selected ISFs reviewed in this memorandum that are located upstream of the Shoshone Power Plant include one of the three ISF water rights within the Upper Colorado River Wild and Scenic eligible reaches and one on the mainstem of the Eagle River. The selected ISFs located downstream of the Shoshone Power Plant include two ISFs on the Roaring Fork River. The ISFs studied herein include major and minor tributaries as well as the mainstem Colorado River and were selected to be representative of the range of influence of the Shoshone Call across

the basin. Overall, the exercise of the Shoshone Water Rights has been found to support upstream ISF reaches in meeting target flows, especially in dry years and in critical months during the late irrigation season, while having minimal impact on tributaries downstream of the Shoshone Power Plant, including on the Roaring Fork River.

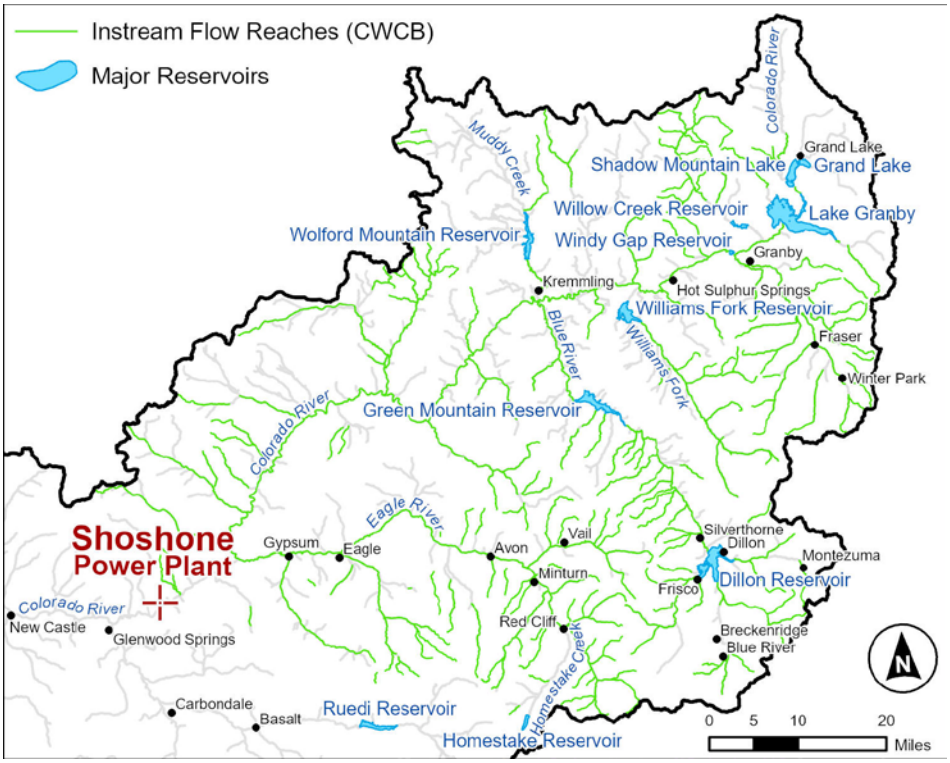


Figure 1 – ISF reaches upstream of the Shoshone Power Plant

The analysis described herein is based on modeled daily average flows from January 1988 to September 2013 at specific locations using the State of Colorado's StateMod 2024 Upper Colorado River Basin Model (the "2024 UCRM"). These average daily flows were modeled by Hydros Consulting, Inc. ("Hydros")[1] in four scenarios: 1) "Shoshone On Current" – Shoshone baseline demands with current basin water demands, [2] 2) "Shoshone Off Current" – Shoshone Water Rights are not active with current basin water demands,[3] 3) "Shoshone On Future" – Shoshone baseline demands with projected future basin water demands,[4] and 4) "Shoshone Off Future" – Shoshone Water Rights are not active with projected future basin water demands.[5] In the first and third

[1]Additional outputs were developed from Hydros' modeling efforts as described in their November 7, 2024, "Shoshone Power Plant Water Rights Yield Assessment – Addendum" and were provided to the Colorado River District in two documents named "CurrentConditions_GageFlows_updated.xlsx" and "FutureConditions_GageFlows_updated.xlsx".

[2] This is equivalent to the "Baseline" current conditions Hydros scenario.

[3] This is equivalent to the "Zero Shoshone" current conditions Hydros scenario.

[4] This is equivalent to the "Baseline" future conditions Hydros scenario. The future water demand scenarios assumed 120,000 acre-feet ("AF") of development including 85,000 AF of transmountain diversions.

[5] This is equivalent to the "Zero Shoshone" future conditions Hydros scenario.

scenarios, when the Shoshone Water Rights are active, the Shoshone baseline demands were developed by the Colorado Water Conservation Board ("CWCB") in the published 2024 UCRM as a "Baseline" scenario to simulate current operations. These demands fluctuate based on daily historical records with demands ranging from 704 cfs (one turbine use as contemplated under the Agreement Concerning Reduction of Shoshone Call effective January 1, 2007 [the "2007 Call Relaxation Agreement"]) to 1,408 cfs.[6] As noted in the Hydros November 2024 *Shoshone Power Plant Water Rights Yield Assessment – Addendum* memorandum, it is important to highlight that the 2024 UCRM has not undergone a formal vetting process, and the outputs are likely less accurate than what would occur under real-time conditions.

The first part of the analysis evaluated the impact of the Shoshone Water Rights on average flows within the identified ISF reaches (such as an increase or decrease in cfs), while the second part of the analysis assessed the impact in meeting the ISFs at each location (number of days the ISF is met). This analysis was done for the current demand comparison (i.e., "Shoshone Off Current" scenario minus "Shoshone On Current" scenario) and the future demand comparison (i.e., "Shoshone Off Future" scenario minus "Shoshone On Future" scenario). It is important to note that the initial part of the analysis focused on average flows over the modeled period to represent the impacts of the Shoshone Water Rights: however, modeled daily flows vary significantly from these averages.

The analysis was limited to days when the Shoshone Water Rights were calling and therefore having an impact on river flows. Thus, the analysis excluded periods such as peak runoff when flows naturally remain above the 1,408 cfs demand of the Shoshone Water Rights. As seen in Figure 2, the Shoshone Call[7] is on more frequently in dry years and during the months of August, September, and October when natural river flows are low. Interestingly, in dry years, the Shoshone Call is on for nearly the entirety of every month from August through December. Therefore, this analysis focused on the dry calendar years of 1989, 1990, 2001, 2002, 2003, 2004, 2012, and 2013,[8] and particularly in the months of August, September, and October during those years, when flows are important to meet minimum ISFs. There is a total of 2,156 dry-year days when the Shoshone Water Rights are calling in the current scenarios and 2,189 days in the future scenarios.

[6] This is equivalent to the "Baseline" scenario in the November 2024 Shoshone Power Plant Water Rights Yield Assessment - Addendum memorandum prepared by Hydros. The scenarios where the Shoshone Call is off are referred to as "Zero Shoshone".

[7] For purposes of the analyses set forth in this memorandum, and unless otherwise defined or limited herein, the "Shoshone Call" means the in-priority demand for administration of water available under the senior and junior priorities for the Shoshone Water Rights (i.e., 1,408 cfs).

[8] The dry calendar year classification is the same as what was utilized by Hydros Consulting Inc. in their November 7, 2024, "Shoshone Power Plant Water Rights Yield Assessment – Addendum".

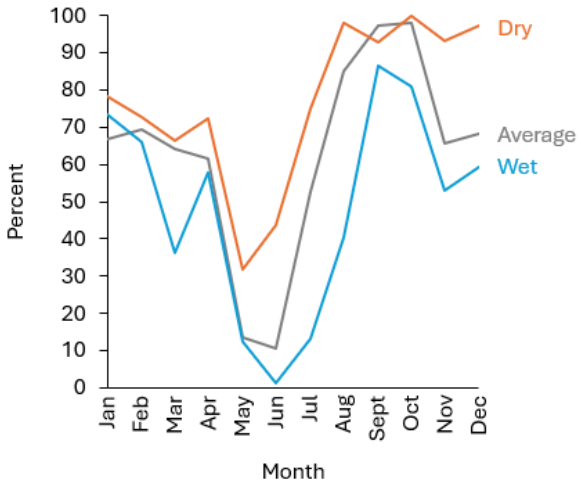


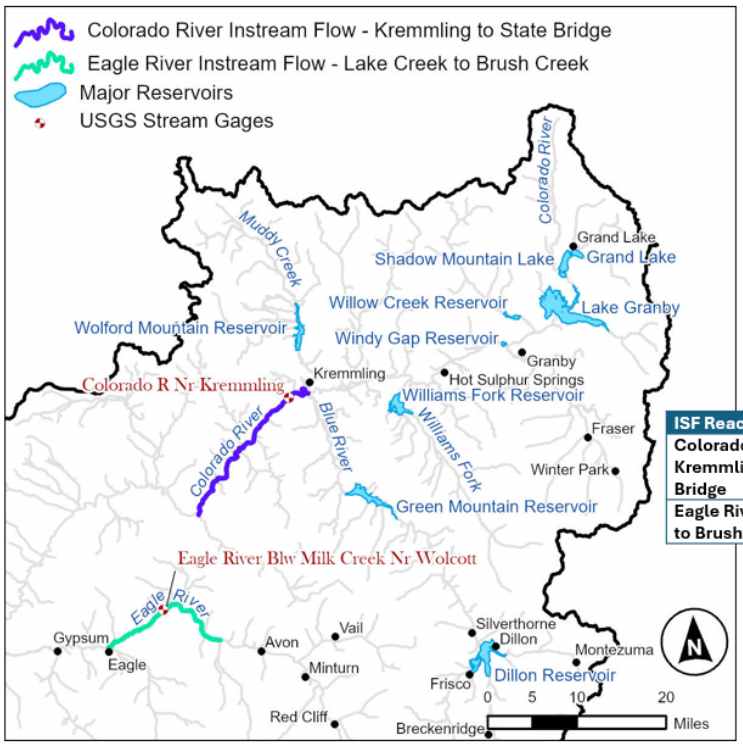
Figure 2 – Percent of modeled days per month when the Shoshone Call was on during dry, average, and wet years under current water demands (January 1988 through September 2013).

ISF Reaches Upstream of the Shoshone Power Plant

The following ISF reaches (Table 1) upstream of the Shoshone Power Plant were selected to better understand the benefits of the Shoshone Water Rights in protecting existing ISF flows. Flows were analyzed at the locations within the ISF reaches identified in Figure 3, below.

Table 1 – Analyzed ISF Reaches Upstream of the Shoshone Power Plant

ISF Reaches	ISF (CFS)	Start Date	End Date	Miles	Appropriation Date	Case Number
Colorado River – Kremmling to State Bridge	500	16-Sep	14-May	23.74	7/12/2011	5-11CW159
	600	15-May	31-Jul			
	750	1-Aug	15-Sep			
Eagle River – Lake Creek to Brush Creek	45	1-Oct	30-Apr	17.64	3/17/1980	5-80CW126
	110	1-May	30-Sep			



ISF Reach	Gage Name	USGS Gage ID
Colorado River – Kremmling to State Bridge	Colorado River at Kremmling	9058000
Eagle River – Lake Creek to Brush Creek	Eagle River near Wolcott	394220106431500

Figure 3 – Upstream ISF Reaches and the Associated USGS Gage Analyzed

Colorado River – Kremmling to State Bridge

The Colorado River – Kremmling to State Bridge ISF reach is located within the Upper Colorado River Wild and Scenic eligible sections. It is one of three ISF appropriations that were pursued as long-term protection measures of the Outstandingly Remarkable Values ("ORVs"). The Amended and Restated Upper Colorado River Wild & Scenic Stakeholder Group Management Plan (the "Management Plant")[9] lists the continuation of the Shoshone Water Rights as a long-term protection measure of the streamflow-influenced ORVs. The Management Plan states that the administration of the Shoshone Call generally results in higher streamflow through the upper Colorado River stream segments.

Several major reservoirs and transmountain diversion projects are located upstream of the Colorado River – Kremmling to State Bridge ISF reach, including but not limited to: the Colorado Big-Thompson Project (Adams Tunnel, Granby Reservoir, Willow Creek Reservoir, Green Mountain Reservoir); the Windy Gap Project (Windy Gap Reservoir and Pumps); the Moffat Collection System, Williams Fork Reservoir, Blue River Project (Dillon Reservoir, Roberts Tunnel); the Continental-Hoosier Project; and Wolford Mountain Reservoir. All of these reservoirs and transmountain diversion projects are junior in priority to the senior Shoshone Water Right and are subject to either curtailment or replacement (releases of water stored in reservoirs to allow continued out-of-priority diversions) to satisfy the senior Shoshone Call. Therefore, if the senior

[9] *See* Amended and Restated Upper Colorado River Wild & Scenic Stakeholder Group Management Plan, https://www.upcowildandscenic.com/uploads/1/3/5/3/135388668/amended_and_restated_sg_plan_july_2024.pdf

Shoshone Water Right was no longer exercised, lower flows would be expected throughout this ISF reach as the normal curtailment or replacement releases from reservoirs would be reduced.

Average flows in the Colorado River – Kremmling to State Bridge ISF reach (*see* Figure 4), analyzed at the Colorado River at Kremmling Gage (USGS gage ID 9058000), would be impacted the most in the Dry Years, Aug-Oct when flows would be reduced by 11% or 80 cfs if the Shoshone Water Rights were not exercised in both the current and future demand comparisons. This is equivalent to a reduction in the average flow volume of approximately 4,550 AF/month.

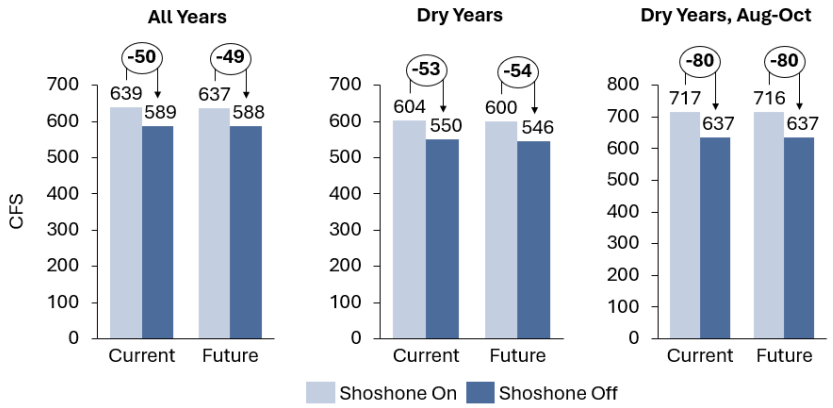


Figure 4 – Average flows at the Colorado River at Kremmling Gage

The reduction in flow in the absence of a Shoshone Call would also translate to fewer days when the ISF is met (*see* Figure 5). The impact to the ISF is highlighted during the Dry Years, Aug-Oct months, when the days the ISF is met are reduced by 31% in both the current and future demand comparisons.

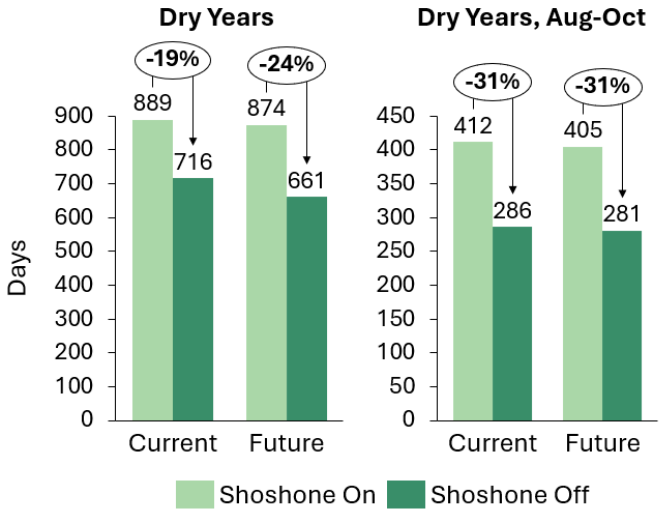


Figure 5 – Minimum ISF exceedance days at the Colorado River at Kremmling Gage

Eagle River – Lake Creek to Brush Creek

As described earlier, the exercise and administration of the Shoshone Water Rights results in an influential "pull" of water down the Colorado River, including through significant tributaries. The Eagle River is one such tributary and it has seven decreed ISFs that span nearly 50 miles. Average flows in this reach (*see* Figure 6), analyzed at the Eagle River near Wolcott Gage (USGS gage ID 394220106431500), would see the most significant average impacts if the Shoshone Water Rights were not exercised in Dry Years where flows would be reduced by 6 to 7 cfs (4% to 5% of the average annual flow) depending on the water demand. This is equivalent to an average reduction in flow volume of approximately 160 AF/month under both the current and future demand comparisons.

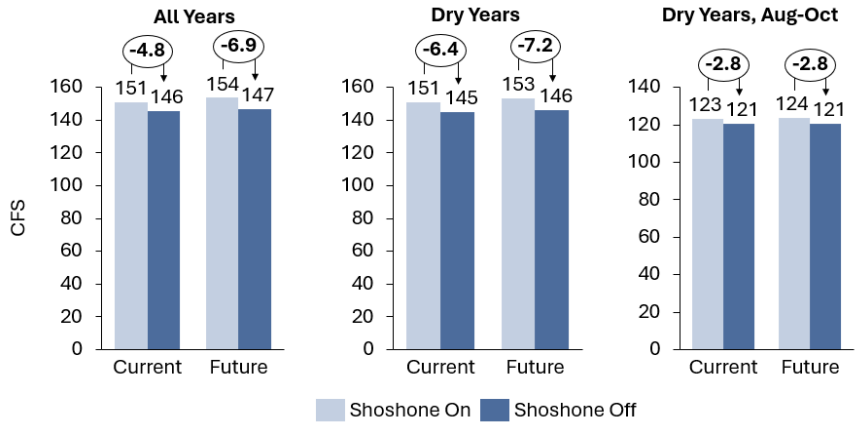


Figure 6 – Average flows at the Eagle River near Wolcott Gage

The reduction in flows from the absence of the Shoshone Call would not significantly impact the number of days the ISF is met and equates to a reduction of three days across the full eight years included in the Dry Years (*see* Figure 7). The ISF at this location is relatively small compared to measured flows. This is illustrated by the fact that in Dry Years, the ISF is met 88% of the time in the current and future demand scenarios.

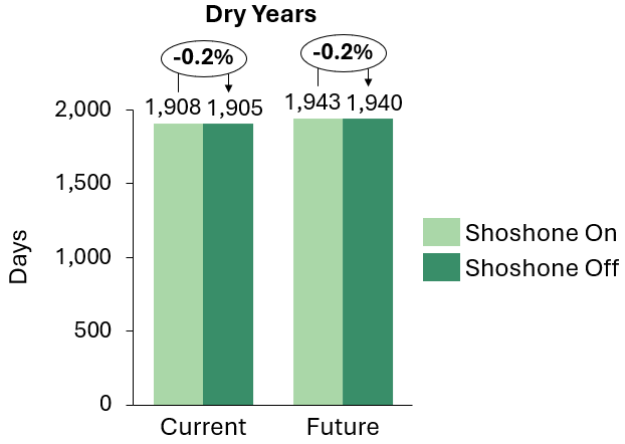


Figure 7 – Minimum ISF exceedance days at the Eagle River near Wolcott Gage

Summary of Upstream ISF Findings

Both upstream ISF reaches evaluated above experienced reduced flows when the Shoshone Water Rights were not exercised. The Colorado River from Kremmling to State Bridge reach saw losses of approximately 80 cfs in August through October in Dry Years, equating to a reduction in days that met the ISF by approximately 31% under current and future demand comparisons. On the Eagle River near Wolcott, the ISF was most impacted across Dry Years with reduced average flows of 6.4 and 7.2 cfs under current and future demand comparisons, respectively. Both reaches see significant responses to the loss of a Shoshone Call as shown in Figure 8 where each reach is shown to have a greater than 75% response in number of days with a realized reduced flow during the Dry Years, Aug-Oct months under current demands.

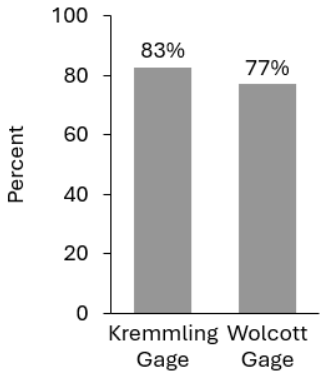


Figure 8 – Percent of August – October Dry Year days when flows are lower if the Shoshone Water Rights are not exercised, under current water demands

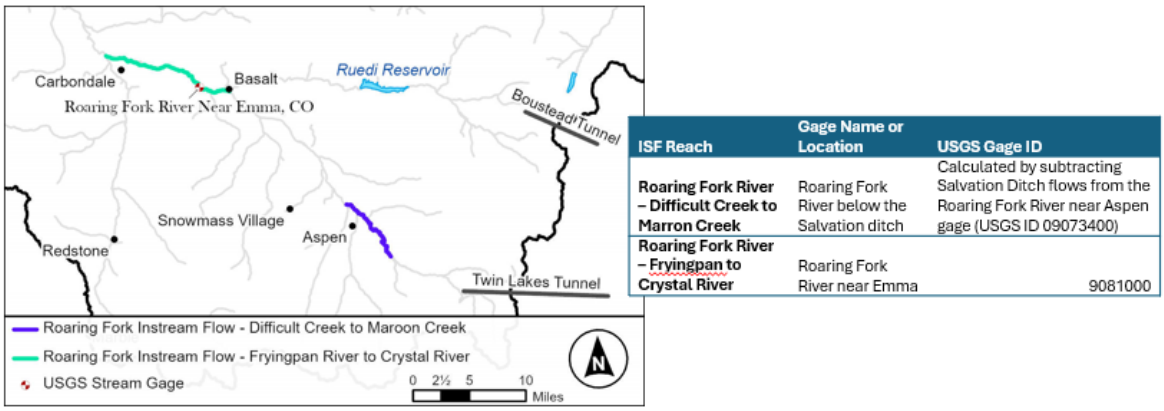
ISF Reaches Downstream of the Shoshone Power Plant – Roaring Fork River

This analysis also considered the impact (or lack thereof) that the absence of a Shoshone Call might have on the Roaring Fork River watershed. The absence of a Shoshone Call could cause the downstream "Cameo Call,"[10] to come on earlier and more often, thereby causing earlier administration of tributaries above Cameo including the Roaring Fork watershed. The increased Cameo Call would prompt curtailing transmountain diversions typically only subject to the Cameo Call such as relatively junior water rights including the Fry-Ark Project (Ruedi Reservoir and Boustead Tunnel) and occasionally even relatively senior rights like the Independence Pass Transmountain Diversion System ("Twin Lakes Tunnel"), as well as other West Slope water rights. To evaluate the impact of this occurrence, River District staff carried out a similar ISF analysis on two ISF reaches in the Roaring Fork watershed as detailed in Table 2 and shown in Figure 9.

[10] A conglomerate of significant and senior irrigation rights which divert from the Colorado River in the Grand Valley near Palisade, Colorado.

Table 2 – Analyzed ISF Reaches in the Roaring Fork River Watershed

ISF Reaches	ISF (CFS)	Start Date	End Date	Miles	Appropriation Date	Case Number
Roaring Fork River – Difficult Creek to Maroon Creek	32	1-Jan	31-Jul	8.67	1/14/1976	5-76W2948
Roaring Fork River – Frying Pan to Crystal River	75	1-Oct	31-Mar	13.46	11/8/1985	5-85CW639
	145	1-Apr	30-sept			



ISF Reach	Gage Name or Location	USGS Gage ID
Roaring Fork River – Difficult Creek to Marron Creek	Roaring Fork River below the Salvation ditch	Calculated by subtracting Salvation Ditch flows from the Roaring Fork River near Aspen gage (USGS ID 09073400)
Roaring Fork River – Fryingpan to Crystal River	Roaring Fork River near Emma	9081000

Figure 9 – Roaring Fork Watershed ISF Reaches, and the Associated USGS Gages/Locations Analyzed

Roaring Fork River – Difficult Creek to Maroon Creek

The Roaring Fork River – Difficult Creek to Maroon Creek ISF reach was selected because it is located on the Roaring Fork River immediately below the Salvation Ditch (WDID 3800981), where flows are frequently below the minimum ISF. At this location, if the Shoshone Water Rights were no longer exercised, average flows would increase slightly. During the Dry Years, Aug-Oct months, this increase would be the most impactful but would still be limited to approximately 0.5 cfs or 1% of total flow (*see* Figure 10) in both the current and future demand comparisons. This is equivalent to an average increase in flow volume of approximately 25 AF/month under both comparisons. It is important to highlight that during Dry Years, Aug-Oct months, most days (92%) would have the same flow regardless of whether the Shoshone Water Rights were calling. Interestingly, there would also be times when flows in the ISF would decrease if the Shoshone Water Rights were not exercised.

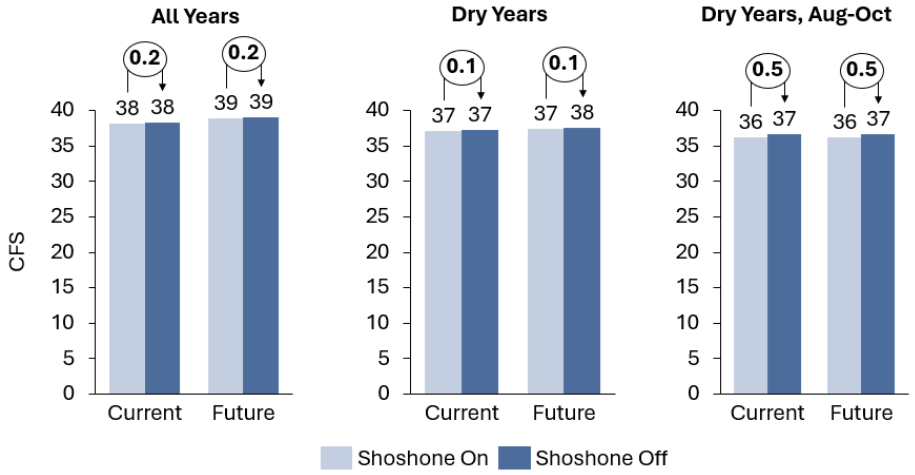


Figure 10 – Average flows at the Roaring Fork River below the Salvation Ditch location

The slight flow increases that are observed if the Shoshone Water Rights were not calling would only lead to an addition of 7 days (current demand comparison) and 6 days (future demand comparison) when the ISF is met across the eight years included in Dry Years, Aug-Oct months (*see* Figure 11). This is equivalent to an increase of approximately 1.5-1.7% of days when the ISF is met. Therefore, if the Shoshone Water Rights were no longer exercised, this reach would see, on average, a slight flow increase during a limited number of days, with only a few additional days when the ISF is met. This is because the Twin Lakes Tunnel is relatively senior in the system and would seldom be impacted by a Cameo Call beyond the administration already in place by the Cameo Call. Importantly, while the complete absence (e.g., future abandonment) of the Shoshone Water Rights could result in a small, modeled increase of 0.5 cfs of flow in the Upper Roaring Fork River, the maintenance of the historical Shoshone Call regime would not result in any change from existing conditions.

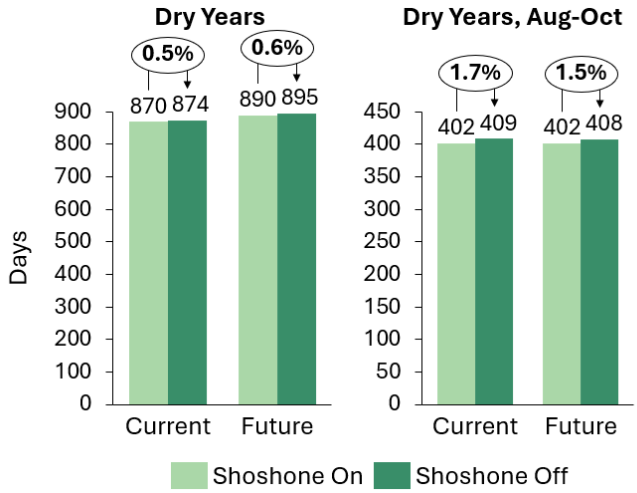


Figure 11 – Minimum ISF exceedance days at the Roaring Fork River below the Salvation Ditch

Roaring Fork River – Fryingpan River to Crystal River

The Roaring Fork River – Fryingpan River to Crystal River ISF reach was selected to capture impacts on the Roaring Fork River from the Fryingpan River where the Fry-Ark Project is mostly located. At this location, if the Shoshone Water Rights were no longer exercised, flows would increase on average by less than 1% (3 cfs) in Dry Years under both the current and future demand comparisons (*see* Figure 12). This is equivalent to an increase in average flow volume of approximately 80 AF/month across Dry Years in the current and future demand comparisons. Although the average flows would slightly increase in Dry Years with the Shoshone Call offline, only 27% of the days were shown to have higher flows in the current demand comparison and 25% in the future demand comparison. Most days (approximately 67% in both comparisons) realized lower flows when the Shoshone Water Rights were not calling.

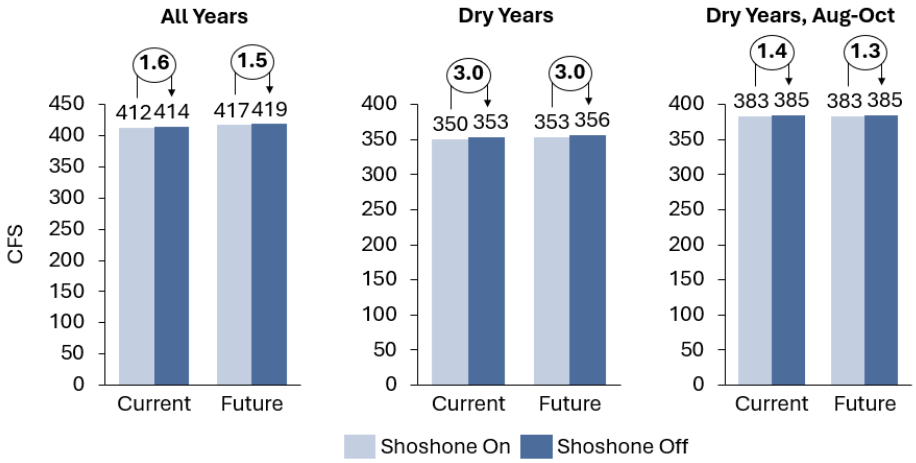


Figure 12 – Average flows at the Roaring Fork River near Emma gage

The average flow increases from the removal of the Shoshone Call would have no impact on the days the ISF is met as seen in Figure 13. The ISF at this location is relatively small compared to typical flows such that the ISF has never been the source of an administrative call on the river. This is illustrated by the fact that in Dry Years, the ISF is modeled to be met 99% of the time in the current and future scenarios.

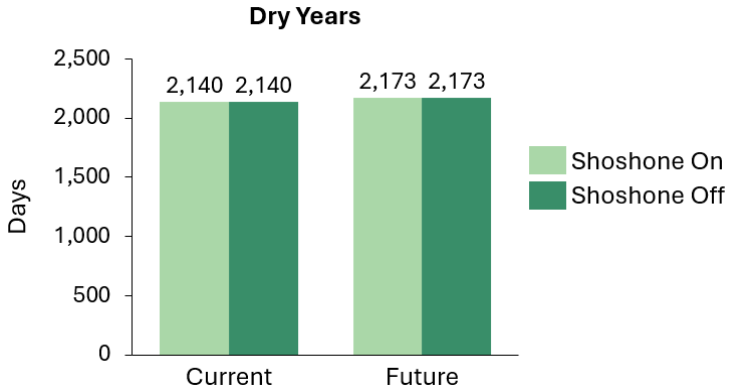


Figure 13 – Minimum ISF exceedance days at the Roaring Fork River near Emma gage

Therefore, while there would be a small increase in flow in the Roaring Fork Watershed if the Shoshone Water Rights were no longer exercised, the increases would be minor. In fact, at the Roaring Fork River - Fryingpan to Crystal River ISF reach, most dry days would see a decrease in river flows.

ISF Reaches Downstream of the Shoshone Power Plant –15-Mile Reach

The benefits of maintaining the Shoshone Water Rights are documented in the November 7, 2024, "Shoshone Power Plant Water Rights Yield Assessment – Addendum" memorandum prepared by Hydros.

Downstream ISF Summary Findings

Without the Shoshone Call, tributaries such as the Roaring Fork River are modeled to see increased impacts from the Cameo Call, which are shown to have variable effects. In the upper reach of the Roaring Fork River, below the Salvation Ditch, flows were shown to have limited increases in flow of less than 0.5 cfs which leads to 6 to 7 additional days of meeting the ISF in Dry Years, Aug-Oct. Similar results were found along the Roaring Fork in the Fryingpan to Crystal River ISF reach with limited increases in flow of up to 3 cfs (less than 1% of total flow) with no associated increase in number of days the ISF is met. Modeling at both sites found variable results with some results finding reduced flows without the Shoshone Call on.

Conclusion

Four separate ISF reaches were evaluated in this memorandum to determine whether and how the Shoshone Call influences hydrology through the selected ISF reaches and how that impacts the number of days each ISF is met. The ISF reaches studied herein include tributaries as well as the mainstem Colorado River and are representative of the range of influence of the Shoshone Call across the basin. Both ISF reaches studied above the Shoshone Reach show average decreases in flow with the Shoshone Call offline, particularly in Dry Years and the late irrigation season months of August through October of Dry Years. For example, average monthly decreases in flows at the Colorado River below Kremmling were shown to be as much as 80 cfs or approximately 11% of the flow, corresponding to an average elimination of approximately 4,550 AF/month in the absence of the Shoshone Call. Findings at Eagle River had similar results, although with relatively smaller flow impacts.

Downstream ISF reaches evaluated focused on the Roaring Fork River at two locations: (1) a segment located near the headwaters below the Salvation Ditch, which runs through the City of Aspen, and (2) a segment located between the Fryingpan River and Crystal River confluence. Findings at these locations showed average increases in flows without the Shoshone Call due to the increased downstream Cameo Call. The analysis found that the Upper Roaring Fork River flows increased up to an average of 0.5 cfs (25 AF/month) and up to an average of 3.0 cfs (80 AF/month) at the Lower Roaring Fork River reach in the August-October months of Dry Years. Only the Upper Roaring Fork River ISF reach experienced additional days of meeting the ISF due to the increase in flows and that was limited to a handful of days across the August through October months of the eight Dry Years evaluated. Much larger and more consistent impacts downstream

of the Shoshone Power Plant through the 15-Mile Reach ISF were examined in the technical report prepared by Hydros.

Overall, the Shoshone Call has been found to support both upstream ISF reaches in meeting the target flows, especially in dry years and in critical months during the late irrigation season while having minimal influence on tributaries downstream of the Shoshone Power Plant such as on the Roaring Fork River.

DISTRICT COURT, WATER DIVISION 5, COLORADO Garfield County Courthouse 109 8th Street, Suite 104 Glenwood Springs, CO 81601 (970) 947-3861	
CONCERNING THE APPLICATION FOR WATER RIGHTS OF THE COLORADO WATER CONSERVATION BOARD, PUBLIC SERVICE COMPANY OF COLORADO, and THE COLORADO RIVER WATER CONSERVATION DISTRICT. In GARFIELD AND EAGLE COUNTIES, COLORADO.	▲ COURT USE ONLY ▲
Attorney for Colorado Water Conservation Board: PHILIP J. WEISER, Attorney General JENNIFER L. MELE, Reg. No. 30720* Natural Resources and Environment Section Colorado Department of Law 1300 Broadway, 10th Floor Denver, Colorado 80203 Phone: (720) 508-6282 Email: jennifer.mele@coag.gov *Attorneys for Public Service Company of Colorado:* Carolyn F. Burr, Reg. No. 25978 Jim M. Noble, Reg. No. 36716 WELBORN SULLIVAN MECK & TOOLEY, P.C. 1401 Lawrence Street, Suite 1800, Denver, Colorado 80202 Phone: (303) 830-2500 E-mail: cburr@wsmtlaw.com jnoble@wsmtlaw.com *Attorneys for Colorado River Water Conservation District*: Names: Peter C. Fleming, Reg. No. 20805 Jason V. Turner, Reg. No. 35665 Bruce C. Walters, Reg. No. 50235 Address: 201 Centennial Street, Suite 200 Glenwood Springs, CO 81601 Phone: (970) 945-8522 E-mail: pfleming@crwcd.org jturner@crwcd.org bwalters@crwcd.org	Case Number: Div.: Ctrm:
APPLICATION FOR CHANGE OF WATER RIGHTS	

PRELIMINARY DRAFT

1. Names, mailing addresses, e-mail addresses, and telephone numbers of Co-Applicants.

Colorado Water Conservation Board (the "CWCB")
Attn: Director
1313 Sherman Street, Room 721
Denver, Colorado 80203
(303) 866-3441

Public Service Company of Colorado, a Colorado Corporation ("PSCo")
Jeff West, Senior Director, Environmental Services
3500 Blake Street, CO1453-03-MCB
Denver, CO 80205
(303) 571-2762

Colorado River Water Conservation District (the "River District")
Attn: Secretary/General Manager
201 Centennial Street, Suite 200
Glenwood Springs, CO 81601
(970) 945-8522

The above-listed parties shall be collectively referred to herein as "Co-Applicants."

Please send all copies of pleadings and correspondence to:

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(Attorneys for River District)

PRELIMINARY DRAFT

1. Summary of Application.

The CWCB is an agency of the State of Colorado created to aid in the protection and development of the waters of the state for the benefit of its present and future inhabitants. Pursuant to section 37-92-102(3), C.R.S., the CWCB is authorized to acquire, by grant, purchase, donation, lease, or other contractual agreement, such water, water rights, and interests in water that are not on the abandonment list in such amount as the CWCB determines is appropriate for stream flows to preserve and/or improve the natural environment to a reasonable degree. The River District is a political subdivision of the State of Colorado charged with, among other duties, promoting the health and general welfare of the inhabitants of the River District by the conservation, use, and development of the water resources of the Colorado River and its principal tributaries. *See* §§ 37-46-101, C.R.S., *et seq*. PSCo is a Colorado corporation and is the owner and operator of the Shoshone hydroelectric power plant ("Shoshone Power Plant") located on the mainstem of the Colorado River in Glenwood Canyon, approximately six miles upstream of the City of Glenwood Springs.

The Shoshone Power Plant produces hydroelectric energy by means of PSCo's diversion of the Shoshone Water Rights, which are more particularly described in paragraph 2 below. Pursuant to the January 1, 2024 Purchase and Sale Agreement between the River District and PSCo (the "PSA"), the River District is the contract purchaser of the Shoshone Water Rights. The "PSA" (including all exhibits) is attached and incorporated hereto as **Exhibit 1.**

At its bi-monthly meeting on September ____, 2025, the CWCB determined that acquiring from the River District the exclusive right to use the Shoshone Water Rights for instream flow purposes in the reach of the Colorado River described in paragraph 3.2., below, is appropriate to preserve and improve the natural environment to a reasonable degree pursuant to section 37-92-102(3), C.R.S. Co-Applicants entered into a Water Rights Dedication and Instream Flow Agreement with the CWCB on September ____, 2025 (the "ISF Agreement," attached and incorporated hereto as **Exhibit 2**). The ISF Agreement grants to the CWCB the exclusive right to use the Shoshone Water Rights to preserve and improve the natural environment within the approximately 2.4 mile-reach of the Colorado River that extends between the Shoshone Diversion Dam and the Shoshone Power Plant's discharge outlets (the "Shoshone Reach"). The PSA provides that PSCo, or its successors and assigns is entitled to a leasehold interest in the Shoshone Water Rights for continued use of those rights for hydropower generation at the Shoshone Power Plant so long as the plant is operating.

By this Application, Co-Applicants seek to add instream flow use by the CWCB to the decreed uses of the Shoshone Water Rights. The change of water rights decree shall confirm that water attributable to the historical exercise of the Shoshone Water Rights for hydropower generation will remain in the stream to preserve and improve the natural environment to a reasonable degree within the Shoshone Reach up to the full decreed rate of the Shoshone Water Rights of available "Natural Flow". For the purposes of this Application, the "Natural Flow" is the amount of water in the Colorado River measured at the streamflow gauge (USGS 09070500) on

PRELIMINARY DRAFT

the Colorado River near Dotsero, Colorado, located in Eagle County (the "Dotsero Gage"), including the amount of water usable by the Shoshone Water Rights when those water rights are in priority, except that the "Natural Flow" does not include any water released from storage and conducted into the Colorado River upstream of the Dotsero Gage (accounting for evaporation and transit loss), which water is intended for delivery for use downstream of the discharge outlets for the Shoshone Power Plant.

2. Decreed water rights for which change is sought and structures associated with the decreed water rights.

2.1. Glenwood Power Canal and Pipeline ("Senior Shoshone Water Right").

2.1.1. Previous Decrees. Civil Action No. 466, Eagle County District Court, decreed December 9, 1907, for a conditional water right, which was made absolute on February 27, 1911, in Civil Action No. 553.

2.1.2. Decreed Point of Diversion. The Shoshone Diversion Dam and Tunnel ("Point of Diversion") located on the right bank, being the northerly bank, of the Colorado River whence the North quarter corner of Section Thirty (30), Township Five (5) South, Range Eighty-Seven (87) West of the 6th Principal Meridian bears North 23° 48'20" East 2,414.64 feet, in Garfield County, Colorado.

2.1.3. Source. Colorado River.

2.1.4. Appropriation Date: January 7, 1902.

2.1.5. Decreed Uses. Power, mining, milling, manufacturing, lighting, heating, and traction purposes.

2.1.6. Amount. 1,250 cubic feet per second ("c.f.s.").

2.2. Shoshone Hydro Plant Diversion No. 2 ("Junior Shoshone Water Right").[1]

2.2.1. Previous Decrees. Civil Action No. 1123, Eagle County District Court, decreed absolute on February 7, 1956.

2.2.2. Decreed Point of Diversion. *See* ¶ 2.1.2. above.

2.2.3. Source. Colorado River.

2.2.4. Appropriation Date. May 15, 1929.

[1] The Senior Shoshone Water Right and Junior Shoshone Water Right are collectively referred to herein as the "Shoshone Water Rights" for a total combined rate of 1,408 c.f.s.

PRELIMINARY DRAFT

2.2.5. Decreed Uses. Manufacturing and generation of electrical energy.

2.2.6. Amount. 158 c.f.s.

2.3. Priorities, appropriation dates, total decreed amounts and rates of flow, and amounts Co-Applicants intend to change.

2.3.1. Co-Applicants seek to continue to use the full 1,408 c.f.s. decreed to the combined Shoshone Water Rights for the changed use for instream flow purposes, subject to terms and conditions preventing injury to other decreed water rights.

Shoshone Water Rights (all amounts are absolute and are in c.f.s.)			
Priority Date	**Appropriation Date**	**Adjudication Date**	**Total Decreed Rate of Diversion and Diversion Rate Co-Applicants Intend to Change**
December 5, 1905	January 7, 1902	December 9, 1907	1,250 c.f.s.
May 31, 1940	May 15, 1929	February 7, 1956	158 c.f.s.
TOTAL			**1,408 c.f.s.**

3. Detailed Description of Proposed Change of Water Right.

3.1. Addition of Instream Flow Use. In addition to the existing decreed hydropower generation use, Co-Applicants seek water court approval to add instream flow use of the Shoshone Water Rights exclusively by the CWCB pursuant to section 37-92-102(3), C.R.S., and the terms of the ISF Agreement (**Exhibit 2**), to preserve and improve the natural environment of the Shoshone Reach to a reasonable degree at flow rates up to 1,408 c.f.s. of Natural Flow, under their individual priorities, as measured and administered at the Dotsero Gage. Co-Applicants intend for the CWCB to use the Shoshone Water Rights for instream flow purposes to the extent that the Shoshone Water Rights are not being used by PSCo for hydropower generation at the Shoshone Power Plant. Subject to the terms and conditions of the ISF Agreement and the change of water rights decree requested herein, the CWCB shall exercise the Shoshone Water Rights for instream flow purposes to the extent that the water rights are not being exercised by PSCo for hydropower generation at the Shoshone Power Plant.

3.2. Shoshone Reach. The CWCB's instream flow use will occur in the following stream reach of the Colorado River ("the Shoshone Reach"), which is approximately 2.4 miles in length between the upstream and downstream termini. The Shoshone Reach is more particularly described below and is depicted on **Exhibit 3** attached hereto.

PRELIMINARY DRAFT

3.2.1. Upstream Terminus – Shoshone Power Plant Diversion Dam and Tunnel.

3.2.1.1. On the right bank, being the northerly bank, of the Colorado River whence the North quarter corner of Section Thirty (30), Township Five (5) South, Range Eighty-Seven (87) West of the 6th Principal Meridian bears North 23° 48'20" East 2,414.64 feet, in Garfield County, Colorado.

3.2.1.2. UTM Zone 13 NAD83; Easting: _____; Northing_____.

3.2.2. Downstream Terminus – Shoshone Power Plant Discharge Outlets.

3.2.2.1. On the right bank, being the northerly bank, of the Colorado River whence the Southeast corner of Section Thirty-five (35), Township Five (5) South, Range Eighty-Eight (88) West of the 6th Principal Meridian bears South 29° 24' 14" East, 1,771 feet, in Garfield County, Colorado.

3.2.2.2. UTM Zone 13 NAD83; Easting: _____; Northing _____.

3.2.3. Maximum Rate of Flow. The maximum rate of flow for the instream flow use of the Shoshone Water Rights will be their combined decreed rate of 1,408 c.f.s. of Natural Flow, under their individual priorities, for the purpose of preserving and improving the natural environment of the Shoshone Reach to a reasonable degree, subject to the terms and conditions of the change of water rights decree requested herein.

4. Quantification of Historical Exercise of the Shoshone Water Rights.

Co-Applicants will determine the historical use of the Shoshone Water Rights over a representative study period that includes wet years, dry years, and average years.

4.1. Historical Use.

4.1.1. The Shoshone Water Rights have been historically administered by the State Engineer and the Division Engineer for Water Division No. 5 (the "Engineers") at the Dotsero Gage, located approximately 8.5 miles upstream of the Shoshone Diversion Dam. The Shoshone Water Rights have historically been diverted by PSCo at the Shoshone Diversion Dam, as described in paragraph 3.2.1. above. The historical use of water attributable to the Shoshone Water Rights has been non-consumptive. The water historically diverted at the Shoshone Diversion Dam and run through the Shoshone Tunnel for delivery to the plant turbines was returned to the Colorado River at the outfall (i.e., discharge outlets) of the Shoshone Power Plant approximately 2.4 miles downstream of the Point of Diversion. *See* **Exhibit 3**. Notwithstanding the foregoing, the practice of diverting water attributable to the Shoshone Water Rights from the Colorado River and

PRELIMINARY DRAFT

into the Shoshone Tunnel for delivery to the Shoshone Power Plant means that the historical exercise of the Shoshone Water Rights has been depletive to the Shoshone Reach before the diversions are returned to the Colorado River at the Shoshone Power Plant Discharge Outlets (i.e., the Downstream Terminus described in ¶ 3.2.2. above).

4.1.2. [ ]

4.1.3. [ ]

5. Maintenance of Historical Return Flows.

5.1. Co-Applicants will maintain historical return flows by ensuring that any future use of the Shoshone Water Rights is consistent with the historical exercise of the Shoshone Water Rights, so that water will continue to be available in the stream at the same time, location, and amount at the Downstream Terminus. This maintenance of the historical return flow pattern will prevent injury to downstream water rights. Upon entry of the change of water rights decree requested herein, Co-Applicants shall maintain the return flows that historically accrued to the Colorado River at the location of the Downstream Terminus.

6. Name(s) and address(es) of owners of land on which structures are located.

6.1. _____.

WHEREFORE, the CWCB, PSCo, and the River District request the Water Court to award a change of water rights decree for the Shoshone Water Rights to confirm the addition of instream flow use by the CWCB, pursuant to section 37-92-102(3), C.R.S., to preserve and improve the natural environment to a reasonable degree in the Shoshone Reach, in the amounts and up to the full decreed 1,408 c.f.s. of Natural Flow, as set forth in this application.

Respectfully submitted this ____ day of _____, 2025.

PRELIMINARY DRAFT

COLORADO RIVER WATER CONSERVATION DISTRICT

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Attorneys for Public Service Company of Colorado

PRELIMINARY DRAFT

VERIFICATION

I, _____, state that I have read the foregoing Application for Change of Water Rights and verify its content. I declare under penalty of perjury under the laws of the State of Colorado that the foregoing is true and correct.

_____ _____

Printed Name **Signature**

PRELIMINARY DRAFT

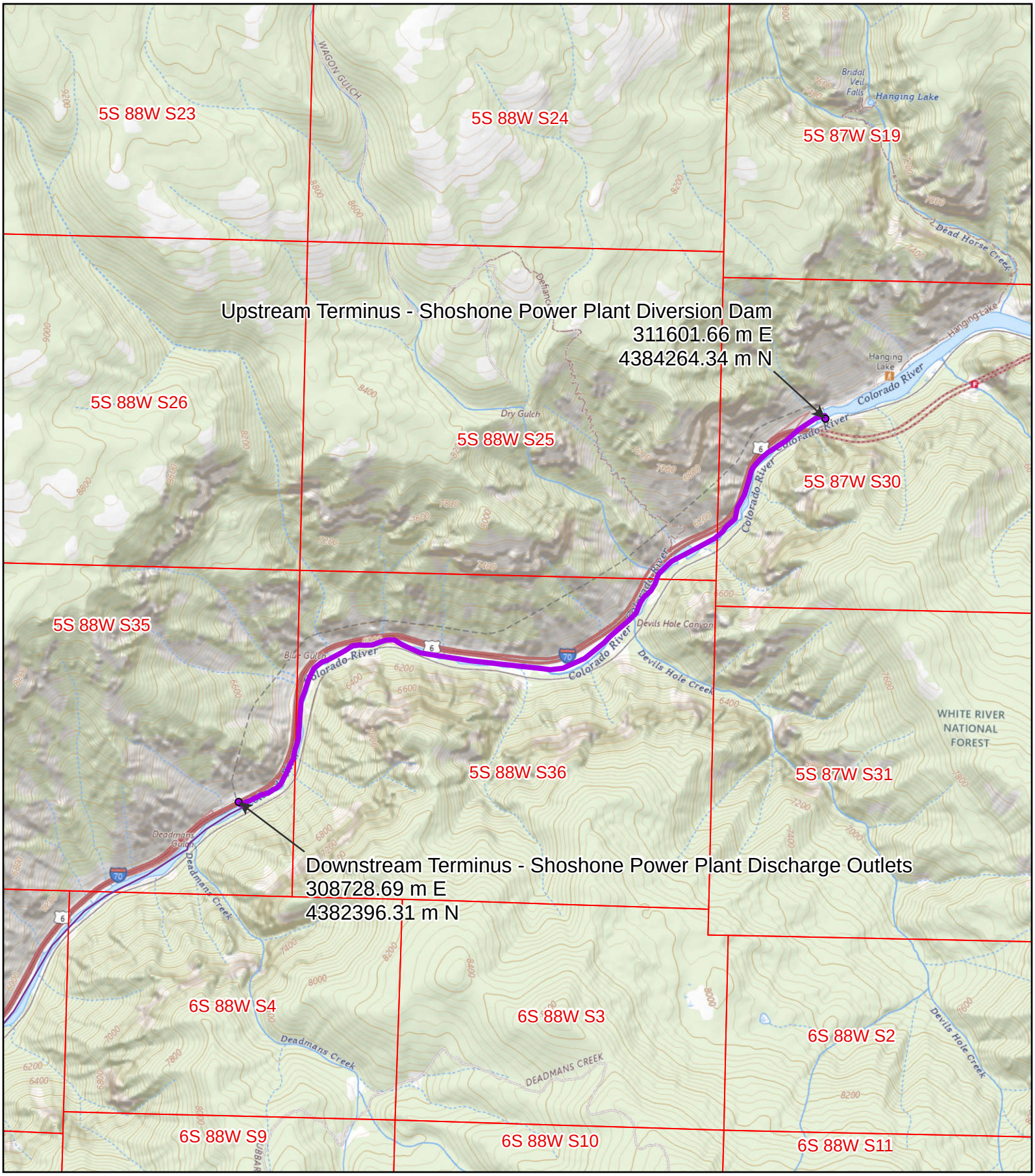


EXHIBIT 3

Garfield County, CO
DWR Division 5

Shoshone Reach

TRUE-NORTH
MAGNETIC-NORTH

Scale: 1:24,000
0 ¼ ½ 1
Miles

DWR Division 5

COLORADO RIVER DISTRICT

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GEI Consultants

Consulting Engineers and Scientists

Review of the Effects of Flow on Biology and Stream Processes, Glenwood Canyon

April 2025

Enclosure G
Agenda Item 10d
CWCB Board Meeting
May 21-22, 2025

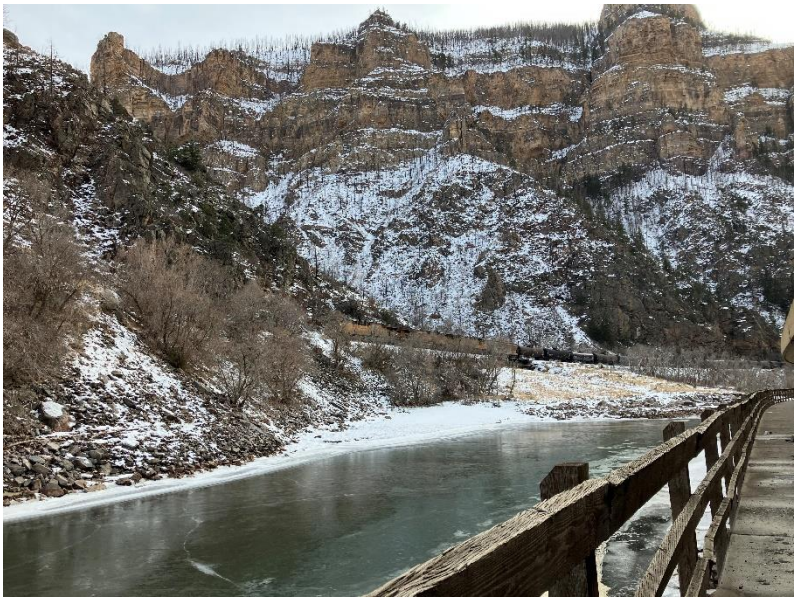




Review of the Effects of Flow on Biology and Stream Processes, Glenwood Canyon

GEI Consultants

Consulting Engineers and Scientists



Submitted to:
Colorado Water Conservation Board
1313 Sherman St.
Denver, CO
80203

Submitted by:
GEI Consultants, Inc.
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April 2025

4/11/2025
Ashley Ficke, Project Manager

4/11/2025
Jeniffer Lynch, Reviewer

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1. Introduction

This report details the benefits of instream flow for the reach of the Colorado River between the Shoshone Dam and the return at the Shoshone Power Plant (referred to hereafter as the Study Reach). The Study Reach is located in Glenwood Canyon and is characterized by steep gradients, limited floodplains, and large boulder substrate. Under moderate to high flow conditions, deep, turbulent, high-velocity flows are typical. This reach is also affected by water withdrawals by the power plant and often experiences flows that are lower than they would be under natural conditions. During the low flow season (i.e., in the months outside of spring runoff), the Study Reach can experience flows that are not continuous in time or space (intermittent flow) or fully dewatered conditions. The goal of this report is to discuss the effects of flow regime on the following: fish and macroinvertebrate populations, food webs, sediment and temperature regimes, and aquatic habitat. Because each of these are profoundly affected by flow, their relative health and function are discussed in the context of intermittent flow, consistent base flow, and higher flows (i.e., those approximating spring runoff).

This report was completed through a three-step process. First, available fish and macroinvertebrate data were reviewed and used to summarize existing biological conditions in the Study Reach. Second, the scientific literature was reviewed to determine the effects of flow on fish and macroinvertebrates, food webs, sediment and temperature regimes, and aquatic habitat. Third, this literature was synthesized with existing conditions to explain the implications of intermittency and the benefits of consistent base flows and higher seasonal flows for the Study Reach.

2. Fish

This section of the report contains species accounts for native fishes expected in the Study Reach, followed by a description of the existing fish assemblages in the Study Reach. Because fishery surveys are not common in the Study Reach, additional data were used to describe the fish assemblage present in this portion of the Upper Colorado River Drainage. A data request was submitted to Colorado Parks and Wildlife; the area covered in the query extended into the Eagle River in the vicinity of Gypsum, CO and into the Colorado River in the vicinity of Lyons Gulch on the upstream end and to the City of Glenwood Springs on the downstream end. The Study Reach is near the downstream end of the area covered by the query (Figure 2-1). This section concludes with a discussion of the potential benefits of increased instream flow for the resident fish assemblage in the Study Reach.

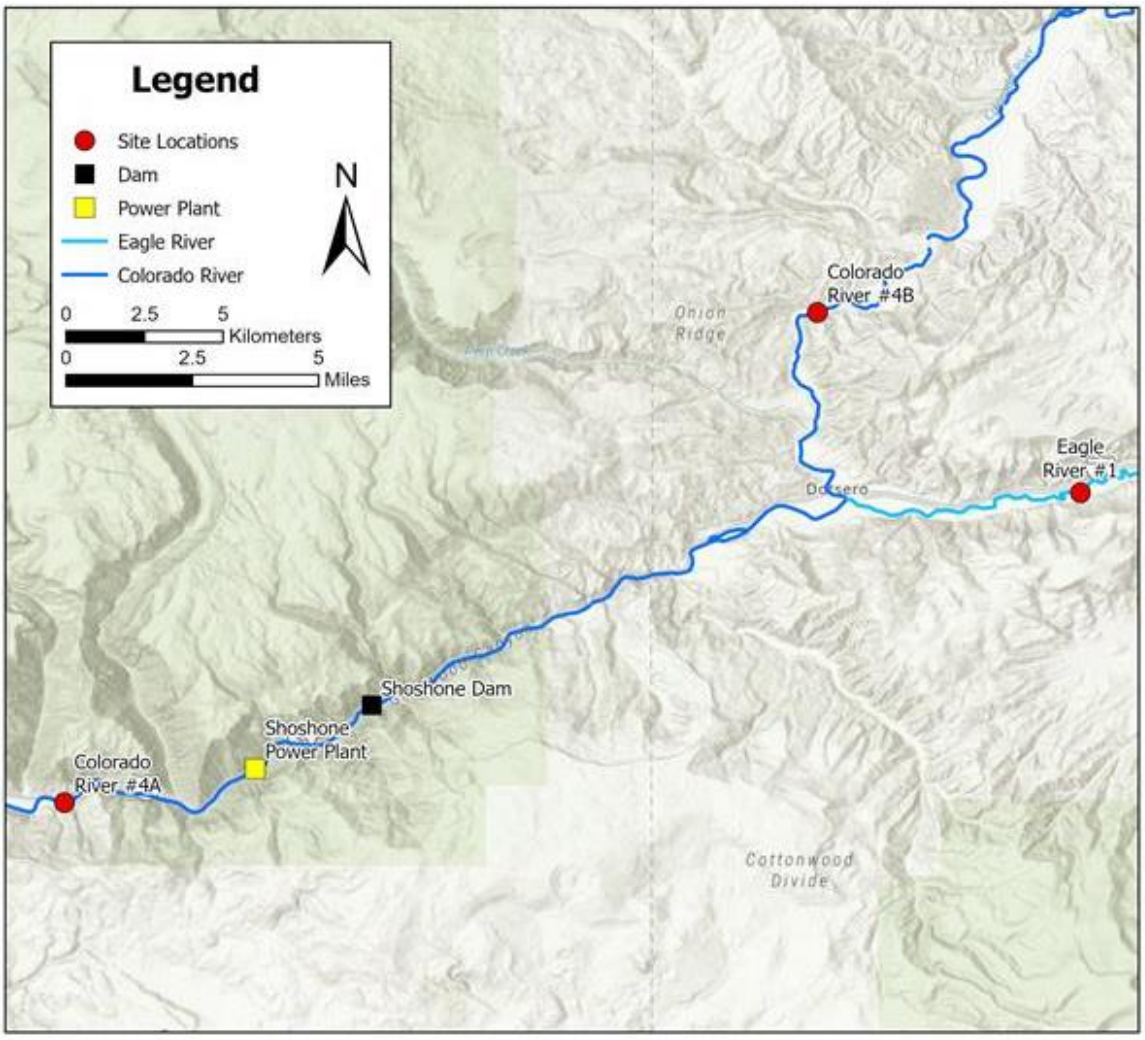


Figure 2-1.—Map of fish sampling sites on the Colorado River, within and upstream of the Study Reach.

2.1 Fish Species Accounts

2.1.1 Cutthroat Trout (Oncorhynchus clarki pleuriticus)

In Colorado, Colorado River Cutthroat Trout (CRCT) are primarily distributed in the colder waters of the Colorado River basin (Young 2008; Western Native Trout Status 2020). Current distribution of the CRCT is limited to isolated populations, and distribution of this species has declined to 1-13% of their historic range since the mid 1800's due to introductions of non-native salmonids and habitat alteration (Young, 2008, Olsen 2013). Hybridization with other Cutthroat Trout species and with Rainbow Trout (*Oncorhynchus mykiss*) has occurred to differing extents in native populations (Baxter and Stone 1995), further reducing CRCT distribution and probability of persistence. Even though Cutthroat Trout are relatively uncommon in the Study Reach, this species was chosen as a representative trout species in the Study Reach for two reasons. First, they are a native species and have been present in the Study Reach. Second, this species has similar habitat to Rainbow Trout and Brown Trout (*Salmo trutta*). However, they prefer lower temperatures than Brown Trout and Rainbow Trout and serve as the basis for the temperature regulations that apply to the Study Reach (See Section 5.2 for temperature criteria).

The average summer thermal temperature preference of CRCT is typically below 16°C along the western slope of the Rocky Mountains (Young 2008). CRCT prefer high gradient streams, but this may be because high gradient streams are not suitable habitat for many nonnative fish species (Young 2008). Like most salmonids, CRCT prefer pools in both summer and winter months to minimize bioenergetic expenditures (Young 2008).

CRCT mature at approximately two or three years of age and spawn from early spring to early July (Baxter and Stone 1995) after spring runoff flows have peaked (Young 1995). Adults can migrate long distances for preferential spawning habitat where they utilize clean gravel substrate for redds (Young 1995). Emergence of fry from the substrate is dependent on water temperature but generally occurs in late summer (Young 1995). Aquatic and terrestrial invertebrates comprise the majority of the CRCT diet (Baxter and Stone 1995, Young 1995), and CRCT forage primarily during daytime (Young 1995).

2.1.2 Speckled Dace (Rhinichthys osculus)

The known distribution of Speckled Dace is reported to be the western region of the United States (USFWS 2023), this species is native and widespread west of the Continental Divide (Baxter and Stone 1995, Woodling 1985). Speckled Dace distribution is largely defined by its tolerances of both high and low temperatures, but this species tolerates a broad thermal range (Batty 2010, Center for Biological Diversity 2020).

Habitat requirements of the Speckled Dace include but are not limited to shallow habitat in riffles, runs and pools, creeks, and small to medium rivers with a mostly rocky substrate (NatureServe 2025). This species can occupy moderately swift water habitat (Wallace and

Zaroban 2013) but is uncommon in water depths greater than three feet (Sigler and Sigler 1987). Speckled Dace are active during day and night, but they are more closely associated with the substrate at night. (Wallace and Zaroban 2013). They are found in shoals, or loose groups.

Speckled Dace mature at approximately two years of age (Sigler and Sigler 1987) spawn from early spring to summer and can spawn more than once in a year (Baxter and Stone 1995). Peak spawning activity occurs at a water temperature near 18°C. In the Yampa River, spawning occurred at temperatures between 15 and 22° C (Bestgen and Zelensky 2004). Spawning occurs beneath rocks and eggs are deposited and adhered to substrate (Baxter and Stone 1995, Sigler and Sigler 1987). Eggs hatch about 6 days after deposition, and fry emerge from gravel after an additional seven to eight days (Sigler and Sigler 1987). Speckled Dace are omnivorous, feeding on invertebrates, plant matter, and zooplankton (Baxter and Stone 1995, Sigler and Sigler 1987).

2.1.3 Native Sculpin (Cottus punctulatus, C. annae)

Genetic research supports the existence of two distinct sculpin species in the Upper Colorado River basin: *C. annae* and/or *C. punctulatus* (Young et al. 2022). Because they co-occur in some drainages, both species may be present in the Study Reach. Despite taxonomic uncertainty prior to the 2022 publication by Young et al., previous literature has accurately described sculpin ecology in Colorado. A brief summary is included below.

Native sculpin inhabit clear, cold streams with rock and gravel substrate, preferring benthic substrate for refuge and foraging (Baxter and Stone 1995). This species can occur in moderate to rapid current (Wallace and Zaroban 2013) and can tolerate water temperatures above 20°C (Wallace and Zaroban 2013, Woodling 1985). Native sculpin are not usually found where sedimentation has occurred, and interstitial habitat is not present (Woodling 1985).

Native sculpin mature at approximately three years of age (Woodling 1985). Spawning occurs beneath rocky substrate or submerged objects; native sculpin are known to share nest sites and guard nests after egg deposition (Baxter and Stone 1995). Spawning occurs between February and June, when water temperatures approach 10° C (Baxter and Stone 1995, Woodling 1985). Native sculpin are more active at night, foraging among benthic substrate (Baxter and Stone 1995). Diet includes aquatic insects, crustaceans, and small fish (Baxter and Stone 1995; Wallace and Zaroban 2013).

2.1.4 Bluehead Sucker (Catostomus discobolus)

Bluehead Sucker are found in tributaries and in larger rivers in western Colorado, Arizona, Idaho, New Mexico, Utah, and Wyoming (Woodling 1985). Adult Bluehead Sucker grow to between 11 and 18 inches and have been reported to reach ages over 20 years (Minckley 1991). Bluehead Sucker occupy a variety of habitats and are typically found in runs or riffles

with rocky substrate and water with moderate to fast velocity (Woodling 1985, Bezzerides and Bestgen 2002). They spawn in spring or early summer (Ptacek et al. 2005). Spawning has been observed over a cleaned area in gravel substrate and at temperatures ranging from 18 to 25 ° C (Maddux and Kepner 1988). They are benthic omnivores, feeding on invertebrates and other material from stones and rocks (Woodling 1985). Bluehead Sucker hybridize with native Flannelmouth Sucker (*Catostomus latipinnis*) and Mountain Sucker (*C. platyrhynchus*) and with non-native White Sucker (*C. commersonii*, Bezzerides and Bestgen 2002) and Longnose Sucker (*C. catostomus*). Nonnative suckers are a primary threat to Bluehead Sucker due to hybridization.

Bluehead Sucker rely on long-range migration as part of their life history (Bottcher 2009; Fraser et al. 2017). Individuals have been documented as moving hundreds of kilometers to access a variety of habitats, including spawning sites (Thompson and Hooley-Underwood 2019). Therefore, fragmentation is also a major threat to the persistence of this species.

2.1.5 Flannelmouth Sucker (Catostomus latipinnis)

The native range of the Flannelmouth Sucker is similar to that of Bluehead Sucker (Baxter and Stone 1995), but they prefer habitat in medium to large streams (Woodling 1985). Flannelmouth Sucker inhabit multiple habitat types including riffles, runs, eddies, pools, and backwaters (Woodling 1985, Valdez and Muth 2005) and are known to migrate long distances (Bezzerides and Bestgen 2002). Flannelmouth Sucker prefer water temperatures ranging from 10 to 27° C (Sublette et al. 1990). Flannelmouth Sucker can reach lengths of 22 inches or more (Baxter and Stone 1995) and are known to reach a maximum age of approximately 30 years (Minckley 1991).

Flannelmouth Sucker are lithophilic spawners; eggs are broadcast over clean substrate and adhere to gravel or rock crevices (Snyder et al. 2004). Flannelmouth Sucker are benthic omnivores foraging mainly on macroinvertebrates and algae (Valdez and Muth 2005).

Flannelmouth Sucker populations have declined throughout much of their historic range (Bezzerides and Bestgen 2002) due to habitat loss and habitat fragmentation. As with Bluehead Sucker, Flannelmouth Sucker hybridize with other native sucker species and non-native White Sucker and Longnose Sucker. Like Bluehead Sucker, Flannelmouth Sucker also make long-distance migrations and are threatened by habitat fragmentation (Bottcher 2009; Fraser et al. 2017).

2.1.6 Roundtail Chub (Gila robusta)

Roundtail Chub is a cyprinid fish species that can grow up to 20 inches in length (Valdez and Muth 2005). Roundtail Chub live in warm streams and larger rivers and utilize pools with cover that are adjacent to fast moving water. This species also concentrates in relatively swift, swirling waters below rapids (Minckley 1973). Maximum temperatures measured in Roundtail Chub habitat were 26.5° C (Bestgen and Propst 1989).

The average lifespan of this species is approximately eight to ten years (Brouder et al. 2000). Individuals first reproduce between ages two and five and spawn in May and June, shortly after peak runoff (Valdez and Muth 2005). Adhesive eggs are scattered over cobble and gravel substrate (Valdez and Muth 2005) and hatch after about five days (Muth 1990). Roundtail Chub are omnivores and consume a variable diet of algae, aquatic plants, invertebrates, fish, and reptiles (Minckley 1973). This species is threatened by nonnative species introductions and habitat fragmentation and destruction (Valdez and Muth 2005). This species also relies on extensive movement to fulfill its life history and is threatened by fragmentation (Bottcher 2009; Fraser et al. 2017).

2.1.7 Mountain Whitefish (Prosopium williamsoni)

Mountain Whitefish have a large natural range extending along both sides of the Continental Divide among the Rocky Mountains in Canada and the United States; its range includes the Colorado River Basin (Baxter and Stone 1995). Mountain Whitefish historically occupied the White and Yampa River Drainages and were subsequently introduced into the Upper Colorado Drainage. This species prefers large, clear, cold rivers with deep and fast water (Baxter and Stone 1995). Mountain Whitefish are fast growing long-lived species reaching a maximum length of about 20 inches. They migrate for spawning, feeding, and overwintering, preferring summer feeding habitat with water temperatures less than 15° C. Overwintering habitat is known to consist of relatively shallow water with large substrate (Schmidt et al. 2019) and deeper pool habitat (Pettit and Wallace 2011).

Mountain Whitefish become sexually mature at a length of about 8 – 10 inches at an age of about three years (Wallace and Zaroban 2013). This species spawns nocturnally from September through November when water temperatures range from 0 to 11°C (Wallace and Zaroban 2013). They migrate into smaller tributaries for spawning, disperse their eggs in cobble and gravel riffles, and return downstream to overwintering habitat (Wallace and Zaroban 2013). Eggs hatch in late winter or early spring (Baxter and Stone 1995, Wallace and Zaroban 2013), and fry remain in their natal stream until late summer before migrating downstream (Wallace and Zaroban 2013). Mountain Whitefish are mainly benthic foragers, consuming macroinvertebrates, small crustaceans, and fish eggs (Laakso 1951).

2.2 Current Fishery Conditions in the Study Reach

GEI requested survey data for the Upper Colorado and Eagle River from Colorado Parks and Wildlife (CPW) from 2010 to 2024 and has summarized the status of the fish populations in the vicinity of the Study Reach. Of note, sampling methods and goals differ by survey, so datasets are not directly comparable. However, all available surveys provide information on species presence and relative abundances. Based on the data provided, multiple surveys of the Colorado River and Eagle River from reaches both upstream and downstream of the Study Reach were conducted from 2010 to 2024.

In the Colorado River upstream of the confluence of the Eagle River (Colorado River #4B), populations are prolific and diverse. Brown Trout and White Sucker were frequently the dominant species (Figure 2-2). Longnose Sucker, Rainbow Trout, Flannelmouth Sucker, Bluehead Sucker, native sculpin, Speckled Dace, and hybrid suckers were also commonly collected. Smaller numbers of Roundtail Chub, Common Carp (*Cyprinus carpio*), and Cutthroat Trout were found during the various sampling events. Four species collected within the reach including Bluehead Sucker, Colorado River Cutthroat Trout, Flannelmouth Sucker, and Roundtail Chub are categorized by CPW as Tier 1 Species of Greatest Conservation Need (SGCN-1). The most recent sampling event in the database occurred in 2022; Brown Trout, Rainbow Trout, White Sucker were the most abundant species. Naturalized trout and White Sucker dominate the reach, with small numbers of native Mountain Whitefish and Speckled Dace also present.

In the Eagle River upstream of the confluence with the Colorado River (Eagle River #1) White Sucker and Brown Trout were the dominant species and were collected in surveys from 2010 through 2023 (Figure 2-3). Rainbow Trout, Longnose Sucker, and Mountain Whitefish were also commonly collected. Smaller numbers of Fathead Minnow (*Pimephales promelas*), native sculpin, Speckled Dace, Flannelmouth Sucker, Bluehead Sucker, and hybrid suckers were found during the various sampling events. Two SGCN-1 species, Bluehead Sucker and Flannelmouth Sucker, were collected within this reach from 2010 to 2023. The most recent sampling event in the database occurred in 2023; Brown Trout, White Sucker, and Fathead Minnow were the dominant species, with smaller numbers of Mountain Whitefish, Rainbow Trout, Longnose Sucker, hybrid suckers, and Speckled Dace.

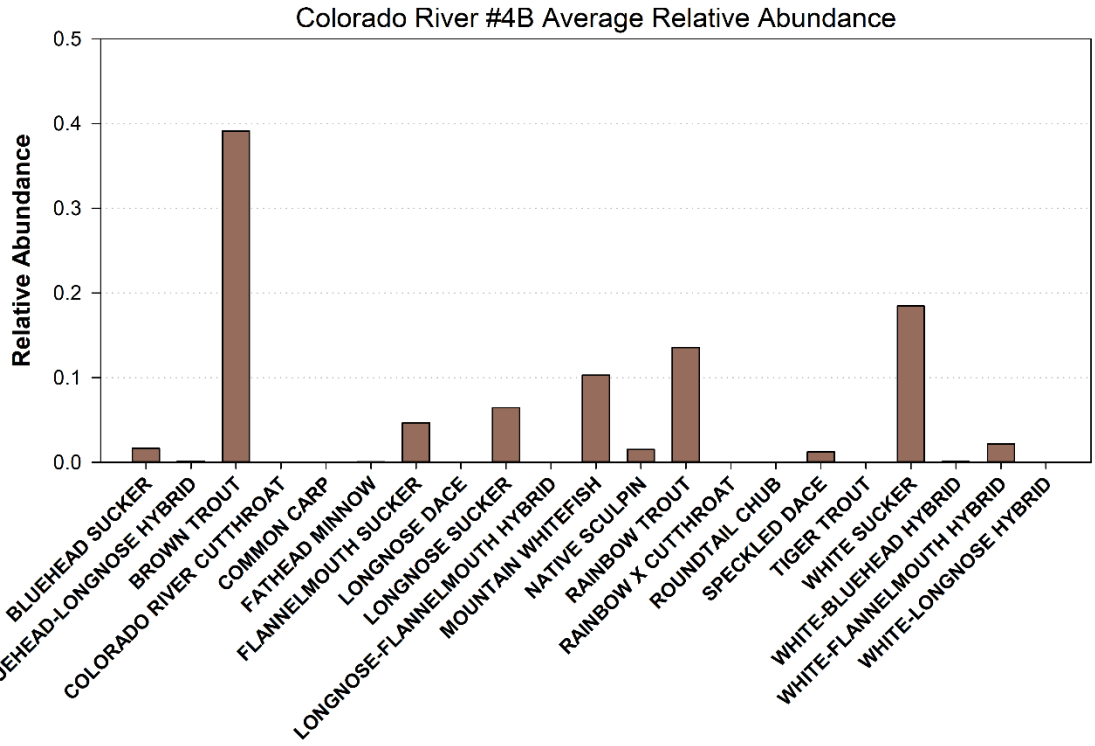


Figure 2-2.—Average relative abundance of fish species in the Colorado River #4B reach upstream of the confluence with the Eagle River. Sampling occurred in 2010, 2013, 2015, 2016, 2018, 2021, and 2022. Species without bars had average relative abundances less than 0.1%.

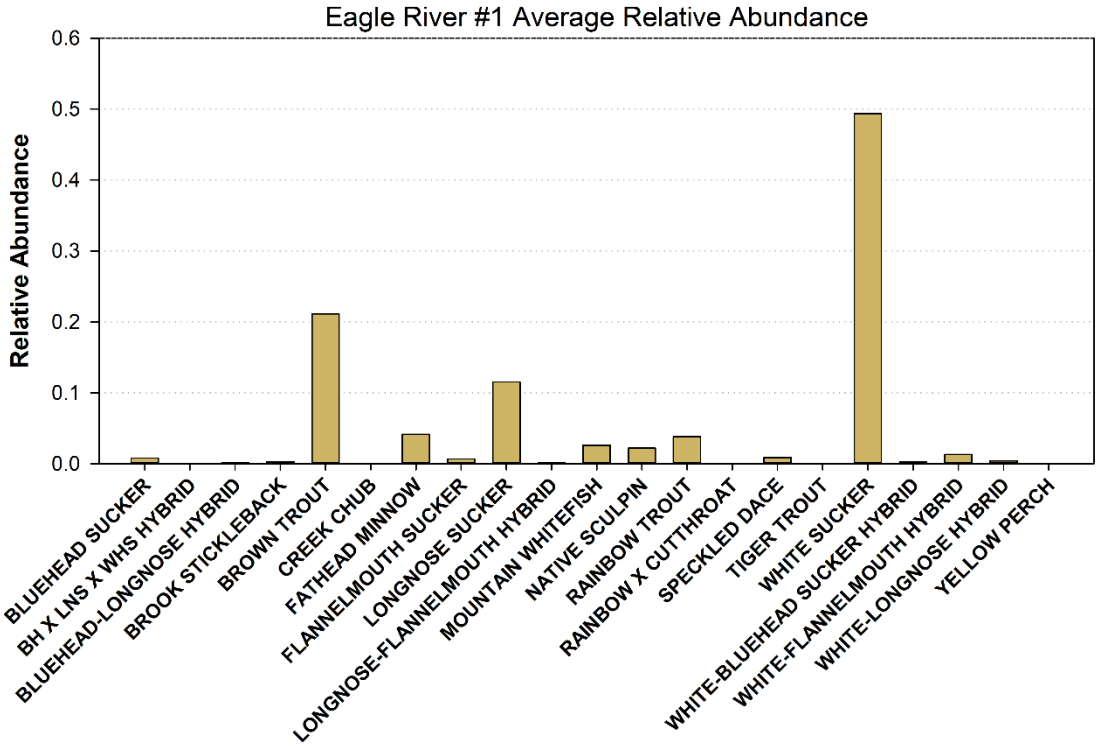


Figure 2-3.—Average relative abundance of fish species in the Eagle River #1 reach upstream of the confluence with the Colorado River. Sampling occurred in 2010, 2014, 2016, 2021, and 2023. Species without bars had relative abundances of less than 0.1%.

In the Colorado River downstream of the Study Reach just above Glenwood Springs, Colorado River #4A (at Grindstone Creek), was sampled in 2021, 2023, and 2024. Brown Trout were the dominant species and were collected in each survey (Figure 2-4). White Sucker, Mountain Whitefish, and Longnose Sucker were also commonly collected. Small numbers of Flannelmouth Sucker, native sculpin, Speckled Dace, and hybrid suckers were found during the three sampling events. The most recent sampling event occurred at this site in 2024; Brown Trout and Rainbow Trout were the dominant species. Lower numbers of Longnose Sucker, native sculpin, Mountain Whitefish, Speckled Dace, White Sucker, and hybrid suckers were also collected in 2024. Additionally, low numbers of two SGCN-1 species, Bluehead Sucker and Flannelmouth Sucker, were collected within this reach among all sampling events. Species diversity was lower at this site, with 12 species collected in 2021 and 2023; a total of 21 and 20 species were collected at Eagle River #1 and Colorado River #4B, respectively. However, the lower fish diversity at Colorado River #4A may be due to the lower number of surveys performed at this site. Despite the lower diversity, comparable numbers of Brown Trout and Rainbow Trout have been collected in most years among Colorado River #4A near Grindstone Creek, Colorado River #4B, and Eagle River #1.

The Study Reach, Colorado River #4A (Shoshone), was sampled once, in the fall of 2024, and the dominant species collected were Brown Trout and Rainbow Trout (Figure 2-5). Moderate numbers of Speckled Dace, Longnose Dace (*Rhinichthys cataractae*) and low numbers of native sculpin and Mountain Whitefish were also collected. One SGCN-1 species, Bluehead Sucker, was also collected at this site in low numbers. The total number of species/hybrids collected in this reach was lower than all other reaches analyzed but was mostly due to the absence of hybrid suckers. All species collected at Colorado River #4A Shoshone in 2024 were also present among all other reaches and years.

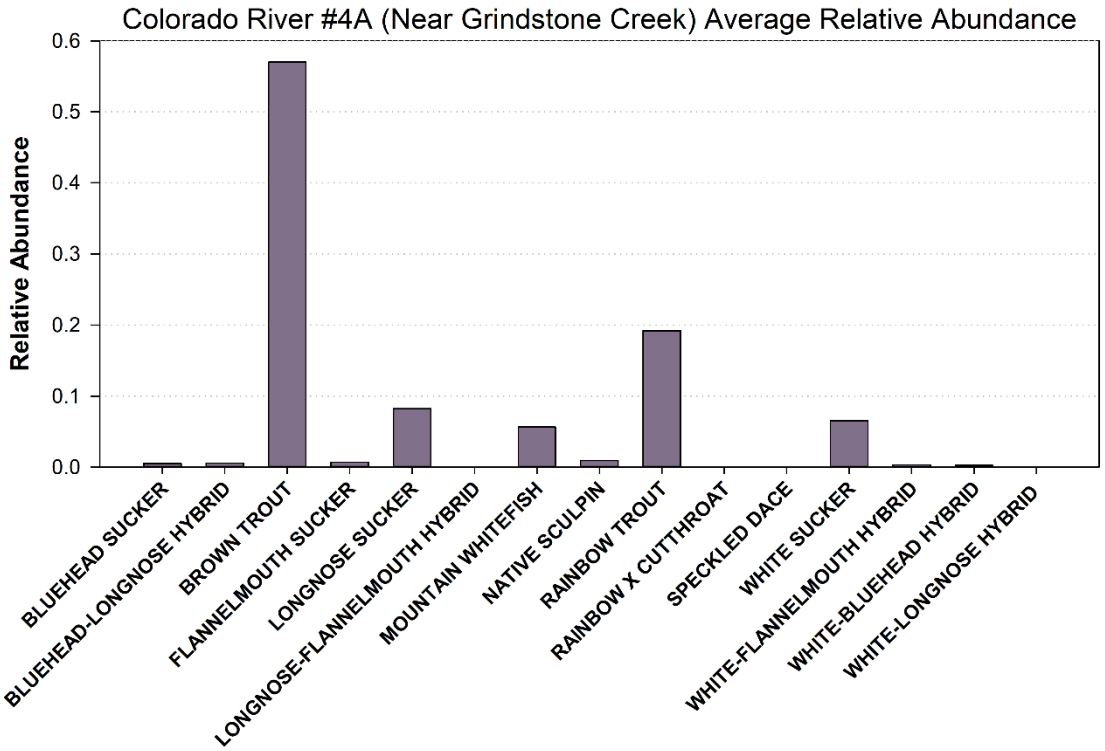


Figure 2-4.—Average relative abundance of fish species in the Colorado River #4A (at Grindstone Creek) downstream of the confluence of the Eagle River near Glenwood Springs, Colorado. Sampling occurred in 2021, 2023, and 2024. Species without bars had relative abundances of less than 0.1%.

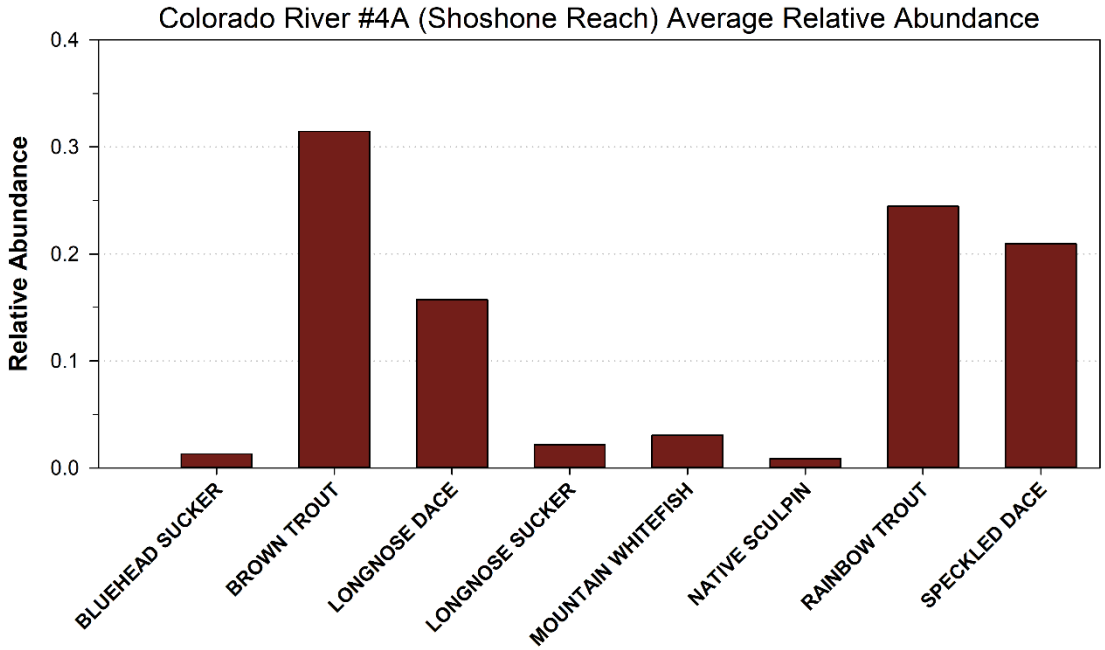


Figure 2-5.—Average relative abundance of fish species in the Colorado River #4A (Shoshone) downstream of the Shoshone Dam and upstream of the Shoshone Hydroelectric Station (referred to as the Study Reach in this report). Sampling occurred in 2024.

The fish density and fish biomass values in the Eagle River #1 site were generally higher than the Colorado River sites from 2010 through 2023 (Figure 2-6). At the Colorado River #4B site, these same metrics remained relatively stable from 2010 through 2022. Limited surveys were completed at the Colorado River #4A site; however, density and biomass values appear similar to Colorado River #4B site. Overall, fish densities have fluctuated considerably at the Eagle River #1 site from 2010 to 2023. The highest fish densities occurred in 2014 and 2021, with 6,285 and 1,818 fish per hectare, respectively. The density value was the highest at Colorado River #4B in 2010, with 732 fish per hectare. The extraordinarily high density values in the Eagle River were attributable to a large number of White Suckers.

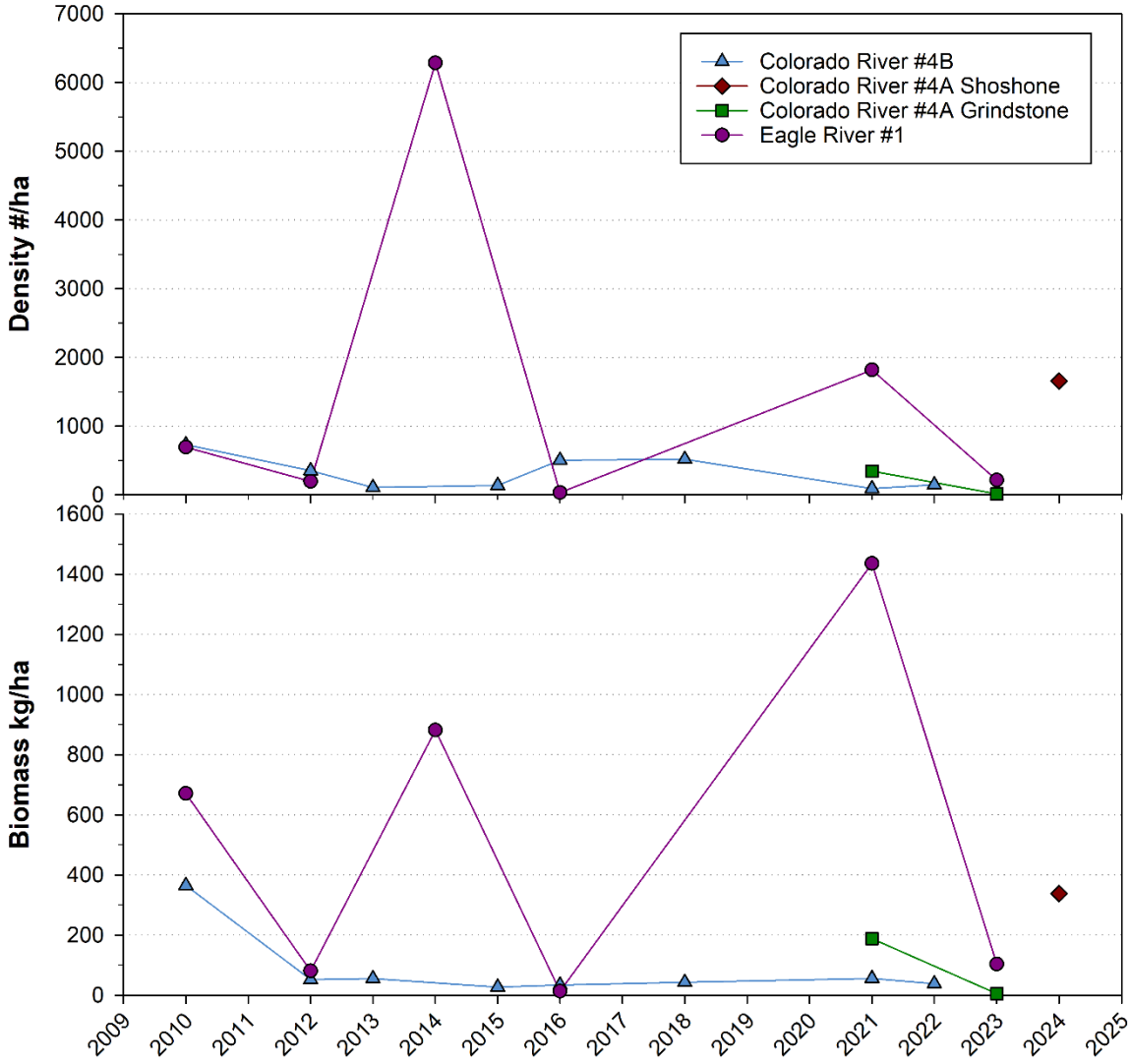


Figure 2-6.—Density and biomass of fish populations in the three Colorado River sites and the Eagle River site from 2010 to 2024.

Patterns in fish biomass explain further differences between the fish communities at the four sites (Figure 2-6). The highest biomass value of all sites was in 2021 at Eagle River #1; this

is the only site of the three sites sampled among multiple years that consistently supported a large number of larger-bodied fish such as White Suckers. Biomass was also relatively high at Site Colorado River #4A (Shoshone), which has only been sampled one time. The lowest biomass values occurred at Colorado River #4A (at Grindstone) in 2023 when low numbers were present. At Colorado River #4A (at Grindstone) in 2023, a relatively small number of large Brown Trout and Rainbow Trout comprised 71 percent of the total biomass. Biomass at Site Colorado River #4B has been relatively stable from 2012 through 2022.

Surveys recorded in CPW's database continued to indicate that White Sucker, Brown Trout and Mountain Whitefish were the most abundant species in almost all surveys. Rainbow Trout, Longnose Sucker, Bluehead Sucker, and Flannelmouth Sucker were also commonly collected and abundant. In addition, a small number of native sculpin, Speckled Dace, Cutthroat Trout species, Roundtail Chub, Tiger Trout, and hybrid suckers were present in several surveys. Despite variations in surveys due to survey goals and sampling methods, fish assemblages were similar between all sites and reflect the fact that nonnative fishes pose a significant threat to native fish persistence. Of note, Mountain Whitefish and Roundtail Chub were collected more frequently and often in high abundances from Colorado River #4B, above the Eagle River confluence, and Bluehead Sucker were common, and sucker hybrids were absent at Colorado River #4A (Shoshone).

2.3 Instream Flow Benefits to Fish

The fish assemblage described above is typical in perennial coldwater or transitional (i.e., between coldwater and warmwater) stream reaches in medium to large rivers on Colorado's Western Slope. Under the current flow regime, the fish assemblage in the Study Reach is subject to significant environmental challenges that are absent in perennial reaches.

Some of the species in the Study Reach can survive in intermittent streams. Most fish that live in intermittent streams do not have specialized adaptations to survive periods of zero flow, such as the ability to breathe air or aestivate. Instead, fishes such as suckers and salmonids survive in intermittent systems because they can tolerate the environmental conditions presented to them during intermittency (Kerezsy et al. 2017), or they emigrate from drying reaches into perennial ones. Suckers and salmonids are known to successfully use intermittent streams for spawning, refuge, and seasonal habitat (Levick et al. 2008; Kelly and Bruckerhoff 2024).

Despite their ability to tolerate intermittent systems, the resident fish assemblage in the Study Reach would benefit from consistent base flows for two reasons. First, even if abiotic conditions in an intermittent stream are conducive to survival, these systems are often food limited. For example, Brook Trout in intermittent Appalachian streams relied heavily on terrestrial insect prey during periods of low flow and did not switch to consuming more aquatic prey as available food was depleted (Courtwright et al. 2013). The authors noted that in 17 days of intermittency, the probability of individual fish having empty stomachs

increased from 4% to 37%. The Study Reach does not support extensive riparian vegetation, so food shortages downstream of the Shoshone Dam may be more severe during periods of zero flow because of a limited terrestrial prey subsidy. Second, intermittent systems contain shorter, simpler food webs than perennial streams. Based on a study of 36 North American streams of varying sizes, flow variability and intermittency significantly reduced aquatic food chain length and complexity, regardless of stream size (Sabo et al. 2010). For example, none of the intermittent streams in the study supported a piscivorous fish, and many of the intermittent streams supported small-bodied fishes or did not support fishes at all. This study implies that conditions in intermittent systems are not necessarily supportive of desirable species such as salmonids. However, if the Study Reach does receive intermittent flow, it is likely that resident fishes will use it on a seasonal basis, as recolonization of rewetted streams tends to be rapid. For example, rewetting of a stream in British Columbia resulted in the return of macroinvertebrates and spawning salmonids within a month (Decker et al. 2008). Rapid recolonization of the Study Reach could be expected after rewetting, particularly because it is close to a perennially flowing reach (e.g., Kerezsy et al. 2017; Kelly and Bruckerhoff 2024).

The expectation would be that an intermittent flow regime in the Study Reach would allow some resident fishes to seasonally inhabit the Study Reach. For example, the presence of native fish larvae (Bluehead Sucker, Flannelmouth Sucker, Roundtail Chub, and Speckled Dace) in the Colorado River in years of negligible runoff (Robinson et al. 1998), indicates that they are adapted to large interannual variations in flow. However, perennial flows would result in markedly improved conditions for fishes. Further, a perennial flow regime that exhibited some increase in flow during spring and early summer (i.e., during the natural spring runoff period) would greatly benefit the resident fishes in the Study Reach for the reasons discussed in the remainder of this report.

3. Macroinvertebrates

3.1 Macroinvertebrate Assemblages in the Study Reach

To provide information on the existing condition of macroinvertebrate assemblages in the reach of the Colorado River between the Shoshone Dam and the return at the Shoshone Power Plant (the "Study Reach"), a general internet search, a search of the Colorado Data Sharing Network (CDSN), and a search of the Water Quality Portal (WQP) of the National Water Quality Monitoring Council (NWQMC) Information System were all completed. No data from within or in the vicinity of the Study Reach were found in the CDSN database, but relevant data were available in the WQP. The internet search also produced multiple reports of macroinvertebrate surveys by Timberline Aquatics (Timberline) that were completed for the Upper Colorado River Wild & Scenic Stakeholder Group (Rees and Musto 2019, Rees and Grap 2019 Rees and Fenske 2022, Rees 2024a). In addition, CPW provided macroinvertebrate data for a single location sampled in November 2024.

Of the existing data, the site sampled by CPW was the only location that was surveyed within the Study Reach (Figure 3-1). The downstream extent of our searches for data in CDSN and WQP was the confluence of the Roaring Fork and the Colorado River, approximately 6.5 miles downstream of the Study Reach. No data were available between the Study Reach downstream to the mouth of the Roaring Fork. The data available from the WQP and Timberline were from samples collected upstream of the Study Reach and upstream of the confluence of the Colorado and Eagle rivers (Figure 3-1). Conditions are not strictly the same upstream of the confluence of the Colorado and Eagle rivers as downstream of it. However, the macroinvertebrate communities upstream of the confluence would likely share many of the attributes of the downstream communities in the absence of dewatering in the Study Reach.

CPW sampled a single site within the Study Reach in November 2024, described as being below Devil's Hole. While full operations of the Shoshone Hydroelectric Plant resumed in August 2024, likely leaving much of the Study Reach dewatered, the CPW located an area to sample that appeared to have perennial flow, most likely due to dam seepage and to input from springs on adjacent hillslopes. Based on this, data from this site does not represent the intermittent flow conditions present in much of the Study Reach when the plant is operating but instead provides information on what the macroinvertebrate assemblages could be expected to resemble throughout the Study Reach if consistent flows were present.

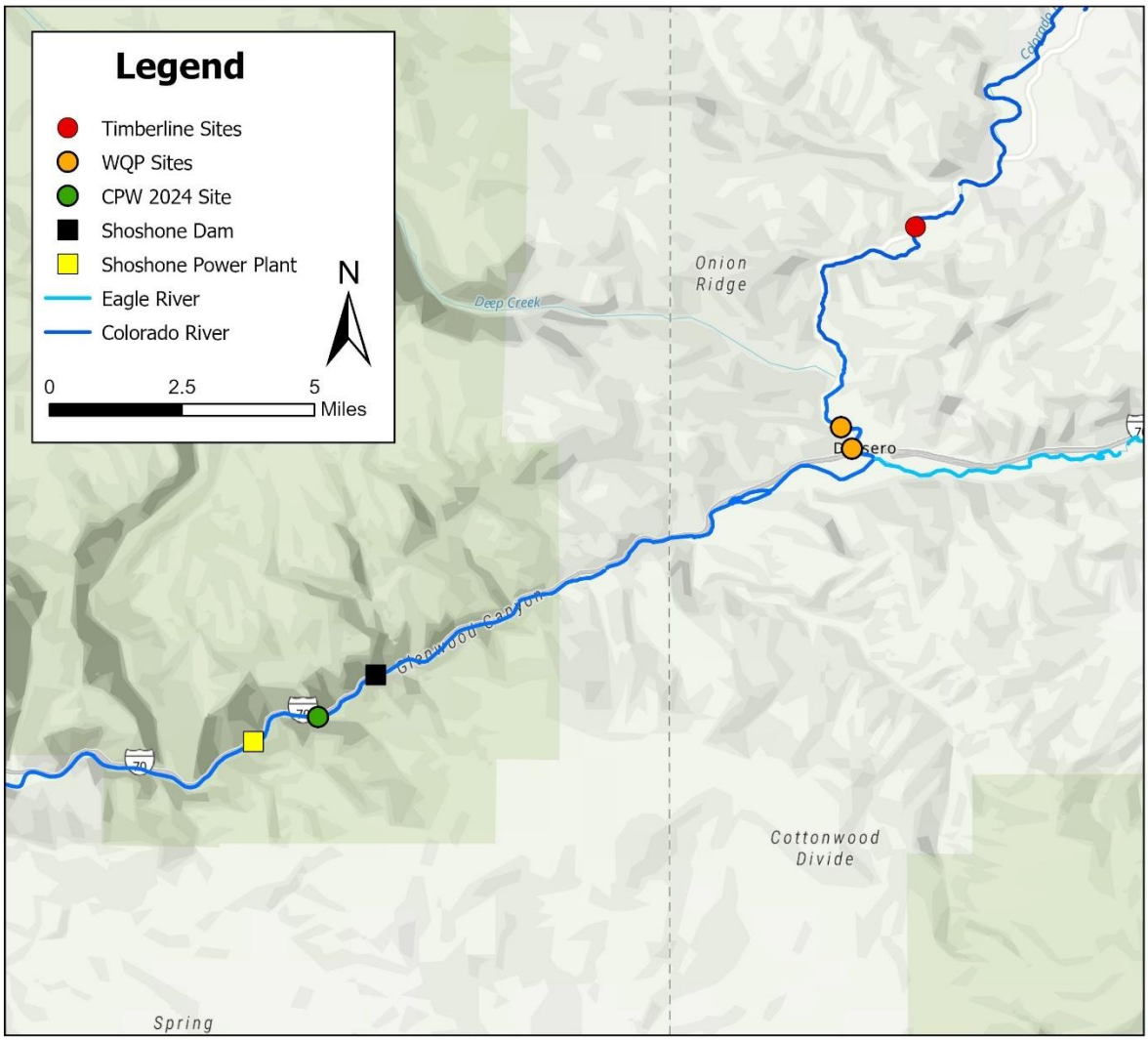


Figure 3-1.—Map of macroinvertebrate sampling sites on the Colorado River, within and upstream of the Study Reach.

Within the sample collected by the CPW in 2024, the generally sensitive Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa comprised 55 percent of the total number of taxa present, suggesting favorable conditions exist for these species (Table 3-1). The diversity value indicated that the community was slightly unbalanced; this resulted from a common and moderately tolerant mayfly taxon, *Baetis tricaudatus*, dominating the community, making up 64 percent of the total abundance. Multiple other mayfly taxa were also present at lower abundances, and these taxa included three mayflies from the Heptageniidae family, a family that is considered especially sensitive to metals as well as other disturbance (Kiffney and Clements1994; Clements et al. 2002, Clements et al. 2021) and generally prefers moderate to high current velocities. Sensitive stonefly and caddisfly taxa were also present, including a single salmonfly individual, *Pternonarcella badia*.

Table 3-1.—Summary of macroinvertebrate metrics for the samples collected from the Colorado River within and upstream of the Study Reach. Data are presented from upstream to downstream. NC = not calculated.

Year Sampled	Number of EPT Taxa	Number of Total Taxa	Diversity Value	MMI Score	HBI Score	TIVSED
Timberline Site						
2018	23	41	3.46	74.7	3.88	4.60
2019	21	41	3.20	71.6	2.64	4.66
2021	25	43	2.56	70.3	4.64	4.45
2023	22	44	3.43	73.4	3.42	4.58
WQP Sites						
2000	19	31	3.34	NC	NC	NC
2013	66	25	4.21	NC	NC	NC
CPW Site (Study Reach)						
2024	18	33	2.40	64.3	4.46	5.63

Multiple indices were calculated from the data provided by the CPW (Table 3-1). The Colorado Multimetric Index (MMI), a measure of macroinvertebrate community health (CDPHE 2020), was calculated to be 64.3, well over the threshold (45) indicating attainment of the aquatic life use. Being in attainment of the aquatic life indicates that the location sampled supports a wide variety of macroinvertebrate species, including sensitive species, and that there are no indications that the abundance or diversity of the community is impaired. This score is also over the threshold designating it as a high-scoring water (56). Such waters are considered exceptional and worth additional protections to prevent any declines in condition.

Two other indices were calculated to describe the macroinvertebrate community, including the Hilsenhoff Biotic Index (HBI) that evaluates the macroinvertebrate assemblages' tolerance to poor water quality and disturbance (Hilsenhoff 1987) and the Tolerance Indicator Value specific to sediment (TIV_{SED}) that evaluates the macroinvertebrate assemblages' tolerance to excessive fine sediment (CDPHE 2024). Values for both were favorable, with the HBI value suggesting conditions were "very good" based on the categorization scale and the TIV_{SED} suggesting that excessive fine sediment is not impacting the macroinvertebrate community. Of note, while metric values suggest a healthy community exists within this location with perennial flow in the Study Reach, scores associated with these metrics were generally lower for this site than for the sites further upstream (see following paragraphs). This may reflect the limited areas with perennial flow that are present within the Study Reach or could indicate that this location has experienced some drying periods in the past. Alternatively, differences in substrate composition or other aspects of the stream habitat may differ, accounting for the slightly lower values.

Macroinvertebrate data were collected on the Colorado River approximately 6 miles upstream of the confluence with the Eagle River over several years, with sampling conducted

in 2018, 2019, 2021, and 2023 (Rees and Musto 2019, Rees and Grap 2019, Rees and Fenske 2022, Rees 2024). In addition to the raw data, multiple metrics were provided in these reports for the samples collected (Table 3-1). Of note, additional sites on the Colorado River were sampled further upstream; the data presented here is from the site location that was in the closest vicinity to the Study Reach. As with the site sampled within the Study Reach, the generally sensitive EPT taxa comprised half or more of the total taxa present. The MMI values ranged from 70 to 75. These values indicated healthy communities were supported in this reach, and these scores were also above the high-scoring water threshold that indicates sensitive communities that are worth additional protection. Diversity values also suggested that balanced assemblages were present. Mayflies were the dominant group in all years, although, as in the CPW sample, typically the common and moderately tolerant mayfly taxon, *Baetis tricaudatus*, was the most abundant taxon. The HBI values were also favorable, categorizing the communities as excellent, very good, or good. The TIV_{SED} values were all less than the threshold for this region, indicating excessive fine sediment is not impacting the macroinvertebrate communities in this stream reach.

Two other sites were sampled upstream of the Study Reach and between 0.3 and 1.0 miles upstream of the confluence with the Eagle and Colorado rivers. Only raw data were available for these sites; the MMI, HBI, and TIV_{SED} values were not provided (Table 3-1). Also of note, data for these sites was included in the WQP database; little background information is provided in this database as to the purpose of the sampling or more specific details about sampling methods. The metrics calculated from these data are not necessarily comparable to the CPW and Timberline data because of this. The site 1.0 mile upstream of the confluence with the Eagle River was sampled in September 2013 and likely consisted of multiple composited replicates or a large area were sampled based on the data. Thirty-eight percent of the taxa were EPT taxa, and the diversity value again suggested a well-balanced community was present. In contrast to the samples collected farther upstream, the common and moderately pollution tolerant caddisfly, *Hydropsyche* sp., was the dominant species, comprising 24 percent of the relative abundance. In April 2000, a site was sampled 0.3 miles upstream of the confluence with the Eagle River. While the total number of taxa collected at this site was lower than observed at the Timberline or other WQP site, EPT taxa comprised 61 percent of the total taxa. Diversity was within the range observed at the other sites, and *B. tricaudatus* was again the dominant species, comprising over 30 percent of the relative abundance.

For the sites sampled by CPW and Timberline (Rees and Musto 2019, Rees and Grap 2019, Rees and Fenske 2022, Rees 2024a, 2024b) on both the Colorado and Eagle rivers, a functional feeding group analysis of the macroinvertebrate assemblage was completed. As is often typical, collector-gatherers or collector-filterers were the dominant groups. These groups feed on fine particulate organic matter in the substrate or water column, respectively. Scrapers which graze on algae by scraping it off of hard substrates or surfaces and are often considered sensitive to pollution and disturbance were also often abundant, although this

group was not well represented in the sample collected within the Study Reach. Shredders, which feed on coarse organic particulate matter such as leaves, and predators, which feed on other macroinvertebrates or organisms, were less abundant but were consistently present. The presence of at least a few long-lived taxa in these samples indicates conditions are favorable and stable over time in and upstream of the Study Reach in the Colorado River, although these taxa were more limited in the sample collected from the Study Reach itself.

3.2 Instream Flow Benefits to Macroinvertebrates

The macroinvertebrate communities described above are only found in perennial systems, but an intermittent flow regime could support a subset of the taxa found in perennial reaches. Intermittent streams can support a diverse macroinvertebrate community. Macroinvertebrates can tolerate periods of little to no flow through physiological adaptations such as tolerance of low dissolved oxygen and behavioral mechanisms such as refuging in the hyporheic zone during periods of no flow (Magland et al. 2020). However, densities and species richness tend to be lower than those found in perennial systems (Levick et al. 2008). The presence of a healthy community in the location within the Study Reach that appeared likely to have more consistent flows present suggests that if continuous flow were present throughout more of this reach, such a community could serve as a source population to provide individuals that could colonize newly wetted areas.

Intermittent streams present challenges ranging from water quality changes to increased predation risk by vertebrates (Stubbington et al. 2017). Environmental changes associated with cessation of flow create unsuitable conditions for taxa that prefer riffle habitat, rheophilic (i.e., flow-loving) taxa, and specialist feeders (Rolls et al. 2012). For example, riffles are more prone to drying than other stream habitat features, and filter feeders rely on flows for food delivery. Scrapers and shredders are also considered specialist feeders, and predators tend to be long-lived, taking one to three years to complete their life cycles. Many of these taxa cannot tolerate flow regimes that include zero-flow days. A 1994 study of an intermittent system in Australia tracked community richness as a function of flow; detritivores were most common during periods of no flow and predator taxa were the last to recolonize after flows resumed (Closs and Lake 1994).

Many of the taxa that do not tolerate intermittency (EPT taxa, select functional feeding groups, and long-lived taxa, Stubbington et al. 2017) provide high-quality forage for trout. Suttle et al. (2004) categorized specific macroinvertebrate families as being vulnerable to predation by juvenile trout, indicating these families are preferred forage for these fish. Several of these families, including mayflies in the family Baetidae, were well represented in the sample data for the Colorado River within and upstream of the Study Reach. Other groups present in lower abundances that were categorized as vulnerable included mayflies in the families Heptageniidae, Leptophlebidae, and Leptohyphidae, stoneflies in the Perlodidae family, caddisflies in the family Brachycentridae, and true flies in the Chironomidae family,

as well as occasional representatives in most of the remaining groups. Several of these EPT families are rheophilic and may presently be uncommon or absent in the Study Reach under current flow conditions other than within the limited locations that support more perennial flow such as the site sampled by CPW. If flows are persistent, these groups would likely become established, providing a forage base for trout and other fish species.

The macroinvertebrate community throughout most of the Study Reach is likely impacted by inconsistent and sometimes absent flows. Other than the locations where perennial flow is present due to dam seepage, groundwater upwellings, or tributary inflows, the current macroinvertebrate community in the Study Reach may be dominated by short-lived taxa such as many chironomid midges that can complete their life cycle quickly during the time that flow is present (Stubbington et al. 2017; Colorado Water Quality Control Division 2020). Other taxa that have adaptions that allow them to disperse aerially, have desiccation tolerant adaptions, or have the ability for certain life stages to persist in the hyporheic zone may also be present in the Study Reach. The expectation would be that if flows in the Study Reach were intermittent, the macroinvertebrate community would contain a subset of the taxa that were found in the samples from the Colorado River by CPW and Timberline and that these taxa would provide some forage for resident fishes. If flows were perennial, the macroinvertebrate communities in the Study Reach would be similar to the ones described from upstream of the Study Reach and within the Study Reach at the location exhibiting perennial flow. In other words, the robust communities found at these locations would presumably expand to all areas with perennial flow. The communities would be comprised of a high proportion of EPT taxa, diverse functional feeding groups, and long-lived taxa, many of which are preferred by trout. These communities would provide ample high-quality forage for fish.

4. Flow and Food Webs

Nutrient dynamics are strongly influenced by flow regime (Poff et al. 1997; Palmer and Ruhi 2019). Although flow regimes vary across river types and climates (Poff et al. 1997), human activities such as water withdrawal and reservoir operations are major influences on hydrological regimes and, therefore, nutrient dynamics (Jiang et al. 2021).

Nutrients are transported downstream in a cyclical fashion. They are taken up by organisms, transformed, and then released back into the water column, where they can be transported further downstream. This process, referred to as nutrient spiraling, requires physical transport of nutrients and biological uptake and transformation (Allen et al. 2021). Therefore, nutrient cycling is affected by flow changes because of their effects on transport rates and on the biological communities that process nutrients.

4.1 Consistent Base Flows Benefit Stream Food Webs

Reduction or cessation of flow can reduce or prevent nutrient and organic matter inputs from upstream, riparian, and hyporheic sources (von Schiller et al. 2017). Dam operations such as flow reduction can reduce the availability of already-limited nutrients such as phosphorus (Maavara et al. 2020) or impact nitrogen concentrations by altering microbial activity in streambed sediments (Merbt et al. 2016). Low flows can also alter nutrient dynamics by stranding of materials during flow recession or drying (von Schiller et al. 2017).

In addition, low flow or lack of flow can inhibit incorporation of raw materials into the food web in a number of ways. First, terrestrial plant litter is a crucial component of the aquatic food web in headwaters and mid-order river systems (Vannote er al. 1980, Rosi and Vallis 2016). This organic material is an integral component of the food web because it provides a primary food source for numerous bacterial and macroinvertebrate taxa. Bacteria living on organic matter can also provide significant nutrition to macroinvertebrates; Hall and Meyer (1998) determined that benthic macroinvertebrates obtained 10 to 100 percent of their carbon from this source. Low flows or lack of flow can inhibit or prevent transport of terrestrial plant litter within or downstream of a stream reach. Low flow or absence of flow can also strand terrestrial plant litter and make it unavailable to the aquatic food web.

Low flow or lack of flow also alters the microbial community in a stream system, which affects the food web. Microbes are essential for breakdown of leaf litter (Rolls et al. 2012) and for maintaining algal communities in aquatic habitat. Algal production can support invertebrate and fish production in a river and be of greater importance than allochthonous inputs (terrestrial inputs) in some systems. This may have particular applicability to the Study Reach, as it is characterized by a limited riparian community (and therefore potentially lower allochthonous inputs). Specific biochemicals that are synthesized by algal communities can

have an inordinate influence on productivity of multiple trophic levels (Brett et al. 2017). The algal community may synthesize long carbon chain polyunsaturated fatty acids, which provide high-quality nutrition to macroinvertebrates and therefore higher trophic levels (Guo et al. 2016). Microbial assemblages recover after drying periods, once aquatic habitat is restored with increased water levels, but an increase in the frequency and magnitude of drying periods greatly inhibits these assemblages from rebounding (Hall and Meyer 1998). When aquatic habitat is exposed to fully dry periods, as opposed to wetted periods, autotrophs (e.g., algae, cyanobacteria, and aquatic plants) are also slow to recolonize (Hall and Meyer 1998). Therefore, consistent base flow facilitates development of a more robust community of primary producers. Finally, low flow or lack of flow selects against certain macroinvertebrate taxa, such as shredders (See Section 3) which also break down organic matter such as leaves for incorporation into the aquatic food web.

4.2 Periodic High Flows Benefit Stream Food Webs

In rivers with variable hydrology, seasonal or occasional high-flow events play a crucial role in nutrient dynamics. These floods can redistribute materials across the floodplain, enhancing nutrient availability and influencing the productivity and diversity of aquatic and terrestrial ecosystems associated with the river (Bunn and Arthington 2002). A lack of periodic high flows in a river restricts connectivity to the floodplain and alters the exchange of energy between aquatic and terrestrial systems. For example, leaf litter availability to and terrestrial invertebrate input into aquatic habitats decline with a reduction in wetted area (Courtwright et al. 2013). Linkages between the terrestrial and aquatic environments are critical to stream health, as they promote reciprocal subsidies (i.e., beneficial exchanges of materials) between the two environments. The subsidies range from bacteria and organic matter to terrestrial invertebrates, and they are essential to the function of aquatic environments (Hall and Meyer 1998; Baxter et al. 2005). For example, multiple studies have shown that inundated floodplains subsidize food webs and increase growth and survival of juvenile salmonids (Sommer et al. 2001; Bellmore et al. 2013; Sturrock et al. 2022). The importance of reciprocal subsidies was demonstrated by Rolls et al. (2012); reduced connection to the floodplain can change the dominant energy source in a stream reach from allochthonous (i.e., external/terrestrial) to autochthonous (i.e., internal/aquatic, Rolls et al. 2012).

Regular exchange of materials between the limited aquatic floodplains and the aquatic environment would still support the aquatic food web in the Study Reach. However, macroinvertebrate prey transport may be more critical in the Study Reach than in lower-gradient reaches, simply because a limited riparian plant community may result in reduced input of terrestrial insect prey. Gresswell et al. (2005) found that shrub cover on stream bank habitat was highly associated with terrestrial prey availability for Coastal Cutthroat Trout and that terrestrial prey comprised seasonally varying but significant portions of trout diets. Saunders and Fausch (2012) determined that in forest and grassland stream ecosystems in the Colorado Rocky Mountains with two or more species of trout, terrestrial invertebrates falling

into streams from riparian vegetation provided 30 to 45 percent of trout annual energy consumption. Because trout benefit from terrestrial invertebrate prey, and because terrestrial insect inputs may be less common in canyon reaches, a healthy food web in the Study Reach will rely on sufficient base flow to maintain aquatic macroinvertebrate drift and to maintain robust, diverse macroinvertebrate populations (See sections 3.2 and 6.4 for more details).

4.3 Intermittent Flow Causes High Unpredictability in Aquatic Food Webs

The spatial and temporal variability of nutrient and prey availability is far higher in intermittent streams than in perennial ones. While the effects of drying were discussed earlier in this section, the variability in nutrient and organic matter availability during and after intermittency is discussed here.

During periods of intermittency, concentrations of nutrients and dissolved organic carbon exhibit high spatiotemporal variability (Stubbington et al. 2020). For example, high temperatures and solar radiation in isolated pools can stimulate high rates of photosynthesis and an uptake in nutrients that decreases water column concentrations. Conversely, in isolated pools with low algae and plant densities, evaporation can increase water column nutrient concentrations. Changing water temperatures also alter microbial activity, which has a large influence on rates of organic matter decomposition and resultant concentrations of dissolved organic carbon (Stubbington et al. 2020). Therefore, the conditions in an isolated pool are dependent on local conditions and the duration of drying and are not typically as stable as would be expected in a perennial system.

The return of consistent flows after intermittency can have significant effects on nutrient and organic matter availability, both within and downstream of the intermittent reach. During dry periods, breakdown of organic matter still occurs in the terrestrial environment (von Schiller et al. 2017), and rewetting causes significant and sudden inputs of allochthonous material. Recovery of bacterial metabolism is rapid and facilitates a pulse of nutrient availability, and flows deliver these materials and nutrients into and downstream of the reach (von Schiller et al. 2017). These “first-flush events” often have high nutrient concentrations and can create water quality issues downstream of the rewetted reach (Stubbington et al. 2020).

The food web in the Study Reach would benefit from a stable base flow that facilitated transport and cycling of organic material and nutrients. Higher flows that allowed periodic floodplain connection would confer benefits such as reciprocal prey subsidies and enhanced exchange of terrestrial and aquatic materials. Intermittent flows in the Study Reach would likely support a limited food web, particularly because of low rates of terrestrial leaf litter input. Finally, because streams are longitudinally constrained, changes in nutrient dynamics at upstream sites, particularly those near dams, can cause cascading effects downstream (Nixon 2003). Therefore, cycles of drying and rewetting in the Study Reach may lead to

periodic downstream disturbances in water quality, but this would depend on myriad factors such as nutrient dynamics during intermittency and flow rates upon rewetting.

5. Flow, Sediment, and Temperature

5.1 Flow Effects on Sediment Regimes in Rivers

Sediment transport in rivers is tightly coupled with water discharge and depends on sediment sources, valley geometry, and in-channel topography. Canyon reaches are typically considered transport reaches, where sediment is predominantly transported rather than sourced or stored (Schumm 1977). Sediment supply and transport capacity determine channel geometry and habitat availability, including bedforms such as riffles, pools, and bars. When averaged temporally at a point in space, the channel-maintaining discharge, or dominant discharge, can be defined as the single most effective discharge that shapes a channel's cross section. This discharge maximizes the flow frequency with the magnitude of geomorphic work, or amount of sediment transported by the channel. Classical geomorphology literature defines this discharge to typically occur every 1-2 years (Wolman and Miller 1960), though the actual recurrence can vary depending on characteristics of the environment (i.e., climate, flashiness, history of disturbance). Though actual channel geometry formation is much more complex and depends on the entire range of flows including baseflows and large floods, these intermediately occurring channel maintenance flows are a useful concept when assessing reaches for instream flows. Channel maintenance flows flush interstitial spaces, scour encroaching vegetation and create germination surfaces, maintain channel conveyance capacity, help maintain bedforms, and recruit and transport wood (Knighton 2014, Wohl 2014).

As sediment transport zones, canyon reaches typically do not contain the same magnitude of physical diversity and biogeochemical cycling as unconfined reaches (Wohl et al. 2018). Within canyon reaches that already lack prolific habitat diversity compared to unconfined reaches, small pockets of habitat are highly valuable as they provide refugia and seasonal habitat for resident species. Aside from the need for biotic inputs, physical maintenance of these pockets of habitat requires balance between flow and sediment regimes (Poff et al. 1997; Wohl et al. 2015).

Flow regulation from dams, reservoirs, hydropower, water diversion, and other water uses impacts channel morphology by disrupting the natural flow regime and the sediment balance (Poff et al. 1997; Wohl et al. 2015; Grant 2012; Church 1995). Typical changes in channel morphology in response to flow regulation include armoring, narrowing, and degradation, though aggradation can occur from the lack of transport capacity to remove sediment inputs from tributaries or suspended sediment (Schmidt and Wilcock 2008). Flow regulation decreases topographic diversity, including pool amplitude and frequency (Duffin et al. 2023), through the accumulation of fine sediments in pools and lack of scouring flows to maintain the pools. To combat this and other potentially negative impacts of flow regulation, several

approaches have been produced for regulated reaches to achieve ecological function with environmental flows that are designed to meet human and ecosystem needs (Poff et al. 2010). Functional flows can target specific ecological functions in regulated reaches (Yarnell et al. 2015) and can even be designed to favor native aquatic species over nonnatives (Chen and Olden 2017). Larger flows, such as seasonal transition flows and peak runoff, serve ecological functions that allow channels to maintain nutrient cycling and population dynamics, and to adjust to rapid sediment inputs such as landslides and debris flows (Yarnell et al., 2015, Figure 5-1).

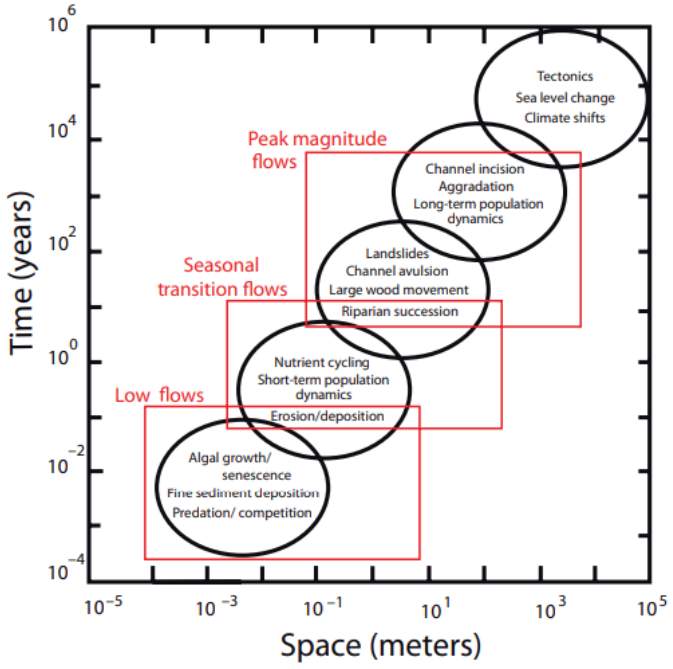


Figure 1. Examples of interrelated physical and ecological riverine processes at varying spatial and temporal scales. Key functional flows supporting specific processes are shown in boxes.

Figure 5-1.-- *Figure 1 of Yarnell et al. (2015) exemplifies the ecological and geomorphic significance of a range of flows.*

The designation of medium to high flows, or flushing flows, that regularly maintain ecosystem function on an annual to bi-annual time span, allows for the evacuation of fine material from the interstitial spaces between larger particles (Kondolf and Wilcock 1996). Flushing flows are often defined by the threshold of incipient motion for particles within the reach. Lower flows, such as consistent base flows, maintain the connection between surface water and groundwater, regulate the thermal regime, and provide consistent access to habitats along channel boundaries (Miller et al. 2016; Wohl et al., 2015). Rumsey et al. (2015) estimate that baseflows comprise up to 48% of total streamflow in the Upper Colorado River Basin. Though not as efficient at transporting sediment as flushing flows, baseflows can help prevent over-siltation of the streambed which could cause loss of habitat (Wohl et al. 2015).

The Study Reach lies within the burn scar of the 2020 Grizzly Creek Fire. Colluvial and tributary sediment sources, especially from debris flows following wildfire, add significant fine material to the Colorado River that may require flushing flows to allow the river to morphologically adjust. Extreme sediment sources such as debris flows also increase overbank flood hazards by filling in the riverbed and leading to lasting turbidity concerns (Rengers et al. 2024; Erku 2021). In 2021, a debris flow from Devil's Hole Creek, a perennial tributary entering the Colorado River from river left approximately one river mile downstream of the dam, temporarily dammed the Colorado River. Large sediment inputs and resulting flow disruptions have also occurred in Blue Gulch and the gulch near local landmark Flag Buttress at Interstate 70-mile marker 124 (Bakich, pers. comm. 2025). In addition to damaging infrastructure, debris flows create biological disturbances where recovery typically takes one to several years (Foster et al. 2020; Graber et al. 2023) but may take longer under regulated flow conditions. Biological consequences from extreme sediment inputs can include large fish kills, such as the July 2012 fish kill upstream of Dotsero caused by large sediment inputs following summer thunderstorms (Willoughby 2012). Flushing flows are necessary to redistribute fine sediment that is input to the channel from debris flows and flash floods.

In addition to extreme, infrequent events, annual high-yield sediment events also add significant sediment load to the channel within the reach. Seasonal high turbidity consistently occurs annually as upstream sources and tributaries input fine sediments to the water column. Annual anthropogenic influences also impact sediment loading, including excess sediment releases from opening of the dam gate during lower flows that do not have capacity to transport the sediment released (Bakich, pers. comm 2025). Whether increased sediment loading events are annual or episodic in nature, flushing flows are required to maintain sediment continuity within the reach.

Just as tributary junctions are biological hotspots more broadly within river networks (Benda et al. 2004), confluences with sediment sources within steep canyon reaches also serve as valuable habitat for biota. Debris fans from tributaries, debris flows, or avalanche chutes not only provide regular sources of sediment but also create adjacent channel morphology that provide velocity refugia to fish and macroinvertebrates. The velocity refugia occur in eddy pools and recirculation currents upstream and downstream of debris fans. These areas are small depositional environments in otherwise transport-dominated canyon reaches (Cinderelli and Cluer 1998, Figure 5-2). With consistent sediment input but absence of flushing flows, the velocity refugia provided in the slower recirculation currents may completely fill with sediment and eliminate disproportionately important habitat. Channel flushing flows are also known to be important in regulated canyon reaches because they allow for removal of sediment from the bed and redistribution of sediment into bars that macroinvertebrates rely on (Mueller et al. 2014; Mueller et al. 2018).

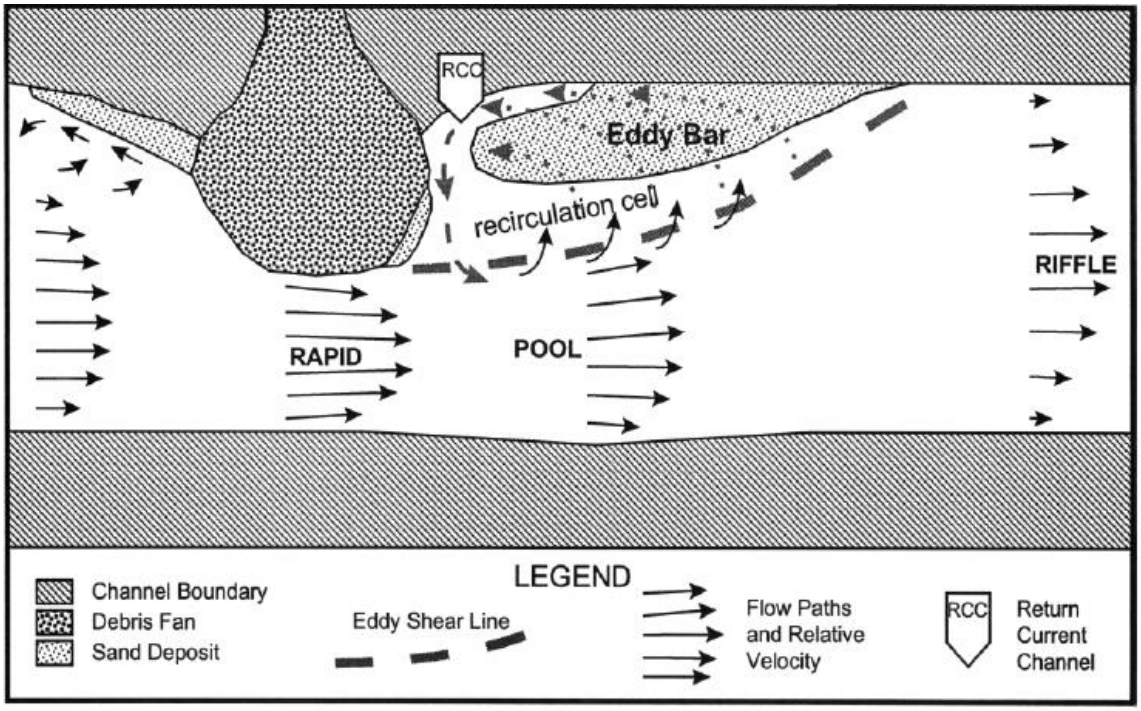


Figure 12. Schematic map showing typical channel margin sand deposits and features of lateral flow separation zones.

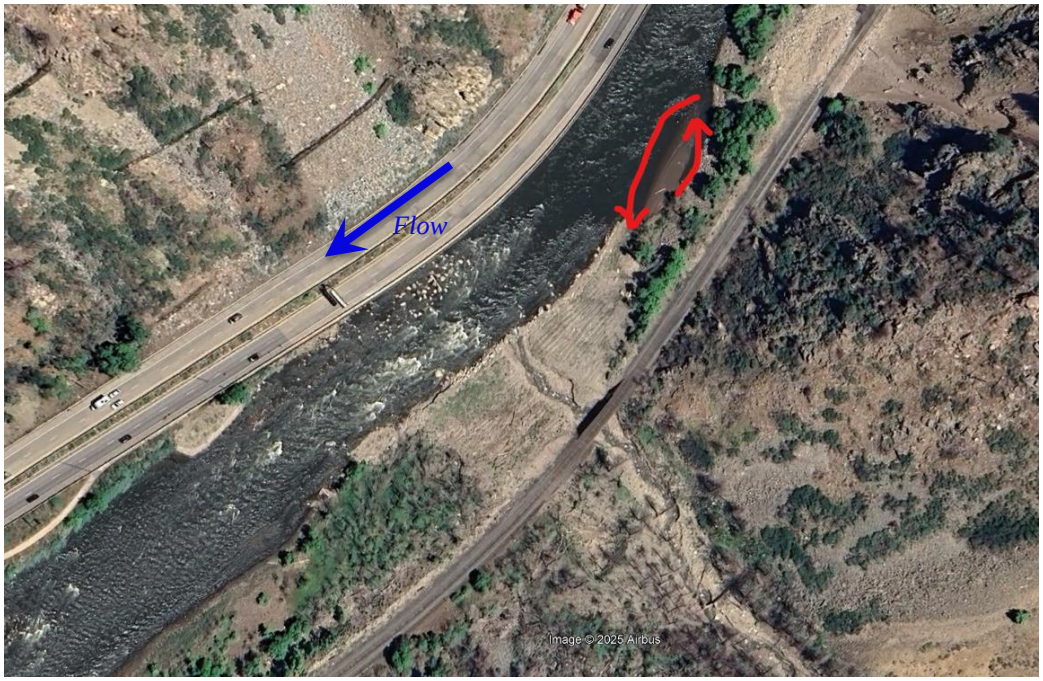


Figure 5-2.—*Cinderelli and Cluer (1998)'s Figure 12 provides a schematic of recirculation currents and eddy bars associated with sediment inputs at tributary junctions in canyon reaches (top). In Glenwood Canyon, these habitats are located upstream and downstream of steep tributary inputs (bottom).*

5.2 Flows Can Stabilize Temperatures in the Study Reach

The thermal regime of rivers controls biological function and timing, contributes to rates of biogeochemical cycling, and buffers ecological response to disturbances such as high temperature events (Olden and Naiman 2010). Major components of a stream's temperature regime include the annual range, the diel range, thermal periodicity, and the winter minimum and summer maximum temperatures (Giller and Malmqvist 1998). The range and distribution of temperatures in a stream system determine what species it can support. Aquatic species ranging from bacteria to fishes cannot regulate their body temperatures and have different thresholds of stream temperatures that they can tolerate, with decreased survival at and beyond the limits of their tolerance ranges. Accumulated thermal patterns, such as the number of days at or above a threshold temperature, determine species' maturation times and development times within their life cycles (Ward and Stanford 1982). Therefore, changes to thermal regimes can impact the survival of native coldwater and important sportfish species such as trout (Ficke et al. 2007; Bear et al. 2007; Elliot and Elliot 2010).

Stream temperature varies seasonally, daily, and spatially depending on solar radiation, atmospheric conditions, in-channel and surrounding topography, riparian vegetation, hyporheic exchange, interaction with groundwater, among other factors (Leach et al. 2023). Spatial thermal heterogeneity within streams is largely dependent on channel topography such as riffles, pools, and marginal backwater habitats. Various species selectively take advantage of thermal heterogeneity to optimize metabolic activity both under normal conditions and to maximize survival during times of stress (Armstrong et al. 2013). For example, over the course of a day, there may be more food availability in cold sections of a channel bed, but the rate of metabolism of the food obtained from colder sections can be optimized by moving to a warmer location. Increases in floodplain connectivity and habitat heterogeneity from river restoration, for example, can help enhance thermal heterogeneity that supports diverse species assemblages (Noone et al. 2024).

The thermal regime of a river is impacted by anthropogenic activity. Water temperatures below water infrastructure such as dams, and thus the ability for a stream to maintain thermal viability for species, is directly dependent on the volume of water in the stream and the temperature of the water released downstream (Mihalevich et al. 2020; Olden & Naiman 2010, Poole and Berman 2001). Inadequate flows do not provide volumes of water sufficient to buffer the impacts of radiation from extreme air temperatures (Sinokrot and Gulliver 2000), and flow diversions typically result in warm summer temperatures and cool winter temperatures outside of the river's typical range (Meier et al. 2003). Thermal regimes altered by flow regulation can also lead to asynchrony between natural seasonal patterns that cue growth, development and other components of the life cycles of species present in the reach (Vannote and Sweeney 1980; Olden and Naiman, 2010). The geomorphic homogenization of channel topography due to flow regulation (Duffin et al. 2023; Rahel 2002; Poff et al. 2007) reduces thermal heterogeneity and the opportunities for species to optimize metabolic

processes and survival through behavioral thermoregulation (Armstrong et al. 2013). Altered temperature regimes can alter the maturation time or development time of species native to the area and make them more sensitive to disturbance or more susceptible to predation.

The Study Reach is categorized as a Cold Tier I stream temperature segment by the Colorado Department of Public Health and Environment (CDPHE), with some variations from typical Cold Tier I standards depending on the time of year (5 CCR 1002-33). As shown in Table 1, temperature standards for this reach include daily maximum temperature (DM, acute) of 21.2° C and maximum weekly average temperature (MWAT, chronic) of 16.9°C between April 1st and May 31st. Between June 1st and September 30th, the segment follows Cold Stream Tier II standards of 18.3° C MWAT and 24.3° C DM. From October 1st-October 31st, the standard for DM temperature is 21.2° C and the MWAT is 16.9° C. Between November 1st and March 31st, the segment is classified under Tier II with standards of 9° C and 13° C for MWAT and DM respectively (Table 5-1).

Table 5-1.—*Temperature standards for the Study Reach.*

	Temperature Standard (°C)	
Date Range	**Daily Maximum**	**Maximum Weekly Average Temperature**
April 1st–May 31st	21.2	16.9
June 1st–September 30th	24.3	18.3
October 1st–October 31st	21.2	16.9
November 1st–March 31st	13	9

Between 2021 and 2025, the daily temperature did not exceed the DM temperature standards at the USGS gages located upstream of the Study Reach at Dotsero or downstream of the Study Reach above Glenwood Springs (Figure 5-3). Weekly average temperatures exceed the defined standards both upstream and downstream of the Study Reach (Figure 5-4).

Though daily maximum temperatures fall within the regulatory standards for reaches upstream and downstream of the Study Reach, the reach does not meet the weekly average temperature standards that were developed in part to be compatible with the biology of resident fishes. Months of July and August did not meet MWAT standards consistently between 2021 and 2024 at the upstream and downstream gages. Flow intermittency or absence of flow within the Study Reach would likely exacerbate unfavorable temperature conditions within the Study Reach, because of a lack of appropriate-magnitude continuous (i.e., baseflow) and episodic (i.e., flushing flow) cold water inputs. Maintenance of spring runoff flows and baseflows could provide thermal benefits through channel maintaining flows that physically scour pools to offer thermal refugia during summer months, and via more consistent supply of cooler flowing water during baseflow.

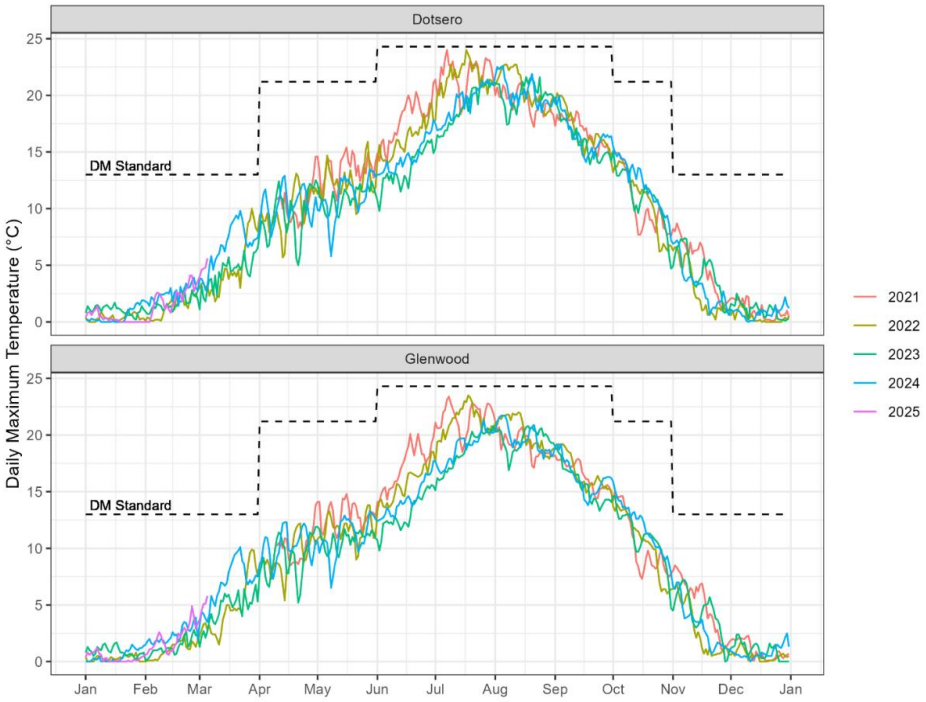


Figure 5-3.—*Daily maximum temperatures from Dotsero and Glenwood USFS stream gages on the Colorado River.*

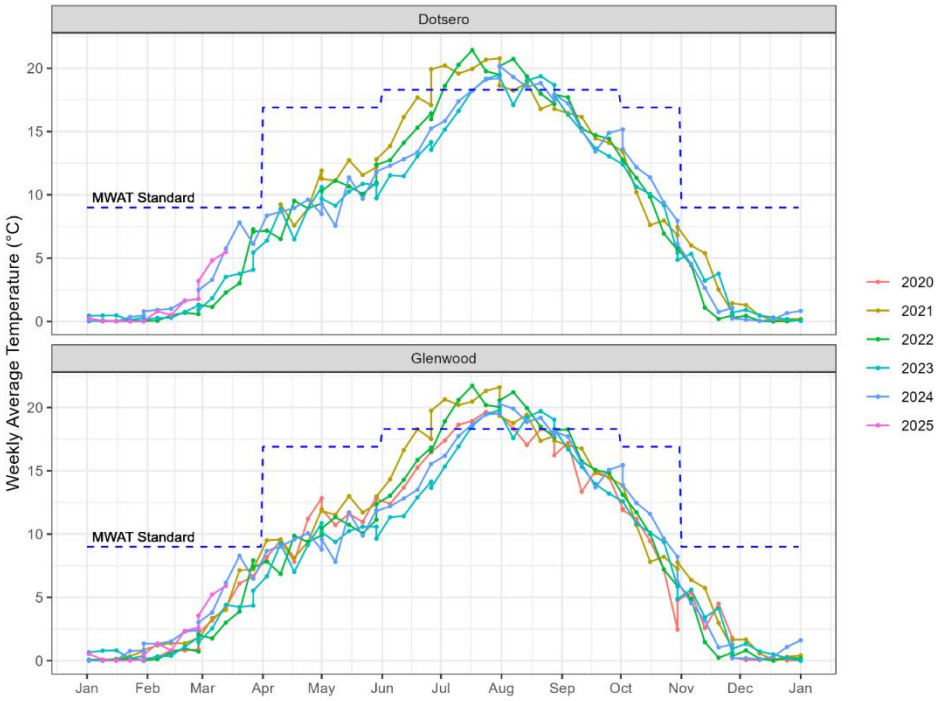


Figure 5-4.—Weekly *average temperature with MWAT standard temperature thresholds for Dotsero and Upstream of Glenwood USGS gages (Gages 09070500 and 09071750). The average weekly temperatures are calculated with continuous 15-minute temperature data.*

6. Flow and Aquatic Habitat

Stream flow and aquatic habitat availability are inextricably linked. To provide context for the ecological importance of the Study Reach, its value to native fishes is discussed in Section 6.1. Subsequent sections review the effects of flow regime in the Study Reach on habitat availability, habitat connectivity, flow-dependent biological processes that maintain connectivity, and habitat maintenance.

6.1 Native Fish Utilize Canyon Habitat

Canyon reaches are characterized by variability in flow velocity, water depth, and water temperature, because flow regimes vary in response to spring runoff from snowmelt, precipitation events, and drought. The interaction of this flow regime with the bed and bank features in canyon reaches create unique and seasonally dynamic fish habitat (Bustard and Narver 1975; Valdez et al. 2001). The Colorado River basin is largely a snowmelt driven system that experiences high water conditions in the spring and lower flow conditions in the summer that can be punctuated by high magnitude floods resulting from convective thunderstorms. This variable flow regime facilitates the survival and growth of native species as they are presumably adapted to find and utilize novel temporary habitat created by high flows.

Though field data is limited, use of canyon habitat has been documented for native fishes in the Colorado River, and these species benefit from habitats that are created by seasonal high flows. Further, connectivity between the main channel and its tributaries is also critical for native species. Connected and diverse rocky habitat found in many canyons is necessary for migration, spawning, feeding, and shelter for Bluehead Sucker and Roundtail Chub (USFWS 2018). The presence of Bluehead Sucker and the absence of White Sucker or hybrid suckers in the Study Reach supports this finding and also suggests that this area may be particularly valuable for native species. Backwaters can form when flows connect with the limited floodplain to provide nursery habitat that promotes fish growth and recruitment (Dodrill et al. 2016). Backwatering of tributaries by seasonally high flows in the Colorado River may have once provided critical rearing habitat for native juvenile fishes in the vicinity of Glen Canyon Dam (Robinson et al. 1998). Tributaries and connected floodplain are beneficial to Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub as they provide refuge (Bower et al. 2008), increase channel complexity (Fraser et al. 2017), and create spawning/nursery areas with increased nutrient availability (Magoulick and Kobza. 2003; Gido and Probst 1999). While these habitats are critical for early life stages of fish, they are utilized by all life stages. Connectivity between tributaries and the main stem provide an opportunity for native fishes to spawn in areas that are not typically utilized by undesirable nonnative species such as White Sucker or predatory species like Brown Trout (Hooley-Underwood et al. 2018;

Thompson and Hooley-Underwood 2019). Native species can be resident or migratory, but both will typically move into tributaries in spring when cued by a combination of increasing flows and increasing water temperatures; because they are often less regulated, tributaries tend to have a more natural flow pattern, thermal regime, and sediment load than mainstem systems (Fraser et al. 2017). Small ephemeral tributaries that are completely dry for most of the year also provide critical habitats for native fish. As snowmelt fills these tributaries, species such as Bluehead Sucker and Flannelmouth Sucker migrate from larger rivers to spawn in these reaches, and then quickly return to the river (Hooley-Underwood et al. 2018). Canyon habitat availability and the connectivity between the main stem of a river and its tributaries rely on sufficient flow in the main stem. Consistent base flows help maintain habitat availability in the main stem, and higher flows in spring help maintain connectivity to critical tributary habitat and to seasonally available habitats used by multiple life stages. For more details on the role of flow in maintaining sediment dynamics and physical habitat, please see Section 5.

While habitat preferences vary by fish species, Colorado's native fishes often utilize similar habitat. Bluehead Sucker and Roundtail Chub occurrence is associated with deep, rocky pools in the Colorado River. Both species feed on periphyton and macroinvertebrates that inhabit rocky substrate in canyon reaches (Holden and Stalnaker 1975; Baxter and Simon 1970). However, while species such as Roundtail Chub are associated with deep, rocky pool habitat, Speckled Dace prefer the swifter sections of pools and are not typically found in slackwater habitats (Vlach et al. 2005). Adult Flannelmouth Sucker, Bluehead Sucker, Rainbow Trout, and Brown Trout typically prefer deep water as they provide stable temperatures, larger substrates, and resting areas (Bustard and Narver 1975). Thus, inundation of the large substrate in the Study Reach should increase habitat availability, even if average velocities increase.

Further, because increased flows can increase habitat availability and variability, and because fish have species-specific habitat preferences, consistent base flows and high flows in spring may facilitate ecological partitioning in the Study Reach. Ecological partitioning occurs when aquatic habitat varies enough to allow species to occupy different physical locations based on their preferences. An extensive literature review of ecological partitioning in aquatic systems demonstrated that fish exhibit partitioning with respect to diet/food availability, physical habitat, and/or timing of usage, and that partitioning appears to allow coexistence of fish species (Ross 1986). This is significant for the Study Reach for two reasons. First, consistent base flow and increased flows in spring would increase habitat variability. Second, many of Colorado's native fishes lack behavioral mechanisms to deal with nonnative predators or competitors, and introduced game fishes such as Rainbow Trout are adapted to environments with limited fish species richness. Therefore, stable base flows sufficient to permit ecological partitioning could reduce negative interspecific (i.e., between-species) interactions, to the benefit of the resident fishes in the reach; this benefit could be increased with a flow regime that included higher flows during spring runoff. On the other

hand, habitat partitioning is less evident in streams with unstable flow regimes and/or large, sudden fluctuations in environmental variables like flow and water chemistry (e.g., Matthews and Hill 1980). Thus, it is possible that an intermittent flow regime or one where flows changed rapidly due to water management would limit or prevent ecological partitioning, consistent base flow would facilitate ecological partitioning, and high flows in spring would further increase opportunities for ecological partitioning in the Study Reach.

6.2 Instream Flows Maintain Interstitial Habitat

Interstitial spaces, or clear spaces between gravel and cobble substrate, are a major component of both physical and biological processes, and the absence of this habitat negatively impacts fish and macroinvertebrate assemblages (e.g., Kondolf et al. 1993; Gayraud and Philippe 2001). The biological implications of the available interstitial space among gravel and cobble stream substrate are discussed here. Specific flow dynamics required to maintain clean sediment are discussed in Section 5.1.

Interstitial spaces are a critical component of fish habitat. Fish such as sculpin and dace live some or all of their lives in the interstitial spaces in riffles (See Section 2.1). Further, interstitial spaces are critical for reproductive success of salmonids. Interstitial habitats are sensitive to low or intermittent flows for two reasons. First, because they do not store water like pools, riffles are particularly prone to drying during low flows (Rolls et al. 2012), which leads to loss of habitat for multiple fish species. Second, low flows and/or lack of flushing flows can facilitate infilling of interstitial spaces with fine sediment. Excess sediment can adversely affect salmonid spawning habitat by eliminating or reducing its capability to support fish eggs, alevins, and juvenile fish (Wood and Armitage 1997, Chapman 1988, and Moring 1982). The time between egg deposition and emergence of young from the gravel is typically several months for salmonids. During this time, fine sediment can have deleterious effects on embryonic development and emergence (Wood and Armitage 1997, Olsson and Petersen 1986). For example, infilling of interstitial spaces can prevent flow from delivering oxygen or removing metabolic wastes from salmonid redds and can prevent fry from emerging from the substrate (Kondolf et al. 1993, Moring 1982).

Excess sediment alters substrate composition (and therefore macroinvertebrate habitat) on the surface of a riverbed and within the hyporheic zone. Reduced substrate porosity and infilling of interstitial spaces eliminates habitat that is utilized and/or preferred by many macroinvertebrate taxa (Wood and Armitage 1997). For example, riffle-dwelling species such as caddisflies require benthic substrate with heterogenous substrate, interstitial spaces, and connectivity to the hyporheos for refuge and foraging habitat (e.g., Natsumeda and Iguchi 2019). Therefore, sedimentation of interstitial spaces at the streambed and in the hyporheic zone may significantly reduce macroinvertebrate habitat and limit secondary production (Richards et al. 1994). Excess sedimentation has been shown to affect macroinvertebrate assemblages by inducing emigration from the reach (Wood and Armitage

1997). Surface dwelling macroinvertebrates, especially those sensitive or most exposed to sediment like stoneflies and mayflies, will emigrate immediately in response to increasing sediment levels (Rosenberg and Wiens 1978).

Therefore, base flows, which help maintain sediment dynamics through near-constant transport of small amounts of fine sediment (Wohl et al. 2015, See Section 5.1), are important for maintenance of fish and macroinvertebrate habitat. Further, because the Study Reach receives sediment from canyon walls, ephemeral and perennial tributaries, and dam releases, higher, flushing flows may be needed to disrupt the riverbed armor layer and resuspend fine sediment that has infiltrated the benthos and hyporheic zone (Gayraud and Philippe 2001).

6.3 Instream Flows Maintain Longitudinal Habitat Connectivity

Moderate to high flows would likely increase the longitudinal connectivity within the Study Reach. A limited number of studies have examined the effects of flow on fish passage over natural obstacles. Some studies have indicated that low flows increase successful movement over waterfalls (e.g., Lennox et al. 2018), and others have indicated that low flows can prevent migration of adult salmonids (e.g., Warren et al. 2015). However, these studies focused on streams with perennial flow regimes and did not address the effects of extremely low flows or intermittent flows on fish passage; fish passage in the Study Reach is highly restricted under the current flow regime. Consistent base flows and periodic higher flows could facilitate fish passage through the Study Reach in multiple ways. First, increased flow can decrease effective drop heights in cascades and at vertical drops. An increase in pool depth downstream of an obstacle has a positive effect on fish passage probability and drop height from the pool to the crest of the obstacle decreases passage probability (Kondratieff and Myrick 2006, Lauritzen et al. 2010). Under high flows, the increase in downstream pool depth and the decrease in drop height can facilitate migration over obstacles for multiple fish species, including salmonids (e.g., Schwalme et al. 1985). Second, increased flows cause an increase in cross-sectional complexity; even if water velocities and turbulence in the thalweg present conditions that are not conducive to fish passage, alternate pathways will likely become available as new areas are inundated near the margins of the stream. Multiple studies of fish passage in a whitewater park demonstrated that adult trout and suckers were unable to move across selected structures at base flows but were able to do so at higher flows, presumably because multiple pathways for upstream movement become available as flows increase (e.g., Fox et al. 2016; Stevens et al. 2015). Increased flows in a confined reach of the Cache la Poudre River also appear to inundate alternate pathways for upstream fish movement (discussed briefly in Stack et al. 2024). This is likely the case in the Study Reach as well (Figure 6-1); many flow pathways that present vertical obstacles under low-flow conditions could likely be navigated without jumping at higher flows. Maintaining connectivity within the Study Reach will benefit resident fishes (See Section 2.1 for information on the importance of movement to native fishes).

6.4 Instream Flows Control Fish and Macroinvertebrate Drift

Ecological connectivity within the Study Reach also depends on drift of larval fishes and of macroinvertebrates; drift rates are affected by flow regime. Drift of early life stages of riverine fish is an important part of their life histories and may help maintain population connectivity and increase or maintain geographic range (Lechner et al. 2016). Native Colorado River fishes (e.g., Bluehead Sucker, Flannelmouth Sucker, Roundtail Chub, native sculpin, and Speckled Dace) hatch from eggs deposited from gravel bars. Larval drift begins in mid-July, on the descending limb of the hydrograph (Carter et al. 1986).

Dispersal by drift is a critical component of the life history of many fishes, as it transports them from spawning to rearing areas. Larvae drift passively with the current until they can swim well enough to leave the current and select near-shore habitats (Robinson et al. 1998). Thus, flows must be sufficient to allow dispersal from spawning to rearing areas. Flow-mediated drift to allow dispersal of early fish life stages within the Study Reach is still important, even though long-distance dispersal from upstream reaches would be prevented by the Shoshone Dam.



Figure 6-1.—*Vertical drop in Upper Death Rapid that would likely be more passable at higher flows.*

While most fish larvae drift on the descending limb of the hydrograph, macroinvertebrate drift occurs at a wide range of flows, including during floods and spring runoff. Drift is a fundamental process in rivers that allows macroinvertebrates to disperse and colonize new habitat, escape from predation, and avoid unfavorable conditions (Kennedy et al. 2013, Caldwell et al. 2018). Drift in response to flow can have a profound effect on macroinvertebrate community composition and size distribution. Most organisms are behavioral (i.e., not accidental) drifters at low flow, and drift appears to be species- and life-stage specific (i.e., due to varying swimming ability). A study by Kennedy et al. (2013) on the Colorado River below Glen Canyon Dam determined that short-term increases in discharge below the dam induced drift in mobile collector-gatherer macroinvertebrates. They also determined that a twofold increase in daily flow discharge increased drift concentrations linearly for chironomids and exponentially for certain amphipod and snail taxa, indicating that river discharge alters drift behavior among macroinvertebrate assemblages on a short time scale. A study on a small coldwater stream below an active diversion determined that invertebrate drift increased with increases in streamflow, average body size of invertebrates decreased with decreases in streamflow, and that significant reductions in streamflow significantly reduced drifting behavior (Caldwell et al. 2018). Macroinvertebrates will also accidentally enter the drift after being dislodged from substrate during high flows. For example, during an experimental flood on the Colorado River, macroinvertebrate drift densities followed the same pattern as sediment transport, indicating that drift was passive and not behavioral at peak or runoff flows (Robinson et al. 2004). While drift in response to high flow events can lead to large local reductions in macroinvertebrate density, the process is still beneficial. For example, investigations of the food web in the Colorado River downstream of Glen Canyon Dam before and after an experimental flood showed a dramatic decrease in macroinvertebrate density but an increase in fish biomass due to higher drift rates and higher production of more desirable macroinvertebrate prey (Collins et al. 2011).

Macroinvertebrates drift to disperse and maintain population connectivity, but this process also delivers macroinvertebrate prey to drift-feeding fishes. Drifting organisms account for large portions of certain fish species diets and is a crucial element in sustaining a natural and healthy river food web. Further, drift density and taxonomic composition is a function of local processes and not attributable to distant sources such as tributaries or distant, upstream reaches (Danehy et al. 2011), indicating that the magnitude and the variability of the flows released from Shoshone Dam would have direct effects on the rate and composition of drift in the Study Reach.

These studies on the effects of flows on macroinvertebrate drift illustrate the importance of consistent base flows and spring runoff flows in maintaining natural invertebrate behavior. Drift is affected by anthropogenic alteration of a wide range of flows, and altered drift patterns can subsequently alter macroinvertebrate assemblages (Caldwell et al. 2018). When alteration of high or low flows changes macroinvertebrate drift patterns, macroinvertebrate assemblages and the aquatic food web can be impacted.

6.5 High Flows Maintain Canyon Habitat

Peak flows are a crucial component for maintenance of aquatic habitat in canyons (Bunn and Arthington 2002). Higher flows increase aquatic habitat by inundating undercut banks, large, low-velocity spaces between boulders, and low-velocity areas downstream of boulders (referred to hereafter as velocity refuges) (e.g., Bustard and Narver, 1975). Providing consistent base flows and allowing them to increase during spring runoff would increase the availability of shoreline habitat for resident fishes. While habitat analyses based on hydraulic modeling may indicate that habitat suitability decreases once flows increase past a certain, site-specific threshold, high flow events typically do not significantly affect distribution and abundance of native fish in canyon reaches. Instead, negative effects have typically been observed in small-bodied invasive species (Valdez et al. 2001).

In many cases, the relationship between flow and aquatic habitat availability/quality is analyzed with a combination of hydraulic models and known information about fish habitat preferences. Often, these models indicate deterioration of habitat with increased flows. The disconnect between modeling results that indicate deteriorating habitat quality/quantity at high flows and the presence of native fish in canyon reaches at all flow stages likely has to do with an incomplete understanding of canyon systems. The incredible complexity of flow in steep canyon reaches is difficult to model, the understanding of fish swimming behavior in these complex flow fields is limited, and habitat suitability information for fish is typically not derived from deep, turbulent systems such as canyons. There is little question that use of one-dimensional, two-dimensional or three-dimensional hydrodynamic models (1D, 2D, and 3D models, respectively) greatly increase our understanding of how hydraulic conditions change with flow in natural systems. However, all hydraulic models have limitations, particularly at small scales that are relevant to a fish. For example, 1D and 2D hydraulic models provide cross-section and depth-averaged hydraulics, respectively, which are useful for characterizing habitat in low-gradient reaches such as pool-riffle complexes. Within canyon reaches, boulder roughness may create slower velocities and refugia at higher flow rates, which cannot be fully captured by these models. The terrain in the project area was captured using comprehensive drone and ground survey and used to develop a modeled surface of Upper Death Rapid in the Study Reach (Figure 6-2). This effort resulted in a representation of the complex and rough stream bed. However, despite detailed surveying, the large interstitial velocity refuges between the boulders in the Study Reach are not well-characterized (Figure 6-1). Further, species-specific microhabitat preferences in canyon habitat are not well understood, due to difficulties associated with collecting fish location data in fast, deep stream reaches. However, multiple laboratory and fishway prototype studies have shown that fish detect flow through multiple sensory pathways, utilize behaviors such as flow refuging and exploitation of vortices to save energy, and are adept at locating hydraulic conditions that are advantageous to them (e.g., Sutterlin and Waddy 1975; Castro-Santos 2005; Liao 2007). This suggests that fish are utilizing small-scale habitat patches in canyon reaches that cannot be described with hydraulic models.

Many of Colorado's native fishes are adapted to and can be found in canyon habitats, including the Study Reach. Consistent base flow in the Study Reach would provide year-round habitat for these species, as well as game species such as Brown Trout and Rainbow Trout, because they can utilize habitat in large interstitial or behind-boulder velocity refuges. Periodic high flows (i.e., increased flows during the spring runoff period) would increase habitat availability in the Study Reach by creating more habitat between and behind large boulders.

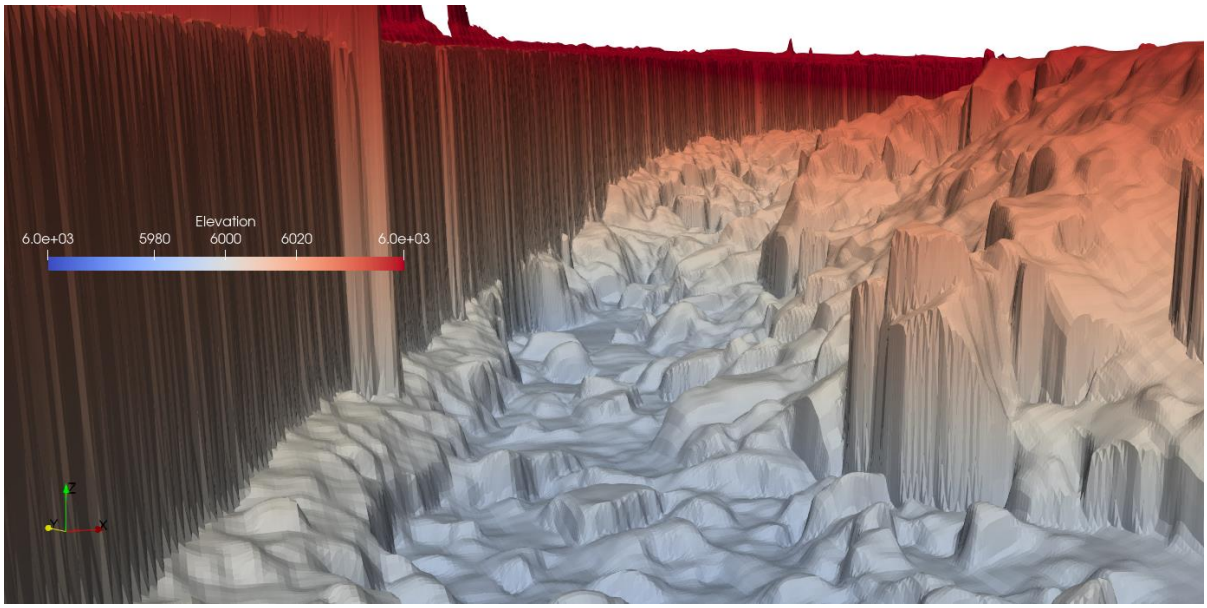


Figure 6-2.—*Modeled surface of Upper Death Rapid, below Shoshone Dam.*

7. Conclusion

The data, literature review, and syntheses contained in this report provide a biological basis for establishing consistent base flows and periodic high flows in the Study Reach. This synthesis incorporated information from studies focused on fish/macroinvertebrate biology, food webs, fluvial geomorphology, and lateral and longitudinal stream connectivity. Together, these studies show how a natural flow regime shapes and supports aquatic systems, and site-specific examples detail the potential benefits of instream flows for the Study Reach.

Fish data from the Study Reach and surrounding area on the Colorado River indicate that fish populations are relatively similar upstream of the Study Reach and within it. CPW data indicate that the Colorado River supports multiple SGCN-1 species (Colorado River Cutthroat Trout, Bluehead Sucker, Flannelmouth Sucker, and potentially Roundtail Chub), as well as Mountain Whitefish. The site sampled within the Study Reach displayed comparable sportfish densities and biomasses to the other sites, but it supported a lower number of nonnative species and hybrids than the other sites. These data suggest that the Study Reach may be particularly valuable to native fishes and that SGCN species and sportfish will inhabit the Study Reach in greater numbers given adequate flow conditions.

Macroinvertebrate data analyzed from a perennial section of the Study Reach and from upstream reaches on the Colorado River showed that sensitive taxa and long-lived taxa were present at all sites. Analysis of macroinvertebrate community metrics showed that the upstream Colorado River sites have greater diversity, slightly greater MMI scores, and more favorable HBI and TIV_{SED} scores than the Study Reach. The difference in scores suggests that existing flow conditions in the Study Reach are negatively affecting the macroinvertebrate assemblage by selecting for species more tolerant to disturbances such as sedimentation. The differences in scores upstream and within the Study Reach emphasizes the potential of the Study Reach to support a robust and ecologically valuable macroinvertebrate community, given a more natural flow regime.

Consistent base flows and periodic high flows would provide major benefits in the Study Reach that include maintenance of food webs and sediment dynamics, dampening of temperature extremes, and increased aquatic habitat. While intermittent flow regimes do support fish and macroinvertebrate communities, specific challenges exist in these systems. Food webs and nutrient dynamics are highly variable in space and time, sediment and temperature dynamics are altered compared to perennial systems, and aquatic habitat is not consistently connected or available. Thus, if an intermittent flow regime or a fully dewatered condition persists in the Study Reach, the fish and macroinvertebrate community will not be as robust as they are in adjacent reaches of the Colorado River.

Logistic difficulties associated with sampling limit our understanding of the geomorphic, biological, and ecological conditions in canyon habitats such as the Study Reach. However, based on the empirical data and the literature presented in this report, it is our opinion that the Study Reach will benefit significantly from consistent base flows, as well as periodic high flows, and that some or all of these benefits will propagate to downstream reaches of the Colorado River.

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Colorado Springs Utilities
It's how we're all connected

Enclosure H
Agenda Item 10.d
CWCB Board Meeting
May 21-22, 2025

May 8, 2025

Ms. Lauren Ris, Director
Colorado Water Conservation Board
1313 Sherman St., Room 718
Denver, Colorado 80203

Re: Colorado Springs Utilities' Comments on the River District's Request to the Colorado Water Conservation Board for Acceptance of Shoshone Water Rights for Instream Flow

Dear Ms. Ris,

We are writing in regard to the Colorado River Water Conservation District's ("River District") proposed offer of an interest in the senior and junior Shoshone water rights to the Colorado Water Conservation Board ("CWCB") for instream flow ("ISF") purposes. The purpose of this letter is to provide Colorado Springs Utilities' specific comments on the CWCB's proposed acquisition of an interest in and judicial change of the Shoshone water rights.

Colorado Springs Utilities, the River District, and several other West Slope entities entered into a Memorandum of Agreement in which Colorado Springs Utilities agreed not to oppose adding ISF purposes as a decreed use of the senior Shoshone right, and agreed to negotiate in good faith to add ISF uses to the junior Shoshone right. Colorado Springs Utilities does not oppose the acquisition and subsequent change of the senior Shoshone water right to provide for permanency of the historic Shoshone call and preservation of the historical Colorado River flow regime. However, Colorado Springs Utilities is concerned that the River District's proposed methodology for determining the historical use of the senior and junior Shoshone water rights will result in the expansion of the junior right that could materially injure Colorado Springs Utilities' and other decreed water rights owned by users across the State of Colorado.

The *Rules Concerning The Colorado Instream Flow and Natural Lake Levels Program* (2 CCR 408-2) (the "Rules") require the CWCB to consider: (a) the natural flow regime of the river; (b) any potential material injury to existing decreed water rights; and (c) the historical use of the water right proposed for acquisition that may be available for ISF when evaluating the appropriateness of any acquisition of water for ISF purposes. Therefore, it is critical for the change of use of the senior and junior Shoshone water rights for ISF purposes to be supported by a quantification of the historic beneficial use of the right that is based on diversions of native water available in priority and put to beneficial use. Colorado Springs Utilities is concerned that the River District's proposed methodology for quantifying the historic use of the Shoshone water rights does not meet this standard and could have significant and consequential effects on the administration of the mainstem of the Colorado River and its tributaries above the Shoshone power plant. Specifically, Colorado Springs Utilities has the following concerns with the River District's proposed methodology:

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1. The proposed methodology defines the study period as 1975-2003 which excludes the most recent 21 years of beneficial use of the Shoshone water rights for hydroelectric power generation.
2. We have concerns with proposed methodology for determining historic use of the Shoshone water rights. An appropriate methodology is to limit Shoshone water rights historic use to the lesser of available (a) natural Colorado River streamflow unenhanced by upstream reservoir releases, and (b) diversions that were demonstrated to have been put to beneficial use as recorded in Colorado's Decision Support System. This database stands as the official public record of diverted water put through the Shoshone power plant generating turbines and were provided annually to the Colorado Division of Water Resources by the owner of the Shoshone water rights.
3. The River District's proposed methodology does not appropriately factor outages of the Shoshone power plant. The diversion record period should include zeros by default when the power plant was not operating. In other applications the non-use of a water right is carried as a zero when historic use is determined. If non-maintenance outages occurred, then appropriate evidence must be provided to support using a non-zero record. This will prevent inflating the average annual volumetric.

An analysis performed on behalf of the FRWC members indicates that, due to these discrepancies, the River District's preliminary historic use analysis inflates the historical use of the Shoshone water rights by approximately 40%, resulting in an expansion of use of the Shoshone water rights, especially the junior right. Specifically, the River District's proposal showing the Bishop Brogden Associates annual volumetric (WY 1975-2003) is 844,644 acre-feet. On the contrary, using a more recent study period, appropriately factoring times of power plant outage, and appropriately utilizing water user supplied diversion records would result in an annual use volume of about 592,190 acre-feet – **a difference of over 250,000 acre-feet.** Such an expansion based on a flawed historic use analysis would negatively impact all water supplies above the Shoshone power plant, and potentially negatively impact timing of flows through the 15-Mile Reach that supports the Upper Colorado River Endangered Fish Recovery Program. Any reduction in water supplies from a growing community like Colorado Springs results in increased reliance on changing agricultural water rights in other basins to meet their customers' demands and limits our ability to fully develop our Colorado River basin supplies. This outcome would seem contrary to the goals of the Colorado State Water Plan.

The Rules also require the CWCB to consider the effect of the proposed acquisition on any relevant interstate compact issue, including whether the acquisition would assist in meeting compact obligations or result in the delivery of more water than is required. While the use of the Shoshone water rights for ISF purposes may help Colorado continue to meet its obligations under the Colorado River Compact and Upper Colorado River Compact of 1948, it is important that the ISF use not reduce the amount of Colorado River water available for existing users and future water supply development within the State under Colorado's Compact apportionments. If the changed Shoshone water right for ISF purposes results in an expansion of historical use under the Shoshone water rights, then more water may be delivered than required under Colorado's compact obligations.

Colorado Springs Utilities, along with other FRWC members, have shared these concerns with River District and other impacted parties, but the River District has not yet been willing to alter their

methodology to address our fundamental concerns. Colorado Springs Utilities encourages the CWCB to work with the River District and other interested parties to develop an agreed upon methodology for determining the historic use of the Shoshone water rights in advance of any decision to accept the Shoshone water rights in an ISF program. A consensus methodology would ensure that the CWCB's exercise of the Shoshone water rights for ISF purposes does not injure other water users. If an appropriate methodology cannot be agreed upon by the parties, then Colorado Springs Utilities requests that the CWCB not endorse a particular methodology or volumetric quantification but rather should affirmatively state in any approved acquisition agreement that it will rely on the Water Court's determination of the proper methodology and resulting volumetrics.

Colorado Springs Utilities also believes that the following terms and conditions are necessary components of an agreement for the CWCB's acceptance of an interest in the Shoshone water rights for ISF purposes to ensure consistency with law and to protect its decreed water rights from injury:

1. The Upper Colorado River Endangered Fish Program shall not be impaired by the use of the changed Shoshone water rights for ISF purposes.
2. Use of the changed Shoshone water rights for ISF purposes shall not impair use or development of Colorado River water under the Colorado River Compact, including currently decreed and operating water rights.
3. Use of the changed Shoshone water rights for ISF purposes must be subject to appropriate seasonal volumetric limitations reflective of the quantified historical use as determined by an adjudicated change decree.

Thank you in advance for consideration of Colorado Springs Utilities' comments. We look forward to working with the CWCB, River District, and other stakeholders to develop an agreed upon methodology for determining the historic use of the Shoshone water rights as well as terms and conditions necessary to protect water rights from injury in advance of any CWCB decision to accept the Shoshone water rights in an ISF program. Please do not hesitate to contact me if you have questions.

Sincerely,

Lisa Barbato

Lisa Barbato
Chief System Planning & Projects Officer

Cc: Colorado River District; Andy Mueller, Peter Flemming, Jason Turner

Aurora Water
City of Aurora
26791 E Quincy Ave.
Aurora CO 80016
phone 303.739.7370
AuroraGov.org

May 9, 2025

Colorado Water Conservation Board
ATTN: Director Lauren Ris
1313 Sherman Street, Room 718
Denver, CO 80203

RE: Concerns Regarding Proposed Changing to the Shoshone Water Rights to Include Instream Flow as an Authorized Use

Dear Director Ris:

The City of Aurora appreciates the Colorado Water Conservation Board's leadership in advancing streamflow protection through the instream flow (ISF) program. Aurora has long supported collaborative and balanced approaches that preserve river flows while protecting existing water rights. In that spirit, Aurora respectfully submits this letter to express specific concerns with the current proposal to add ISF use to the senior and junior Shoshone water rights.

As a statewide agency, the CWCB plays a critical role in ensuring that instream flow acquisitions are implemented in a manner that protects all Colorado water users and upholds the integrity of the prior appropriation system. In doing so, the CWCB must take a balanced, statewide view that accounts not only for environmental objectives but also for the legal and operational impacts to existing water rights. It is essential that the outcome of this process is an ISF right that reflects the historical flow regime of the river, not one that is improperly expanded to the detriment of other water users.

As a party to the 2018 Intergovernmental Agreement (IGA) on Shoshone Permanency, Aurora agreed not to oppose a change to the senior Shoshone water right to include ISF as a decreed use and committed to negotiating in good faith regarding the junior Shoshone right. Aurora continues to support efforts to preserve the streamflow regime historically maintained by the Shoshone Power Plant. Consistent with the 2018 IGA, Aurora does not oppose the loan and subsequent change of the senior Shoshone right if it serves to maintain the historic Shoshone call and the historical flow regime of the Colorado River.

However, Aurora has significant concerns that the River District's proposed methodology for determining the historical use of both the senior and junior Shoshone rights may result in an unlawful expansion of those rights. Such expansion poses a substantial risk of material injury to Aurora's water rights and to other decreed water rights held by users across Colorado.

Specifically, Aurora is concerned that the current historical use (HU) analysis underpinning the proposed change suffers from the following flaws:

1. It includes pre-1998 data that reflects releases from Green Mountain Reservoir, rather than isolating natural flow available to the Shoshone diversion;

2. It ends the study period in 2003, omitting more recent years with significant outage periods and over 30% of the driest years;

3. It excludes outage periods from volumetric averages which artificially inflates the calculated historical use; and

4. It relies on the Dotsero gage, which overstates diversions, rather than on CDSS diversion records that more accurately reflect hydropower deliveries at Shoshone.

Aurora's analysis indicates that these deficiencies could result in inflated historical use estimates—by hundreds of thousands of acre-feet—and lead to a material expansion of the Shoshone rights, to the detriment of existing water rights, including Aurora's.

These concerns are consistent with positions Aurora has previously communicated directly to the Colorado River Water Conservation District. Aurora maintains that any change to the Shoshone rights to include ISF use must be based on a credible and accurate historical use analysis and must avoid injury to other water rights.

If the parties are unable to agree on an appropriate methodology, Aurora respectfully requests that the CWCB refrain from endorsing any specific methodology or volumetric quantification. Ideally, the CWCB would support and help facilitate a collaborative process in which all stakeholders work together to identify a methodology that protects the stream while avoiding injury to the water rights of utilities serving the majority of Colorado's citizens. If such a facilitative role is not feasible, the CWCB should remain neutral in the Water Court proceedings and defer to the Court's determination of the appropriate methodology and volumetric quantification.

Aurora remains committed to continued good-faith engagement with the River District, the CWCB, and other stakeholders to reach a durable and legally sound outcome—one that protects instream flows while safeguarding Colorado's existing water rights system.

Thank you for your time and consideration. We welcome the opportunity to further discuss our concerns and to contribute to the development of a fair and sustainable path forward.

Sincerely,



Marshall Brown,
General Manager
Aurora Water

CC:
Colorado River Water Conservation District

CWCB-Facilitated Process for Historical Use Resolution

Proposed One-Page Summary

Purpose:

To establish a transparent, technically sound, and collaborative process to evaluate and agree upon the historical use (HU) of the senior and junior Shoshone water rights. The goal is to support a defensible instream flow (ISF) agreement that protects the Colorado River while avoiding injury to existing water rights.

Summary:

The CWCB would serve as convener of a structured, time-bound process involving the Colorado River Water Conservation District (CRWCD), members of the Front Range Water Council and possibly other key stakeholders. The goal is to collaboratively evaluate and agree on the appropriate methodology for determining historical use of the Shoshone water rights to ensure an accurate ISF proposal that achieves permanent Shoshone flows based on historical use without enlargement of rights or injury to existing users.

Key Process Elements

- **CWCB as Neutral Convener**
  - Facilitates the process without endorsing a specific outcome.
  - Designates a neutral facilitator or mediator.
- **Inclusive Stakeholder Participation**
  - CRWCD
  - FRWC members
  - CWCB staff and legal counsel
  - Division Engineer for Water Division 5
  - Colorado Attorney General's Office (as needed)
  - Public Service Company of Colorado (if applicable)
  - Other affected water right holders
- **Ground Rules**
  - Commit to transparency, respectful dialogue, and shared technical understanding.
  - Acknowledge that the Water Court retains final authority.

- **Technical Workgroup Formation**
  - Joint team from CRD, FRWC and CWCB
  - Tasks:
    - Agree on the period of record.
    - Assess proper data sources.
    - Define how outage periods are treated.
    - Develop and compare HU scenarios.
    - Impact of existing agreements.
- **Shared Review and Facilitation**
  - Present side-by-side HU alternatives.
  - Facilitate discussion to build consensus or clarify areas of disagreement.
- **Framing for Water Court**
  - If no full agreement is reached:
    - Document agreed elements and outstanding issues.
    - Support Court review with a shared technical record.

Proposed Timeline (60–120 days)

- **Weeks 1–2**: Convening and scoping
- **Weeks 3–6**: Technical team analysis
- **Weeks 7–10**: Stakeholder review and discussion
- **Weeks 11–16**: Final facilitation and documentation

Expected Benefits

- Promotes transparency and accountability
- Builds interbasin trust and collaboration
- Reduces litigation risk
- Strengthens legal defensibility of ISF acquisition
- Protects both streamflows and municipal water supplies

Aurora encourages the CWCB to lead this process and supports a collaborative path toward a balanced and legally sound resolution.

MESA COUNTY

BOARD OF COMMISSIONERS

District 1 – Cody Davis 970-244-1605
District 2 – Bobbie Daniel 970-244-1604
District 3 – JJ Fletcher 970-244-1606

May 20, 2025

Colorado Water Conservation Board
1313 Sherman Street
Room 718
Denver, Colorado 80203

RE: Proposed Acquisition of an Interest in the Shoshone Water Rights for Instream Flow Use on the Colorado River, Water Division 5

Dear Colorado Water Conservation Board Members:

Thank you for the opportunity to express our support for the proposed acquisition offered by the Colorado River Water Conservation District ("River District") and Public Service Company of Colorado ("PSCo") to the CWCB for an interest in the Shoshone Water Rights for instream flow ("ISF") use on the mainstem of the Colorado River. The permanency, reliability, and assurance offered by this agreement cannot be understated.

This historical opportunity has the potential to provide vital reliability to the Upper Colorado Endangered Fish Recovery Program, ensuring continued operation in the critical 15-mile reach. The ability to safeguard important wildlife habitat and provide a better and more stable ecosystem for all species dependent on this crucial waterway is reason enough to support this proposal.

However, the Shoshone water also offers essential reliability to communities dependent on the Colorado River for drinking water. It supports water users such as agricultural producers who face increasingly challenging conditions in ensuring food security and preserving an important piece of Western Colorado's history and way of life. It provides for continued recreational opportunities which connect users to nature, improve mental and physical health, and contribute to Western Slope economies.

The benefits of improving water quantity and quality to the Colorado River are multi-faceted and extend far beyond Western Colorado. We encourage your support of this proposal by the River District and PSCo and look forward to the positive impacts this will have for generations.

Sincerely,

Cody Davis, Chair
Mesa County Board of Commissioners

Bobbie Daniel
Commissioner

JJ Fletcher
Commissioner

CC: Todd Hollenbeck, Mesa County Administrator
Todd Starr, Mesa County Attorney
Mesa County Administration

FRONT RANGE WATER COUNCIL

1600 West 12th Avenue
Denver, CO 80204-3412

Privileged and Confidential Atty-Client Communication/Work Product
Provided Pursuant to Joint Defense Privilege

May 12, 2025

Colorado Water Conservation Board Members
1313 Sherman St., Room 718
Denver, Colorado 80203

Re: May 2025 Colorado River Water Conservation District request to CWCB for acquisition of interest in Shoshone Water Rights for Instream Flow (ISF) purposes.

Dear Colorado Water Conservation Board Members,

On behalf of the Front Range Water Council (FRWC), I am sending this letter to provide our joint comments on the Colorado River District's offer of an interest in the Senior and Junior Shoshone water rights (Shoshone Water Rights) to the Colorado Water Conservation Board (CWCB) for instream flow purposes.

The FRWC consists of Northern Colorado Water Conservancy District, Denver Water, Aurora Water, Pueblo Water, Colorado Springs Utilities, Twin Lakes Reservoir and Canal Company and the Southeastern Colorado Water Conservancy District. Each FRWC member's respective system responds to calls placed by the Shoshone Water Rights differently and have the potential to be impacted by the River District's proposed addition of instream flow use to the Shoshone Water Rights in different ways. For this reason, the individual FRWC members have additional concerns that will be discussed by them in separate letters.

The FRWC members support the CWCB's acquisition of an interest in and the judicial change of the Senior Shoshone water right to instream flow purposes to provide for permanency of the Shoshone historical call and maintenance of the historical flow regime of the Colorado River and its tributaries to maintain the status quo. However, the River District and the FRWC have significant differences over what constitutes maintenance of the status quo.

The CWCB must consider several factors when determining the "appropriateness" of any acquisition of water for instream flow purposes and what terms and conditions it will accept in the acquisition contract. Among the factors that the CWCB must consider is the natural flow regime of the river, any potential material injury to existing decreed water rights, and the historical consumptive use, or in this case, the historical use, and historical return flows of the water right proposed for acquisition that may be available for instream flow use. The CWCB must also consider the effect of the proposed acquisition on any relevant interstate compact issue, including whether the acquisition would assist in meeting compact obligations or result in the delivery of more water than is required, thereby depriving Colorado water rights of water available under the Compact's apportionment.

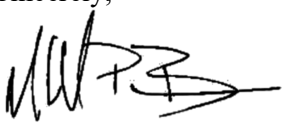
The FRWC's significant differences with the proposed acquisition have been previously described by its members to the River District. The River District's preliminary proposal for the acquisition of the Shoshone Water Rights and addition of instream flow purpose fails to accurately reflect the status quo. The proposal also has the potential to result in material injury, in part, because the proposed methodology for determining the historical use of the Shoshone Water Rights is flawed. Additionally, while the use of the Shoshone Water Rights for instream flow purposes has the potential to help Colorado continue to meet its obligations under the Colorado River Compact and Upper Colorado River Compact of 1948, if the historical operations are not maintained, it could result in delivery of more water than required under Colorado's compact obligations and deprive Colorado water users of water available under the Compact's apportionment.

The FRWC have met with the River District and its consultants to make them aware of the FRWC members' respective concerns. The FRWC members have not yet had an opportunity to fully review the proposed acquisition that is now before the CWCB to determine if there have been any modifications to the River District's previous proposal. We will, however, be evaluating the proposed acquisition to determine if any changes have been made.

While we have not yet reached agreement with the River District on it is proposed methodology, we hope that before a final hearing concerning the CWCB's proposed acquisition of an interest in the Shoshone Water Rights that we will be able to reach an agreed upon methodology for determining the historical use of the Shoshone Water Rights and terms and conditions to prevent material injury to water rights in advance of any decision to accept the Shoshone Water Rights into the CWCB's instream flow program. By proceeding with its current schedule the CWCB, by necessity, will be required to choose a methodology for quantifying the historical use of the Shoshone Water Rights which necessitates the participation of the FRWC members at this time.

If you have any questions about the specific impacts of the River District's proposal on individual FRWC members, please direct your questions to the individual FRWC members.

Sincerely,



Marshall Brown, Chair
Front Range Water Council

DENVER WATER

1600 West 12th Ave
Denver, CO 80204-3412
303.628.6000
denverwater.org

May 14, 2025

The Colorado Water Conservation Board
1313 Sherman St., Room 718
Denver, Colorado 80203

Re: Proposed Acquisition of Shoshone Water Rights

Dear CWCB Board Members,

On behalf of Denver Water, I am writing to provide you with Denver Water's comments regarding the proposed acquisition of the Senior and Junior Shoshone Water Rights (Shoshone Water Rights) for instream flow purposes.

First, I want to thank you for your consideration of this letter, and for the attention of CWCB staff to this matter. Denver Water supports a mechanism or combination of mechanisms that will permanently preserve the historical flow regime created by the Senior Shoshone Call for instream flow use and, as the Colorado River District contends, to do so without harm to others, preserving the "status quo". The "status quo" as Denver Water understands it, represents existing contractual commitments assumed by Denver Water and the Colorado River District and reflects the historical flow regime created by the Senior Shoshone Call. This is necessary to avoid injury or harm to Denver Water's water rights which are used to meet the needs of a growing population of 1.5 million people. Unfortunately, the River District's proposed lease or loan of the Shoshone Water Rights, as it has been presented to Denver Water, fails to maintain the status quo.

The most direct way to maintain the status quo, is for the acquisition and change of the Shoshone Water Rights for instream flow purposes to incorporate the Shoshone Outage Protocol (ShOP) drought exceptions under Article VI.B.1.a-c and VI.B.3.a-c of the Colorado River Cooperative Agreement (CRCA). The ShOP drought exceptions are intended to apply when a "water shortage" occurs and the Shoshone Power Plant is not operating for any reason. Under the CRCA, the irrigation season drought exceptions take effect when a water shortage occurs, which is defined as when Denver Water's storage contents fall below certain levels by July 1 and the most probable forecast of streamflow for April-July flow of the Colorado River at the Kremmling gage will be less than or equal to 85% of average. For winter seasons, the ShOP drought exceptions take effect if the flows at the Dotsero Gauge are at or below 900 cfs and Denver Water's system falls below certain levels by November 1. These circumstances do not occur often. Rather, they take effect when severe droughts arise and serve to protect public safety to ensure that a sufficient supply of water will continue to be available to reliably meet essential needs within Denver Water's service area.

Denver Water has met with the River District and requested that it include the CRCA ShOP drought exceptions as part of any CWCB acquisition of the Shoshone Water

Rights consistent with the River District's commitment to maintain the status quo. Although it is Denver Water's understanding that the River District has not yet incorporated the CRCA ShOP drought exceptions as part of its proposed change of the Shoshone Water Rights to instream flow purposes, it is Denver Water's hope and expectation that these contractual commitments will be honored.

As parties to the CRCA, Denver Water and the River District, committed to the goal "to achieve permanent management of the flow of the Colorado River so that the flow mimics the Shoshone Call Flows, whether or not the Senior Shoshone Call is on the river and whether or not the Shoshone Power Plant remains operational."[1] (Article VI.C.1) To permanently protect the Shoshone Call Flows, Denver Water and the River District agreed under Article VI.C.2 of the CRCA to operate their systems on "a *permanent basis* under [ShOP] . . . described in Article VI.B of the CRCA, *even if the Shoshone Power Plant ceases operations altogether*, and regardless of whether the plant is acquired. . . ." This commitment included the ShOP drought exceptions that relieve the River District, Middle Park and Denver Water of having to operate as if the Shoshone Water Rights are calling during very dry irrigation seasons and winters when the Shoshone Power Plant is down for any reason. Thus, any acquisition of the Shoshone Water Rights must incorporate and be subject to the CRCA ShOP drought exceptions.[2]

Additionally, to prevent an unlawful enlargement of the Shoshone Water Rights, the conversion of the Shoshone Water Rights to instream flow use needs to be consistent with the flow regime created by the historical calls placed by the Senior and Junior Shoshone Water Rights. To maintain the historical flow regime created by the Shoshone Water Rights' calls, a sound technical analysis of the historical calls and use of the Shoshone Water Rights is essential. Denver Water has met with the River District and its consultant, as well as CWCB staff on several occasions to better understand the River District's historical use analysis of the Shoshone Water Rights. Unfortunately, the historical use analysis that was presented relies on a skewed study period, does not accurately determine the natural flow of the river, selectively omits periods of nonuse with legally dubious justification, and improperly relies on the Dotsero gage as a measure of the historical beneficial use of the Shoshone water rights. These inaccuracies result in an inflated quantification of the Shoshone Water Rights that is both factually incorrect and not supported by the law. Denver Water has communicated its concerns to the River District of the need for an accurate quantification of the historical use and calls placed by the Shoshone Water Rights, but to date no such analysis has been provided.

Without modifications to the River District's analysis, the unlawful enlargement of the Shoshone Water Rights will likely cause Green Mountain Reservoir to fail to fill more

[1] The CRCA defines the "Shoshone Call Flows" as "flow regime created by the Senior Shoshone Call."

[2] A "Shoshone Outage", which triggers the terms of ShOP is defined as "[w]henever the Shoshone Power Plant is subject to a shutdown for repair, maintenance, or other reasons" CRCA, VI.A.3.

often. This in turn will result in Dillon, Williams Fork Reservoir, and Wolford Mountain Reservoirs being drawn down to pay Green Mountain Reservoir back for water diverted out-of-priority against Green Mountain Reservoir. More frequent and severe drawdowns at Dillon, Williams Fork and Wolford Mountain Reservoirs will impact the security of the water supply for a significant percentage of the State's population, particularly during severe drought years. It is also likely to impact flat water recreation and contribute to larger diversions to storage after droughts in an effort to recover the reservoirs.

At the River District's request, Denver Water and River District representatives met on March 5, 2025 to discuss these impacts. However, since this meeting, the River District has not responded to Denver Water's invitation for additional meetings to find a collaborative solution to Denver Water's concerns.

In closing, Denver Water wants to find a solution to permanently quantify and protect the Shoshone Call Flows as defined in the CRCA. We are open to creative approaches that might even improve Colorado River operations from the River District's perspective and continue to protect the 15-Mile Reach while also maintaining the resiliency of Denver Water's system. We think that all of the CRCA commitments can be incorporated within the context of the proposed acquisition, and we look forward to continuing the conversation about how we can seek common ground to achieve a favorable result for the State of Colorado.

Please be advised that Denver Water expressly reserves its rights under applicable law. Nothing in this letter is intended to be, nor shall it be construed to interpret, diminish, or modify its rights under State law, including any administrative rule, regulation, guideline or statute. This letter is not intended to be, and shall not be construed in any way, as a waiver of any such rights. Moreover, we reserve the right to provide further comments on the proposed acquisition and change of the Shoshone Water Rights, including requesting a hearing, filing prehearing statements and statements of opposition to any change of the Shoshone Water Rights.

Sincerely,



Alan Salazar
CEO/Manager
Denver Water