



Sustainable Rivers Program

Evaluating Constraints, Opportunities, and Partnerships for Environmental Flows and Ecosystem Improvements in the Rio Grande Basin, New Mexico

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**US Army Corps
of Engineers®**
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Cover: Cochiti Dam and Reservoir, New Mexico (USACE photo).

Contents

Contents	iii
Table of Figures	iii
Table of Tables	iii
Acronyms	iv
Acknowledgements.....	v
1. Introduction.....	1
1.1 Background.....	1
1.2 Sustainable Rivers Program Study.....	4
1.3 The E-Flows Workshop.....	5
2. Challenges and Opportunities: Key Findings	9
2.1 Dam and Reservoir Operations.....	9
2.2 Environmental Authorities and Mission Activities.....	11
2.3 Physical Environment.....	13
2.4 Critical Uncertainties	13
2.5 Partnerships and Engagement.....	14
3. Summary.....	17
4. Next Steps.....	17
4.1 Follow-Up to the Workshop.....	17
4.2 Addressing Critical Uncertainties	18
4.3 Improving Partnerships and Engagement.....	18
5. Literature Cited.....	19
Appendix A: Environmental Flow Recommendations	20

Table of Figures

Figure 1: Rio Grande Basin Map.....	3
Figure 2: Collaborative Program Signatory Mission Similarities.....	16

Table of Tables

Table 1: Environmental Flows Workshop Participating Organizations.....	7
Table 2: Reaches and Species	8
Table 3: Water Operations.....	10
Table 4: USACE Authorities.....	12
Table 5: Collaborative Program Signatories.....	15

Acronyms

Abbreviation	Definition
BLM	US Bureau of Land Management
CAP	Continuing Authorities Program
CFS	Cubic Feet Per Second
ER	Engineering Regulation
ft ³ s ⁻¹	Cubic Feet per Second
FPMS	Floodplain Management Services
FY	Fiscal Year
GIS	Geographic Information Systems
m ³ s ⁻¹	Cubic Meters per Second
MOU	Memorandum of Understanding
MRGCD	Middle Rio Grande Conservancy District
NMWA	New Mexico Water Advocates
OSE	Office of the State Engineer
PAS	Planning Assistance to States
SPA	US Army Corps of Engineers South Pacific Division-Albuquerque District
SRP	Sustainable Rivers Program
TNC	The Nature Conservancy
USACE	US Army Corps of Engineers
USBR	US Bureau of Reclamation
WRDA	Water Resources Development Act

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1. Introduction

1.1 Background

The Rio Grande is one of the longest rivers in North America (Figure 1). Sustained primarily by snowmelt and monsoonal precipitation, it flows 1,896 miles (3,051 km) from its headwaters in the San Juan Mountains of southern Colorado south through the length of New Mexico, along the southern boundary of Texas (where it serves as a natural border between the United States and Mexico), and into the Gulf of Mexico. The Rio Grande and its tributaries within the larger Rio Grande Basin are highly managed and allocated, and extensive infrastructure has been built to ensure that communities and rural areas on both sides of the United States-Mexico border are provided with irrigation and industrial waters, drinking water, recreational opportunities, hydroelectricity, and protection from damaging floods. Within the state of New Mexico, federal, tribal, state, local, and non-government entities affect management of Rio Grande water. The US Army Corps of Engineers (USACE) Albuquerque District (SPA) is one of the two federal agencies that manages the state's Rio Grande water (the other being the US Bureau of Reclamation [USBR]). Not a water owner itself, SPA manages Rio Grande water by operating four dams for flood risk management, sediment management, recreation, and water supply: Cochiti Dam on the Rio Grande and Abiquiu, Galisteo, and Jemez Canyon dams on the tributary rivers of the Rio Chama, Galisteo Creek, and Rio Jemez, respectively.

USACE's authority to undertake flood risk management along the Rio Grande in New Mexico began in 1948 with the passage of the Flood Control Act. In the 1950s and 1960s, USACE began making significant changes to the river channel through such activities as the construction of levees and the installation of jetty jacks – large, crossed steel structures that serve to build up and stabilize the riverbank by capturing and retaining sediment and flood debris. By the mid-1970s, USACE's four dams were constructed. These developments, along with construction of irrigation ditches, river levees, drainage canals, and dams by the Middle Rio Grande Conservancy District (MRGCD) and other entities, have resulted in an extensive and efficient system for water storage and delivery, as well as protection from damaging floods. Coinciding with the anthropogenic changes to the river, the Rio Grande riverine and adjacent floodplain ecosystems experienced significant changes to the natural hydrograph, the geomorphology of the active and historical floodplain, the frequency of overbank flooding and connection to the floodplain, and the geographic extent and composition of native riparian vegetation communities.

Regulation of water flow, human encroachment, and resultant loss, degradation, and fragmentation of the natural ecosystems within the Rio Grande Basin in New Mexico (hereafter referred to as “the Basin”) has encouraged the spread of invasive animals, such as non-native fish species and plants, such as tamarisk (*Tamarix*) and Russian-olive (*Elaeagnus angustifolia*). In addition, native plants and animals have gone extinct, been locally extirpated, or are in danger or threat of going extinct. An estimated 36% to 73% of native fish species have been eliminated (e.g., shovelnose sturgeon [*Scaphirhynchus platyrhynchus*], blue catfish [*Ictalurus furcatus*]) or gone extinct (two minnows; the Rio Grande bluntnose shiner [*Notropis simus simus*] and the

phantom shiner [*Notropis orca*] (Sublette et al. 1990). In addition, five species that currently occur along the Rio Grande in New Mexico are listed on the federal Endangered Species Act (1973): the endangered Rio Grande silvery minnow (*Hybognathus amarus*; “silvery minnow”), endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*; “flycatcher”), threatened Western Distinct Population Segment of the Yellow-billed Cuckoo (*Coccyzus americanus*), threatened Pecos sunflower (*Helianthus paradoxus*), and threatened New Mexico meadow jumping mouse (*Zapus hudsonius luteus*).

The environmental impacts of water management and dam operations have called into question SPA’s and others (namely the USBR) ability to modify their actions and reduce negative impacts to native species, particularly the silvery minnow and flycatcher (e.g., *Rio Grande Silvery Minnow v. Keys, et al.*). However, in 2020, the US Court of Appeals for the 10th Circuit determined in *WildEarth Guardians vs US Army Corps of Engineers* that SPA has no discretion on how it operates its dams for flood control purposes. The rule was largely based on the fact that the Flood Control Acts of 1948 and 1960, which authorized construction and maintenance of SPA’s four New Mexico dams, stipulated that the dams “shall be operated solely for flood control,” except as otherwise required by the 1938 interstate Rio Grande Compact among Colorado, New Mexico, and Texas that ensures equitable apportionment of waters within the Rio Grande Basin. Thus, SPA has no autonomy to release flows (“environmental flows” or “e-flows”) from dams to create hydrological regimes that mimic dynamic natural processes required to restore critical ecological functions and support species of conservation concern.

Despite the fact that SPA must operate its dams within a strict set of parameters related to flood control and compliance with the Rio Grande Compact, SPA does have several authorities and mission responsibilities that can achieve similar objectives as e-flows, namely improving ecosystem function and benefiting native species and ecosystems. Furthermore, SPA coordinates its dam operations and water and ecosystem management with water owners and other water managers that have the ability to implement e-flow and ecosystem restoration projects in the Basin. Thus, there are opportunities to explore how SPA can work with partners under its existing authorities to enhance functions of natural ecosystems along the Rio Grande in New Mexico.

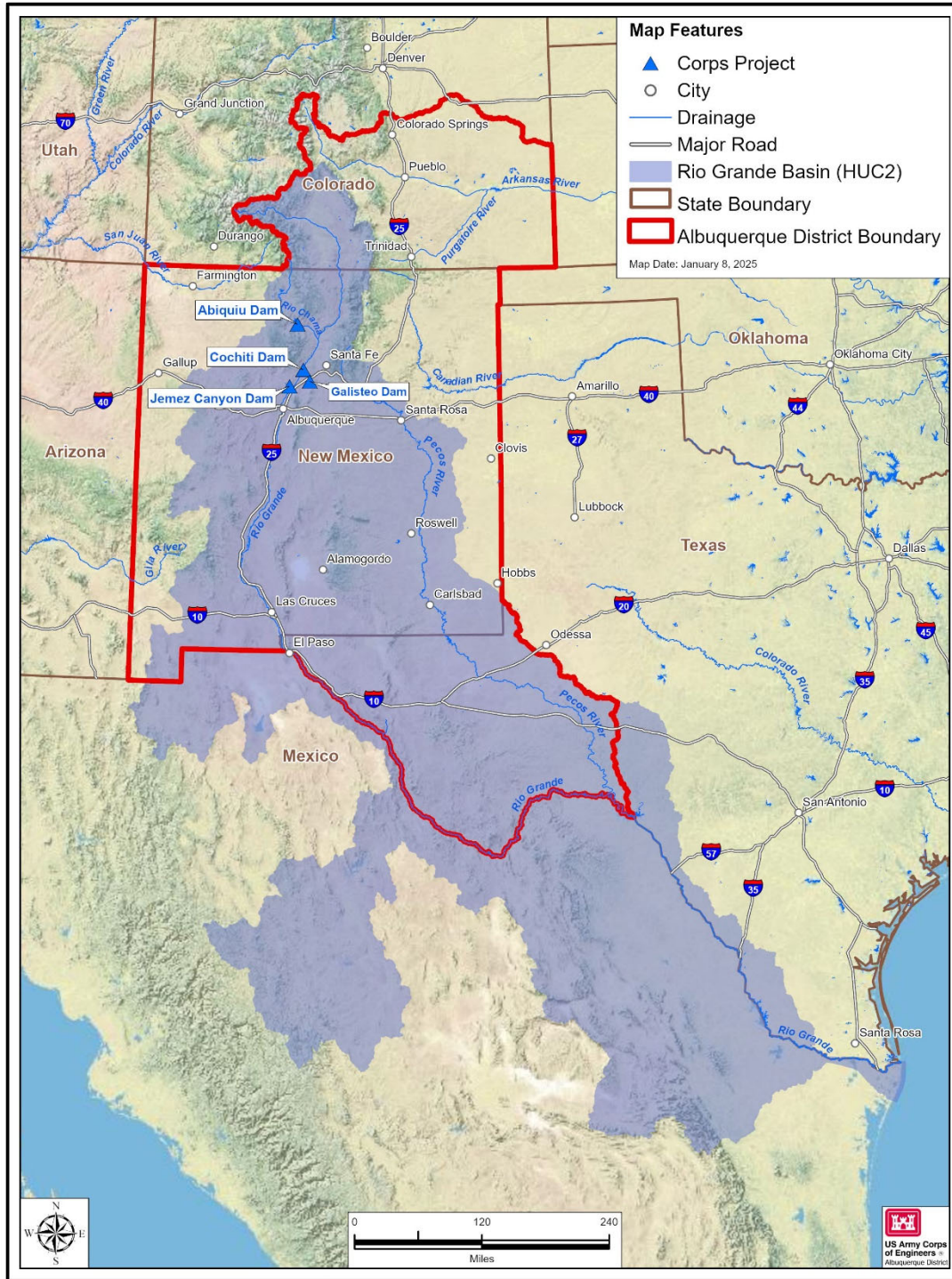


Figure 1: Rio Grande Basin Map. The Rio Grande Basin, and the US Army Corps of Engineers Albuquerque District's boundary and four New Mexico dams.

1.2 Sustainable Rivers Program Study

In 2000, USACE and The Nature Conservancy (TNC) signed a Memorandum of Understanding (MOU; Westphal and Weeks 2000) to “facilitate effective and efficient management of important biological resources within the context of the [USACE’s] civil works and regulatory missions.” Under this MOU, USACE and TNC launched a collaborative effort in 2002, now called the Sustainable Rivers Program (SRP), to improve the health and life of rivers, in accordance with existing authorities, by designing and implementing modifications to USACE dam operations that help improve and protect natural ecosystems while also maintaining and enhancing benefits to local economies.

Since 2020, SRP has received approximately \$5M annually to fund programmatic and location-based efforts to fulfill SRP’s mission. According to SRP (2024:pg2), “*SRP funding is part of the USACE Operations budget and is provided via the Aquatic Ecosystem Restoration (AER) business line. USACE program management is performed by the Hydrologic Engineering Center with oversight from chain of command and USACE Headquarters staff including representatives of the AER business line, Operations, and Environmental Planning.*” Funded projects include those that are part of SRP’s 3-stage process (Advance, Implement, and Incorporate) for modifying USACE dam and reservoir operating procedures to improve and protect natural ecosystems (see <https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/sustainable-rivers-project/>), as detailed in the below bullets:

- Advance the science on unique flow requirements for rivers by engaging stakeholders in a science-based process to define the flow needs of specific riverine ecosystems;
- Engage partners to advance, implement, and test the effectiveness and feasibility of innovative environmental flow strategies; and/or
- Propose and promote incorporation of operating plans that achieve scientific prescriptions for the timing, quantity, and quality of water flow that must occur downstream and upstream of dams in order to sustain critical ecological functions and habitat for species (defined as environmental flows or e-flows).

In 2023, SRP funded SPA to undertake a project to identify constraints and opportunities for supporting e-flows as they relate to SPA’s operational and management activities in the Basin. This project falls within the Advance stage discussed above. Generally, the Advance stage involves USACE advancing the science on the flow needs of river basins by gathering experts to 1) discuss problems within basins, 2) assess e-flow requirements for species, habitats, and environmental conditions, and 3) determine opportunities to test the feasibility and effectiveness of e-flows. However, this first step was already underway by partner entities. As part of the Rio Grande in New Mexico Basin Study (NMWA 2024), the Non-Governmental Organizations Sectoral Committee (hereafter referred to as “the Committee”) was developing an e-flow framework for the Basin (Briggs et al. 2025). Thus, SPA’s SRP project entailed:

1. Presenting at, participating in, and facilitating e-flow framework discussions at the Rio Grande in New Mexico Basin Study Environmental Flows Workshop (hereafter referred to as “Workshop”);
2. Providing peer review of the draft e-flow framework for the Basin; and
3. Investigating and compiling information on SPA’s management constraints and opportunities pertaining to e-flows for the Rio Grande.

In this report, we provide information on opportunities and challenges for SPA operations in the Rio Grande Basin pertaining to the e-flows defined during the Workshop and in post-Workshop analyses ([Section 2](#)).

1.3 The E-Flows Workshop

As discussed in [Section 1.2](#), to help decision-makers take actions in support of resilient, economically sound, and environmentally healthy river ecosystems, USBR and MRGCD are both leading the Rio Grande in New Mexico Basin Study (NMWA 2024). As part of this study, the Committee (comprised of Audubon Southwest, New Mexico Wild, World Wildlife Fund, and New River Consulting) developed an e-flow framework for the Rio Grande Basin from the New Mexico-Colorado border south to Elephant Butte Reservoir (Briggs et al. 2025).

As part of their efforts to develop the e-flow framework and receive peer-review feedback, the Committee held a 3-day Workshop on August 5-7, 2024, at the Randall Davey Audubon center in Santa Fe, New Mexico. The Workshop was attended by 52 experts in water use, supply, management, and quality, and in animals, plants, and habitats of management concern representing a large diversity of organizations (Table 1

Table 1). USACE was represented at the Workshop by SPA staff (Chief of Planning, Program Manager for the Collaborative Program, Tribal Liaison, Water Operations Manager for the Rio Grande Basin, and Reservoir Operations Manager for Cochiti Dam), the Sacramento District (Regional Fisheries Biologist), and the Engineer Research and Development Center (Research Civil Engineer). This USACE Project Delivery Team had combined expertise in water management, dam operations, hydrology and hydraulics, fisheries, riparian ecosystems, avian ecology, and endangered species.

Table 1: Environmental Flows Workshop Participating Organizations. Organizations participating in the Rio Grande in New Mexico Basin Study Environmental Flows Workshop, August 5-7, 2024, in Santa Fe, New Mexico.

Organization Type	Organization
<i>Non-Profit</i>	American Rivers, Amigos Bravos, Audubon Southwest*, Bosque Ecosystem Monitoring Program*, Friends of Bosque del Apache National Wildlife Refuge, Natural Heritage New Mexico, New Mexico Wild, Rio Chama Acequia Association, Rio Grande Restoration, The Nature Conservancy, Trout Unlimited, Utton Center, Water Foundation, WildEarth Guardians
<i>Federal Government</i>	US Army Corps of Engineers*, US Bureau of Land Management, US Bureau of Reclamation*, US Fish and Wildlife Service*
<i>State Government</i>	New Mexico Bureau of Geology and Mineral Resources, New Mexico Environment Department, New Mexico Interstate Stream Commission*, the University of New Mexico*
<i>Local Government</i>	Middle Rio Grande Conservancy District*
<i>Tribal</i>	Ohkay Owingeh

* Signatories to the Middle Rio Grande Endangered Species Collaborative Program

During the Workshop, participants were presented with e-flow prescriptions for six reaches of the Basin ([Appendix A](#) & Table 2). These prescriptions were developed to meet the hydrologic-habitat needs of multiple indicator species selected to target one or more key parts of each reach’s annual hydrograph: spring pulse flow (May to June; categorized as high, medium, and low flows), monsoon flushing flow (June 15 to September 30), spring-summer low flow (April 1 to September 30), and fall-winter low flow (October 1 to March 31). Workshop participants then collaborated on review and identification of water management, physical, and biological challenges to and opportunities for implementing the recommended e-flow prescriptions. Participants were encouraged to be creative and contemplate whether there were any important opportunities other than those related to water management to improve ecosystem function. In addition, participants were tasked with identifying data gaps and uncertainties. The diverse audience of decision-makers and stakeholders helped validate the credibility of the Workshop outcomes.

Workshop results were incorporated into the Committee’s e-flow framework for the Basin, finalized in August 2025 (Briggs et al. 2025). In the following section ([Section 2](#)), we present our own synthesis and interpretation of the Workshop outcomes, with focus on the subset of challenges and opportunities for SPA’s engagement in e-flow projects in the Basin. We have organized the discussion in this section into five categories: [2.1 Dam & Reservoir Operations](#), [2.2 Environmental Authorities & Mission Activities](#), [2.3 Physical Environment](#), [2.4 Critical Uncertainties](#), and [2.5 Partnerships](#).

Table 2: Reaches and Species. River reaches and indicator species in the environmental flow framework developed by the Non-Governmental Organizations Sectoral Committee of the US Bureau of Reclamation and Middle Rio Grande Conservancy District’s Rio Grande in New Mexico Basin Study (Briggs et al. 2025; see Appendix A for flow prescriptions by reach).

Reach	Location	Indicator Species: Flow Needs
1: Rio Grande from Questa to Velarde	84 river miles from the New Mexico-Colorado border to the Rio Grande-Rio Chama confluence	<ul style="list-style-type: none"> – Cottonwood (<i>Populus</i>): spring runoff (high and medium) and low flow – Brown trout (<i>Salmo trutta</i>): low flows, especially during summer and fall – (Secondary) American Dipper (<i>Cinclus mexicanus</i>), North American river otter (<i>Lontra canadensis</i>), Southwestern Willow Flycatcher (<i>Empidonax traillii extimus</i>), and stonefly (Order: Plecoptera)
2: Rio Chama Headwaters	26 river miles from the New Mexico-Colorado border to La Puente	<ul style="list-style-type: none"> – Cottonwood: spring runoff (high and medium) and low flow – Brown trout: low flows, especially during summer and fall
3: Rio Chama below El Vado	32 river miles from below El Vado Dam to Abiquiu Dam	<ul style="list-style-type: none"> – Cottonwood: spring runoff (high and medium) and low flow – Brown trout: low flows, especially during summer and fall – (Secondary) Stonefly
4: Rio Chama below Abiquiu.	29.4 river miles from below Abiquiu Dam to the Rio Chama-Rio Grande confluence	<ul style="list-style-type: none"> – Cottonwood: spring runoff (high and medium) and low flow – Brown trout: low flows, especially during summer and fall
5: Rio Grande-Rio Chama Confluence	35 river miles from the Rio Grande-Rio Chama confluence to Cochiti Dam	<ul style="list-style-type: none"> – Cottonwood: spring runoff (high and medium) and low flow – Rio Grande sucker (<i>Catostomus plebeius</i>) and Rio Grande chub (<i>Gila pandora</i>) – (Secondary) coyote willow (<i>Salix exigua</i>), Summer Tanager (<i>Piranga rubra</i>), and North American river otter
6: Middle Rio Grande	~173 river miles from Cochiti Dam to Elephant Butte Dam	<ul style="list-style-type: none"> – Cottonwood: spring runoff (high) – Rio Grande silvery minnow (<i>Hybognathus amarus</i>): spring runoff (mid and low) and low flows – Nesting songbirds (e.g. Southwestern Willow Flycatcher): spring runoff (all levels) and spring-summer low flows – Winter migratory birds (e.g., Rocky Mountain population of the Greater Sandhill Crane [<i>Antigone canadensis tabiya</i>]): fall-winter low flows

2. Challenges and Opportunities: Key Findings

2.1 Dam and Reservoir Operations

Sustainable River Program goals include creating “scientific prescriptions for the timing, quantity and quality of water flow that must occur downstream and upstream of dams in order to sustain critical ecological functions and habitat for species,” and then exploring opportunities for USACE and its partners to revise operating plans for dams (Water Control Plans and dam-specific Water Control Manuals) to incorporate these flows (<https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/sustainable-rivers-project/>).

In general, USACE operates its dams and reservoirs for 1) the purposes authorized by Congress and other applicable laws, 2) maintenance of both structural and operation integrity, and 3) avoiding risk to public health and safety, life, and property. In New Mexico, the authorized purposes of the four SPA dams in the Rio Grande Basin are limited to flood control, sediment management, recreation, and water supply (Table 3). Although SPA manages water, it does not own any water, and it has limited-to-no autonomy to implement e-flow prescriptions such as altering river flow magnitude, timing, duration, frequency, and/or rates of change. Therefore, changes in the water control management activities, including establishment of water control plans and manuals, at SPA Middle Rio Grande dams to incorporate e-flows most likely would require authorization and funding from Congress, support from affected communities, and coordination with water managers and owners.

Prior to and after any changes to its water control management, SPA’s primary role in e-flows projects include 1) identifying opportunities and constraints, and 2) coordinating both daily and annual operations of upstream and downstream facilities with water owners/managers and stakeholders. A good example of SPA’s functioning in this role has been its coordination with USBR in the timing of the annual refilling of the recreation pool at Cochiti Lake to support waterfowl around the lake and to maintain minimum flows downstream of Abiquiu Dam. SPA has an opportunity to function in a similar role upstream of Abiquiu Dam. The 2020 Water Resources Development Act (WRDA) gave USACE the authority to contemporaneously store Rio Grande system water and San Juan-Chama water at Abiquiu Dam, and SPA could work with water managers to explore how the increased flexibility in storage and movement of water between Abiquiu Dam and the USBR-owned El Vado Dam could be capitalized to benefit ecosystems in that reach of the Rio Chama.

Another way that USACE could support e-flows is by incorporating important improvements to dam infrastructure and levees. During the Workshop, it was identified that New Mexico dams do not have gates to regulate water temperature, which likely will be necessary to ensure benefits of e-flows on target species (especially those dependent on warmer water temperatures than current outflows). Also during the Workshop, channel capacity was identified as being a limiting factor for implementing e-flows in the Basin. Levee improvements that allow for higher river flows could allow water managers to better accommodate e-flows. Any such improvements would require authorization and funding from Congress.

Table 3: Water Operations. *Water Operations at Cochiti and Abiquiu dams and reservoirs, New Mexico.*

Reservoir Operation Action	Parameters
<i>Cochiti Dam and Reservoir</i>	
Safe Channel Capacity	Up to 7,000 cubic feet per second (cfs) at Central Avenue Bridge (Albuquerque) for limited duration (typically up to 7 days)
Flood Operation	Flood water is passthrough as quickly as downstream conditions permit (within safe channel capacity at Central Avenue Bridge)
Release of Carryover Storage	Any captured runoff still in storage after 1 July must be held in storage if the Otowi Gauge drops below 1,500 cfs of native water, and must be released 1 November to 1 March
<i>Abiquiu Dam and Reservoir</i>	
Safe Channel Capacity	Up to 1,800 cfs immediately downstream from the dam Up to 3,000 cfs at Chamita Up to 10,000 cfs at Otowi Bridge
Flood Operation	Flood water is passthrough as quickly as downstream conditions permit (within safe channel capacity)
Release of Carryover Storage	Any captured runoff still in storage after 1 July must be held in storage if the Otowi Gauge drops below 1,500 cfs of native water, and must be released 1 November to 1 March

2.2 Environmental Authorities and Mission Activities

SPA has authorities (Table 4) that involve improving ecosystem function in the Basin and, thus, allow SPA to meet or support objectives of e-flow projects, such as promoting healthy river and floodplain ecosystems that support species of conservation concern, without changing dam operation and maintenance activities. Furthermore, USACE's Levee Safety Program and construction and improvement of levees could support e-flow recommendations by reducing risk during high flow conditions. Described in the following bullets are four examples of projects that SPA has or will plan, design, and implement in the Basin under its authorities and missions that directly or indirectly improve ecosystem function. These examples also demonstrate the non-federal collaboration (assistance and cost-share) required for USACE to allocate resources to these activities.

- The Espanola Valley Ecosystem Restoration Project with the Ohkay Owingeh and Santa Clara pueblos (the non-federal sponsors) plans to restore over 900 acres of aquatic and riparian habitats along the Rio Grande and its tributaries (Lockyear 2022).
- The Sandia to Isleta Ecosystem Restoration Project will create earthwork features to increase areal inundation of the floodplain within the section of the Middle Rio Grande between the Sandia and Isleta pueblos (USACE 2019). Potential non-federal sponsors include the MRGCD and City of Albuquerque Open Space.
- The Rio Chama Aquatic Habitat Project, Rio Arriba County was completed below Abiquiu Dam in 2020 as a multi-agency collaboration to improve fish habitat and riparian health directly downstream of Abiquiu Dam. The project was funded and led by New Mexico Department of Game and Fish and included coordination with SPA, US Bureau of Land Management (BLM), New Mexico State Land Office, the US Forest Service Santa Fe and Carson national forests, Trout Unlimited, and the National Fish and Wildlife Foundation.
- The Bernalillo to Belen project will result in the construction of over 60 miles of levees along the Rio Grande to replace an existing spoil bank with accompanying and significant mitigation (including wetland creation) for fish and wildlife. The project objective is to mitigate flood risk from high river flows, which could allow water managers to better accommodate e-flows. The non-federal sponsor is the MRGCD.

Conceivably, working with partners investigating and implementing environmental improvement projects, such as the Committee, will increase the efficacy of design and implementation of any future USACE projects similar to those described above.

Table 4: USACE Authorities. Authorities under which the US Army Corps of Engineers can participate in environmental flow projects and meet environmental flow targets.

Authority	Description
<p><i>Continuing Authorities Program (CAP)</i></p>	<p>CAP is a group of authorities under which USACE can plan, design, and implement certain types of water resources projects without additional project-specific congressional authorization. CAP projects include a feasibility phase and an implementation phase. In the feasibility phase, USACE conducts a feasibility study that evaluates project alternatives, environmental effects, project requirements, and cost. If recommended for implementation, USACE can prepare project plans and specifications, obtain any required federal permits, and manage construction.</p> <p>CAP authorities related to environmental flows: <u>Section 206-Aquatic Ecosystem Restoration:</u> As authorized by WRDA 1996, USACE may plan, design, and build projects to restore aquatic ecosystems for fish and wildlife at the request of a state or local government or national non-profit organization. The non-federal sponsor must be able to undertake future operation, maintenance, etc. of the project and provide any necessary lands, easements, etc. For a non-profit entity to sponsor a project, the affected local government must consent to a non-profit entity being the sponsor. The cost-share requirement is 50/50 for federally funded studies exceeding \$100k, and 65% federal/35% non-federal for design and construction.</p> <p><u>Section 1135-Environmental Restoration:</u> As authorized by WRDA 1986, at the request of a state or local government or national non-profit organization, USACE may plan, design, and build modifications to existing USACE projects or areas degraded by a USACE project to restore aquatic habitats for fish and wildlife. The cost-share requirement is 50/50 for federally funded studies exceeding \$100k, 75% federal/25% non-federal for design and construction, and 100% non-federal for the cost of operation and maintenance.</p>
<p><i>Floodplain Management Services (FPMS) Program</i></p>	<p>FPMS was first authorized in Section 206 of the Flood Control Act of 1960. Studies conducted under the program that pertain to inundation and flood risk are relevant to developing environmental flow recommendations. These studies, conducted at the request of a state, regional, local government, or federally recognized tribe, provide information on flood hazards and development on floodplains and flood prone areas. Work products are used as planning guidance for nonstructural measures and comprehensive floodplain management. The program does not fund implementation. Studies under the FPMS program are 100% federally funded.</p>
<p><i>Planning Assistance to States (PAS)</i></p>	<p>As authorized by Section 22 of WRDA 1974, USACE offers two main types of assistance: technical assistance and comprehensive plans. Any state, group of states, regional, or local government, or federally recognized tribe may request this type of assistance. PAS studies and activities can include watershed planning, environmental restoration, water supply/demand, and GIS mapping. Usually, the duration of planning assistance is 1- to 2-years. The cost-share requirement is generally 50/50, but it can be 100% federally funded if certain conditions are met.</p>
<p><i>Tribal Partnership Program</i></p>	<p>As authorized by Section 203 of WRDA 2000, at the request of a tribe, USACE may collaborate on feasibility analyses for projects on tribal trust lands that substantially benefit tribes. Studies conducted under this program may cover flood damage reduction, environmental restoration, water resources, and protection and preservation of natural and cultural resources. The cost-share requirement is 50/50 for feasibility studies and 65% federal/35% non-federal for construction. Cost-share waivers up to \$665k are available for both types of activities.</p>
<p><i>Bosque Wildfire Restoration Project</i></p>	<p>As authorized by Section 1357 of WRDA 2024, (a) the Secretary shall establish a program to carry out appropriate planning, design, and construction measures for wildfire prevention and habitat restoration in the Middle Rio Grande Bosque, including the removal of jetty jacks. Implementation Guidance for this authority has not yet been developed.</p>

2.3 Physical Environment

A primary physical challenge to implementing e-flow prescriptions in the Basin identified at the Workshop is channel capacity. Although overbank flooding is needed for development and maintenance of wetland and riparian ecosystems – and the plants and animals that depend on them – e-flows have the potential to increase flooding to the point that they damage infrastructure and property, such as bridges and private homes. This is particularly true in the spring, when high spring pulse flows are prescribed to promote native woody riparian vegetation recruitment and silvery minnow spawning. Furthermore, spring snowmelt contributions of tributaries where streamflow in these systems is not controlled can compound flood risk of e-flow releases (throughout the Basin but particularly along the Rio Chama). As discussed in [Section 2.2](#), USACE’s maintenance and construction of engineered flood control levees can reduce flood risk and accommodate spring high pulse e-flow prescriptions ([Appendix A](#)).

In addition to the dangers resulting from flooding, high e-flow prescriptions can lead to shifts in channel form and floodplain connectivity. In particular, along the Rio Grande, the active channel tends to be incised within the larger floodplain – caused by jetty jacks, urban development, and other factors – and increased scouring with large pulse flows could further degrade the channel. Furthermore, increased releases of clear, sediment-starved waters from dams that trap sediment can result in deeper incision of the channel. As a result, increasingly higher flows would be required to inundate the floodplain and provide benefits to wetland and riparian plants and animals. SPA’s ecosystem restoration efforts that involve bank terracing and other earthwork to connect the floodplain to the active river channel, such as those mentioned in [Section 2.2](#), can mitigate some of these potential negative outcomes of e-flows.

2.4 Critical Uncertainties

At the Workshop, USACE staff helped to identify critical uncertainties, that is, those uncertainties in our knowledge that would prevent or limit e-flow implementation. One prevailing challenge identified at the Workshop was the uncertainty in safe channel capacity and how e-flows affect flood risk. Additional research on geomorphology and flood patterns is needed to address these uncertainties. Relatedly, more research is needed assessing the potential impacts of altering flow releases on environmental conditions. While both geomorphic and hydraulic models are widely used in decision-making in the Basin, more study is needed crosslinking channel form and river flows with ecosystem functions and life history requirements of plant and animal species of conservation and management concern.

Some opportunities to address these critical uncertainties exist from the Middle Rio Grande and the Rio Chama. Though more hydraulic and geomorphic studies are needed, substantial biological research and monitoring have occurred in the Middle Rio Grande. In addition, on the Rio Chama upstream of Abiquiu Dam, BLM and others have collected abundant research and monitoring data on flora, fauna, and streamflow. These data, along with data from additional hydraulic and geomorphic studies, could be analyzed to cross-walk ecosystem function metrics to e-flow recommendations made at the Workshop. While USBR conducts research on channel capacity to ensure water delivery, SPA could implement a project to complete analyses relating

ecosystem function metrics to e-flow recommendations, which would help to 1) develop effective e-flow prescriptions and 2) inform river engineering and design of geomorphic features in the floodplain for ecosystem restoration and improvement (See [Section 2.2](#)).

In addition to those discussed above, another critical uncertainty identified at the Workshop is water need and availability for e-flows, particularly in an increasingly arid and variable climate. Given water scarcity in the Basin, increasing water use for e-flows most certainly will have to be offset by conservation measures. Prior to experimentation and implementation, more data are required to better understand the volume of water needed for e-flows and the impact of allocating water to environmental purposes. Such data can be costly and time-intensive to acquire, which might constrain the ability to obtain these datasets.

2.5 Partnerships and Engagement

Governance – the overall framework and processes for decision-making and implementation of policies, regulations, and rules related to water resource development and management – of water is complex and can be a barrier to e-flows (Wineland et al. 2022). Specifically, it can be challenging to navigate the complexities of who manages the water, who owns the water, and how and when water can be used. In New Mexico, water is apportioned according to federal, state, and local laws and policies. The Office of the State Engineer (OSE) is charged with administering the state’s water resources, and the State Engineer has authority over supervision of the measurement, appropriation, and distribution of all surface and groundwater. Delivery of the water is supported by USACE, USBR, and the OSE/New Mexico Interstate Commission, who ensure that water is supplied to water users, including tribes, acequias, municipalities, and agricultural, industrial, residential, and recreational users. Water right holders (permitted by OSE) that likely would be integral to an e-flow project in the Basin include the MRGCD, the Albuquerque Bernalillo County Water Utility Authority, and the City of Santa Fe. Private citizens and irrigators also are major water-owners that could contribute to e-flow implementation.

To effectively implement e-flows in the Basin, substantial coordination is required among the water managers, water owners, and water users, not only within New Mexico but in the adjacent states of Colorado and Texas. SPA, in particular, has limited to no ability to operate dams for e-flows and must seek out collaborative opportunities to pilot and implement e-flows. The composition of the Workshop attendees (Table 1) was helpful in identifying potential partners interested in engaging on e-flows. However, there were noticeable gaps in representation by major potential partners. For example, while the Committee reached out to all 10 Tribes within the Middle Rio Grande to encourage their participation in the Workshop, only one tribe was in attendance (Ohkay Owingeh Pueblo). Other significant partners missing from the Workshop were irrigators and acequia associations. Even within the Workshop attendees, there were expressed concerns about barriers to participation.

As efforts move forward on experimenting with and implementing e-flows in the Basin, it would be beneficial to identify constraints to potential partners participating in collaborative discussions and whether supplying resources such as funding would improve participation in future e-flows

conversations. Furthermore, at a broader scale, it would be valuable to understand potential partners’ capacity for and challenges to participating in e-flows projects. Some partners have funding and other resources that could be leveraged to implement e-flows, while others face challenges in securing adequate organizational support, leadership, funding, staffing, and/or time. For example, in addition to water rights, irrigators often have infrastructure for delivery and diversion of water, but could face challenges in securing organizational support (e.g., from acequia associations) for e-flows unless concerns about potential flooding impacts are addressed.

As demonstrated during the Workshop, an effective method for reaching and communicating with the necessarily broad spectrum of partners on e-flow and ecosystem improvement projects is to work through collaborative networks, such as the one formed as part of the Rio Grande in New Mexico Basin Study. The Middle Rio Grande Endangered Species Collaborative Program (hereafter, “Collaborative Program”) can be an effective vehicle for identifying, pursuing, and securing partners and resources for planning and implementing future ecosystem improvement projects, such as e-flows. The Collaborative Program is a diverse partnership of federal, state, local, tribal, and non-profit entities that endeavors to leverage the strengths and missions of its 17 signatories (Table 5; Figure 2) to cooperatively 1) manage and protect endangered species and aquatic and terrestrial ecosystems, 2) regulate and manage water delivery and conservation, and 3) implement flood control actions (MRGESCP 2008). The Collaborative Program’s ecosystem-scale priorities, and the quantity and diversity of organizational types, authorities, and resources within the Collaborative Program can support large ecosystem-scale projects.

Table 5: Collaborative Program Signatories. *The 17 current signatories to the Middle Rio Grande Endangered Species Collaborative Program and the organizational type of each.*

Signatory	Organizational Type
Albuquerque Bernalillo County Water Utility Authority	Local
Audubon Southwest	Non-Profit
Bosque Ecosystem Monitoring Program	Non-Profit
Buckman Direct Diversion	Local
City of Albuquerque Open Space Division	Local
Middle Rio Grande Conservancy District	Local
New Mexico Department of Game and Fish	State
New Mexico Department of Justice	State
New Mexico Interstate Stream Commission	State
Pueblo of Isleta	Tribal
Pueblo of Sandia	Tribal
Pueblo of Santa Ana	Tribal
University of New Mexico	State
US Army Corps of Engineers Albuquerque District	Federal
US Bureau of Reclamation	Federal
US Fish and Wildlife Service (New Mexico Ecological Services Office)	Federal
Valencia Soil & Water Conservation District	Local

3. Summary

The Rio Grande is a water-scarce river system with a unique set of challenges to e-flow experimentation and implementation, as well as a diversity of entities interested in improving e-flows and ecosystem function. With funding from the Sustainable Rivers Program, SPA investigated the opportunities and challenges of implementing e-flows in the Rio Grande Basin in New Mexico. This investigation involved participating in and compiling major findings from the Rio Grande in New Mexico Basin Study Workshop ([Section 2](#)). We also evaluated USACE's ecosystem improvement authorities ([Section 2.2](#)) and opportunities to work with partners and through collaborative pathways to implement river and floodplain restoration within the Basin ([Section 2.5](#)), both of which can support or achieve similar ecological results as e-flows.

A primary outcome from the Workshop was that dam and reservoir authorities present the biggest challenge to SPA's involvement in e-flow implementation in the Basin as these authorities are almost singularly-focused on flood control. On the other hand, SPA 1) can coordinate its releases (e.g., from Abiquiu Dam) with other entities that have authorities congruent with e-flows and 2) has authorities and mechanisms to implement ecosystem improvement projects that meet e-flow objectives. Both approaches are more accessible pathways for SPA to participate in e-flow projects than pursuing changes to water control management activities, but they require substantial partnering efforts to ensure that projects are successfully implemented and critical uncertainties – such as water availability, safe channel capacities, and relationships between stream flows and ecological outcomes – are addressed. Strategically building partnerships can be time-intensive and this study elucidated the value of leveraging existing collaborative networks. Specifically, we found that SPA can effectively reach and communicate with a broad spectrum of potential collaborators on e-flow and ecosystem improvement projects by working with the Collaborative Program and its diverse membership on core components of e-flow and ecosystem improvement projects, such as 1) water management (e.g., delivery amount and timing), 2) structural alterations (in the floodplain or river channel), 3) earthwork (in the floodplain or river channel), and 4) vegetation management.

4. Next Steps

Through its dam operations, strong partnerships, and project-specific congressional appropriations, SPA can serve as an integral partner in implementing future e-flow and environmental improvement projects in the Basin. With completion of this SRP-funded project, SPA is well-positioned to continue supporting e-flow efforts in the Basin, such as: 1) providing continued support for the Committee's efforts to identify and promote e-flows opportunities in the Basin; 2) conducting studies to reduce decision uncertainties; and 3) developing and strengthening strategic partnerships to plan, coordinate, and implement a pilot e-flows project.

4.1 Follow-Up to the Workshop

Following the Workshop, the Committee identified several actions that would move e-flow conversations, planning, and implementation forward, including: 1) collating, condensing, refining, and reviewing information generated from the Workshop breakout sessions; 2)

summarizing the constraints and opportunities identified at the Workshop; 3) prioritizing actions identified at the Workshop to be a roadmap for on-the-ground next steps and activities; 4) engaging partners in efforts to identify and rank strategies (including implementation strategies and model development) to address priority flow issues and deficits; and 5) developing a living document that captures and synthesizes results of the Committee's efforts (Briggs et al. 2025). As funding allows, we suggest that SPA continue to support and engage with the Committee as it takes steps to build upon the outcomes of the Workshop.

4.2 Addressing Critical Uncertainties

To address critical uncertainties discovered in this study related to planning and implementing e-flow and ecosystem improvement projects in the Basin, we suggest completion of scientific studies that would be useful in evaluating feasibility and efficacy of e-flow project designs. Namely,

- 1) Environmental flow recommendations from the Workshop could be cross-walked to actual water availability, as water delivery is one of the most constrained restoration opportunities in the system. This could be accomplished by creating idealized hydrographs using the Hydrologic Engineering Center's Regime Prescription Tool to demonstrate whether the required amount of water is available in the Basin and, correspondingly, what magnitude of modification is required to achieve recommended flows.
- 2) Streamflow and eco-value relationships can be quantified with the use of hydraulic modeling and spatial analysis. Monitoring data are available from the Middle Rio Grande and from the Rio Chama above Abiquiu Dam that can be cross walked with inundation mapping and flow frequency to identify drivers of riparian habitats for fish and wildlife of management concern. Analysis can be used for upcoming restoration projects and informing e-flow releases from USACE and USBR dams into the Rio Chama.

4.3 Improving Partnerships and Engagement

This study found sufficient engagement and coordination with partners and stakeholders are vital to successful e-flow discussions and projects; absence of key partners can hamper efforts to modify dam operations and river flows. When developing e-flow projects, we suggest 1) exploring opportunities to locate funding for entities such as tribes, irrigators, and others to engage in e-flow discussions, and 2) conducting a social science study to understand potential partners' capacity for and challenges to participating in e-flows projects. We further recommend enhancing participation and partnerships by 1) shoring up ineffective communication methods, 2) repairing and strengthening existing partner engagement strategies, 3) strategically soliciting new partnership opportunities and agreements, and 4) utilizing and building upon existing collaborative networks.

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Appendix A: Environmental Flow Recommendations for the Rio Grande Basin in New Mexico

Environmental flow recommendations for six reaches within the Rio Grande Basin in New Mexico, which were developed as part of an environmental flow framework developed by the Non-Governmental Organizations Sectoral Committee of the Rio Grande in New Mexico Basin Study to meet the hydrologic-habitat needs of multiple indicator species selected to target one or more key parts of each reach's annual hydrograph (Briggs et al. 2025). Tables A1 to A6 provide summary information for each reach.

Table A1. E-Flow Recommendations for Reach One-Questa to Velarde. Geographic location, indicator species, and e-flow recommendations for the Rio Grande from Questa to Velarde from Briggs et al. (2025). Note: Recommendations are rounded to nearest $100 \text{ ft}^3\text{s}^{-1}$ ($2.8 \text{ m}^3\text{s}^{-1}$) for prescription values that are greater than $1,000 \text{ ft}^3\text{s}^{-1}$ ($28 \text{ m}^3\text{s}^{-1}$) and to nearest $10 \text{ ft}^3\text{s}^{-1}$ ($0.3 \text{ m}^3\text{s}^{-1}$) for values less than $1,000 \text{ ft}^3\text{s}^{-1}$ ($28 \text{ m}^3\text{s}^{-1}$).

Reach One							
Name: Questa to Velarde		Core Indicators:					
Location: Rio Grande from the Colorado-New Mexico state line (roughly 15 miles [24 km] north of the town of Questa) to the Rio Chama confluence, located ~14 miles (23 km) downstream of the town of Velarde		1. <u>Rio Grande cottonwood</u> (<i>Populus deltoides</i> ssp. <i>wislizeni</i>): High Spring Pulse, Medium Spring Pulse, Low Spring Pulse					
Reach Length: 84 miles (135 km)		2. <u>Brown trout</u> (<i>Salmo trutta</i>): Monsoon, Spring-Summer Low, Fall-Winter Low (Spawning)					
Reference Years (Spring Pulse)		Supporting Indicators:					
<u>High Flow Years:</u> 1979 and 1986		American Dipper (<i>Cinclus mexicanus</i>), North American river otter (<i>Lontra canadensis</i>), Southwestern Willow Flycatcher (<i>Empidonax traillii eximius</i>)					
<u>Medium Flow Years:</u> 1993-1994, 1997, 2005, 2019, and 2023							
<u>Low Flow Years:</u> 1998-1999, 2001, 2008-2010, and 2015-2017							
Reference Years (Spring-Summer Low)							
<u>Below Minimum Required Flow Years:</u> 2000, 2004, 2012, 2018, and 2020							
E-Flow Recommendations							
	High Spring Pulse	Medium Spring Pulse	Low Spring Pulse	Monsoon Flushing	Spring-Summer Low	Fall-Winter Low (Spawning)	Fall-Winter Low (Non-Spawning)
Discharge: Peak				$2,600 \text{ ft}^3\text{s}^{-1}$ ($74 \text{ m}^3\text{s}^{-1}$)			
Discharge: Average Daily Decline After Peak				$2,500 \text{ ft}^3\text{s}^{-1}$ ($71 \text{ m}^3\text{s}^{-1}$)	$260 \text{ ft}^3\text{s}^{-1}$ ($7.4 \text{ m}^3\text{s}^{-1}$)	$530 \text{ ft}^3\text{s}^{-1}$ ($15 \text{ m}^3\text{s}^{-1}$)	
Discharge: Average 1-Day Around Peak	$7,100 \text{ ft}^3\text{s}^{-1}$ ($201 \text{ m}^3\text{s}^{-1}$)	$4,700 \text{ ft}^3\text{s}^{-1}$ ($133 \text{ m}^3\text{s}^{-1}$)	$2,700 \text{ ft}^3\text{s}^{-1}$ ($76 \text{ m}^3\text{s}^{-1}$)				
Discharge: Average 10-Day Around Peak	$6,000 \text{ ft}^3\text{s}^{-1}$ ($170 \text{ m}^3\text{s}^{-1}$)	$4,000 \text{ ft}^3\text{s}^{-1}$ ($113 \text{ m}^3\text{s}^{-1}$)	$2,300 \text{ ft}^3\text{s}^{-1}$ ($65 \text{ m}^3\text{s}^{-1}$)				
Discharge: Minimum					$150 \text{ ft}^3\text{s}^{-1}$ ($4.2 \text{ m}^3\text{s}^{-1}$)	$450 \text{ ft}^3\text{s}^{-1}$ ($13 \text{ m}^3\text{s}^{-1}$)	
Discharge: Rate of Recession	$360 \text{ ft}^3\text{s}^{-1}$ ($10 \text{ m}^3\text{s}^{-1}$)	$220 \text{ ft}^3\text{s}^{-1}$ ($6.2 \text{ m}^3\text{s}^{-1}$)	$80 \text{ ft}^3\text{s}^{-1}$ ($2.3 \text{ m}^3\text{s}^{-1}$)				
Flow Variation							
Duration	10 days	10 days	10 days	5 days	183 days	107 days	
Timing	May-Jun	May-Jun	May-Jun	Jun 15-Sep 30	Apr 1-Sep 30	Nov 1-Feb 15	
Frequency	1:25 yrs	1:5 yrs	1:2 yrs	1:2 yrs	Annual	Annual	

Table A2. E-Flow Recommendations for Reach Two-Chama Headwaters. Geographic location, indicator species, and e-flow recommendations for the headwaters of the Rio Chama from Briggs et al. (2025). Note: Recommendations are rounded to nearest 100 ft^3s^{-1} ($2.8 \text{ m}^3\text{s}^{-1}$) for prescription values that are greater than 1,000 ft^3s^{-1} ($28 \text{ m}^3\text{s}^{-1}$) and to nearest 10 ft^3s^{-1} ($0.3 \text{ m}^3\text{s}^{-1}$) for values less than 1,000 ft^3s^{-1} ($28 \text{ m}^3\text{s}^{-1}$).

Reach Two							
Name: Chama Headwaters		Core Indicators:					
Location: Rio Chama from the Colorado state line to the USGS streamflow gauge at La Puente near the town of Tierra Amarilla		<ol style="list-style-type: none"> 1. <u>Rio Grande cottonwood (<i>Populus deltoides</i> ssp. <i>wislizeni</i>)</u>: High Spring Pulse, Medium Spring Pulse, Low Spring Pulse 2. <u>Brown trout (<i>Salmo trutta</i>)</u>: Spring-Summer Low, Fall-Winter Low (Spawning), Fall-Winter Low (Non-Spawning) 3. <u>Rio Grande chub (<i>Gila pandora</i>)</u>: Spring-Summer Low 4. <u>Rio Grande shiner (<i>Notropis jemezianus</i>)</u>: Spring-Summer Low 					
Reach Length: 26 miles (41.8 km)							
Reference Years (Spring Pulse)							
<u>High Flow Years:</u> 1993, 1995, and 2005							
<u>Medium Flow Years:</u> 1994, 1997, 2008-2010, 2015, 2017, 2019, and 2023							
<u>Low Flow Years:</u> 1996, 1998-1999, 2001, 2003-2004, 2007, 2011, 2016, and 2020-2021							
Reference Years (Spring-Summer Low)							
<u>Sufficient Flow Years:</u> 1994, 1998, 2003, 2005, 2008, 2013, 2015-2017, 2019, and 2023							
<u>Below Minimum Required Flow Years:</u> 1996, 2000, 2002, 2004, 2012, and 2018							
Reference Years (Fall-Winter Spawning)							
<u>Sufficient Flow Years:</u> 1995, 2011, and 2014							
E-Flow Recommendations							
	High Spring Pulse	Medium Spring Pulse	Low Spring Pulse	Monsoon Flushing	Spring-Summer Low	Fall-Winter Low (Spawning)	Fall-Winter Low (Non-Spawning)
Discharge: Peak							
Discharge: Average					80 ft^3s^{-1} (2.3 m^3s^{-1})	70 ft^3s^{-1} (2 m^3s^{-1})	70 ft^3s^{-1} (2 m^3s^{-1})
Discharge: Average 1-Day Around Peak	4,100 ft^3s^{-1} (116 m^3s^{-1})	3,700 ft^3s^{-1} (105 m^3s^{-1})	2,200 ft^3s^{-1} (62 m^3s^{-1})				
Discharge: Average 10-Day Around Peak	3,900 ft^3s^{-1} (111 m^3s^{-1})	2,900 ft^3s^{-1} (82 m^3s^{-1})	1,700 ft^3s^{-1} (48 m^3s^{-1})				
Discharge: Minimum					50 ft^3s^{-1} (1.4 m^3s^{-1})	50 ft^3s^{-1} (1.4 m^3s^{-1})	50 ft^3s^{-1} (1.4 m^3s^{-1})
Discharge: Average Daily Decline After Peak	330 ft^3s^{-1} (9.3 m^3s^{-1})	280 ft^3s^{-1} (8.0 m^3s^{-1})	240 ft^3s^{-1} (6.8 m^3s^{-1})				
Flow Variation					Discharge < 60 ft^3s^{-1} ≤ 50% of time	% time discharge < 50 ft^3s^{-1} =0 % time discharge < 130 ft^3s^{-1} =0	% time discharge < 50 ft^3s^{-1} =0 % time discharge < 130 ft^3s^{-1} =17
Duration	10 days	10 days	10 days		183 days	107 days	44 days
Timing	May-Jun	May-Jun	May-Jun		Apr 1-Sep 30	Nov 1-Feb 15	Feb 16-Mar 31
Frequency	1:25 yrs	1:5 yrs	1:2 yrs		Annual	Annual	Annual

Table A3. E-Flow Recommendations for Reach Three-Chama Below El Vado. Geographic location, indicator species, and e-flow recommendations for the Rio Chama from El Vado Dam to Abiquiu Reservoir from Briggs et al. (2025). Note: Recommendations are rounded to nearest 100 ft^3s^{-1} ($2.8 \text{ m}^3\text{s}^{-1}$) for prescription values that are greater than 1,000 ft^3s^{-1} ($28 \text{ m}^3\text{s}^{-1}$) and to nearest 10 ft^3s^{-1} ($0.3 \text{ m}^3\text{s}^{-1}$) for values less than 1,000 ft^3s^{-1} ($28 \text{ m}^3\text{s}^{-1}$).

Reach Three							
Name: Chama Below El Vado	Core Indicators:						
Location: Rio Chama between El Vado Dam and the upstream portion of Abiquiu Reservoir	1. <u>Rio Grande cottonwood</u> (<i>Populus deltoides</i> ssp. <i>wislizeni</i>): High Spring Pulse, Medium Spring Pulse, Low Spring Pulse 2. <u>Brown trout</u> (<i>Salmo trutta</i>): Monsoon, Spring-Summer Low, Fall-Winter Low (Spawning) 3. <u>Native fish</u> : Fall-Winter Low (Non-Spawning)						
Reach Length: 32 miles (52 km)							
Reference Years (Spring Pulse)							
<u>High Flow Years:</u> 1941, 1973, and 1985							
<u>Medium Flow Years:</u> 1993-1995, 2005, 2009, 2016, and 2023							
<u>Low Flow Years:</u> 1997-1999, 2001, 2004, 2008, 2014, 2017, 2019, and 2022							
Reference Years (Monsoon Flushing & Spring-Summer Low)							
<u>Average Flow:</u> 1993-2023							
	E-Flow Recommendations						
	High Spring Pulse	Medium Spring Pulse	Low Spring Pulse	Monsoon Flushing	Spring-Summer Low	Fall-Winter Low (Spawning)	Fall-Winter Low (Non-Spawning)
Discharge: Peak							
Discharge: Average				700 ft^3s^{-1} - 1,000 ft^3s^{-1} (20 m^3s^{-1} - 28 m^3s^{-1})	150 ft^3s^{-1} (4.2 m^3s^{-1})	150 ft^3s^{-1} (4.2 m^3s^{-1})	150 ft^3s^{-1} (4.2 m^3s^{-1})
Discharge: Average 1-Day Around Peak	5,800 ft^3s^{-1} (164 m^3s^{-1})	4,300 ft^3s^{-1} (122 m^3s^{-1})	2,000 ft^3s^{-1} (57 m^3s^{-1})				
Discharge: Average 10-Day Around Peak	3,900 ft^3s^{-1} (110 m^3s^{-1})	2,000 ft^3s^{-1} (57 m^3s^{-1})	1,700 ft^3s^{-1} (48 m^3s^{-1})				
Discharge: Minimum					70 ft^3s^{-1} (1.8 m^3s^{-1})	90 ft^3s^{-1} (2.5 m^3s^{-1})	65 ft^3s^{-1} (1.8 m^3s^{-1})
Discharge: Average Daily Decline After Peak	380 ft^3s^{-1} (11 m^3s^{-1})	280 ft^3s^{-1} (7.9 m^3s^{-1})	240 ft^3s^{-1} (6.8 m^3s^{-1})				
Flow Variation						% time discharge <90 ft^3s^{-1} =0	% time discharge <100 ft^3s^{-1} =0
Duration	10 days	10 days	10 days	4 hrs	183 days	107 days	44 days
Timing	May-Jun	May-Jun	May-Jun		Apr 1-Sep 30	Nov 1-Feb 15	Feb 16-Mar 31
Frequency	1:25 yrs	1:5 yrs	1:2 yrs	3/season	Annual	Annual	Annual

Table A4. E-Flow Recommendations for Reach Four-Chama Below Abiquiu. Geographic location, indicator species, and e-flow recommendations for the Rio Chama from Abiquiu Dam to Confluence with Rio Grande from Briggs et al. (2025). Note: Recommendations are rounded to nearest 100 ft³s⁻¹ (2.8 m³s⁻¹) for prescription values that are greater than 1,000 ft³s⁻¹ (28 m³s⁻¹) and to nearest 10 ft³s⁻¹ (0.3 m³s⁻¹) for values less than 1,000 ft³s⁻¹ (28 m³s⁻¹).

Reach Four							
Name: Chama Below Abiquiu		Core Indicators:					
Location: Rio Chama from Abiquiu Dam to the confluence with the Rio Grande		1. <u>Sediment evacuation</u> in aggraded areas for riverside citizens and native species: High Spring Pulse					
Reach Length: 29.4 miles (47.3 km)		2. <u>Rio Grande cottonwood (<i>Populus deltoides</i> ssp. <i>wislizeni</i>)</u> : Medium Spring Pulse, Low Spring Pulse					
Reference Years (Spring Pulse)		3. <u>Native aquatic habitat</u> : Spring-Summer Low					
<u>High Flow Years:</u> (Same as Medium Flow Years)		4. <u>Brown trout (<i>Salmo trutta</i>)</u> : Fall-Winter Low					
<u>Medium Flow Years:</u> 1914, 1917, 1919, 1930, 1933, and 1935							
<u>Low Flow Years:</u> 1993-1994, 1997, 1999, 2004, 2007, 2009, 2017, and 2019							
Reference Years (Spring-Summer Low & Fall-Winter Low)							
<u>Average Flow:</u> 1993-2023							
	E-Flow Recommendations						
	High Spring Pulse	Medium Spring Pulse	Low Spring Pulse	Monsoon Flushing	Spring-Summer Low	Fall-Winter Low (Spawning)	Fall-Winter Low (Non-Spawning)
Discharge: Peak							
Discharge: Average					400 ft ³ s ⁻¹ (50 m ³ s ⁻¹)	250 ft ³ s ⁻¹ (7.1 m ³ s ⁻¹)	198 ft ³ s ⁻¹ (5.6 m ³ s ⁻¹)
Discharge: Average 1-Day Around Peak	3,400 ft ³ s ⁻¹ (96 m ³ s ⁻¹)	3,400 ft ³ s ⁻¹ (96 m ³ s ⁻¹)	1,800 ft ³ s ⁻¹ (51 m ³ s ⁻¹)				
Discharge: Average 10-Day Around Peak	3,200 ft ³ s ⁻¹ (91 m ³ s ⁻¹)	3,200 ft ³ s ⁻¹ (91 m ³ s ⁻¹)	1,700 ft ³ s ⁻¹ (48 m ³ s ⁻¹)				
Discharge: Minimum					300 ft ³ s ⁻¹ (8.5 m ³ s ⁻¹)	200 ft ³ s ⁻¹ (5.7 m ³ s ⁻¹)	50 ft ³ s ⁻¹ (1.4 m ³ s ⁻¹)
Discharge: Average Daily Decline After Peak	<i>Minimal after peak, then abrupt reduction to average flow after 20 days</i>	150 ft ³ s ⁻¹ (4.2 m ³ s ⁻¹)	280 ft ³ s ⁻¹ (7.9 m ³ s ⁻¹)				
Flow Variation					% time discharge < 300 ft ³ s ⁻¹ = 0	% time discharge > 400 ft ³ s ⁻¹ = 0 % time discharge < 200 ft ³ s ⁻¹ = 0	% time discharge < 50 ft ³ s ⁻¹ = 0
Duration	10 days	10 days	10 days		183 days	123 days	58 days
Timing	May-Jun	May-Jun	May-Jun		Apr 1-Sep 30	Nov 1-Feb 15	Feb 16-Mar 31
Frequency	1:25 yrs	1:5 yrs	1:2 yrs		Annual	Annual	Annual

Table A5. E-Flow Recommendations for Reach Five-Rio Chama-Rio Grande Confluence to Cochiti.

Geographic location, indicator species, and e-flow recommendations for the Rio Grande from the confluence with the Rio Chama to the Cochiti Reservoir from Briggs et al. (2025). Note: Recommendations are rounded to nearest 100 ft³s⁻¹ (2.8 m³s⁻¹) for prescription values that are greater than 1,000 ft³s⁻¹ (28 m³s⁻¹) and to nearest 10 ft³s⁻¹ (0.3 m³s⁻¹) for values less than 1,000 ft³s⁻¹ (28 m³s⁻¹).

Reach Five						
Name: Rio Chama-Rio Grande Confluence to Cochiti		Core Indicators:				
Location: Rio Grande from the Rio Grande-Rio Chama confluence to Cochiti Reservoir		1. <u>Rio Grande cottonwood (<i>Populus deltoides</i> ssp. <i>wislizeni</i>)</u> : High Spring Pulse, Medium Spring Pulse, Low Spring Pulse				
Reach Length: 35 miles (56 km)		2. <u>Rio Grande Chub (<i>Gila pandora</i>)</u> : Spring-Summer Low, Fall-Winter Low				
		3. <u>Rio Grande sucker (<i>Catostomus plebeius</i>)</u> : Spring-Summer Low				
		4. <u>Rio Grande Shiner (<i>Notropis jemezanus</i>)</u> : Fall-Winter Low				
		Supporting Indicators: North American River Otter (<i>Lontra canadensis</i>), Summer Tanager (<i>Piranga rubra</i>)				
Reference Years (Spring Pulse)						
<u>High Flow Years:</u> 1994						
<u>Medium Flow Years:</u> 1993, 1995, 1997, 2008-2009, 2016-2017, 2019, and 2023						
<u>Low Flow Years:</u> 1998, 1999, 2001, 2003-2004, 2007, 2010, and 2015						
Reference Years (Spring-Summer Low Flow)						
<u>Below Minimum Required Flow Years:</u> 2003, 2012, 2013, 2018, 2020, and 2021						
Reference Years (Fall-Winter Low)						
<u>Average Flow:</u> 1993-2023						
E-Flow Recommendations						
	High Spring Pulse	Medium Spring Pulse	Low Spring Pulse	Monsoon Flushing	Spring-Summer Low	Fall-Winter Low
Discharge: Peak						
Discharge: Average					450 ft ³ s ⁻¹ (13 m ³ s ⁻¹)	380 ft ³ s ⁻¹ (11 m ³ s ⁻¹)
Discharge: Average 1-Day Around Peak	8,200 ft ³ s ⁻¹ (232 m ³ s ⁻¹)	6,600 ft ³ s ⁻¹ (187 m ³ s ⁻¹)	3,700 ft ³ s ⁻¹ (105 m ³ s ⁻¹)			
Discharge: Average 10-Day Around Peak	7,500 ft ³ s ⁻¹ (212 m ³ s ⁻¹)	5,800 ft ³ s ⁻¹ (164 m ³ s ⁻¹)	3,200 ft ³ s ⁻¹ (91 m ³ s ⁻¹)			
Discharge: Minimum					620 ft ³ s ⁻¹ (18 m ³ s ⁻¹)	610 ft ³ s ⁻¹ (17 m ³ s ⁻¹)
Discharge: Average Daily Decline After Peak	440 ft ³ s ⁻¹ (12 m ³ s ⁻¹)	260 ft ³ s ⁻¹ (7.4 m ³ s ⁻¹)	180 ft ³ s ⁻¹ (5.1 m ³ s ⁻¹)			
Flow Variation					Discharge <500 ft ³ s ⁻¹ <10% of time	Minimum flow of 380 ft ³ s ⁻¹
Duration	10 days	10 days	10 days			182 days
Timing	May-Jun	May-Jun	May-Jun		Apr 1-Sep 30	Oct 1-Mar 31
Frequency	1:25 yrs	1:5 yrs	1:2 yrs		Annual	Annual

Table A6. E-Flow Recommendations for Reach Six-Middle Rio Grande. Geographic location, indicator species, and e-flow recommendations for the Rio Grande from the Cochiti Dam to the Elephant Butte Reservoir from Briggs et al. (2025). Note: Recommendations are rounded to nearest $100 \text{ ft}^3\text{s}^{-1}$ ($2.8 \text{ m}^3\text{s}^{-1}$) for prescription values that are greater than $1,000 \text{ ft}^3\text{s}^{-1}$ ($28 \text{ m}^3\text{s}^{-1}$) and to nearest $10 \text{ ft}^3\text{s}^{-1}$ ($0.3 \text{ m}^3\text{s}^{-1}$) for values less than $1,000 \text{ ft}^3\text{s}^{-1}$ ($28 \text{ m}^3\text{s}^{-1}$).

Reach Six						
Name: Middle Rio Grande	Core Indicators:					
Location: Rio Grande from Cochiti Dam to Elephant Butte Reservoir	1. <u>Rio Grande cottonwood (<i>Populus deltoides</i> ssp. <i>wislizeni</i>)</u> : High Spring Pulse, Medium Spring, Low Spring Pulse					
Reach Length: ~173 miles (~278 km)	2. <u>Rio Grande silvery minnow (<i>Hybognathus amarus</i>)</u> : High Spring Pulse, Medium Spring, Low Spring Pulse, Spring-Summer Low					
	3. <u>Southwestern Willow Flycatcher (<i>Empidonax traillii extimus</i>)</u> : High Spring Pulse					
	4. <u>Sandhill Crane (<i>Antigone canadensis</i>)</u> : Fall-Winter Low					
Reference Years (Spring Pulse)						
<u>Low Flow Years:</u> 1998, 1999, 2001, and 2015-2016						
<u>Medium Flow Years:</u> 1993-1995, 1997, 2005, 2017, 2019, and 2023						
<u>High Flow Years:</u> 1967, 1984-1985						
E-Flow Recommendations						
	High Spring Pulse	Medium Spring Pulse	Low Spring Pulse	Monsoon Flushing	Spring-Summer Low	Fall-Winter Low
Discharge: Peak						
Discharge: Average					$270 \text{ ft}^3\text{s}^{-1}$ ($7.6 \text{ m}^3\text{s}^{-1}$)	$170 \text{ ft}^3\text{s}^{-1}$ ($4.8 \text{ m}^3\text{s}^{-1}$)
Discharge: Average 1-Day Around Peak	$8,500 \text{ ft}^3\text{s}^{-1}$ ($241 \text{ m}^3\text{s}^{-1}$)	$6,000 \text{ ft}^3\text{s}^{-1}$ ($170 \text{ m}^3\text{s}^{-1}$)	$2,000 \text{ ft}^3\text{s}^{-1}$ ($57 \text{ m}^3\text{s}^{-1}$)			
Discharge: Average 10-Day Around Peak	$7,500 \text{ ft}^3\text{s}^{-1}$ ($212 \text{ m}^3\text{s}^{-1}$)	$5,400 \text{ ft}^3\text{s}^{-1}$ ($153 \text{ m}^3\text{s}^{-1}$)	$1,700 \text{ ft}^3\text{s}^{-1}$ ($48 \text{ m}^3\text{s}^{-1}$)			
Discharge: Minimum					$130 \text{ ft}^3\text{s}^{-1}$ ($3.7 \text{ m}^3\text{s}^{-1}$)	$590 \text{ ft}^3\text{s}^{-1}$ ($16.7 \text{ m}^3\text{s}^{-1}$)
Discharge: Average Daily Decline After Peak	$40 \text{ ft}^3\text{s}^{-1}$ ($1.1 \text{ m}^3\text{s}^{-1}$)	$500 \text{ ft}^3\text{s}^{-1}$ ($14 \text{ m}^3\text{s}^{-1}$)	$140 \text{ ft}^3\text{s}^{-1}$ ($4 \text{ m}^3\text{s}^{-1}$)			
Flow Variation						% time discharge > $1,000 \text{ ft}^3\text{s}^{-1}$ =6 % time discharge > 700 ft^3s^{-1} =22
Duration	10 days	20 days	20 days		183 days	182 days
Timing	May-Jun	May-Jun	May-Jun		Apr 1-Sep 30	Oct 1-Mar 31
Frequency	1:25 yrs	1:5 yrs	1:2 yrs		Annual	Annual