Saguache Creek Stream Management Plan

Prepared for:

Rio Grande Basin Roundtable and the
Stream Management Plan Technical Advisory Team

With support from:

Colorado Water Conservation Board
San Luis Valley Conservation and Connection Initiative
Bureau of Reclamation WaterSMART Program
American Whitewater
Sangre de Cristo National Heritage Area
San Luis Valley Water Conservancy District
Conejos Water Conservancy District

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Executive Summary

The purpose of the Rio Grande, Conejos River, and Saguache Creek Stream Management Plans (SMPs) is to assess stream conditions to enable local stakeholders to develop informed and data-driven management actions with the goal of preserving and enhancing water uses and community values. Following the release of the 2015 Colorado Water Plan, the Rio Grande Basin Roundtable (Roundtable) recognized the need for comprehensive assessments and management plans for locally prioritized streams in the Rio Grande Basin. Streams in the Rio Grande Basin were prioritized by a SMP Subcommittee of the Roundtable. The SMP Subcommittee prioritized the following stream segments: 1) The Rio Grande from Stony Pass to the Colorado state line, 2) Conejos River from Platoro Reservoir to the Rio Grande confluence, and 3) Saguache Creek from the South Fork Saguache Creek confluence to Braun Bridge. To support the project, a SMP Technical Advisory Team (TAT) was formed and composed of state and federal agency officials, local water managers, nonprofit organizations, private landowners, and interested stakeholders. The TAT was instrumental in guiding data collection and the overall direction of the SMPs.

The SMPs are built on and guided by stakeholder input and values. Stakeholder engagement, through public meetings, landowner outreach, surveys, and email and social media updates, was critically important throughout the planning process. The SMP goals and priority projects were developed with significant stakeholder input and are aligned with stakeholder values.

To characterize stream condition and function, a *conditions assessment* was conducted for each stream. Each stream was divided into reaches based on similarities in geomorphology and reach breaks influenced by infrastructure, such as diversion dams. Assessments of recreational and aquatic habitat streamflow needs, diversion infrastructure, geomorphology, riparian vegetation, water quality, and aquatic life were completed. Conditions assessment results are organized by reach and include a list of impacts, or stressors, affecting each reach as well as a discussion of the likely cause(s) of stressors. The SMPs define management goals as well as priority projects and actions stakeholders may take to further each goal. Rough cost estimates are included, where appropriate.

The Rio Grande, Conejos River, and Saguache Creek SMPs are intended to be used as science-based guides for stream management through collaborative and multi-benefit projects. They provide an implementation strategy to support healthy streams and protect the ecosystem services they provide for fish, wildlife, and communities that rely on them.

Acknowledgements

Technical Advisory Team

Representatives from the Following Agencies and Organizations:

American Whitewater
Bird Conservancy of the Rockies
Bureau of Land Management
Colorado Parks and Wildlife
Colorado Water Conservation Board
Conejos Water Conservancy District
Conejos Water Users Association
Headwaters Alliance
Natural Resources Conservation Service
Rio Grande Basin Roundtable
Rio Grande Headwaters Land Trust
Rio Grande Headwaters Restoration Project
Rio Grande Water Conservation District
Rio Grande Water Users Association
Saguache Creek Water Users Association
San Luis Valley Irrigation District
San Luis Valley Water Conservancy District
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United States Forest Service
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Sangre de Cristo National Heritage Area
San Luis Valley Water Conservancy District
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Glossary

Alluvial aquifer – An aquifer comprising unconsolidated material deposited by water, typically occurring adjacent to rivers.

Armoring (bed or channel) – The application of resistant materials on a river bed or banks to reduce scour and erosion.

Augmentation (of flow) – The addition of water to a system. In the case of water rights, this typically refers to augmentation plans used to replace depletions to streams caused by well pumping.

Avulsion – The sudden change of river's location or path.

Base flow – The portion of streamflow occurring outside of runoff, typically lasting from mid- to late-summer through early spring.

Benthic macroinvertebrates – Aquatic insects and other invertebrate (lacking a backbone) organisms living on the stream channel bed, often within interstitial spaces of channel substrate anywhere from sand to large boulders. Although some aquatic invertebrates may be quite small, "macro" refers to their visibility without magnification.

Channelization – Mechanical alteration of a river or stream that confines flow within a single course. Often times these actions can be combined with straightening.

Channel migration – The natural process by which stream channels move laterally over time.

Compact – The interstate Rio Grande Compact signed in 1938 between the states of Colorado, New Mexico, and Texas.

C-value – A value ranging from 0 to 10 and representing an estimated probability that a plant is likely to occur in a landscape relatively unaltered from pre-European settlement conditions. Also known as a coefficient of conservatism.

Depletion (of flow) – Removal of water from a system.

Flow duration curve – A graph representing the percent of time a specified discharge is equaled or exceeded.

Geomorphic – Relating to the form of the land or topography. In the context of streams, geomorphic characteristics include the physical shapes of streams, their water and sediment transport processes, and the landforms they create.

Hyporheic zone – Delineates a volume of saturated sediment that surrounds a river, where mixing of surface water and shallow groundwater occurs, and constitutes a transitional area (ecotone) between the surface and groundwater hydrologic systems and between aquatic and terrestrial habitats in the riparian zone. Referred to in this document in the context of hyporheic exchange.

Peak flow – Highest streamflow of the year, typically during spring snowmelt runoff.

Reach – A stream segment along which similar hydrologic conditions exist, such as discharge, depth, area, and slope.

River miles – River miles represent the distance of a stream channel across a landscape. In this report, river miles were calculated using the Source Water Route Framework dataset, which is extracted from the National Hydrography Dataset. Note: river miles are synonymous with stream miles.

Roundtable – The Rio Grande Basin Roundtable

San Luis Valley Closed Basin – A basin in the northern San Luis Valley where surface water outflow is prevented by a hydrologic divide and therefore surface waters are not tributary to the Rio Grande.

Sediment transport – The ability of a stream or river to transport an equal amount of sediment out of a reach as the amount entering the reach.

Subdistrict – A groundwater management subdistrict of the Rio Grande Water Conservation District or the Trinchera Water Conservancy District.

Turbidity – The measure of relative clarity of a liquid.

Wet meadow – A type of wetland characterized by soils that are saturated for part or all of the growing season.

Acronyms

303(d)	The 303(d) list of impaired waters in Colorado (defined by the Colorado Department of Public Health and Environment)
AA	Targeted Assessment Area (see Riparian Vegetation Assessment)
AF	Acre-feet
AW	American Whitewater
Basin	Rio Grande Basin
BLM	Bureau of Land Management
BMI	Benthic Macroinvertebrates
CDPHE	Colorado Department of Public Health and Environment
CFS	Cubic feet per second
CNHP	Colorado Natural Heritage Program
CPW	Colorado Parks and Wildlife
CWCB	Colorado Water Conservation Board
DEM	Digital Elevation Model
EIA	Ecological Integrity Assessment
FQA	Floristic Quality Assessment
GIS	Geographic Information System
ISF	Instream Flow
M&E	Monitoring and Evaluation List
MMI	Multi-Metric Index (see Aquatic Life Assessment)
NRCS	Natural Resources Conservation Service
RGDSS	Rio Grande Decision Support System
RGHRP	Rio Grande Headwaters Restoration Project
SLV	San Luis Valley
SMP	Stream Management Plan
SWE	Snow Water Equivalent
SWRF	Source Water Route Framework
TAT	Technical Advisory Team
TMDL	Total maximum daily load
USFS	United States Forest Service
USGS	United States Geological Survey

Contents

1. Introduction

1.1 Purpose and Scope

The 2015 Colorado Water Plan set a goal that 80 percent of locally prioritized rivers be covered by stream management plans (SMPs) by 2030. Following publication of the Water Plan, the Rio Grande Basin Roundtable (Roundtable) recognized the need for comprehensive assessments and management plans for locally prioritized streams in the Rio Grande Basin. To help meet this need, a subcommittee of the Roundtable selected three priority stream segments for an initial round of SMPs. The SMP subcommittee prioritized the following stream segments: 1) The Rio Grande from Stony Pass to the Colorado state line (191.3 river miles), 2) Conejos River from Platoro Reservoir to the Rio Grande confluence (84.4 river miles), and 3) Saguache Creek from the South Fork Saguache Creek confluence to Braun Bridge (65.7 river miles). A map of the prioritized streams is shown in Figure 1.1.

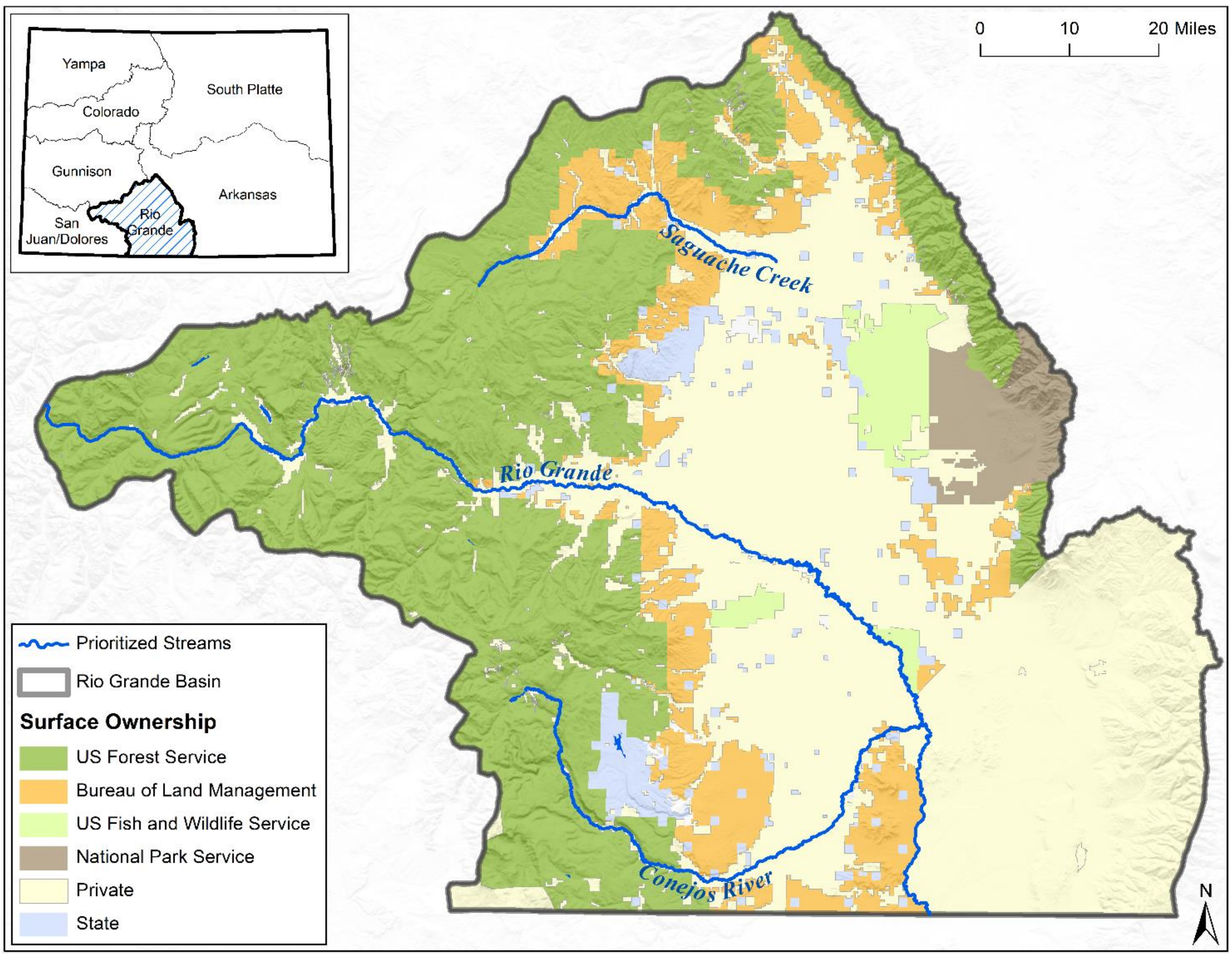


Figure 1.1: SMP prioritized streams with land ownership overlaid and delineation of Rio Grande Basin boundary.

To support the project, a SMP Technical Advisory Team (TAT) was formed and composed of state and federal agency officials, local water managers, nonprofit organizations, private landowners, and interested stakeholders. The TAT was instrumental in guiding data collection and the overall direction of the SMPs. The purpose of the Rio Grande, Conejos River, and Saguache Creek SMPs is to assess stream conditions to enable local stakeholders to develop informed and data-driven management actions with the goal of preserving and enhancing water uses and community values. The SMPs are intended to be used as guides for effective and multi-benefit restoration and stream management projects.

Although multiple studies have been conducted on the Rio Grande in Colorado, the Roundtable and TAT recognized a need to better understand the condition and function of streams in the Rio Grande Basin. Previous studies documenting the condition of the Rio Grande include the 2001 Rio Grande Headwater Restoration Project, the 2016 Rio Grande Natural Area River Condition Assessment, and the 2018 Upper Rio Grande Watershed Assessment (MWH, 2001; Riverbend Engineering, 2016; SGM & Lotic Hydrological, 2018). However, a study covering the entire Rio Grande in Colorado with consistent methodology had not been completed, and data for the Conejos River and Saguache Creek was particularly limited. The Roundtable recognized that a comprehensive study of these three prioritized streams was needed. The Rio Grande, Conejos River, and Saguache Creek SMPs address that need.

1.2 Project Objectives

The objectives of the Rio Grande, Conejos River, and Saguache Creek SMPs were to:

- Maintain and build on the coalition of community partners engaged in stream management planning through frequent and robust stakeholder engagement throughout the project.
- Summarize and obtain information regarding the biological, hydrological, and geomorphological condition of identified stream reaches in the Rio Grande watershed.
- Define and prioritize environmental, recreational, and community values.
- Develop goals to improve flows and physical conditions needed to support values.
- Outline actions to achieve measurable progress toward maintaining or improving goals.
- Identify opportunities and constraints for implementation of projects, and additional data needed to inform project development.

1.3 Why are Stream Management Plans Important?

SMPs offer a valuable opportunity for communities to address issues related to stream functions in an effort to better support diverse groups of water users. They provide the opportunity to assess stream conditions and function, identify likely stressors adversely affecting these conditions, and develop multi-objective solutions to mitigate stressors and improve conditions. Because SMPs are stakeholder-driven, diverse community values are represented in decision making and the development of goals and priority actions. Strong stakeholder interest and support provided the impetus for the Rio Grande, Conejos River, and Saguache Creek SMPs and contributed significantly to the success of each SMP.

1.4 Stakeholder Engagement

A diverse group of stakeholders utilize and are intimately connected to the Rio Grande, Conejos River, and Saguache Creek. Irrigated agriculture has a rich history on the basin, having utilized surface water from the Rio Grande for over 150 years. Agricultural producers depend on surface water to irrigate crops during the growing season, and many farms and ranches are now operated by the fourth and fifth generation producers. Anglers have access to exceptional Rio Grande, Conejos River, and Saguache Creek sport fisheries. Recreational boating opportunities are also plentiful, with commercial and private boaters floating the Rio Grande and Conejos River. Not least, San Luis Valley residents enjoy and take pride in the aesthetic value of the streams and rivers flowing through the region.

To engage stakeholders and gather input, significant outreach was conducted throughout the SMP process. Regular email updates were sent to a SMP stakeholder listserv, individual and group meetings were held, and the SMP Project Coordinator presented regularly to the Roundtable and several other stakeholder groups. A summary of stakeholder engagement activities is detailed below:

- Provided regular project updates via the SMP email listserv.
- Held six TAT meetings to discuss stream conditions assessment methodology, assessment results, and project goals/priority projects. Resources from TAT and public meetings including minutes, handouts, and presentations were published on the Rio Grande Headwaters Restoration Project website.
- Held five public community meetings in summer 2019. Each meeting was specific to one of the three SMPs. Public meetings were advertised in the Valley Courier, Saguache Crescent, Conejos County Citizen, Del Norte Prospector, Monte Vista Journal, and through the SMP listserv and several Facebook groups. Meetings were also advertised on KSLV and KRZA radio stations.
- Provided regular updates for the following groups: Rio Grande Basin Roundtable, Rio Grande Water Users Association, Conejos Water Users Association, Saguache Creek Water Users Association, San Luis Valley Wetland Focus Area Committee, and the boards of the Rio Grande Headwaters Restoration Project, San Luis Valley Water Conservancy District, Rio Grande Water Conservation District, and the Conejos Water Conservancy District.
- Presented to several other interested groups including the Colorado Agricultural Water Alliance and the San Luis Valley Cattlemen's Association.
- Published an online ArcGIS "Story Map" outlining the Stream Management Plans.
- Distributed three public SMP stakeholder surveys, one for each SMP.
- Coordinated with American Whitewater to distribute a "boatable days" survey, which informed the recreational use assessment study on the Rio Grande and Conejos River.
- Completed significant outreach to and held meetings with many individual landowners.
- Held meetings with water commissioners for each SMP.

- Held special meetings with state and federal agencies including Colorado Parks and Wildlife (CPW), U.S. Fish and Wildlife Service (USFWS), Bureau of Land Management (BLM), and U.S. Forest Service (USFS).

Individual responses and themes resulting from the surveys, as well as feedback and input from formal and informal meetings, were incorporated into the planning process. The community values identified during this process include:

- Diversion infrastructure improvements to increase efficiency, reduce maintenance, and promote stream health.
- Maintaining and enhancing riparian areas.
- Improve the understanding of surface-groundwater interactions. This may include installing additional stream gages and monitoring wells as well as conducting research on surface-groundwater dynamics.
- Maintaining adequate streamflows for aquatic habitat, overall stream health, agriculture, and recreation.
- Removal or mitigation of recreational hazards (fencing, diversions, bridges, etc.).
- Improved infrastructure for sustainable recreational access to the river, especially fishing access.
- Riparian and aquatic habitat connectivity and agriculture viability through conservation easements and other strategies.
- Protecting and restoring floodplain connection and wet meadows and other wetlands for increased alluvial aquifer storage.
- Improving overall stream health for imperiled species, including fish and riparian habitat restoration.
- Additional monitoring data on water quality, irrigation infrastructure, and streamflows.
- Mitigating effects of flooding and debris flows (i.e., addressing severe bank erosion, particularly near key infrastructure).

1.5 Physiographic and Geologic Setting

Regional geologic and climatic history play important roles in fluvial geomorphology, which largely shapes the streams and rivers we see today. For the purposes of the SMPs, the physiographic context of a study area is defined by the dominant geologic and climatic conditions that define the modern landscape, which influence the study streams' form and associated physical processes.

The Upper Rio Grande Basin (Basin) in south-central Colorado covers 7,630 square miles and is bordered to the south by New Mexico. Within the Basin lies the San Luis Valley (SLV), a high elevation intermountain valley situated between two major mountain ranges. The SLV is a large rift valley in the Southern Rocky Mountains Province (Figure 1.2) and is part of the larger Rio Grande rift which extends from north of the SLV near Leadville, Colorado to southern Mexico (Bachman & Mehnert, 1978).

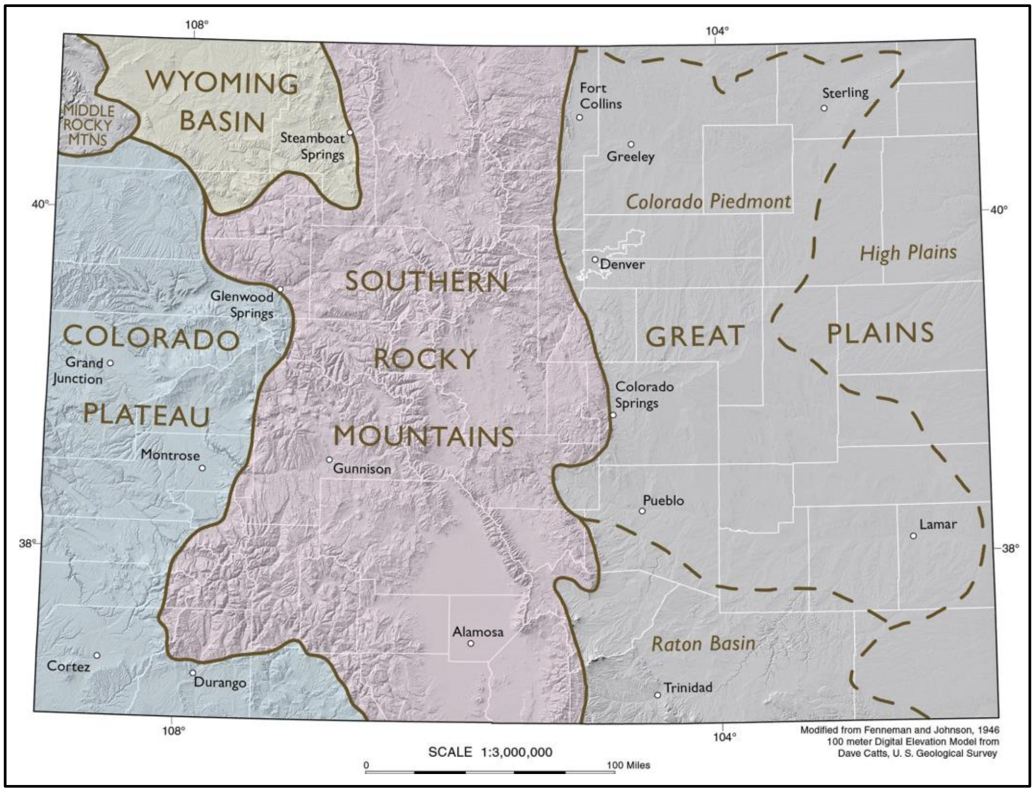


Figure 1.2: Physio-geographic regions of Colorado (source: Colorado Geological Survey website).

The geology of the Southern Rocky Mountains Province is dominated by Precambrian igneous and metamorphic rocks uplifted and exposed during mountain building events. The last major event, the Laramide orogeny, ended approximately 70 million years ago and was largely responsible for building the San Juan Mountains. The Sangre de Cristo Mountains bound the SLV on the east, while the eastern San Juan Mountains form the western edge of the valley. The La Garita Range, which lies on the northwest edge of the valley and on the north end of the San Juan Mountains, was formed from volcanism and tectonics. The La Garita Range forms the headwaters of Saguache Creek, which also drains the Cochetopa Hills to the north. The La Garitas and eastern San Juans contribute to the Upper Rio Grande Watershed while the south-eastern San Juans make up the headwaters of Conejos River. Much of this area was influenced during the Paleocene (approximately 60 million years ago) by the La Garita super-caldera eruption, one of the largest known volcanic eruptions in Earth's history.

Generally speaking, the La Garitas are less steep than the San Juans and drain lower elevations. Significant glaciation was not noted to have occurred in the headwaters of Saguache Creek. The valley in which Saguache Creek lies is bound by lava and ash deposits. Near the town of Saguache, the Creek escapes onto the broad Alamosa Basin, an alluvial basin which makes up the north end of the Rio Grande Rift Valley (Figure 1.3). Alternating layers of sand, gravel and clay compromise the Alamosa alluvial basin. This material was transported and deposited by fluvial processes that fan material out onto the valley floor as well as by shallow water bodies where clay layers would have formed.

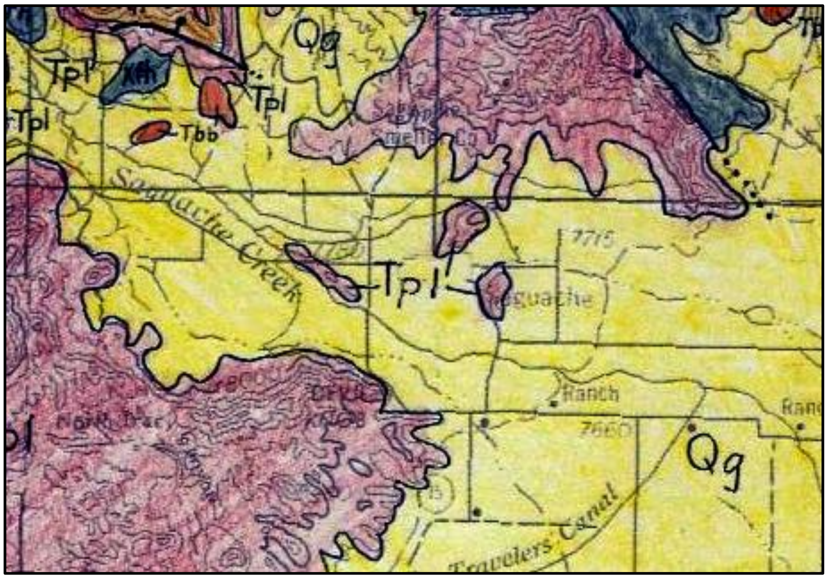
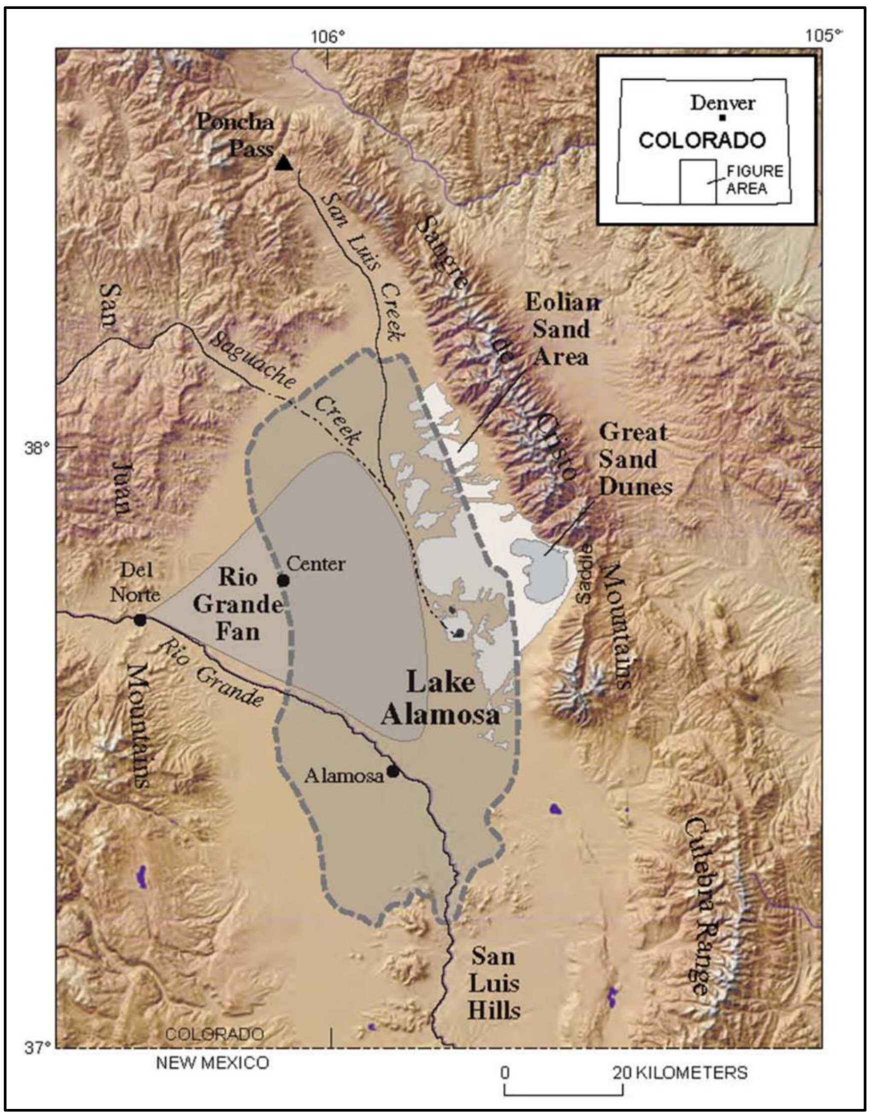


Figure 1.3: Simplified geologic map of the lower portion of the Saguache Creek study area. Qg (yellow) indicates alluvium; Tpl (light purple) indicates pre-ash flow andesitic lavas and breccias (volcanic origin).



Conversely, both the Rio Grande and Conejos River headwaters were heavily glaciated. Sediment excavated and deposited by glacial movement and melt as recently as 10,000 years ago still exists throughout the canyons and within the floodplains of the Rio Grande and Conejos River. Sediment and runoff contributions from glacial meltwater contributed to large alluvial fan formations where the streams break free from the San Juan foothills and spill onto the Rio Grande rift valley floor (Figure 1.4).

Figure 1.4: Map showing the generalized location of the Rio Grande Fan which covered over the ancient lakebed sediments of Lake Alamosa (Madole et al., 2008).

The Rio Grande, Conejos River, and Saguache Creek drain east out of the mountains and into the SLV. On the northern end of the SLV, Saguache Creek and other streams drain into a high altitude subbasin known as the San Luis Valley Closed Basin (Closed Basin), also referred to as the Alamosa Basin (Upson, 1939). The Closed Basin is endorheic, meaning its surface waters do not flow outside its boundaries and therefore are not tributary to the Rio Grande. Within the Closed Basin, streams draining the La Garita and Sangre de Cristo Ranges on the west and east sides of the valley, respectively, terminate in low points, or sump areas, forming numerous Inter-Mountain Basin Playas. The lowest elevation playa complex in the Closed Basin is San Luis Lakes, located just west of the Great Sand Dunes. The southern boundary of the San Luis Valley Closed Basin is thought to be formed by a low hydrologic divide resulting from the Rio Grande alluvial fan on the west and alluvial material from the Sangre de Cristo Mountain on the east (Alstine & Simon, 1982). The Closed Basin covers approximately 2,940 mi^2, making up about 39% of the Rio Grande Basin, shown in Figure 1.5.

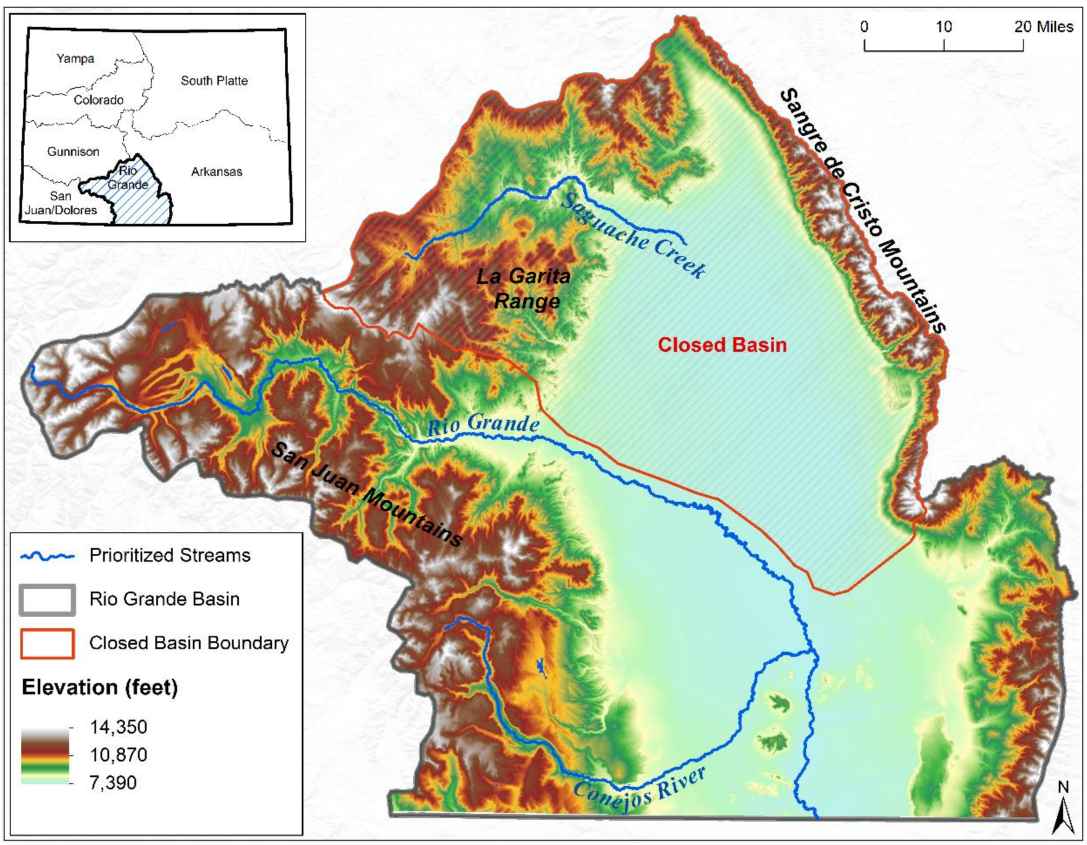


Figure 1.5. Prioritized streams in the Rio Grande Basin with elevation, major mountain ranges, and delineation of the Closed Basin boundary.

The headwaters of the Rio Grande are located on the Continental Divide near Stony Pass. From Stony Pass, the river flows east through the San Juan Mountains toward the SLV. At the Town of Del Norte, the river spreads out onto a broad alluvial fan, meandering east through the SLV. At the City of Alamosa, the river turns south and eventually crosses the Colorado - New Mexico state line. The

Conejos River begins near the Continental Divide at Lake Ann. The river flows southeast through the San Juan Mountains, meeting the San Luis Valley near the Town of Mogote. From Mogote, the river flows northeast to its confluence with the Rio Grande near Lasauses, CO.

Saguache Creek is located in the northwest corner of the San Luis Valley floor. The Saguache Creek watershed drains the La Garita Range of the San Juan Mountains to the south and west and the Cochetopa Hills to the north and west. Both of these ranges are of volcanic origin with no known history of glaciation. The Creek is generally characterized as a low-gradient meandering stream escaping from the confinement of the La Garita Mountains and Cochetopa Hills out onto the broad Alamosa Basin of the SLV. The Saguache Creek SMP covers the Creek from the South Fork Saguache Creek confluence (38°00'32.66"N, 106°39'16.01"W) to Braun Bridge, where the Creek crosses County Rd X downstream of the Town of Saguache (38°03'15.58"N, 106°02'40.45"W).

Saguache Creek begins at a series of small lakes at approximately 12,727 ft in the La Garita Wilderness. From its headwaters, it flows northeast, converges with the North and South Forks of Saguache Creek, and runs through a narrow gorge. Approximately 14 miles upstream of the Town of Saguache, the Creek reaches a wide alluvial fan, where it turns southeast. The Creek then flows past Saguache and into the Closed Basin at the northern end of the SLV, where it terminates at playa lakes near Highway 17. The actual location of the Creek's terminus can vary substantially depending on winter snowpack and spring runoff conditions. Because Saguache Creek drains into the Closed Basin, it is not naturally connected by surface water to the Rio Grande. The total watershed area of Saguache Creek at the downstream end of the study area is 621 mi^2.

The majority of Saguache Creek included in this SMP is privately owned, with only the first reach within the Rio Grande National Forest. Surface water from the Creek supports irrigated agriculture, angling, and abundant wildlife habitat. The Saguache Creek Water Users Association was instrumental in guiding this SMP and played a large role in its completion.

1.6 Hydrologic Context

Hydrology plays a fundamental role in channel form, riparian areas, water quality, and aquatic life. The timing and magnitude of streamflow is a driver of geomorphic “work” in stream channels (i.e., more water in the system means more work being done to mobilize and transport sediment in the system, affecting stream channel and floodplain morphology). These hydrologic processes also affect the establishment and maintenance of riparian vegetation, water quality parameters, and the type and abundance of aquatic life. Surface hydrology in Colorado’s Rio Grande Basin is characterized by high flows during spring runoff lasting into early summer, and significantly lower (base) flows in late summer, early fall, and winter. The SMP study streams are snowmelt-driven, with the vast majority of water production occurring in the form of snow. These characteristics are illustrated by the hydrograph in Figure 1.6, showing average daily flows at the Rio Grande near Del Norte gage from 1890 to 2017.

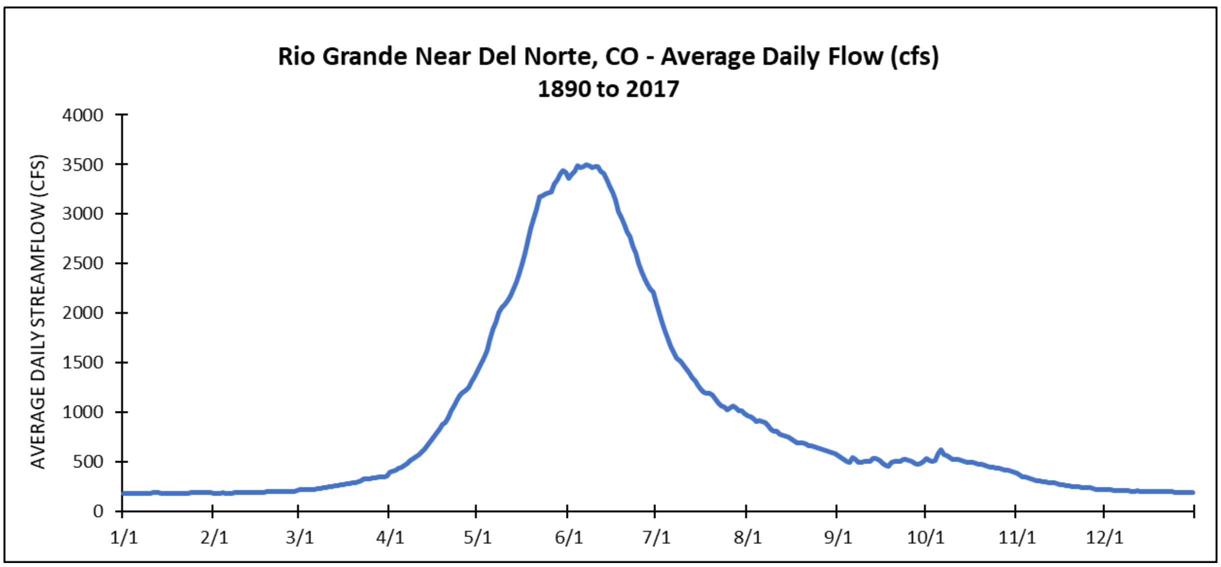


Figure 1.6: Average daily streamflow at the Rio Grande Near Del Norte, CO (RIODELCO) gage – 1890 to 2017.

Monsoon season typically results in sufficient precipitation to increase flows again in mid- to late-summer. Flooding from both snowmelt runoff and small-scale convective rainfall events during the monsoon are common mechanisms for high water events in the SMP study streams (Figure 1.7). Though rare in the period of record, extreme events have been observed to occur on streams draining into the SLV from the San Juan Mountains. Localized flash floods are likely to occur on tributary streams, which may cause the mainstems to swell, but more likely influence the streams by bringing fresh sediment down to the valley bottom and supplying the channels with material (Figure 1.7).

Saguache Creek does not have considerable upstream water storage facilities (dams and reservoirs) or flow regulation, so flows are more likely to fluctuate depending on available runoff in the watershed. The Rio Grande and Conejos River both have water storage reservoirs in their headwaters, which have reduced peak flows and thus the frequency with which geomorphically significant flows pass through the channels and floodplains. In all the study streams, numerous diversion structures influence flows by withdrawing water, but not typically enough to significantly alter the geomorphic condition or trajectory of the study reaches. However, these diversions change the frequency in which floodplains are inundated and bed sediments are mobilized.

Figure 1.7: Left: Snowmelt runoff doing geomorphic work on the Rio Grande floodplain, June 2019. Right: Sediment washed down from a small watershed that feeds a tributary to Saguache Creek (Photo: Round River Design, LLC).

In the “plains” reaches of the San Luis Valley, relatively impermeable clay layers connect the contributing streams to the relatively shallow aquifer that sits on top of these clay layers. Until as recent as the 1970s, the Alamosa Basin in the northern part of the San Luis Valley was naturally endorheic with water only escaping through evapo-transpiration of which the endpoint was a playa adjacent to the Great Sand Dunes. Modern water engineering projects have created some transfer of water out of the basin and into the Rio Grande watershed. In any event, the shallow depth to clay creates a situation where flooding can occur from water percolating up from below when the shallow aquifer is saturated (as opposed to flooding only occurring from over-topping of streambanks). The shallow depth to water in portions of the study area creates naturally abundant wetlands (Figure 1.8).

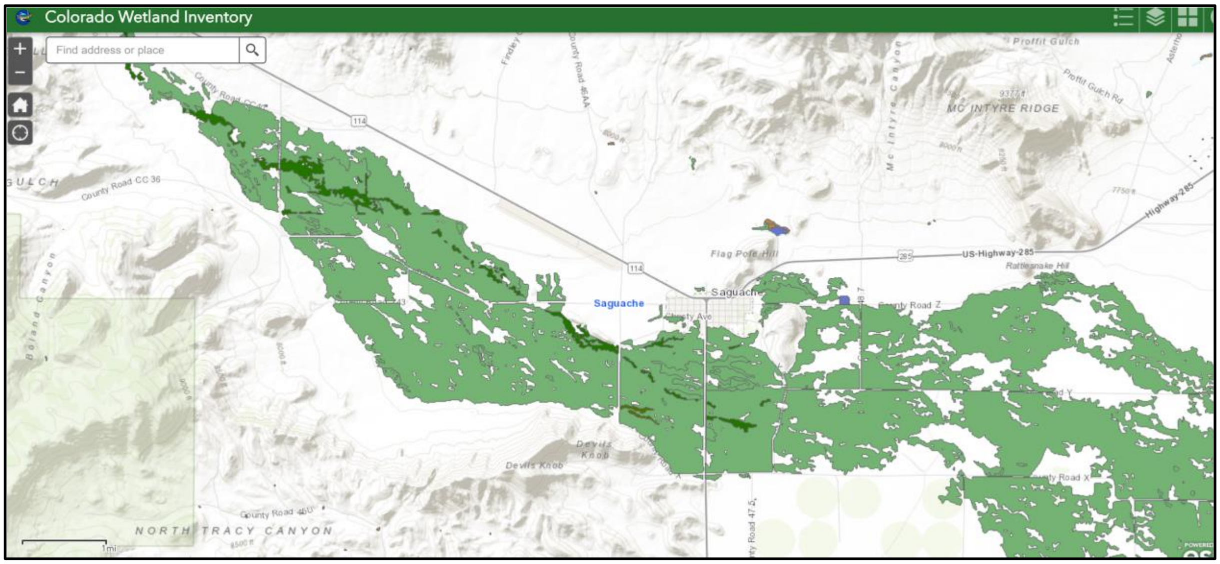


Figure 1.8: Wetlands map showing that much of the valley floor of Saguache Creek is sub-irrigated Source: Colorado Wetland Inventory Mapping Tool (CNHP, 2019).

Temporal Trends in Rio Grande Hydrology

Generally speaking, average annual streamflow of the SMP study streams has been in decline since the 1930s (Figure 1.9) and winter and spring season temperatures have increased in the Rio Grande Basin (Chavarria & Gutzler, 2018). Recent climate modeling suggests this trend of decreasing annual precipitation and streamflow in the Rio Grande Basin will continue in the future (Lukas et al., 2014).

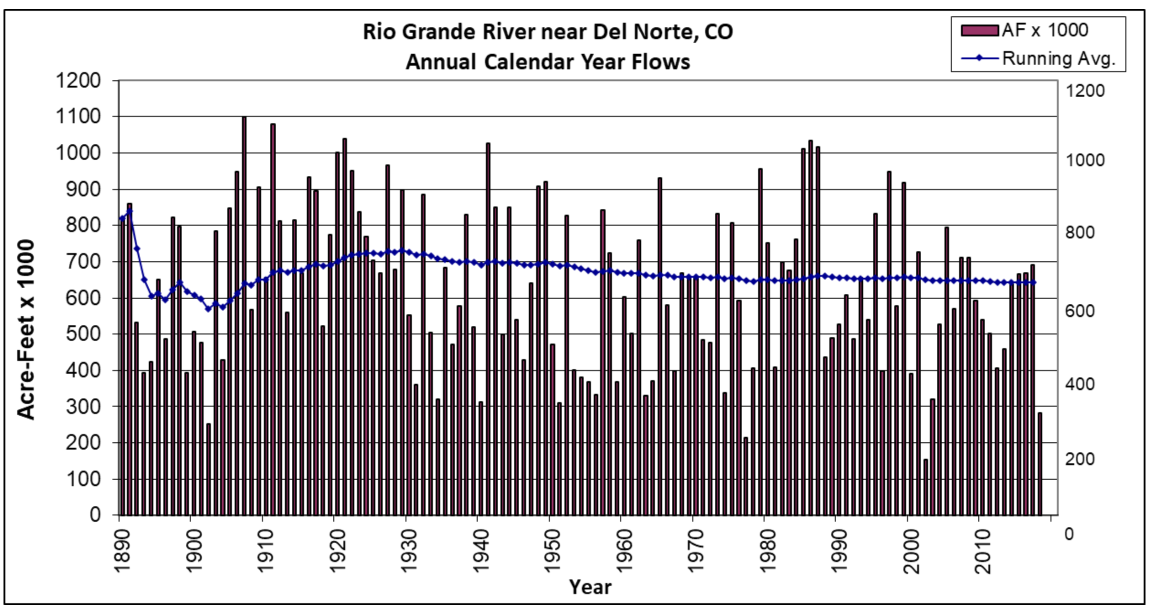


Figure 1.9: Annual flows (acre-feet x 1000) at the Rio Grande Near Del Norte, CO gage, illustrating downward trend in average annual flow (Source: Colorado Division of Water Resources).

In addition, compared to historic hydrology (viewed here as 1950 to 1997), the timing and peak of spring snowmelt and runoff has shifted in the last 20 years. Saguache Creek peak runoff has, on average, decreased 16% and shifted four days earlier, from June 3rd to May 30th. To help illustrate this shift, Figure 1.10 compares average daily streamflow at the Saguache Creek Near Saguache gage from 1950 to 1997 to those of 1998 to 2017.

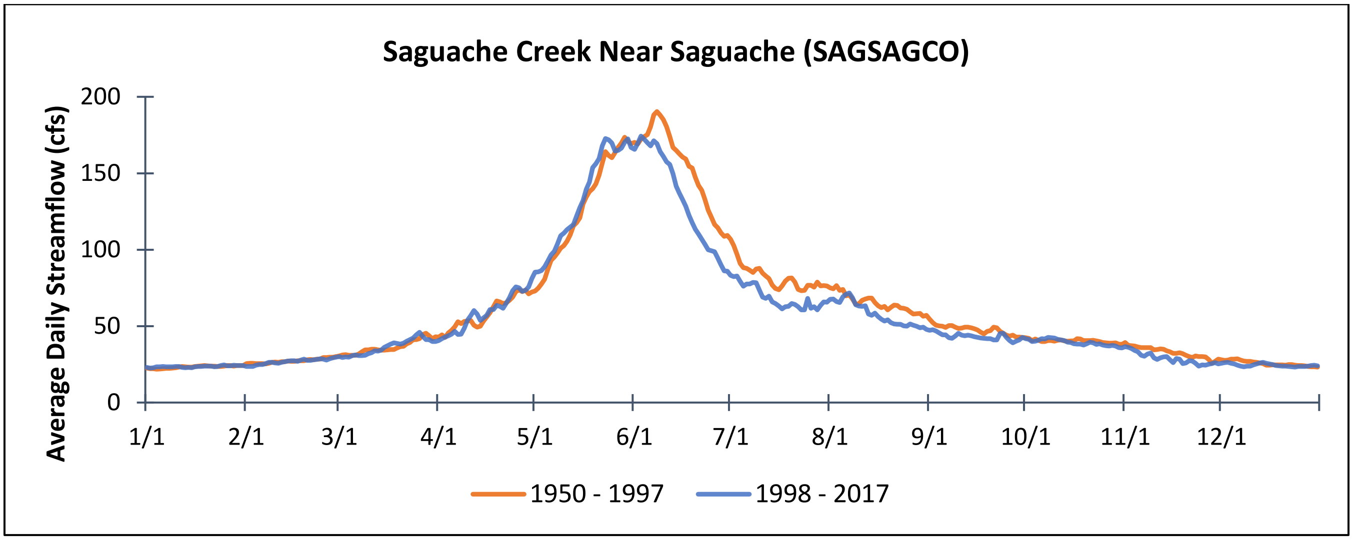


Figure 1.10: Comparison of average daily flows at the SAGSAGCO stream gage.

Studies suggest these changes in peak runoff can be attributed to a combination of lower Snow Water Equivalent (SWE), a warming trend in spring temperature, and increased solar absorption caused by dust-on-snow events (Clow, 2010; Stewart et al., 2004; Lukas et al., 2014). Research by Chavarria and Gutzler (2018) showed April 1 SWE decreased approximately 25% across the Rio Grande Basin between 1958 and 2015. Although average peak runoff has decreased, recent increases in dust-on-snow events can result in significantly earlier and *higher* peak runoff. Figure 1.11 illustrates this phenomenon at the Rio Grande Near Del Norte gage following a 2009 dust-on-snow event in the San Juan Mountains.

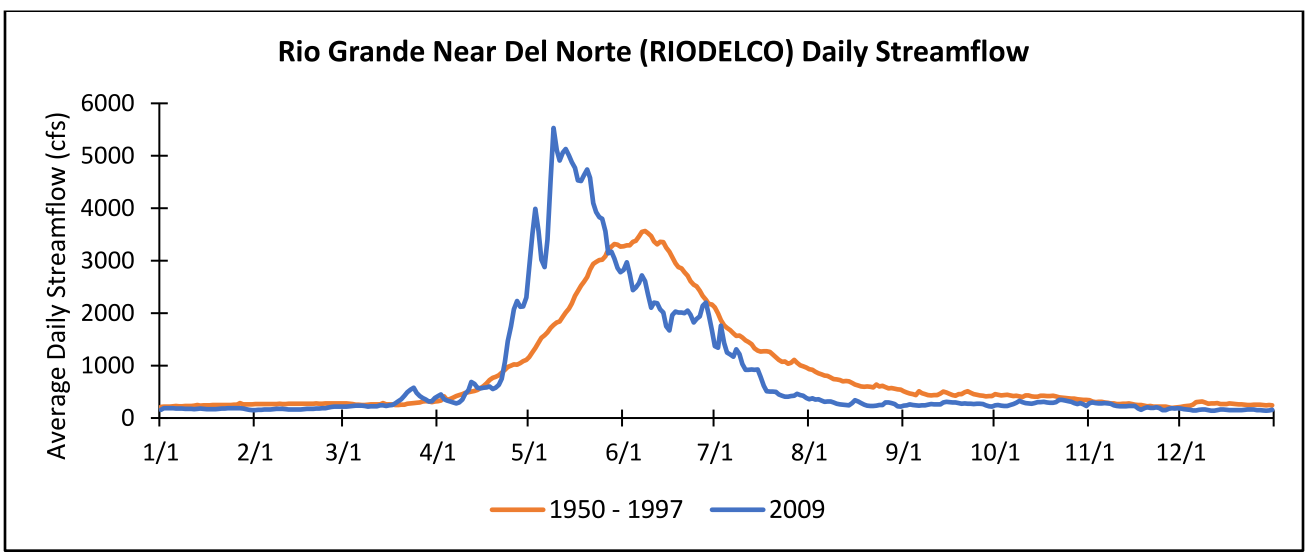


Figure 1.11: 2009 average daily flow at the RIODELCO gage following a dust-on-snow event plotted with 1950 to 1997 average daily flow.

As peak runoff continues to occur earlier in the spring, late summer flows are also predicted to decrease, as seen in the Figure 1.11. Furthermore, climate projections indicate that more precipitation will likely shift from snow to rain. One study showed the extent of snow-dominated land area within the upper Rio Grande Basin could decrease from 65% to 36% by the mid-21st century (Klos et al., 2017). Because the Basin's hydrology is primarily snowmelt-driven, this shift from snow to rain will have significant impacts on natural flow regimes. For example, increased precipitation in the form of rain paired with higher air temperature will increase the rate of evapotranspiration, resulting in less water reaching streams and contributing to streamflow. Studies also suggest this shift will cause less predictable, "flashier" streamflow and a reduction in the natural snowpack reservoir will accelerate the trends of decreasing annual streamflow, earlier peak flow, and lower late summer flow. Additionally, wildfires, tree mortality due to insects, and other forest health impacts will exacerbate these impacts. For example, vegetation loss decreases snowpack shading and increases snowmelt rates, creating a positive feedback loop (Lukas et al., 2020).

These projected changes in precipitation and hydrology may have a variety of impacts for water managers, water users, and aquatic life. Changes in the timing and amount of available water will affect agriculture, boating, fishing, and aquatic species. With less predictable flows, water managers, including reservoir operators, will be challenged to store and deliver water effectively using current infrastructure and may need to invest in additional or altered infrastructure. Farmers and ranchers are likely to have significantly less surface water available for agricultural use and groundwater recharge may decline. Aquatic species, including insects and fish, may be stressed by lower and warmer streamflow as well as a lack of adequate flows to maintain aquatic habitat. In turn, anglers and boaters are likely to have fewer recreational opportunities when flows are ideal. Many aspects of stream function, and the ecosystem services provided by those functions, may also be affected. For example, the geomorphic work performed by historic hydrology will be altered, riparian areas and flood-dependent species such as cottonwoods may no longer receive overbank flows at the same time or frequency, and water quality will almost certainly be affected. Adaptation to these effects and creative solutions to water management are critical to maintaining adequate surface water for water users and the environment.

1.7 Groundwater–Surface Water Interactions and Aquifer Storage

Groundwater-surface water interactions have been well documented across the western U.S., including in Colorado (Arnold et al., 2016; Hatch et al., 2006; Winter et al., 1998). In Colorado's Rio Grande Basin, groundwater-surface water dynamics have been extensively studied, especially as part of the Rio Grande Decision Support System (RGDSS) Groundwater Model. Although aquifer dynamics and groundwater-surface water interactions are not fully understood, RGDSS utilizes the best available data to model these dynamics, including calculations of streamflow depletions due to groundwater pumping. This section discusses the history of groundwater development in the Basin, the modeled impact of groundwater pumping on streamflows, and the conservation efforts underway to reduce groundwater withdrawals, replace injurious streamflow depletions resulting from pumping, and ultimately reach sustainable aquifer conditions.

There are two aquifers in the Basin: the confined and unconfined aquifers. The shallow, expansive unconfined aquifer is made up of sands and gravels and occupies the entire Alamosa Basin. The relatively deep confined aquifer lies beneath the unconfined and the two aquifer systems are separated by a series of blue clay layers.

The Rio Grande, Conejos River, and Saguache Creek are located within the jurisdiction of Colorado Department of Natural Resources – Division of Water Resources, Division 3 which manages all water well permits for the Rio Grande Basin. Well permit appropriations within the Rio Grande Basin withdraw unconfined and confined aquifer groundwater. Well withdrawals cause depletions to streams from which surface water right holders obtain their water supplies; the depletions to surface water rights result from the consumptive use of water withdrawn from the wells. Well development in the Basin began in the 1920s with scattered development across the Basin. Figure 1.12 shows Division 3 wells in 1930.

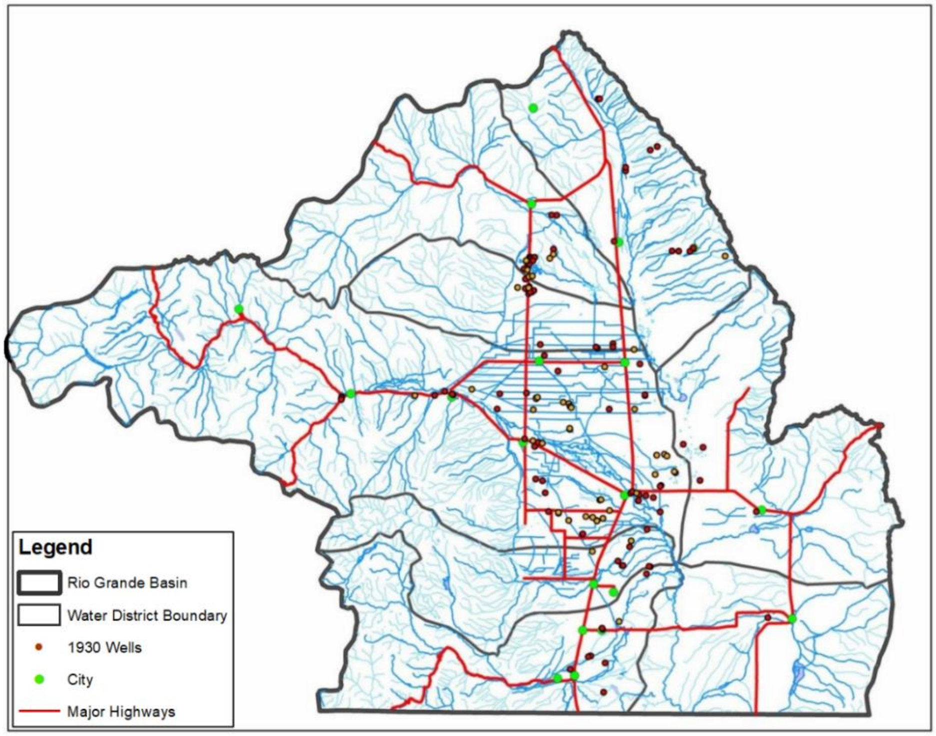


Figure 1.12: Division 3 well locations in 1930.

In the late 1930s, new well development increased significantly and by 1952 there were 1,300 wells in the Basin. By 1980, there were more than 2,300 wells. There are currently over 6,000 irrigation, commercial, and municipal wells in Division 3. Figure 1.13 shows current Division 3 wells.

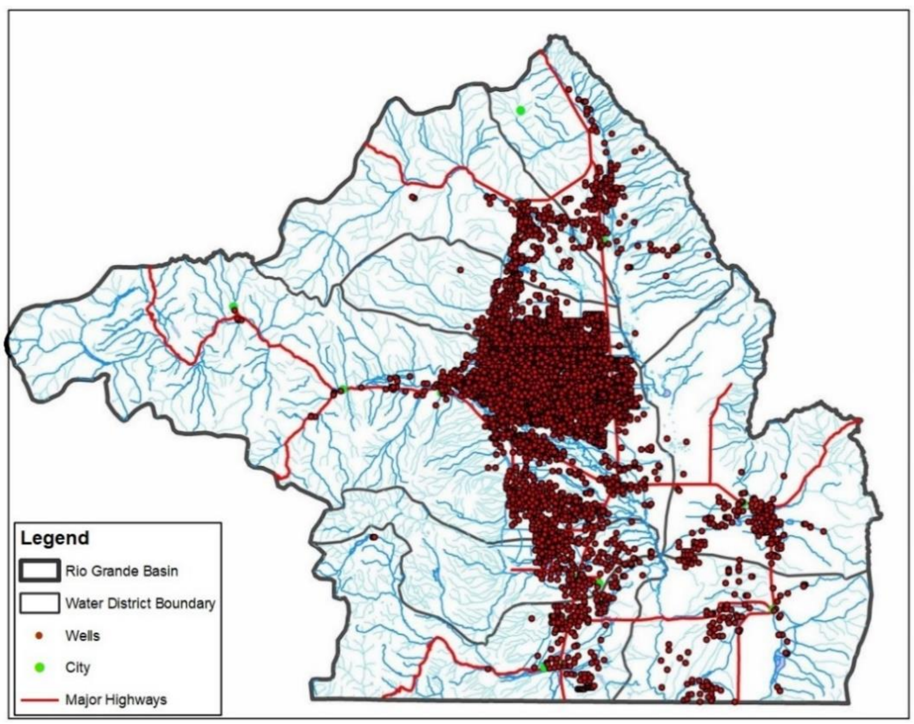


Figure 1.13: Current Division 3 well locations.

Groundwater development led to extensive groundwater use and over appropriation, eventually resulting in the need for groundwater withdrawal rules and regulations. To help inform and develop the rules, the RGDSS Groundwater Model (Model) was developed. The Model calculates flows through the confined and unconfined aquifer systems and can be used to predict stream gains/losses as a result of pumping stresses.

Surface Water Depletions

The Model shows that groundwater withdrawal can cause surface water (stream) depletions. To quantify depletions for a given stream reach, the San Luis Valley floor was divided into geographic subdivisions called Response Areas (RAs) which share broad hydrologic commonalities. The Model was then used to generate Response Functions (RFs), which describe the relationships between groundwater withdrawals and stream depletions, within each RA. RFs can be used within the Model to evaluate current and/or hypothetical changes in groundwater withdrawals such as switching off select wells. Using these spatial and temporal inputs, stream depletions caused by groundwater withdrawals can be calculated under varying conditions. Each stream with modeled depletions resulting from groundwater withdrawals in a given RA was divided into administrative reaches, shown in Table 1.1.

Table 1.1: Administrative stream reaches RGDSS Groundwater Model Response Area stream reaches.

Stream	Stream Reaches
Rio Grande	1. Rio Grande Del Norte to Excelsior Ditch 2. Excelsior Ditch to Chicago Ditch 3. Chicago Ditch to the State Line
Conejos River	1. Conejos Above Seledonia/Garcia Ditches 2. Conejos Below Seledonia/Garcia Ditches
Saguache Creek	1. Malone Ditch to Braun Bros Ditch

Modeled stream depletions from the groundwater withdrawals extend well into the future. A portion of the depletions in most RAs extend ±20 years past the current year's groundwater withdrawals. Over time, gradual refinements have been applied to the Model, typically when one or more of the modeled stresses are changed or new data is available and Model calibration refinement is applied.

Division 3 Well Rules

In 2015, the State Engineer submitted new Well Rules through the Division 3 water court system (DWR, 2015) to mitigate stream depletions, which injure senior surface water rights, and to attain sustainable groundwater levels within each RA. The Well Rules were approved by water court decree on March 15, 2019 and require all non-exempt wells to replace their calculated depletions to Rio Grande Basin streams through following a formal water augmentation plan or joining a groundwater management subdistrict (Subdistrict). Under a water augmentation plan, a water district or other entity mitigates a well's injury to senior water rights by physically replacing depletions in time, place, and quantity.

Beginning in 2006, the Rio Grande Water Conservation District (RGWCD) began forming Subdistricts, whose boundaries are based on geologic and hydrologic characteristics of the Basin. Subdistricts are responsible for replacing the injurious stream depletions caused by groundwater withdrawal by well owners within a given Subdistrict. Each Subdistrict operates under an annual replacement plans (ARP) to replace their injurious stream depletions. They also strive to reduce well pumping in an effort to regain sustainable aquifer levels. Wells not in compliance with the Well Rules after March 15, 2021 will be curtailed by the State Engineer.

For planning purposes, the Model was run using the RFs for Subdistricts located on the Rio Grande, Conejos River, and Saguache Creek. This example was completed to estimate the amount of water that will be replaced on these streams when all Subdistricts are operating. The example included streamflow and groundwater withdrawal data from 2017 and results are shown in Table 1.2.

Table 1.2: Total depletions on each stream system in 2017.

Stream	Total Depletions - May through April (acre-feet)
Rio Grande	10,316
Conejos River	6,923
Saguache Creek	912

The 2017 example illustrates the measurable effect of well pumping on streamflows in the Rio Grande Basin. Within each Subdistrict, participating well owners are making considerable efforts to reduce overall well pumping. Through these efforts, Subdistricts are working toward aquifer sustainability and reductions in surface water depletions resulting from well pumping. As a result of groundwater users replacing depletions to streams and rivers throughout the Rio Grande Basin, streamflows are expected to increase and result in healthier, more resilient systems.

There is also potential to mitigate streamflow depletions and the associated water quality impacts through conservation and restoration activities throughout the watershed. For example, streams with active and connected floodplains support groundwater-surface water exchange within hyporheic zones, thereby buffering water temperature. Additionally, alluvial aquifer and wet meadow restoration efforts have been shown to attenuate flood flows and enhance late summer streamflow in the arid West (Hammersmark et al., 2008 & Loheide et al., 2009). These restoration techniques mitigate the risk of flooding and the damage it may cause by enabling high flows, most commonly experienced during spring runoff, to spread out onto floodplains and soak into alluvial systems. This water, stored in wet meadows and alluvial systems, is slowly released throughout the summer irrigation season, augmenting late summer and fall base flow in streams. Finally, conserving existing surface water use and protecting wet meadows, wetlands, and riparian areas also has the potential to mitigate stream depletions and aide in groundwater recharge and aquifer sustainability.

1.8 Major Reservoirs on the Rio Grande and Conejos River Systems

Reservoirs provide water storage on both the Rio Grande and Conejos River. Major reservoirs affecting the Rio Grande are “pre-Compact,” which, under the terms of the Compact, means they were built before 1929, while the two reservoirs on the Conejos River are “post-Compact.” Operations of post-Compact reservoirs are limited by Article VII of the Compact. Under Article VII, post-Compact reservoirs are not permitted to store water when total Rio Grande Project (downstream Compact reservoirs) storage is less than 400,000 acre-feet (Compact, 1938). This significantly limits post-Compact reservoir operations in the Basin.

Rio Grande Reservoirs

Four major reservoirs provide storage for the Rio Grande: Rio Grande Reservoir, Santa Maria Reservoir, Continental Reservoir, and Beaver Creek Reservoir. Figure 1.14 shows the locations of these reservoirs.

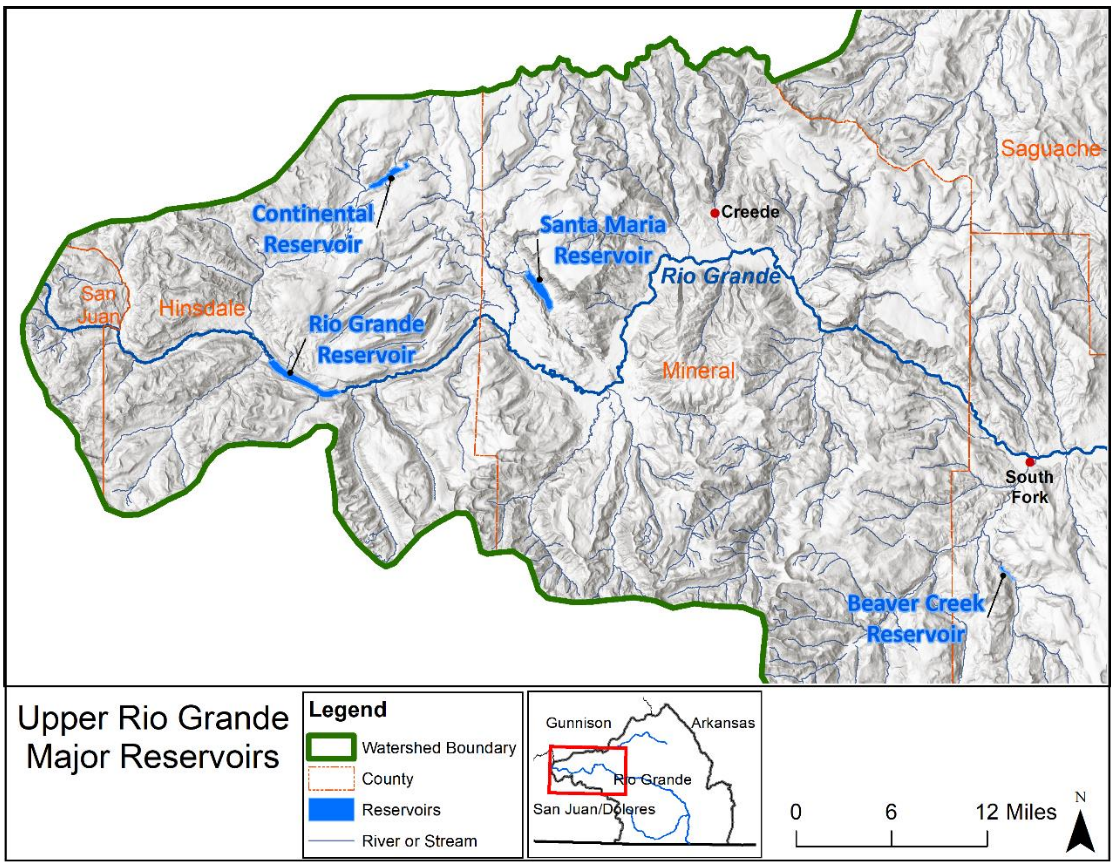


Figure 1.14: Major reservoirs in the Rio Grande watershed upstream of South Fork.

Rio Grande Reservoir is an on-channel reservoir on the Rio Grande just upstream of the Rio Grande Box Canyon. It was built in 1912 to provide water storage for farmers in the San Luis Valley Irrigation District and has a capacity of 51,113 AF. It is owned and operated by the San Luis Valley Irrigation District. Between 2012 and 2020, significant improvements were made to the dam and its outlet works to address seepage and dam safety concerns. Improvements included resurfacing the dam to prevent seepage as well as updating the outlet tunnel and adding new valves to the outlet works, which will allow the reservoir to pass high flows and eliminate leakage from the outlet. The improvements were made as part of the Rio Grande Cooperative Project and the Rio Grande Reservoir Rehabilitation Project, completed in 2020.

Continental Reservoir is an on-channel reservoir on North Clear Creek. It was built in 1928 and has a capacity of 26,716 AF. Santa Maria Reservoir is an off-channel reservoir built in 1911 with a capacity of 43,826 AF. Santa Maria Reservoir flows are released into Boulder Creek, a tributary to Clear Creek downstream of Continental Reservoir. Clear Creek joins the Rio Grande approximately 2.1 miles downstream of the Rio Grande Box Canyon. Santa Maria Reservoir and Continental Reservoir are owned and operated by the Santa Maria Reservoir Company.

Beaver Creek Reservoir is an on-channel reservoir on Beaver Creek. It was built in 1914 and has a capacity of 4,758 AF. It is owned and managed by CPW. Along with Rio Grande Reservoir, improvements were also made to Beaver Creek Reservoir as part of the Rio Grande Cooperative Project. The reservoir's spillway was rebuilt, a new abutment was constructed, and the outlet tunnel was improved to enhance outlet control and downstream flow management. Additionally, seepage issues on the dam were addressed.

All four major Rio Grande reservoirs are pre-Compact, allowing them to store during the non-irrigation season and operate with more flexibility than post-Compact reservoirs. Rio Grande, Santa Maria, and Continental reservoirs store water primarily for irrigation, Rio Grande Compact deliveries, augmentation plans, and instream replacements for Subdistricts. Beaver Creek Reservoir is primarily managed for wildlife and recreation.

Conejos River Reservoirs

Platoro Reservoir and Trujillo Meadows Reservoir, both of which are post-Compact reservoirs, provide the only significant storage in the Conejos River watershed. The Platoro dam was completed in 1951 by the Bureau of Reclamation (BOR), making it a post-Compact reservoir. The dam is an earthfill structure consisting of a main embankment and a dike section, separated by a rock knoll in which the spillway is excavated. The reservoir formed by the dam has a capacity of 59,570 AF, 6,060 AF of which are for flood control and 53,510 AF for joint use. While BOR retains ownership of the dam, operations are managed by the Conejos Water Conservancy District (CWCD). The dam is situated at 10,000 ft, relatively high in the watershed.


Upper portion of Platoro Reservoir during winter (Photo: Christi Bode).

Trujillo Meadows Reservoir is located on the mainstem Rio De Los Pinos, a tributary to the Rio San Antonio, and was completed in 1957. It has a capacity of 913 AF and is managed by CPW for recreation.

1.9 Inter-State Legal Context and Surface Water Rights

History of Surface Water Rights

Development of surface water irrigation in the Rio Grande Basin began in the 1850s. The two most senior water rights on Saguache Creek are decreed to Chase Peyton Ditch and Malone Sullivan Ditch, both of which were appropriated in 1866. By the late 1800s, surface water rights from Saguache Creek (Water District 26) were fully appropriated. Water rights continued to be issued through the early 1900s, leading to an over-appropriation of Saguache Creek surface water rights. Figure 1.15 shows the relationship between cumulative absolute surface water rights versus dry, average, and wet streamflow hydrographs, as measured at the Saguache Creek near Saguache gage. The average daily flow from the year 1957 is included to illustrate an exceptionally wet year when the majority of water right were in priority and received water for some period of time. Average daily flow from the year 1957 is also shown on the graph below to illustrate an exceptionally wet year in which most water rights were in priority.

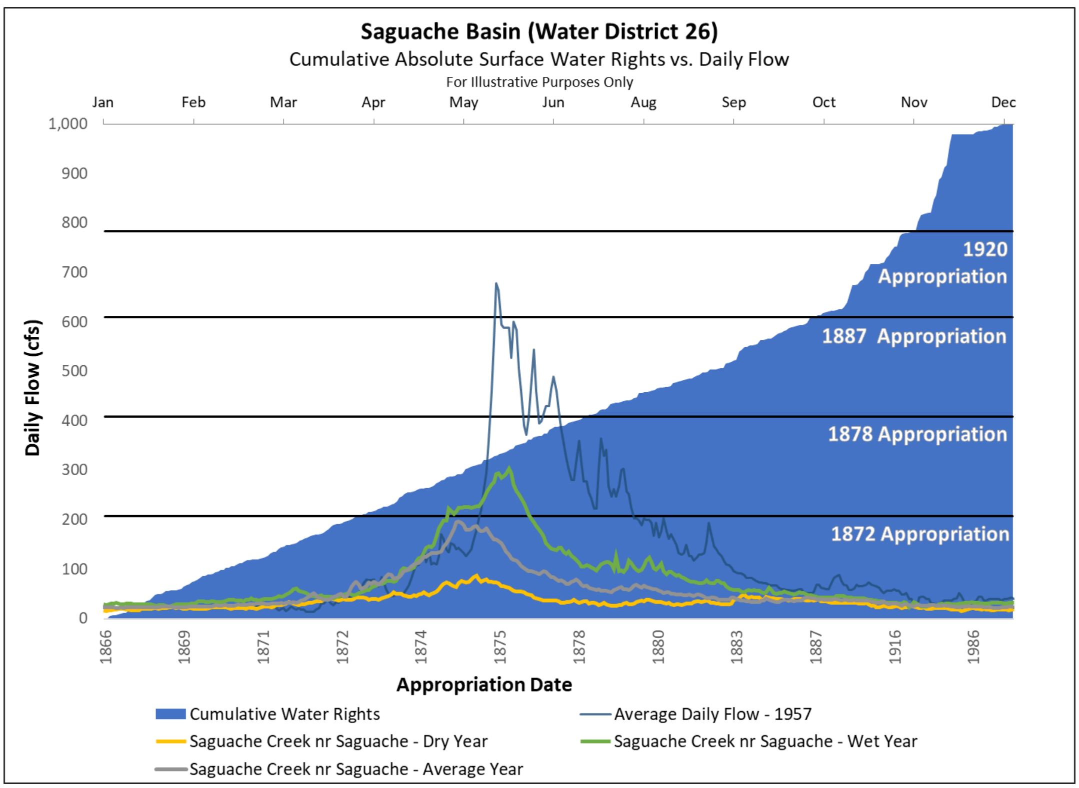


Figure 1.15: Water District 26 cumulative surface water rights versus dry, average, and wet streamflow hydrographs measured at the Saguache Creek Near Saguache, CO (SAGSAGCO) stream gage.

Rio Grande Compact

The equitable distribution of Rio Grande waters between the United States and Mexico was established in the 1906 Convention between the two countries (Convention, 1906). In 1938, the states of Colorado, New Mexico, and Texas entered into the Rio Grande Compact (Compact). The Compact equitably apportions the waters of the Rio Grande in the U.S. and defines Colorado's delivery requirement to New Mexico along with many other aspects of management of the river. To determine baseline water supply and use, inflows at upstream gaging stations (index stations) were compared to outflows at downstream gaging stations during a study period from 1928 to 1937. Under the Compact, Colorado agreed to deliver a predetermined amount of water to New Mexico based on flows at index stream gage stations (Compact, 1938). On the Rio Grande, index flows are determined by measurements at the Rio Grande Near Del Norte, CO (RIODELCO) stream gage. On the Conejos River, index supply is measured as the sum of the Conejos River Near Mogote, CO (CONMOGCO) stream gage during the calendar year, plus the measured flows of Rio San Antonio and Rio de Los Pinos (SANORTCO and LOSORTCO, respectively) during the months of April to October. Conejos River Compact deliveries to the Rio Grande are measured as the sum of two gages, the North Channel Conejos River Near La Sauces (NORLASCO) and South Channel Conejos River Near La Sauces (SOULASCO). Saguache Creek does not have a delivery requirement under the Rio Grande Compact because it drains into the Closed Basin and therefore is not considered a tributary to the Rio Grande.

The combined flows of the Rio Grande and Conejos River are measured at the Rio Grande Near Lobatos, CO (RIOLOBCO) stream gage to determine total deliveries to New Mexico (Compact, 1938). Figure 1.16 shows locations of stream gages used to measure Rio Grande Compact index and delivery flows in Colorado, while figure 1.15 shows the larger spatial extent of the international Compact.

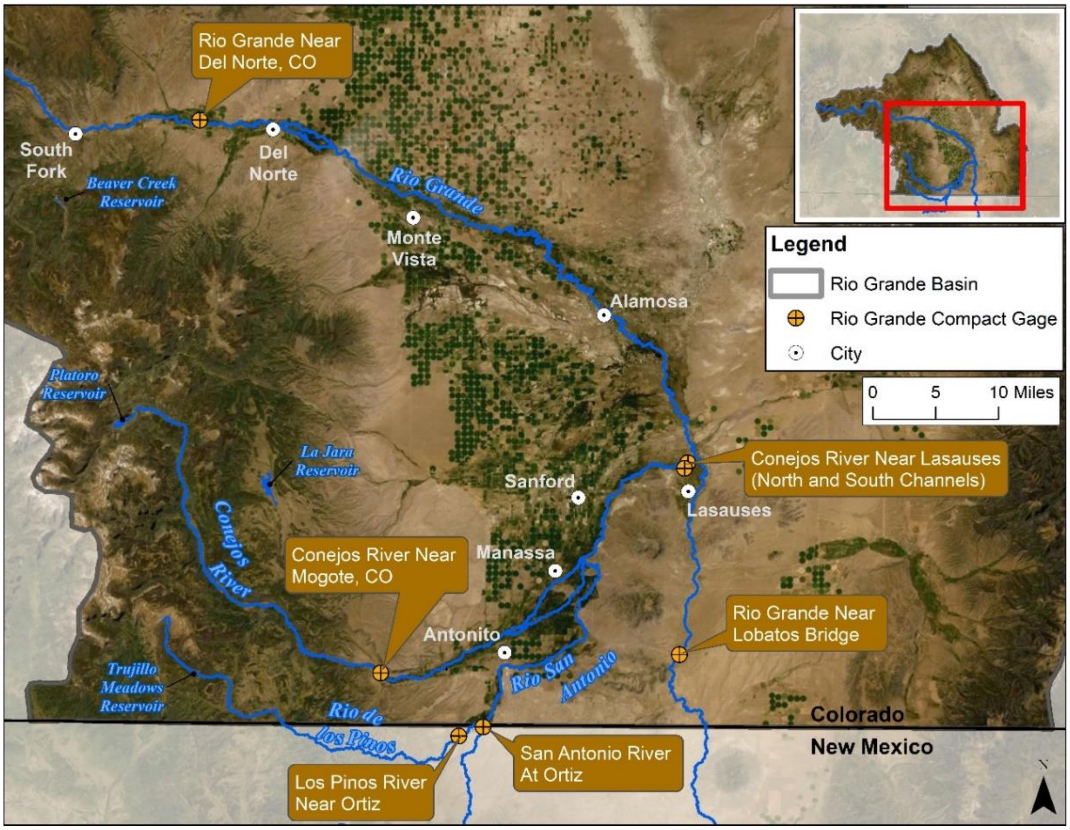


Figure 1.16: Stream gage locations used to measure Rio Grande Compact index and delivery flows.

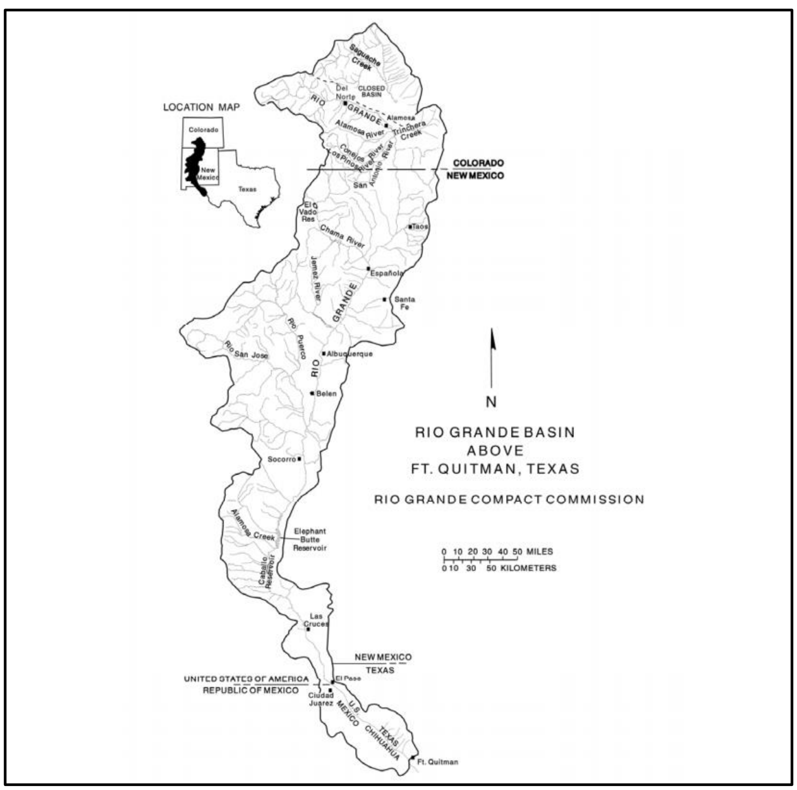


Figure 1.17: Spatial extent of the Rio Grande Compact (Rio Grande Compact Commission, 2015).

Figure 1.18 shows Rio Grande and Conejos River delivery obligations as a function of each river's annual measured index flows.

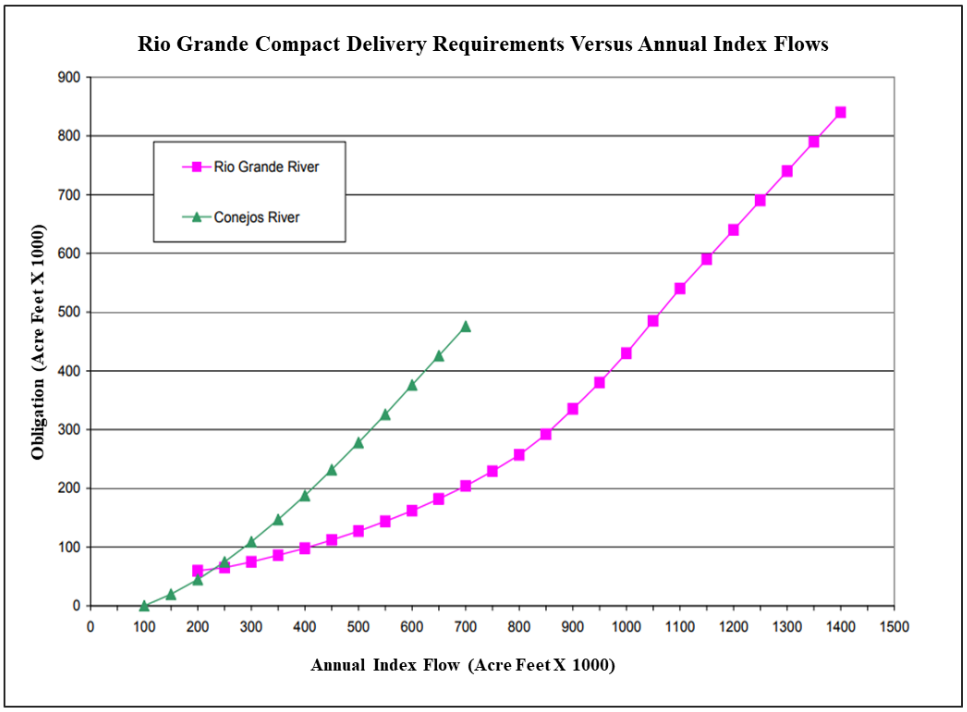


Figure 1.18: Rio Grande and Conejos River delivery obligations as a function of annual index flows under the Rio Grande Compact.

Water Rights Curtailment

Because water rights in Division 3 are over-appropriated, the Division 3 Engineer is required to curtail surface water diversions on the Rio Grande and Conejos River during the irrigation season (typically April 1 to October 31) in order to meet Compact delivery obligations (DWR, 2015). During the irrigation season, the Division Engineer estimates annual flow at the index gages using snowpack measurements, weather forecasts, and streamflow models. The Division Engineer uses the flow estimates and models to calculate total anticipated annual streamflow and flow within the winter months and the irrigation season. Because all winter flows are delivered to the state line, the Division Engineer subtracts these flows from the total anticipated delivery requirement. The remaining obligation must be met with flows produced in the irrigation season and therefore, is curtailed from irrigators. The curtailment is applied to surface water rights on a daily basis, which results in some water rights not being served. Annual index flow estimates and curtailment are updated every 10 days to reflect the most recent data. As noted above, Saguache Creek does not have a delivery requirement under the Compact. Saguache Creek water rights are administered based on prior appropriation.

2. Conditions Assessment Methods

The Rio Grande, Conejos River, and Saguache Creek SMPs utilized a reach-scale conditions assessment to assess current stream condition and function. The conditions assessment considered seven indicators of stream health and function: diversion infrastructure, recreational flow needs, aquatic habitat flow needs, geomorphology, riparian vegetation, aquatic life, and water quality. With the exception of recreational and aquatic habitat flow needs, each indicator was rated by reach using an academic rating scale. Recreational and aquatic habitat flow needs were quantified by reach but were not rated. Each indicator was assessed using two or more metrics, or subvariables, to determine an overall rating. The conditions assessment focused on identifying stressors affecting stream condition as well as opportunities to improve those conditions for environmental, recreational, agricultural, and other stakeholder uses. The assessment provides benchmark data that can be used for management decisions and can be incorporated into long-term monitoring programs. In addition, assessment findings provide an opportunity to approach restoration, conservation, and stream management planning using an interdisciplinary and multi-benefit approach.

Where appropriate, a modified version of the Functional Assessment of Colorado Streams (FACStream) 1.0 framework was utilized to rate stream health indicators by reach (Beardsley et al., 2015). FACStream is an organizational framework that uses an academic grading scale (A-F) to assess a stream condition and its degree of functional impairment as compared to reference condition. Table 2.1 shows the FACStream grading system. Each grade represents a condition class defined by the degree of functional impairment. Pristine streams having no impact score 100 (A+). A score of 50 (F-) indicates the lowest level of functioning for a reach that is profoundly impaired, but still recognizable as a feature that conveys water.

The water quality and aquatic life assessments utilized modified FACStream while other stream condition variables included in the assessment utilized slightly different methodology. Methodology for each variable is described in sections 2.3 through 2.10.

Table 2.1: FACStream functional condition rating criteria.

	A	Reference standard
	B	Highly functional
	C	Functional
	D	Functionally impaired
	F	Nonfunctional

2.1 Reach Delineation

Each prioritized stream was divided into relatively homogenous reaches with start/end points based on significant changes in geomorphology, land use, tributary streams, and major diversion structures. The intention of reach delineation is to provide discrete spatial units for analysis. Due to the large geographic extent of the study area, some reaches include subtle changes in geomorphology that are not captured. Conditions assessment results are organized by reach within each SMP for ease of use. Reach descriptions, overview maps, photos, associated river miles, and assessment results are provided in each SMP.

River miles for each reach were calculated using the Colorado Decision Support System (CDSS) Source Water Route Framework (SWRF). The SWRF is a GIS dataset extracted from the National Hydrography Dataset and specifically developed for Colorado. The SWRF dataset contains measured route data for all named streams and rivers in Colorado. Measurements on each stream begin at its most downstream location and progress upstream to the headwaters of the stream. River mile 0 may be located at the Colorado state line (e.g., Rio Grande), at a confluence with a larger river (e.g., Conejos River), or at a stream's terminus (e.g., Saguache Creek). For example, river mile 0 on the Conejos River is defined as its confluence with the Rio Grande and the outlet of Platoro Reservoir is located at river mile 84.4. River miles represent the distance of a stream channel across a landscape. This is important to note because river miles are based on a stream or river's centerline, and therefore the calculated lengths over-represent the distance geographically of the valleys from start to endpoint.

2.2 Review of Relevant Existing Information

Existing reports, studies, datasets, and other information on stream condition were compiled for each SMP. A significant amount of existing information was gathered, particularly related to the Rio Grande, including the Upper Rio Grande Watershed Assessment, the Rio Grande Headwaters Restoration Project, and the Rio Grande Natural Area River Condition Assessment (MWH, 2001; Riverbend Engineering, 2016; SGM & Lotic Hydrological, 2018). Table 2.2 lists existing information used in the condition assessment as well as the primary information types.

Table 2.2: Summary of existing information.

Summary of Existing Information		Applicable SMP Assessments					
Report or Data Source	**Description**	**Diversion Infrastructure**	**Hydrology and Flow Needs**	**Geomorphology**	**Riparian Vegetation**	**Water Quality**	**Aquatic Life**
Rio Grande Headwaters Restoration Project (2001)	Planning document for mainstem Rio Grande	X		X	X		
Rio Grande Basin Implementation Plan (2015)	Planning document supporting Colorado Water Plan and Rio Grande Basin needs		X				
Rio Grande Natural Area River Condition Assessment (2016)	Assessment of stream conditions within Rio Grande Natural Area			X	X	X	X
Upper Rio Grande Watershed Assessment (2018)	Physical and biological stream assessment driven by stakeholders and technical advisory team			X	X	X	X
Feasibility Study: River Corridor Improvements Rio Grande in Alamosa, CO (2017)	Planning document for Rio Grande in Alamosa						
Colorado Water Conservation Board Diversion Infrastructure Inventory (2006)	Inventory and maps of diversion structures, including condition	X					
Rio Grande Decision Support System (RGDSS)	Irrigation statistics for all decreed water rights	X	X				
Measurable Results Program and Phase II Monitoring (2015)	SVAP, macroinvertebrates, water quality, bank stability						X
Bureau of Land Management Aquatic Assessment, Inventory, and Monitoring (AIM) program (2017)	Detailed reach-level assessment of stream condition					X	X
Integrated Water Quality Monitoring and Assessment Report, Colorado Department of Public Health and Environment (CDPHE) (2018)	Water quality parameters (e.g. pH, conductivity, dissolved oxygen) National Water Quality Assessment Program, United States Geological Survey, and EPA					X	X
Wildfire Impacts on Water Quality, Macroinvertebrate, and Trout Populations in the Upper Rio Grande (Rust, 2019)	Study of post-wildfire impacts on water quality and aquatic life.					X	X
Colorado Parks and Wildlife (Nehring and Anderson, 1993)	PHABSIM surveys and IFIM		X				
CPW Fish Survey and Stocking Data (2006 - 2018)	Fish population surveys and stocking data	X	X				X
CPW Rio Grande Fisheries Management Plan (2016)	An overview for collaborative efforts in river restoration efforts	X	X				X
Colorado State Wildlife Action Plan (2015)	Planning document						X
Instream Flows (ISF) Water Rights - Held by the Colorado Water Conservation Board (CWCB)	Decreed instream flows		X				
Division of Water Resources Division 3 Streamflow Monitoring Network	Stream gage data		X				
Rio Grande Basin LiDAR survey (2012)	SLV-wide LiDAR dataset (bare earth)	X		X			
Colorado Natural Heritage Program (CNHP) Vegetation Surveys	Vegetation surveys, including wetlands				X		
Rio Grande National Forest Vegetation Mapping	GIS data containing vegetation communities				X		

2.3 Diversion Infrastructure Inventory and Assessment

The Rio Grande Headwaters Restoration Project (RGHRP) completed an inventory and functional assessment of instream diversion infrastructure. Diversion structures located on the mainstems of each prioritized SMP stream were included in the inventory. The inventories include assessments of diversion structure headgates, diversion dams, measurement devices, and nearby channel conditions affecting each structure. Each structure's impact on stream function was also included.

Figure 2.1: Braun Brothers Ditch No. 1 diversion on Saguache Creek.

Each structure's condition was rated using the A-F scale defined by FACStream. Two ratings were determined for each structure. One rating was assigned to the structure's headgate and a separate rating was assigned to the cumulative condition of the structure's diversion dam, measurement structure, and nearby channel conditions. Ratings were based on the structure's ability to effectively divert water as well as its impact on channel conditions, stream function, and fish passage. Grades were averaged for an overall rating. The overall rating scale is described in Table 2.3.

Table 2.3: Rating scale used for diversion infrastructure assessment.

Rating Scale	Impairment	Description
A ≥ 90	Negligible	The structure functions very well and no stream health impacts were detected. Improvements are not currently needed.
B ≥ 80	Mild	The structure functions well, however minor repair needs were noted and/or stream health impacts were detected. Minor improvements are recommended.
C ≥ 70	Significant	The structure functions, however significant repair needs were noted and/or significant stream impacts were detected. Improvements are recommended.
D ≥ 60	Severe	The structure functions poorly and/or severely impacts stream health. Extensive repairs or replacement of structural elements is recommended.
F ≥ 50	Profound	The structure is nonfunctional and/or profoundly impacts stream health. Full structure replacement is recommended.
N/A	N/A	The structure does not exist or was not rated.

To determine diversion structure condition and function, three kickoff meetings were held with the water commissioners for Water Districts 20 (Rio Grande), 22 (Conejos River), and 26 (Saguache Creek). During meetings, concerns, needed improvements, and other functional considerations were noted. Following kickoff meetings, each structure was visited and photographed to document its condition and to highlight repairs and/or improvements needed. Individual landowners and ditch companies were also consulted and field visits were arranged.

Channel Migration Analysis

Channel margins along the Rio Grande and the Conejos River were delineated using available aerial photography for the years 1960, 1975, 1998 and 2017. These delineations identify an approximated, but not exact, location of the channel margin at the time the image was taken (further information regarding their accuracy and known error is described in **Appendix B**). These delineations (example in Figure 2.2) were used to investigate significant channel migration since 1960 at the reach level in order to identify potential threats to a given structure. For example, although channel avulsion is a naturally occurring process, it can cause the river to bypass diversion structures.

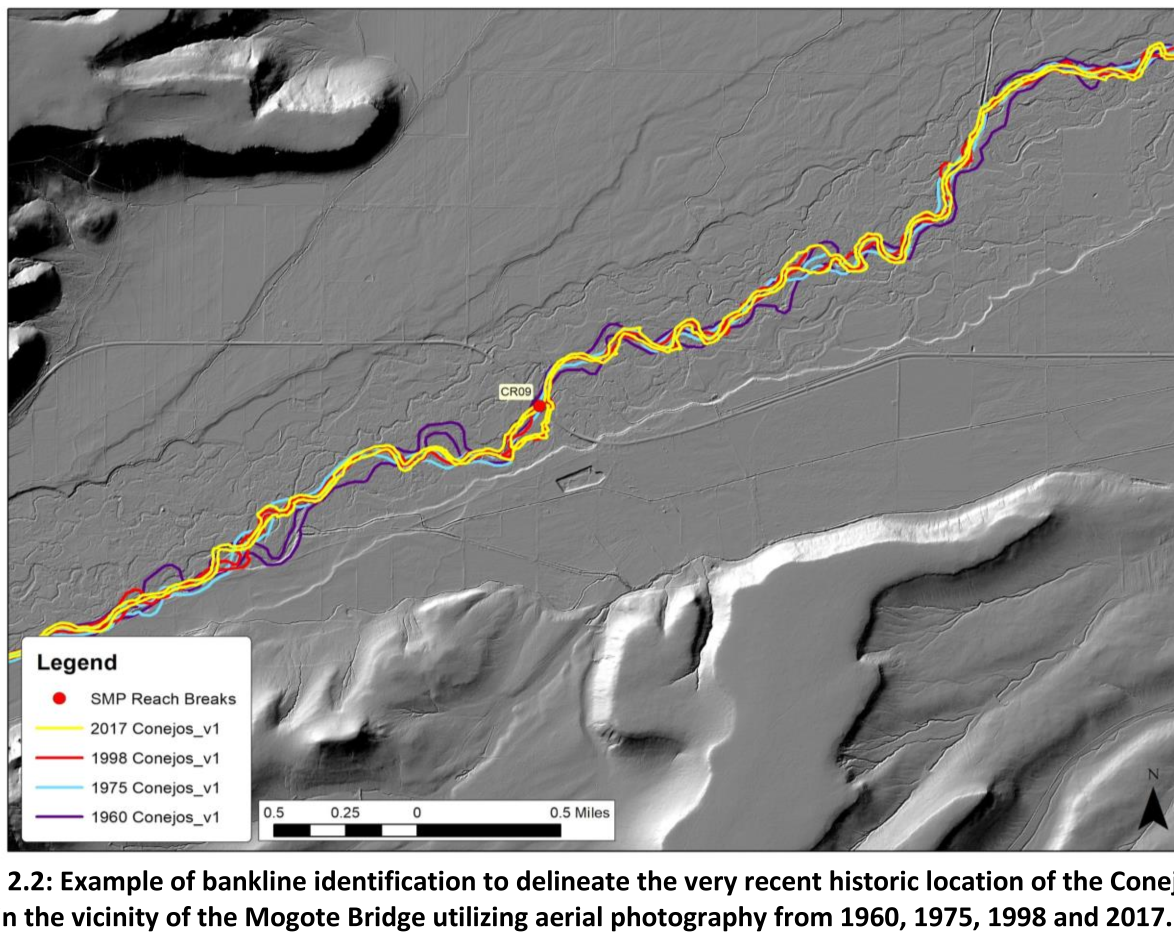


Figure 2.2: Example of bankline identification to delineate the very recent historic location of the Conejos River in the vicinity of the Mogote Bridge utilizing aerial photography from 1960, 1975, 1998 and 2017.

Using the information described above, a "report card" containing descriptive statistics, photographs, location, and channel migration maps, and recommended improvements was created for each structure. An example report card for the Chase Peyton Ditch is shown in Figures 2.3 and 2.4.

Each structure's report card was saved as a PDF. Links to each structure's report card, as well as a map showing diversion structure locations, are available on Rio Grande Headwaters Restoration Project's "Stream Management Plans" webpage at the following url: https://riograndeheadwaters.org/stream-management-plans. The report cards are intended to be used by water commissioners, landowners, ditch companies, and other water users to monitor structure conditions over time. A summary of each structure, including recommended improvements, can be found in section 3.2.

Example Report Card

SAGUACHE CREEK
DIVERSION INFRASTRUCTURE INVENTORY

Structure Name: CHASE PEYTON D

Reported By: Daniel Boyes

Date: April 4, 2019

Headgate Location:	Latitude	Longitude
	38.08586	-106.51121

Headgate Type: Manually operated 3' screw gate

Headgate Condition: A ☐ B ☒ C ☐ D ☐ F ☐

Diversion and other Condition: A ☐ B ☐ C ☐ D ☒ F ☐

Stream Miles From Saguache Creek Terminus (Point of Diversion): 74.29 mi

Structure Submerged: Yes ☐ No ☒

Repair(s) or Improvement(s) Currently Needed: There are a few possible solutions to the meander being cut off. One possible solution is to rebuild the stream bank that was breached to redirect flow to the original stream channel and to the headgate. Another possible solution is to relocate the point of diversion to divert flows just downstream of the current point of diversion. If the point of diversion was relocated, the original diversion dam and headgate should be retained in the event the stream recaptures the original channel. As part of any future repairs, fish passage and riparian restoration should be considered.

Structure Description: This is the first diversion on Saguache Creek. A stacked rock diversion dam directs water to the headgate, located on the north bank of the stream. A new diversion dam and bank stabilization structures were installed in 2019 in partnership with NRCS. The headgate and flume were not affected as part of those repairs. Bank erosion and meander cutoffs are relatively common on upper Saguache Creek. During spring runoff in 2019, the meander feeding this ditch was cut off, resulting in the stream bypassing the structure (see map below).

Comments: This ditch is a priority 1. The photo log below includes photos taken prior and after the diversion and bank work completed in 2019.

Notes:

Estimated Range of Cost: Moderate

Headgate (pre-2019 runoff)

Headgate outlet (post-2019 runoff)

Headgate and diversion dam

Dry channel looking downstream

Dry channel looking upstream

Flume looking downstream

SAGUACHE CREEK DIVERSION INFRASTRUCTURE INVENTORY

CHASE PEYTON DITCH

PHOTO LOG

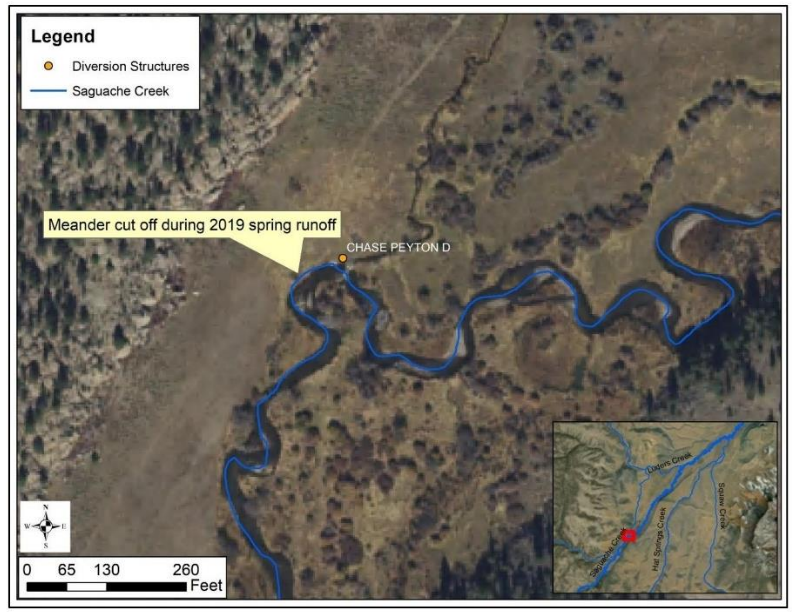
Saguache Creek Stream Management Plan

Figure 2.3: Example report card developed for diversion infrastructure inventory (pages 1-2).

Dry meander, which was cut off during 2019 spring runoff.

This photo, looking downstream, shows the meander (left) that was cut off during 2019 spring runoff.

Headgate and diversion looking downstream



Point of diversion and meander that was cut off during 2019 spring runoff.

Figure 2.4: Example report card developed for diversion infrastructure inventory (pages 3-4).

2.4 Hydrology Assessment

The hydrology assessment characterized flow regimes and assessed flow targets for the Rio Grande, Conejos River, and Saguache Creek SMPs. Daily point flow models (PFMs) were developed by Wilson Water Group, LLC, for each stream using a combination of gaged streamflow data, diversion records, stream gains/losses, USGS Stream Stats, and local knowledge from water commissioners and hydrographers. Within each PFM, daily streamflows were generated for both gaged and ungaged locations of interest (i.e., hydrology nodes). Locations of hydrologic interest within each SMP were selected with input from the TAT. At ungaged locations, the tools described above were used to simulate daily historical streamflow conditions.

The Conejos River and Rio Grande PFMs were calibrated by comparing simulated streamflow to recorded values and anecdotal information from the Water Commissioner and water users. The Saguache Creek PFM was calibrated assuming no flow after the last diversion on the Creek, per discussions with the Water Commissioner. A study period of 1998 to 2017 was used for all point flow models and reflects current administration over variable hydrology including the critically dry period during 2002. Gains and losses were distributed along the river based on irrigated acreage, tributary inflows, and on-the-ground observations by the Water Commissioners. Flows were estimated at all ungaged hydrology nodes, using the closest gages, diversions, and gains and losses. It should be noted that the level of calibration at each node varied depending on several external factors including frozen streams, irrigation return flows, ungaged tributaries, springs and seeps, etc.

The results from each point flow model were summarized both graphically and tabularly and used in the recreational flow needs assessment as well as the aquatic habitat flow needs assessment. Using the PFM, wet, dry, and average daily hydrographs for the 1998 to 2017 period of record were calculated based on average annual streamflow. Wet years were classified as the 75th percentile and above, average was the 25th to the 75th percentile, and dry was the 25th percentile and below. Figure 2.5 illustrates a typical hydrograph resulting from the PFM.

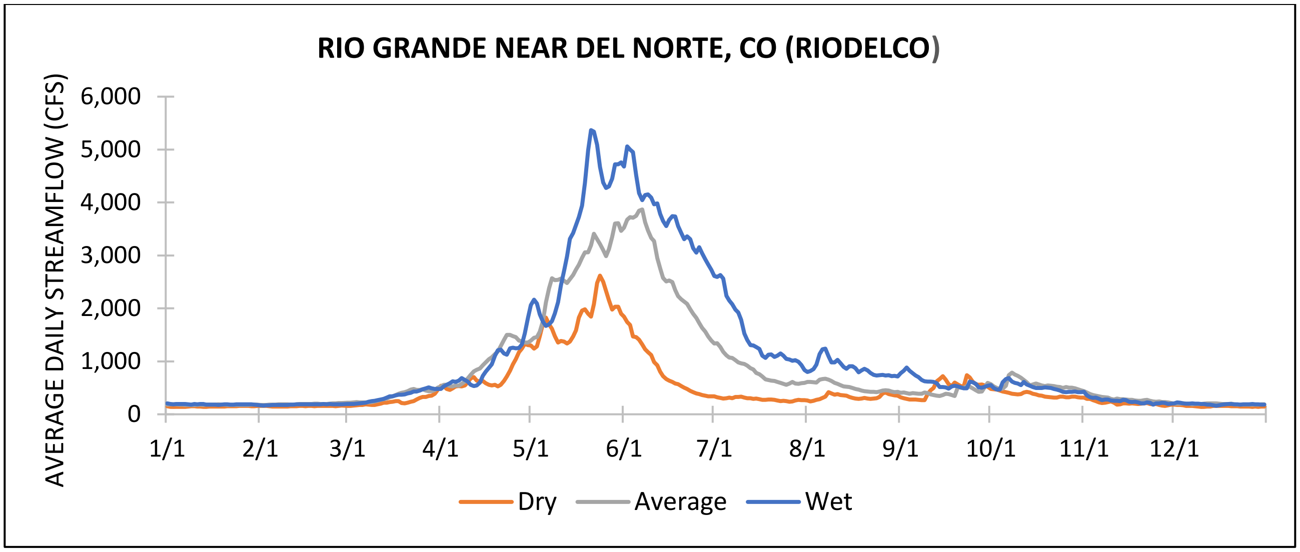


Figure 2.5: Typical hydrograph developed as part of the hydrology assessment.

Application of Hydrology Data and Point Flow Models

In addition to characterizing general hydrology and flow regimes, the hydrology data described above was used in the geomorphology, the recreational use and streamflow needs, and aquatic habitat needs assessments. Specifically, flow duration curves for each hydrology node were utilized in the geomorphology assessment to calculate bed mobility thresholds and frequency of overbanking events. Additionally, daily PFMs were utilized to calculate boatable days as part of the Recreational Use and Streamflow Needs assessment and to determine frequency of flow target attainment as part of the Aquatic Habitat Streamflow Needs assessment. Each of these assessments is described in detail below.

2.5 Recreational Use and Streamflow Needs Assessment

With input from the TAT, local stakeholders, and the RGHRP, American Whitewater (AW) completed a recreational use and streamflow needs assessment on the Rio Grande and Conejos River. Eight Rio Grande reaches and three Conejos River reaches were identified as priorities for recreational use and were included in the assessment.

To determine flow preferences for each reach, an online recreational use survey was distributed. Four types of questions were presented to survey respondents, three of which quantified flow preferences by reach, collectively, while another was directly related to water management and stream management planning. SMP-related questions allowed for comments on recreation constraints caused by infrastructure, navigational hazards, and opportunities to improve streamflow and overall recreational opportunities. Responses to SMP-related questions were incorporated into Rio Grande and Conejos River SMP stakeholder values.

Survey results were analyzed to determine streamflow preferences as well as acceptable and optimal flow thresholds for each reach. Having identified flow preferences and thresholds, AW's Boatable Days tool was run using daily streamflow data for dry, average, and wet year types (described above) to capture flow variations over the period of record. The tool applied flow preferences as inputs to calculate the number of boatable days by flow year type and reach. The Boatable Days tool has been employed in previous recreational use assessments, including the Colorado and San Miguel rivers, and is an accepted methodology for assessing and defining recreational flow needs (Stafford et al., 2016). Assessment results defined the range of flows supporting recreational use and illustrated how flows affect recreational opportunities for each reach.

This assessment played a critical role in the SMP process by quantifying baseline recreational use on the Rio Grande and Conejos River. Although some information existed previously, this assessment provided quantitative information needed to develop goals to maintain and enhance streamflows for recreational use on these two rivers. The TAT and local stakeholders used this information to develop a variety of action items to maintain and enhance recreational streamflows on the Rio Grande and Conejos River. The assessment will be available to inform water management operations in the future. Additionally, the TAT used the results to identify additional river access needs and infrastructure hazards currently limiting recreational use.

Detailed assessment methodology, results by assessment reach, and a copy of the survey questions, are available in the full report, *Assessment of Streamflow Needs for Supporting Recreational Water Uses on the Rio Grande and Conejos River* (**Appendix A**).

2.6 Aquatic Habitat Streamflow Needs Assessment

The RGHRP used a combination of data and models to determine aquatic habitat flow needs for each SMP assessment reach. The R2-Cross protocol was used to determine minimum flow targets for aquatic species habitat (CWCB, 1996). This protocol includes detailed site-level data collection, including a cross section, discharge measurement, and pebble count. This field data is run using the R2Cross model and results in two minimum flow recommendations: a winter recommendation and a summer recommendation. For the purposes of aquatic habitat flow targets, *winter* is defined as October 1 through April 30 while *summer* is defined as May 1 through September 30 (see Figure 2.6). This is the time period used for existing decreed instream flows (ISFs). Summer and winter flows are applied as recommended minimum flows for each reach.

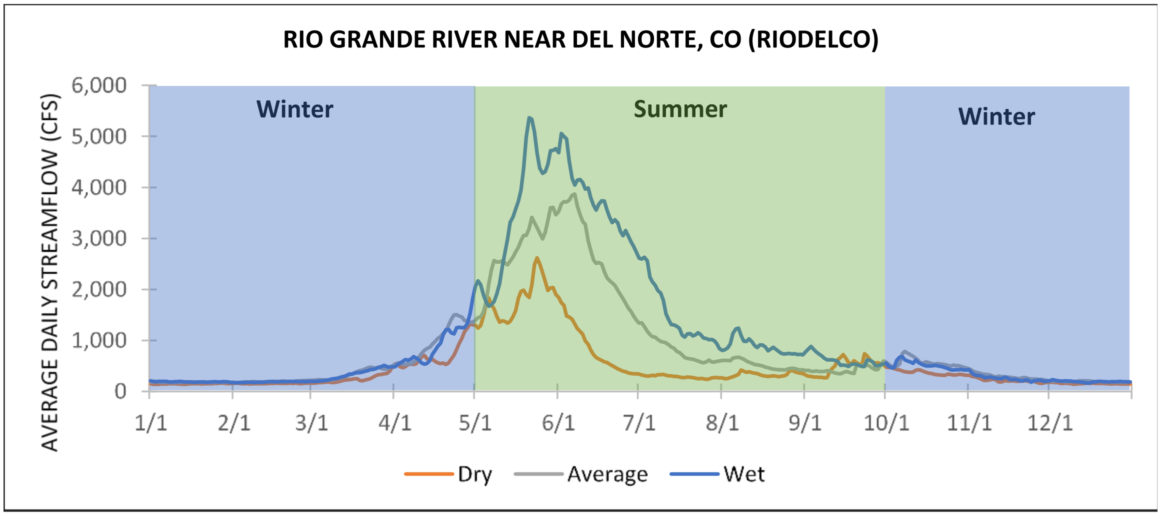


Figure 2.6: Winter versus summer time periods used in aquatic habitat flow needs assessment.

Final minimum flow determinations from R2Cross were also compared to existing aquatic habitat assessments completed on the Conejos River. Specifically, results from Physical Habitat Simulation Model (PHABSIM) and Instream Flow Incremental Methodology (IFIM) assessments previously conducted on the Conejos River were used to verify the accuracy of R2Cross results within reaches CR01 through CR04. R2Cross site locations for each reach were selected based on two primary criteria, which are standard for R2Cross: 1) Located within the lower third of the reach, and 2) located at a critical, habitat-limiting riffle.

Similar to the recreational needs assessment, results from the aquatic habitat flow needs assessment were paired with hydrographs created as part of the hydrology assessment. As described above in section 2.5, hydrographs for low, average, and high flows were applied to each priority reach. By overlaying these three hydrographs with aquatic habitat flow targets, the frequency of flow target attainment was determined. This information will be available to inform existing and potential voluntary programs and opportunities aimed at better meeting aquatic habitat flow recommendations.

Important Caveats Regarding Aquatic Habitat Flow Targets

It is important to note the following caveats regarding aquatic habitat flow recommendations:

- R2Cross was developed using habitat criteria for lower order streams and cold-water fisheries, with a focus on supporting salmonid species. Some sites within the SMP study area occurred outside these typical parameters, including in reaches classified as warm-water fisheries.
- The time period defined for winter and summer flow recommendations does not align with the Rio Grande Basin irrigation season, which to a large degree dictates reservoir releases and surface water diversions. Specifically, the summer period, as defined for aquatic habitat, begins May 1 and ends September 30 while the irrigation season is two months longer, beginning April 1 and ending October 31. The seasonal periods used in the aquatic habitat needs assessment

are intended to best protect critical life stages of salmonid species and were determined using the best available data.

- It is likely that flow targets for some reaches would not have been met even under unaltered hydrologic conditions. For example, natural, unaltered inflows to Platoro Reservoir rarely meet the calculated winter flow targets below Platoro Reservoir (reaches CR01 and CR02). There may be external factors contributing to the relatively high flow targets calculated for those reaches.
- The effects of climate change on the timing and amount of precipitation and snowmelt runoff have exacerbated existing challenges with regard to water storage and delivery.
- The timing and/or amount of legal water delivery requirements, including decreed water rights as well as those required under the Rio Grande Compact, can result in very limited flexibility in reservoir releases. In some cases, often due to below-average snowpack or other hydrologic factors, existing legal delivery requirements may prohibit reservoirs from shifting releases in an effort to meet flow targets.
- Some reservoirs affecting the Rio Grande and Conejos River are privately owned and are operated at the discretion of the reservoir company.

2.7 Geomorphology Assessment

The geomorphology assessment, conducted by Round River Design, Inc and Watershed Science and Design, LLC, utilized GIS and field data to assess the reach-scale geomorphic condition for each SMP study stream. Geomorphic characterization begins with identifying the fundamental processes of river change. Eventually, additional factors, both natural and human-caused, may create circumstances that increase the uncertainty of how a channel will react when energized.

In order to individually and collectively tell the story of a stream's geomorphic condition and attempt to decipher its expected future trajectory, both the examination of existing data and development of new remote-sensed data layers were completed. The assessment focused on documenting the geomorphic characteristics and constraints of each reach using GIS data. Additionally, site-level data was used, and, where vehicle access exists, field observations were conducted. An overall assessment of existing geomorphic condition in relation to an assumed natural reference condition was completed. Using assessment results, a qualitative rating was assigned to each reach. Table 2.4 defines the rating scale used for geomorphic condition.

Table 2.4: Rating scale used for geomorphology assessment.

Rating Scale	Impairment	Description
A	Very Low	Reach geomorphology is at or near reference condition with very little or no impact due to stressors. Few stressors may exist, however their impact on the geomorphology is minimal.
B	Low	Geomorphic condition is mildly impaired, with mild impacts resulting from a few stressors.
C	Moderate	Geomorphic condition is significantly impaired, with measurable impacts exist resulting from several stressors.
D	High	Geomorphic condition is severely impaired, with impacts resulting from numerous stressors. The reach is considered geomorphically impaired.
F	Very High	Geomorphic condition is profoundly impaired, with extreme impacts resulting from numerous stressors. The reach is considered nonfunctional in terms of geomorphic processes.

Several subvariables were included in the geomorphology assessment and are described in Tables 2.5 and 2.6. Among other subvariables, assessments of floodplain connectivity, sediment transport, and flow regime in terms of bankfull flow were included.

Table 2.5: Geomorphic reach information sheets explanation.

Reach	Determined by the RGHRP
Confinement	A reach averaged ratio comparing the average channel width over the average valley width.
D50	Median bed surface grain size (as determined through a pebble count conducted by RGHRP staff).
Bed composition	Descriptive categorization of the D50 grain (e.g., sand, fine gravel, large gravel, cobble).
Stream form	Generalized qualitative categorization of the existing and reference morphology of the stream bed based on categories developed by Montgomery and Buffington (1997). See **Appendix D**.
SEM stage	A qualitative assessment of existing and idealized/undisturbed stream evolution stage based on guidance developed by Cluer and Thorne (2014). See **Appendix D**.
Sediment regime	A qualitative assessment of current and idealized sediment regime based on guidance developed by Vermont's River Management Program (see **Appendix D**).
Valley slope	A measurement of the change in elevation between the top of the reach and the bottom of the reach divided by the length of the valley within which the stream has the opportunity to pass through (note this is not always a straight line as large terraces or bedrock outcrops might force "bends" into the valley length measurement.
Stream Power △	Qualitative assessment of change in stream power based on changes in valley slope and confinement.
Mobility Threshold Flows	A calculation of the flow or range of flows as described below in **Section 2.7.1**.
Frequency of Occurrence	How often the mobility threshold flow is exceeded as described below in **Section 2.7.1**.
Overbank Flow Estimate	The flow that is estimated to overtop the channel and initiates floodplain activation based on HEC-RAS modeling using surveyed cross-sections.
Overbank Flow Frequency	How often the overbank flow estimate is exceeded as described below in **Section 2.7.1**.
Watershed setting	"Landscape units" broadly defined by their position within a watershed and the prevailing sediment transport processes of net erosion, transfer, or accumulation as described by Fryirs et al. (2005).
River Style	River styles were identified in the 2018 Upper Rio Grande Watershed Assessment (Lotic, 2018). In the interest of continuity, this assessment has largely kept those same River Style names and descriptions while adding a few new ones for the reaches that were not described in that report (Table 2.6).
Stressors	A qualitative summary of the stressors to the geomorphic condition of the reach. These may include anthropomorphic-induced changes to the watershed or stream corridor including alterations to the hydrologic, biotic and/or geomorphic controls that determine the quality of the geomorphic condition of the reach and lend to an evaluation of its departure from an unadulterated assumed reference condition (i.e., degree of geomorphic impairment).
Degree of Geomorphic Impairment	Overall assessment of existing geomorphic condition in relation to an assumed natural reference condition.

Table 2.6: River Styles (adapted from the Upper Rio Grande Watershed Assessment, 2018).

Watershed Setting	Watershed Setting	Modifiers	River Style
Headwaters	Source	Valley Slope Floodplain Presence or Absence Planform (Existing and Potential) Floodplain Geomorphology Channel Geomorphology Bed/Bank Material Structural Elements	Alpine Headwaters
Canyon (Confined and Partially Confined)	Transport		Step Cascade
			Confined Valley
			Confined Valley Occasional Floodplain Pockets
Mountain Valley (Partially Confined and Unconfined Reaches)	Response		Elongated Discontinuous Floodplain, Bedrock and/or terrace confined
			Low-Moderate Sinuosity Planform-Controlled Discontinuous Floodplain
			Meandering Planform Controlled Discontinuous Floodplain
Alluvial Fans, Plains and San Luis Valley Floor (Unconfined)	Accumulation		Low-Moderate Sinuosity Unconfined
			Meandering Coarse Grain Bed
			Meandering Fine Grain Bed
Altered	Altered		Altered

2.7.1 Geomorphic Condition – Floodplain Activation and Bed Mobility

Geomorphic condition was assessed through the lens of a traditional bankfull flow. This bankfull flow has two components to its definition: 1) it is the flow at which water begins to spill out of the channel and onto the adjacent floodplain and 2) it is the flow that transports the greatest amount of sediment over time. Both components of this definition were assessed by calculating the flow at which the adjacent floodplain is activated and by calculating the flow that can mobilize the channel bed. Generally speaking, the floodplain activation flow and the bed mobility flow should be similar at any given location in an alluvial stream system.

The bankfull flow in an unimpaired system has a recurrence interval of approximately 1.5 years, on average. This means that in any given year there is a 67% chance that the river will rise to or overtop the channel banks and activate the floodplain. There is a small amount of variability in the frequency of bankfull flows but typically they are always smaller than the 2 to 3-year peak flow if there is not a prevalence of biotic factors in the stream system, which is the case for all three streams in this study.

Floodplain Activation Flows

A channel is said to be at bankfull stage when it is just about to flood the active floodplain. Thus, the active floodplain defines the limits of the bankfull channel. The active floodplain is the flat portion of the valley adjacent to the channel that is constructed by the present river in the present climate. The phrase “present river in the present climate” is especially important because if the river degrades or incises, what was formerly the floodplain is abandoned and becomes a terrace or abandoned floodplain. It is therefore important to distinguish the active floodplain from abandoned terraces.

HEC-RAS, a tool developed by the U.S. Army Corps of Engineers, was used to perform cross-sectional hydraulic calculations for floodplain activation flow (i.e., the flow that fills the channel and begins to spill onto the floodplain immediately adjacent to the channel). This analysis is only applicable to alluvial channels; reaches in confined bedrock canyons or whose shape is defined by geologic factors were not assessed through this method. Additionally, the analysis was limited to the surveyed channel and not tied to any floodplain modeling. To assess hydrologic geomorphic impairment, the calculated floodplain activation flow for each reach was compared to streamflow data from the hydrology assessment. For a given reach, the calculated floodplain activation flow should be roughly equal to the peak flow from the hydrology assessment’s *average year* hydrograph and should be greater than the 2-year peak flow. If this standard was not met, the reach was considered impaired. The degree of impairment is linked to the deviation in the frequency of floodplain inundation.

Function and Benefits of Floodplain Connectivity

Floodplain connectivity refers to a stream’s ability to spread out on its floodplain during overbanking events. The floodplain activation analysis described above is important because functional, well-connected floodplains play a critical role in overall stream function, providing a multitude of benefits to stream health as well as water users. Floodplain inundation recharges alluvial aquifer systems, a process sometimes referred to as “wetting the sponge.” Alluvial water storage results in sustained streamflow during baseflow periods in late summer and fall. These sustained flows not only benefit aquatic species but also surface irrigators, who receive more consistent late season flows. For this reason, alluvial aquifers are often referred to as “natural reservoirs.”

Figure 2.7: Floodplain activation on Saguache Creek, June 2019.

Floodplain activation and overbanking events are also critical to cottonwood and other riparian vegetation establishment. In some cases, an elevated groundwater table may be supporting riparian vegetation. Elevated groundwater tables are naturally common throughout the SLV with flood irrigation contributing. Conversely, poor floodplain connectivity reduces groundwater-surface water exchange in the hyporheic zone, can negatively impact stream temperature and dissolved oxygen levels, and reduces alluvial aquifer storage potential.

Figure 2.8: Activated floodplain in Saguache Creek riparian area, August 2019 (Photo: Tyrell Mares).

Function and Benefits of Wet Meadows

Functional floodplains also exist as both natural and managed wetlands. Many wetland types are found in the Basin and one type of particular importance is wet meadows. Natural wet meadows are common at higher elevations and headwaters of the Rio Grande Basin, including tributaries to mainstem streams and rivers. Managed, or “working,” wet meadows are abundant on the floor of the SLV in the form of irrigated lands. Wet meadows provide valuable ecosystem services including attenuation of flood flows, augmentation of baseflow, mitigation of post-wildfire sediment production, streambank stability, buffering of surface water temperature, nutrient filtering, and wildlife habitat (Findlay, 1995). Wet meadows are typically seasonally saturated. During high flows resulting from spring runoff or monsoon rains, wet meadows become saturated and act as a sponge in alluvial aquifer systems. In late summer, water stored in these sponges is slowly released, resulting in baseflow augmentation. Additionally, wet meadows have been shown to increase streambank stability and resiliency. One study indicated that streambanks colonized by wet meadow vegetation were, on average, five times stronger than banks with xeric vegetation (Micheli & Kirchner, 2002). This suggests that instability caused by loss of riparian vegetation can be mitigated by meadow vegetation.

Figure 2.9: Wet meadow adjacent to Saguache Creek near County Road 46, July 2019.

In the event of high severity wildfires and other disturbance events, wet meadows, particularly those at high- to mid-elevations, play an important role in mitigating potential downstream fluvial hazards. Post-wildfire precipitation can lead to significant soil erosion and an increased risk of flooding, debris flows, and other flow-related impacts. For example, following the 2013 West Fork Complex Fire, the upper Rio Grande watershed exhibited resiliency to wildfire impacts. Elevated turbidity and total suspended solids concentrations was observed and a fish kill of brown and rainbow trout on Trout Creek was attributed to sediment loading resulting from wildfire impacts (Rust et al., 2019). However, outside of these short-term impacts, the watershed as a whole was shown to be very resilient to wildfire. This resiliency is likely due in part to intact wet meadows and other wetland types. In functional wetlands and wet meadows, flood flows spread out, dissipate their energy, and allow for sediment deposition. In this way, wet meadows can act as sediment banks, thereby significantly mitigating downstream flooding and sedimentation caused by wildfire and other impacts. Although the SMPs focus on the Rio Grande, Conejos River, and Saguache Creek mainstems, maintaining the condition and resiliency of wet meadows on tributary streams, in alpine and subalpine basins, and in adjacent uplands is crucial to protecting water quality and mitigating the risk of fluvial hazards downstream and in the mainstems.

In addition to the benefits listed above, working wet meadows maintained by annual flood irrigation have been shown to be important habitat for migratory bird species. Among other species, iconic sandhill cranes, which migrate through the SLV twice a year, rely upon working wet meadows (Wetland Dynamics LLC, 2019).

Bed Mobility Flows

Long-term bed load and flow measurements have shown that the bankfull flow transports the greatest amount of material over time. While larger flow events transport greater quantities per event and smaller flow events occur more frequently, the bankfull flow is effective and sufficiently frequent to perform the greatest amount of work in establishing and maintaining channel shape.

Bankfull flows should mobilize the bed material in alluvial channels, though this assessment can become more complex in areas where the streams are working through glacial outwash alluvium rather than contemporary alluvium. Similar to the floodplain activation flows, the bed mobility flows should occur during the peak flows in the *average year* hydrographs and if peak flow data is available, the floodplain activating flow should be greater than the 2-year peak flow. If this standard was not met, the reach was considered impaired. Again, the degree of impairment is linked to the deviation in the frequency of floodplain inundation. Bed mobility flows were calculated using Critical Shear Stress and Shields Analysis, which are further described in **Appendix C**, and were reported as a range.

Function and Benefits of Bed Mobilization

At larger scales, the mobilization and deposition of bed sediments creates and maintains bedform features that provide in-channel habitat such as riffles and pools to support aquatic species at various stages of their life-cycle. At smaller scales, flows that flush fine particles such as sand and silt from the interstitial spaces between more coarse material are important for food web building blocks such as algae, zooplankton, phytoplankton, and macroinvertebrates. Flows that evacuate fine sediment from pools and deposit coarse sediment on bars are important to maintain the quality and quantity of habitat used for many species of cold-water fish to spawn and rear their young. Conversely, a lack of flows that trigger bed mobility will tend to cause either long-term scour or aggradation (site specific) of the channel bed and tend to simplify the channel, reduce bedform variability, and homogenize aquatic and riparian habitat. On the floodplain, riparian vegetation establishment and succession is often dependent upon the mobilization and deposition of sediment (and seed) within the stream corridor. Mobilizing sediments may also result in the erosion of banks (and therefore the recruitment of wood) and the deposition of new bars (and therefore places for early successional species to colonize.

2.8 Riparian Vegetation Assessment

Riparian vegetation was assessed using site-level surveys as well as larger scale remote sensing methods. A site-level botany survey, conducted by McBride BioTracking, LLC, assessed the current ecological integrity of selected assessment areas (AAs) along the Rio Grande, Conejos River, and Saguache Creek riparian areas. Additionally, the RGHRP used a GIS tool to characterize riparian condition at a reach scale. Each assessment yielded a rating and the two ratings were averaged for an overall reach rating. The overall riparian vegetation rating scale is outlined in Table 2.7.

Table 2.7: Rating scale used for riparian vegetation assessment.

Rating Scale		Impairment	Description
A	≥ 90	Negligible	Riparian area is unaltered, at or near reference condition, and supports stream health. Native vegetation diversity is self-sustaining and there is no evidence of exotic or noxious species.
B	≥ 80	Mild	Riparian area is in good condition with only minor alterations. Native species predominate and if nonnative species are present, their impact on diversity and native species cover is insignificant. The riparian area's ability to support stream health may be slightly reduced.
C	≥ 70	Significant	Riparian area exhibits decreased plant diversity, loss of structural complexity, and may be hydrologically disconnected from the river. Nonnative species may be widespread and small populations of noxious species may be present. Riparian area degradation is a significant stream health stressor.
D	≥ 60	Severe	Riparian area has severely decreased species diversity, loss of structural complexity, hydrologic alteration, and is disconnected from the river. Lack of riparian function is a main stream health stressor. Noxious species are prevalent or dominant, leading to very low native species cover. Bare ground may be a substantial proportion of land cover.
F	≥ 50	Profound	Riparian area is dominated by noxious species and/or has been converted to bare ground or other impervious surfaces. Riparian habitat is essentially nonfunctional and poor riparian condition is a primary stream health stressor.

2.8.1 Site-Level Assessment (Ecological Integrity Assessment)

A site-level riparian vegetation assessment was completed for most, but not all, SMP reaches. The sampling methodology was based on the Ecological Integrity Assessment (EIA) for Colorado Wetlands, Version 2.1 (Lemly et al., 2016). This protocol has itself been adapted from the U.S. Environmental Protection Agency's (EPA) National Wetlands Condition Assessment (NWCA) flexible-plot method (U.S. EPA, 2011). The EIA framework was designed by the EPA and NatureServe in response to the need to assess the effectiveness of biological and functional indicators of wetlands nationwide. In its entirety, this method collects data to evaluate the following range of Major Ecological Factors for each assessment area (AA), or site: 1) Landscape, 2) Buffer, 3) Vegetation, 4) Hydrology, 5) Physiochemistry, and 6) Size (Table 2.8). Because the focus of the assessment was riparian vegetation, field data collection only included Major Ecological Factors 1 – 3.

Table 2.8: Hierarchical structure of the Colorado EIA method (Lemly et al., 2016).

Rank Factor	*Major Ecological Factor*	*Metrics*[1]	*Metric Variants*
Landscape Context	Landscape	L1. Contiguous Natural Land Cover L2. Land Use Index	
	Buffer	B1. Perimeter with Natural Buffer B2. Width of Natural Buffer B3. Condition of Natural Buffer	
Condition	Vegetation	V1. Native Plant Species Cover V2. Invasive Nonnative Plant Species Cover V3. Native Plant Species Composition V4. Vegetation Structure V5. Regeneration of Native Woody Species **[opt.]** V6. Coarse and Fine Woody Debris **[opt.]**	V3 and V4 vary by wetland type. V5 and V6 are for woody systems.
	Hydrology	H1. Water Source H2. Hydroperiod H3. Hydrologic Connectivity	H1, H2, and H3 vary by wetland type.
	Physiochemistry	S1. Soil Condition S2. Surface Water Turbidity / Pollutants **[opt.]** S3. Algal Growth **[opt.]**	S2 and S3 are for sites with surface water.
Size	Size	Z1. Comparative Size **[opt.]** Z2. Change in Size **[opt.]**	Z1 and Z2 are for assessments of entire wetlands.

[1] Optional metrics noted as **[opt.]** can be used depending on study design and wetland type.

A modified version of the CNHP (2015) Colorado EIA Scorecard was used to determine individual metric and overall ratings for each AA. The modified scorecard includes the following rating weights:

<u>Modified EIA Scorecard</u>

- Rank Factor: Landscape Context (overall rating weight of 0.3)
    1) Landscape metrics (rating sub-weight 0.33)
    2) Buffer metrics (rating sub-weight 0.67)
- Rank Factor: Condition (overall rating weight of 0.7)
    3) Vegetation metrics (rating sub-weight 1)

Each metric is rated according to deviation from its natural state, or the best current understanding of how the particular ecological system is expected to look and function under reference conditions (Lemly & Rocchio, 2009). The further a metric moves away from its natural range of structure and function, the lower the rating it receives. The ratings for each category are collectively applied to produce an overall Ecological Integrity Score (EIS) for each site. General EIS score definitions are shown in Table 2.9.

Table 2.9: Definition of Ecological Integrity Assessment ratings (Lemly et al., 2016).

Rank Value	Description
A	**Reference Condition (No or Minimal Human Impact):** Wetland functions within the bounds of natural disturbance regimes. The surrounding landscape contains natural habitats that are essentially unfragmented with little to no stressors; vegetation structure and composition are within the natural range of variation, nonnative species are essentially absent, and a comprehensive set of key species are present; soil properties and hydrological functions are intact. Management should focus on preservation and protection.
B	**Slight Deviation from Reference:** Wetland predominantly functions within the bounds of natural disturbance regimes. The surrounding landscape contains largely natural habitats that are minimally fragmented with few stressors; vegetation structure and composition deviate slightly from the natural range of variation, nonnative species and noxious weeds are present in minor amounts, and most key species are present; soils properties and hydrology are only slightly altered. Management should focus on the prevention of further alteration.
C	**Moderate Deviation from Reference:** Wetland has a number of unfavorable characteristics. The surrounding landscape is moderately fragmented with several stressors; the vegetation structure and composition is somewhat outside the natural range of variation, nonnative species and noxious weeds may have a sizeable presence or moderately negative impacts, and many key species are absent; soil properties and hydrology are altered. Management would be needed to maintain or restore certain ecological attributes.
D	**Significant Deviation from Reference:** Wetland has severely altered characteristics. The surrounding landscape contains little natural habitat and is very fragmented; the vegetation structure and composition are well beyond their natural range of variation, nonnative species and noxious weeds exert a strong negative impact, and most key species are absent; soil properties and hydrology are severely altered. There may be little long term conservation value without restoration, and such restoration may be difficult or uncertain.

According to Lemly and Rocchio (2009), there are two important thresholds which indicate degradation to the point where action is needed within the assigned ranks:

- The B-C threshold (i.e., transition from a rating of B to a rating of C) indicates the level below which conditions are not considered acceptable for sustaining ecological integrity.
- The C-D threshold indicates a level below which system integrity has been drastically compromised and is unlikely to be restorable.

EIA metrics and associated ratings are specific to the particular ecological system being sampled. The Ecological System definitions and descriptions are components of the International Vegetation Classification System and have been developed by NatureServe and the Natural Heritage Network (Lemly et al., 2016). The EIA for an assessment area helps clarify the minimum performance standards for a wetland system, identifies the current ecological integrity of a system, and specifies the particular ecological components that must be repaired in order to restore a wetland to a desired level of ecological integrity (Lemly & Rocchio, 2009).

NatureServe has begun development of descriptions for specific wetland and riparian ecological systems found in the Southern Rocky Mountain Ecoregion (Lemly & Rocchio, 2009):

- Subalpine-Montane Riparian Shrublands
- Subalpine-Montane Riparian Woodlands
- Lower Montane Riparian Woodlands and Shrublands
- Subalpine-Montane Fen
- Alpine-Montane Wet Meadow

- North American Arid Freshwater Marsh
- Intermountain Basin Playas

As part of the EIA assessment, CNHP's Floristic Quality Assessment (FQA) tool was also used to assess native riparian vegetation (Lemly et al., 2016). The FQA method uses "coefficients of conservatism" (C-values), which are assigned to all native species in Colorado. C-values range from 0 to 10 and represent an estimated probability that a species is likely to occur in unaltered, pre-European settlement conditions. Species which are intolerant of habitat degradation and are obligate to reference condition landscapes have high C-values while those more tolerant of habitat degradation have low C-values. Most nonnative species have C-values of 0. For the SMP, the basic FQA index called mean C (i.e., average C-value for a given site) was calculated at each SMP site. See **Appendix E** for a detailed description of the site-level EIA survey methods.

2.8.2 GIS Remote Sensing Vegetation Assessment

To assess riparian vegetation condition at a larger scale, the RGHRP employed a set of GIS tools. The tools are collectively known as the Riparian Condition Assessment Tool (RCAT), which includes the Valley Bottom Extraction Tool (VBET), Riparian Vegetation Departure (RVD) tool, and the Riparian Condition Assessment (RCA) tool (Macfarlane et al., 2018). These GIS tools consist of ArcPython scripts that use nationally available digital elevation models (DEMs) and 30-meter LANDFIRE imagery to assess the current condition of riparian vegetation. Because the RCAT tools and analysis are based upon watershed boundaries, the analysis was completed for all perennial streams within the Rio Grande Basin. First, VBET was used to delineate the maximum possible extent of riparian vegetation along each study stream using a DEM and average slope and valley width thresholds. Note: the riparian extent does not include wetlands that are not associated with the perennial stream network. Where available, a 2-meter DEM, derived from LiDAR data, was used. For the remainder of the Basin, the nationally available 10-meter DEM was used.

The RVD assessment tool divides each stream into discrete 500-meter assessment units. Within each assessment unit, the tools overlay the VBET output and LANDFIRE imagery. To compare current and reference vegetation, two LANDFIRE datasets are used. Current riparian vegetation cover is modeled using the Existing Vegetation Type (EVT) layer, while historic (pre-European settlement) vegetation is modeled using the LANDFIRE Bio-physical Setting (BpS) layer. Imagery falling within the VBET boundary is included in each assessment. RVD calculates the degree to which each unit has "departed" or been converted from pre-European, or "reference," condition. This is expressed as a percentage. Additionally, the tool analyzes the LANDFIRE imagery to determine what primary type of land conversion, if any, has occurred within each unit.

The more comprehensive RCA tool assesses riparian area condition using three inputs: riparian vegetation departure (modeled by the RVD tool), land use intensity, and floodplain connectivity. Each assessment unit is attributed with values on continuous scales for each of the three inputs. To determine floodplain connectivity, roads, railroads, development, and other types of land conversion were used to assess overall riparian conditions for each spatial unit. The overall RCA score is calculated using all three inputs and is expressed as a value between 0 and 1. An example of the RCA output is shown in Figure 2.10 and RCA rating scale, including RCA score thresholds, is in Table 2.10.

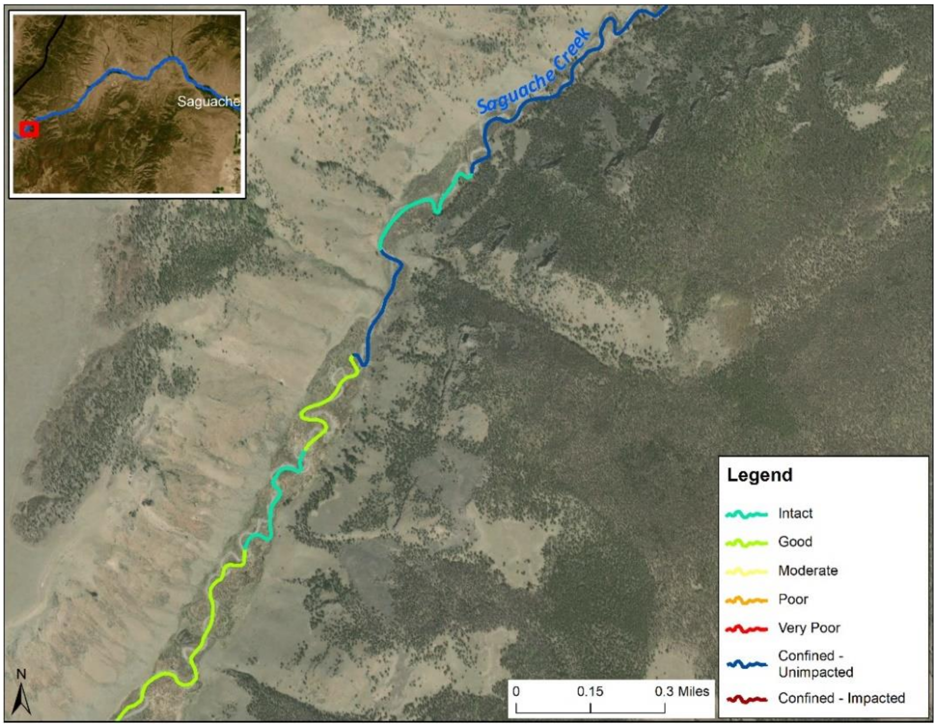


Figure 2.10: Example of GIS riparian vegetation assessment results.

Table 2.10: Rating scale used GIS remote sensing vegetation assessment

Rating Scale	Impairment	RCA Score	Description
A ≥ 90	Negligible	≥ 0.9	Riparian vegetation is considered to be in reference condition. Few, if any, nonnative species are present, land use intensity is negligible, and floodplain connectivity is intact.
B ≥ 80	Mild	0.6 - 0.89	Riparian vegetation is in good condition with few nonnative species present. Land use intensity is low and river-floodplain connectivity is mostly intact.
C ≥ 70	Significant	0.3 - 0.59	Riparian vegetation is in moderate condition and small populations of noxious species may be present. Land use intensity is moderate and there is some loss of river-floodplain connectivity.
D ≥ 60	Severe	0.1 - .29	Riparian vegetation is in poor condition. Noxious plant species are prevalent. Land use intensity is high and, in many areas, the river lacks floodplain access.
F ≥ 50	Profound	< 0.1	Riparian vegetation is in very poor condition. Noxious plant species are dominant. Land use intensity is extreme and the majority of the reach lacks floodplain access.

The RCAT tools were developed by a team of researchers at Utah State University. Additional information and documentation of these tools is available at this url: http://rcat.riverscapes.xyz/. As noted above, both the site-level and GIS assessments were used in assessing overall riparian vegetation condition. The EIA rating and RCA ratings were averaged to calculate a final grade for each SMP reach.

2.9 Water Quality Assessment

A modified version of the FACStream framework was utilized for the water quality assessment. The assessment primarily utilized existing data collected by the Colorado Water Quality Control Division (CWQCD), CPW's River Watch program, and the U.S. Geological Survey's National Water Quality Assessment (NAWQA) program. Recent data (i.e., post-2010) was prioritized to best capture current water quality conditions. Existing data was supplemented with targeted water quality data collection during summer and fall 2018. Three water quality parameters (subvariables) were assessed: 1) temperature, 2) nutrients, and 3) chemical conditions (including pH and metal concentrations). Each of these parameters is an important indicator of water quality and, collectively, provide a detailed assessment of overall water quality. Where data was available, sediment was also analyzed but not included in the overall water quality reach ratings. Subvariables were rated according to the rating scales in Tables 2.11 to 2.13.

Table 2.11: Rating scale used for water temperature subvariable

Rating Scale		Impairment	Description
A	≥ 90	Negligible	The temperature regime is natural and appropriate for a pristine, high-functioning river in reference condition.
B	≥ 80	Mild	The temperature regime is within the range of natural variability and standards are not exceeded. However, natural aquatic biota may be minimally impaired.
C	≥ 70	Significant	The temperature regime is altered to a degree that could potentially limit natural aquatic biota and/or regulatory standards are occasionally exceeded. This rating applies to **303(d) Monitoring and Evaluation (M&E)** reaches.
D	≥ 60	Severe	The temperature regime is altered to a degree that is known to be lethal or limiting to natural aquatic biota and/or regulatory standards are *frequently* exceeded. This rating applies to **303(d) listed** reaches.
F	≥ 50	Profound	The temperature regime is severely altered. Natural biota may be severely impaired and/or regulatory standards are *chronically* exceeded. This rating also applies to **303(d) listed** reaches.

Table 2.12: Rating scale used for nutrients subvariable

Rating Scale		Impairment	Description
A	≥ 90	Negligible	Nutrient levels are natural and appropriate for a pristine, high-functioning river in reference condition.
B	≥ 80	Mild	Nutrient levels are within the range of natural variability and standards are not exceeded. However, natural aquatic biota may be minimally impaired.
C	≥ 70	Significant	Nutrient levels are altered to a degree that could potentially limit natural aquatic biota and/or regulatory standards are occasionally exceeded. This rating applies to **303(d) Monitoring and Evaluation (M&E)** reaches.
D	≥ 60	Severe	Nutrient levels are altered to a degree that is known to be lethal or limiting to natural aquatic biota and/or regulatory standards are *frequently* exceeded. This rating applies to **303(d) listed** reaches.
F	≥ 50	Profound	Nutrient levels are severely altered. Natural biota may be severely impaired and/or regulatory standards are *chronically* exceeded. This rating also applies to **303(d) listed** reaches.

Table 2.13: Rating scale used for chemical conditions subvariable

Rating Scale		Impairment	Description
A	≥ 90	Negligible	Chemical conditions are natural and appropriate for a pristine, high-functioning river in reference condition.
B	≥ 80	Mild	Chemical conditions are within the range of natural variability and standards are not exceeded. However, natural aquatic biota may be minimally impaired.
C	≥ 70	Significant	Chemical conditions are altered to a degree that could potentially limit natural aquatic biota and/or regulatory standards are occasionally exceeded. This rating applies to **303(d) Monitoring and Evaluation (M&E)** reaches.
D	≥ 60	Severe	Chemical conditions are altered to a degree that is known to be lethal or limiting to natural aquatic biota and/or regulatory standards are *frequently* exceeded. This rating applies to **303(d) listed** reaches.
F	≥ 50	Profound	Chemical conditions are severely altered. Natural biota may be severely impaired and/or regulatory standards are *chronically* exceeded. This rating also applies to **303(d) listed** reaches.

The overall water quality score was calculated as the mean of the subvariable scores. In some reaches, there was insufficient data to assess one or more subvariables. Any subvariables lacking sufficient data for a given reach were not included in the calculation of that reach's overall water quality score. An exception to the chemical conditions subvariable (Table 2.13) was made for reaches having only a chronic total arsenic impairment. Many SMP reaches as well as pristine headwater streams exceed the chronic water supply standard for total arsenic of 0.02. The impairments do not appear to affect aquatic life. Because the impact is negligible and because it is likely that these exceedances are likely attributable to naturally occurring arsenic, any such reaches were assigned a chemical condition rating of B. A summary of water quality data and impairments is included in **Appendix F**.

2.10 Aquatic Life Assessment

The aquatic life assessment included an assessment of benthic macroinvertebrates and trout species' abundance and health. These two subvariables were rated using a modified version of the FACStream framework, described in Tables 2.14 through 2.16. The overall aquatic life rating was calculated as the mean of the subvariable scores. In some reaches, there was insufficient data to assess one or more subvariables. Any subvariables lacking sufficient data for a given reach were not included in the calculation of that reach's overall water quality score. Table 2.14 describes the aquatic life rating scale. The two subvariables are described below.

Table 2.14: Rating scale used for aquatic life assessment

Rating Scale	Impairment	Description
A ≥ 90	Negligible	Aquatic biota indicate a high-functioning reach that is representative of an unaltered, reference condition reach.
B ≥ 80	Mild	Aquatic biota are mildly impaired, indicating a functioning reach near reference condition. Macroinvertebrate and/or fish species presence or abundance may be slightly altered.
C ≥ 70	Significant	Aquatic biota are altered. Exotic species may be common, diversity lacking, and/or species distributions skewed. Important functional groups are appropriately represented even when nonnative species are present.
D ≥ 60	Severe	Aquatic biota are severely altered and may include abundant exotic species, major loss of diversity, or lacking keystone species. One or more important functional groups is unfilled or poorly represented.
F ≥ 50	Profound	Aquatic biota are fundamentally altered. Examples include communities dominated by exotic species and communities with multiple important functional groups that are vacant or severely diminished.

Benthic Macroinvertebrates

Benthic macroinvertebrates (BMI) are excellent indicators of water quality, aquatic habitat, and overall river health. BMI assemblages are sensitive to many stressors including altered habitat, changes in sediment input, hydrologic regimes, and water quality. Different macroinvertebrates groups respond differently to these stressors. For example, species of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), often referred to as EPT, are intolerant of pollution and poor water quality while other aquatic invertebrate groups are relatively tolerant. Macroinvertebrates are also a significant food source for fish and play a critical role in the transfer of energy to higher trophic levels. Changes in BMI communities can result in changes to fish communities.

Figure 2.11: Stoneflies, an indicator of good water quality.

BMI data was obtained from previously collected samples and was supplemented with targeted sampling during the summer of 2018. BMI samples were assessed using multi-metric index (MMI) scores. The MMI uses multiple equally weighted metrics to score the macroinvertebrate population diversity and density on a scale from 0-100 (CDPHE, 2020). The MMI is calibrated to one of three “biotypes,” where biotypes are defined as regions that would have similar macroinvertebrate assemblages based on the elevation, slope, and ecoregion. The biotypes group macroinvertebrate assemblages into mountain streams, plains streams, and the transition streams in between the mountains and plains. The sampling locations within the SMP study area include Biotype 1 (transition) and Biotype 2 (mountain) sites. The state of Colorado sets different MMI attainment and impairment thresholds for each Biotype, which are described in Table 2.15.

Table 2.15: Thresholds for Biotype 1 and Biotype 2.

MMI	Biotype 1	Biotype 2
Attainment	45.2	47.5
Impairment	33.7	39.8

If a site’s MMI score is between the impairment and attainment threshold, further investigation is warranted and other metrics are considered. To determine impairment, two additional indices, the Shannon-Wiener Diversity Index (SDI) and Hilsenhoff Biotic Index (HBI), are considered. The SDI is a measure of relative species abundance, on a scale from zero to five, with higher values indicating higher species diversity (MacArthur, 1965). HBI is a measure of the relative abundance of pollution-tolerant species and ranges from zero to ten, where a higher value indicates more pollution tolerant species are present (Hilsenhoff, 1987).

The rating scale for the benthic macroinvertebrates subvariable is described in Table 2.16.

Table 2.16: Rating scale used for MMI aquatic life subvariable

Rating Scale	Impairment	Description
A	Negligible	The reach sustains and supports reference conditions for macroinvertebrate communities and aquatic life use. No management is needed other than protection of existing conditions. MMI score is 80–100.
B	Mild	Some detectable stressors are likely with minor alterations to macroinvertebrate communities. The ecological system retains essential qualities and supports a high level of function. Some management may be required to sustain or improve this condition. MMI score is 65 – <80.
C	Significant	The reach supports and maintains essential components of macroinvertebrate communities, but exhibits measurable signs of degradation and less than optimal community parameters. The reach meets the attainment threshold, with an MMI score >45.2 (Biotype 1) or >47.5 (Biotype 2) and <65.
D	Severe	There are detectable alterations or degradation of aquatic life use, but the system still supports a fundamental community structure and function. Active management is recommended to maintain and improve characteristic functional support. MMI score is >33.8 – 45.2 (Biotype 1) or 39.9 – 47.5 (Biotype 2).
F	Profound	There is clear impairment to macroinvertebrate communities and aquatic life. This level of alteration generally results in an inability to support characteristic benthic organisms, or makes the stream segment biologically unsuitable. The reach has a “below impairment” threshold. MMI score of <33.7 (Biotype 1) or <39.8 (Biotype 2).

Trout

Trout biomass was also included as a subvariable in the aquatic life assessment. Because trout species depend on abundant food sources and high-quality habitat, their presence is an indicator of good water quality and aquatic habitat. Within the SMP study area, several native fishes are present, however due to limited data on native fish habitat requirements and abundance, native species were not assessed in this subavariable. The subvariable was measured as total pounds of trout species per acre, as shown in Table 2.17.

Table 2.17: Rating scale used for trout aquatic life metric

Rating Scale	Impairment	Description
A ≥ 90	Negligible	High total biomass (≥60 lbs/acre-gold medal standard); overall average relative weight is average or higher than average; viable recreational fishery.
B ≥ 80	Mild	Medium total biomass (40-59 lbs/acre); overall average relative weight is average; mediocre fishery with moderate numbers of adult fish.
C ≥ 70	Significant	Low total biomass (20-39 lbs/acre); overall average relative weight is below average; inconsistent recreational fishery with low numbers of adult fish.
D ≥ 60	Severe	Very low total biomass (0-19 lbs/acre); overall average relative weight is substantially below average; minimal recreational fishery potential with very low numbers of adult fish.
F ≥ 50	Profound	No trout present; no natural reproduction; no biomass; no recreational fishery.

A summary of macroinvertebrate and trout data is included in **Appendix F**.

2.11 Stream Condition Stressors

For the purposes of the SMP, stream condition stressors are considered to be past or present anthropogenic impacts affecting stream conditions. To understand the likely causes of impairment for each condition assessment, stream condition stressors were investigated for each SMP study reach. Stressors are often manifested and can be observed through their impact on stream condition. For example, degraded water quality may be the measurable result of a historic mining stressor. This section lists the most common stressors affecting the SMP study streams, many of which are interrelated and affect multiple stream health variables.

Crossings and Diversions

Structures such as bridges, culverts, diversion dams, and weirs may exacerbate channel migration or erosion. These structures can direct and concentrate flows into a streambank or embankment resulting in damage to infrastructure. Structures that are undersized, located near tight bends, or located where slopes change are more likely to have trouble passing sediment and debris being transported by a stream (Figure 2.12). This can result in upstream deposition of this material and subsequent channel movement while on the downstream side the sediment-deprived water becomes erosive. It is important to understand that this is often a structure problem, not a sediment or debris problem. As such, negative impacts can often be ameliorated through improved design or structure retrofits. Sediment and debris transport disruption is common at diversion structures within the SMP study area.

Prediction of geomorphic instability as a result of crossing structures or the most likely location of new channels should a crossing become blocked or fail is beyond the scope of this SMP. It is recommended, however, that road crossing designs allow for appropriate sediment transport at low, medium, and high flows (including the overflow areas), as well as the capability to pass debris. Crossings or crossing approaches might even be designed to fail (e.g., break-away designs) should they become plugged during a flood so as to encourage flood waters to stay in the channel. Similarly, diversion dams may create instability in a system partially due to their attempt to lock a laterally dynamic channel into a fixed location.

Disruption of natural sediment and/or debris transport regimes also degrades aquatic habitat. Sediment accumulation upstream of structures decreases fish as well as aquatic insect habitat complexity by eliminating interstitial spaces. Sediment and/or woody debris deprivation downstream of structures also decreases habitat complexity and limits nutrient inputs. Additionally, in-channel structures such as diversion dams can create barriers to fish passage, thereby fragmenting aquatic habitats. Habitat fragmentation can negatively affect fish populations and communities in a variety of ways including preventing fish from reaching spawning areas, isolating breeding populations and decreasing genetic diversity, and increasing the risk of disease.

Figure 2.12: (Left) Bridge over Saguache Creek with a pier in the middle of the bridge that may collect debris during a flood. (Right) Undersized culverts failing to transport sediment in a dry wash in Saguache County.

Roads and Railways

Roads oriented so they constrict the active river corridor can increase flow depths, shear stresses, and sediment transport capacities of streams. These constrictions can affect reaches upstream and downstream. Road and railroad bed encroachment does not appear to be significantly affecting the geomorphic stability of any of the streams in the SMP study area (Figure 2.13).

Figure 2.13: Railroad lines and bridges crossing the Rio Grande near flood stage, June 2019.

Channelization, Armoring, and Disconnection of Floodplains

Channelization (i.e., straightening of channel meanders; removal of large wood and/or beavers; filling of side channels to force a stream into a single-thread) and stream bank armoring (i.e., placement of rock riprap, concrete barriers, or other materials to prevent channel migration or widening) has occurred on the SMP study streams and adversely affects natural channel processes and stream health. Figure 2.14 shows a channelized portion of the Rio Grande.

Figure 2.14: Channelization of the Rio Grande at the Soldiers Home Road (County Road 3E).

These features can cause river-floodplain disconnection (i.e., the river is unable to access its floodplain at high flows where it otherwise would have). Stream response to floodplain disconnection and/or bank armoring typically results in the transfer of erosive energy to the opposite bank, a downstream reach, or toward the channel bed.


Figure 2.15: River-floodplain disconnection on the Rio Grande upstream of Alamosa.

Generally speaking, these changes lead to a fluvial response (i.e., instability seen as increased erosion, sedimentation, and/or channel movement). Disconnecting features such as berms or levees are not uncommon in the SMP study area, typically as a result of land conversion or road and railroad construction that now occupies former river floodplain.

Fill and Floodplain/Riparian Area Conversion

Land conversion can alter or eliminate floodplain complexity, side channels, wetlands, riparian vegetation, overflow relief channels, and other important geomorphic and ecological components of streams. Riparian vegetation and wetlands along some SMP reaches are impacted by fill and/or floodplain/riparian area conversion resulting from development, overgrazing, and nonnative species dominance. Riparian vegetation throughout the floodplain and river corridor, not just along the main channel, is critical to energy dissipation, stream shading, bank stability, wildlife habitat, and many other natural stream processes. Overgrazing and/or development fill brought into the corridor erases the evidence of past channel migration, possibly creating a false sense of protection from fluvial erosion to those that occupy the land. Furthermore, development creates the expectation (e.g., stable banks) that these rivers will remain in their current location indefinitely and therefore current and future generations will be willing and able to invest in the costs (both monetary and ecological) that will be required to resist natural channel processes (e.g., bank erosion and channel migration) (Figure 2.16).

Figure 2.16: Development in the active river corridor of the Rio Grande in the Town of Del Norte.

Flow Alteration: Impoundments

While Saguache Creek is a free-flowing stream, large dams affect both the Rio Grande and Conejos River. Dams affect these rivers both by reducing sediment transport, by trapping sediment behind them (Figure 2.17), as well as by reducing the peak flows that might otherwise provide channel-forming flows to flush fines, mobilize sediments, and do other geomorphic work. The Rio Grande is controlled by the earthen dam of the Rio Grande Reservoir which sits approximately 20 miles west of Creede. To a lesser degree, flows are also affected by Continental and Santa Maria reservoirs, which flow into Clear Creek. The Platoro dam on Conejos River is located roughly 1 mile above the town of Platoro, Colorado. Because these reservoirs are required to pass inflows during spring runoff, peak runoff is only altered when reservoir inflows surpass reservoir outlet capacity.

Figure 2.17: Sediment trapped behind the Rio Grande Reservoir (seen during dam repairs which had the reservoir drained during the fall of 2018).

Flow Alteration: Diversions

Diversion structures can affect stream health in two main ways: they act as small dams, trapping sediment behind them and they can act as barriers to aquatic habitat connectivity. The disruption of sediment transport can create localized channel and bank instability. As water is diverted out of the stream system, it can create conditions where channel flow is below optimal to perform geomorphic work. Without channel-maintaining flows, channels may narrow as vegetation creeps into the channel where scouring flows once kept the channel open. This process is particularly evident in Rio Grande SMP reach RG14, within the Alamosa levee system. Diversions can act as fish barriers, thereby reducing aquatic habitat connectivity and limiting species movement. Although very little is known regarding the habitat requirements of native species inhabiting the SMP study streams, fish species thrive when they are able to move between a variety of habitat types.

Hillslope/Channel Erosion

Streams receive sediment of varying sizes from naturally-occurring hillslope and channel erosion processes. However, unusually high or low sediment inputs can adversely affect stream health. Among other impacts, unusually high sediment loads decrease fish and macroinvertebrate habitat complexity by eliminating interstitial spaces, while low sediment loads can also decrease habitat complexity and limit key nutrient inputs. High sediment input often occurs as a result of hillslope, bank, and channel instability. Instability often results from a loss of riparian vegetation that would otherwise stabilize banks and can be exacerbated by floodplain disconnection. In areas lacking floodplain connectivity, high flows cannot dissipate energy by spreading out, leading to accelerated bank erosion and downstream sedimentation. Low sediment supply can also be caused by bank stabilization efforts which have resulted in less erosion than would have occurred under natural conditions.

Abandoned Mine Lands

Historic mining operations, or Abandoned Mine Lands (AML) continue to affect water quality in the SMP study area. For example, historic mining near Creede is known to be the primary source of elevated heavy metal concentrations in Willow Creek, which has led to elevated concentrations in the Rio Grande downstream of Willow Creek. State water quality standard exceedances of both cadmium and zinc resulted in a 303(d) listing and subsequent Total Maximum Daily Load (TMDL) requirement for these metals from the Willow Creek confluence to the Rio Grande/Alamosa County line. Mild AML water quality impacts were noted in the Conejos River but were not noted in Saguache Creek. Elevated metal concentrations can have toxic effects on aquatic life.

Exotic/Naturalized Plant Species

It is worth briefly exploring the difference between nonnative invasive (including noxious) plant species and nonnative naturalized species. Native plant species occurred in the U.S. before European settlement, while a nonnative species is thought to have been introduced as a result of European settlement. An invasive plant is nonnative, able to establish itself at a variety of sites, grows quickly, and spreads to the point of disrupting the local plant community and associated ecosystem. A naturalized plant species is also nonnative, but doesn't take over the existing native plant community or associated ecosystem dynamics (USDA NRCS, 2019).

Dense stands of invasive species can negatively affect hydrologic processes and ecological function of an area, particularly in riparian zones (Gebauer, 2013). A key trait of invasive plant species is their potential to outcompete the native plant community, sometimes resulting in a monoculture of vegetation. The presence of naturalized species, however, may have minimal impacts on the native biological integrity, species or functional group diversity, or productivity of a given site (Spyreas et al., 2010).

Buffer width is one important factor in riparian health. A buffer of sufficient size and quality improves water quality by trapping sediments and filtering pollutants before they reach the river or stream. When the buffer includes a variety of canopy layers, it also provides stream shading and helps control water temperature. Finally, the presence of woody debris helps shape the riparian channel and provides habitat for a variety of species (Gebauer, 2013). These pivotal ecosystem services provided by a diverse and structurally complex plant community are often diminished when invasive species spread through and area. Naturalized species however, have been observed to exist within a community without having strong adverse impacts to these ecological functions. Therefore, while the presence of naturalized plant species may not be as desirable as that of native plants, naturalized species should not be managed in the same aggressive manner used to control populations of invasive species.

For the purpose of the SMPs, the following plant species encountered during surveys were considered to be naturalized rather than invasive: *Dactylis gomerata* (Orchardgrass), *Phleum pratense* (Timothy grass), *Poa compressa* (Canada bluegrass), *Poa pratensis* (Kentucky bluegrass)*, Taraxacum officinale* (Dandelion)*, Trifolium pratense* (Red clover)*,* and *Trifolium repens* (White clover)*.* It is important to note that these species may be considered to be invasive in some locations and under certain ecological conditions. However, during SMP surveys, these species were neither observed to establish monocultures, nor to have obvious harmful impacts on the biological integrity of any given assessment area.

Additionally, all noxious plants encountered in addition to the species, *Phalaris arundinaea* (Reed canarygrass), were considered to be invasive. Noxious plants were identified using the state of Colorado's Noxious Weed List (CDA, 2018). While not classified as a noxious species, *P. arundinacea* is thought to have both native and nonnative types within the U.S. It has been promoted and intentionally spread in the past as a forage grass for livestock. For the purpose of the Colorado EIA Scorecard, this species is considered to be an increaser species with a '0' rating for its C-value. Spyreas et al. (2008) suggested that when *P. arundinacea* becomes invasive, it decreases community level diversity and biological integrity of sampled sites across Illinois. This species has also been implicated in contributing to low streamflow during the growing season in semi-arid riparian zones in eastern Washington. The recommendation for assessment areas with a presence by noxious plant species is to actively control these populations to minimize spread and prevent further disruption to the site's ecological integrity.

Exotic Aquatic Species

Nonnative aquatic species such as common carp and northern pike, both of which are present in the SMP study streams, may indicate degraded stream health. Exotic species are more likely to survive in areas where water quality or habitat degradation has led to unsuitable conditions for native species.

Removal or Lack of Woody Material

Large and small woody material, both alive and dead, is an important driver of river function and the creation and maintenance of aquatic species habitat. Woody material within the main channel, secondary channels, and floodplain influences the transport of water, sediment, and debris as well as the geomorphic form and stability of streams. It also creates valuable aquatic habitat including pools, which provide refuge for fish and other aquatic species during high and low flows and buffer water temperature. Lack of woody material in some SMP study reaches has resulted in reduced floodplain connectivity, less diverse aquatic habitat, and lower overall system resiliency.

Unknown Stressors

In some cases, causes of impairment are unknown. Most often, unknown stressors are related to water chemistry impairment. For example, elevated arsenic concentrations measured in the headwaters of the Rio Grande, Conejos River, and Saguache Creek have no readily apparent source. Likely, the impairment can be attributed to high concentrations of naturally occurring arsenic in geologic formations. However, the point source is unknown and warrants further research.

3. Saguache Creek SMP Conditions Assessment Results

3.1 Summary of Saguache Creek SMP Conditions Assessment Findings

This section provides a summary of the conditions assessment results for all Saguache Creek reaches. Table 3.1 and the corresponding map in Figure 3.1 outline the Saguache Creek Stream Management Plan assessment reaches, including each reach's length in river miles.

Table 3.1: Description of Saguache Creek SMP assessment reaches.

Reach ID	Reach Description	Length (River Miles)*
SC01	South Fork Saguache Creek Confluence to Rio Grande National Forest Boundary	8.4
SC02	Rio Grande National Forest Boundary to Chase Peyton Ditch	4.2
SC03	Chase Peyton Ditch to Ford Ditch	31.0
SC04	Ford Ditch to County Road 46	12.7
SC05	County Road 46 to Braun Bridge	9.4
	Total River Miles	**65.7**

*River miles were calculated using SWRF (see section 2.1).

Diversion structures were also assessed on Werner Arroyo, a 9-mile secondary channel off the mainstem Saguache Creek. Just upstream of County Road 42, Saguache Creek bifurcates, with the Werner Arroyo channel heading south of the mainstem. Other stream health conditions were not assessed for Werner Arroyo.

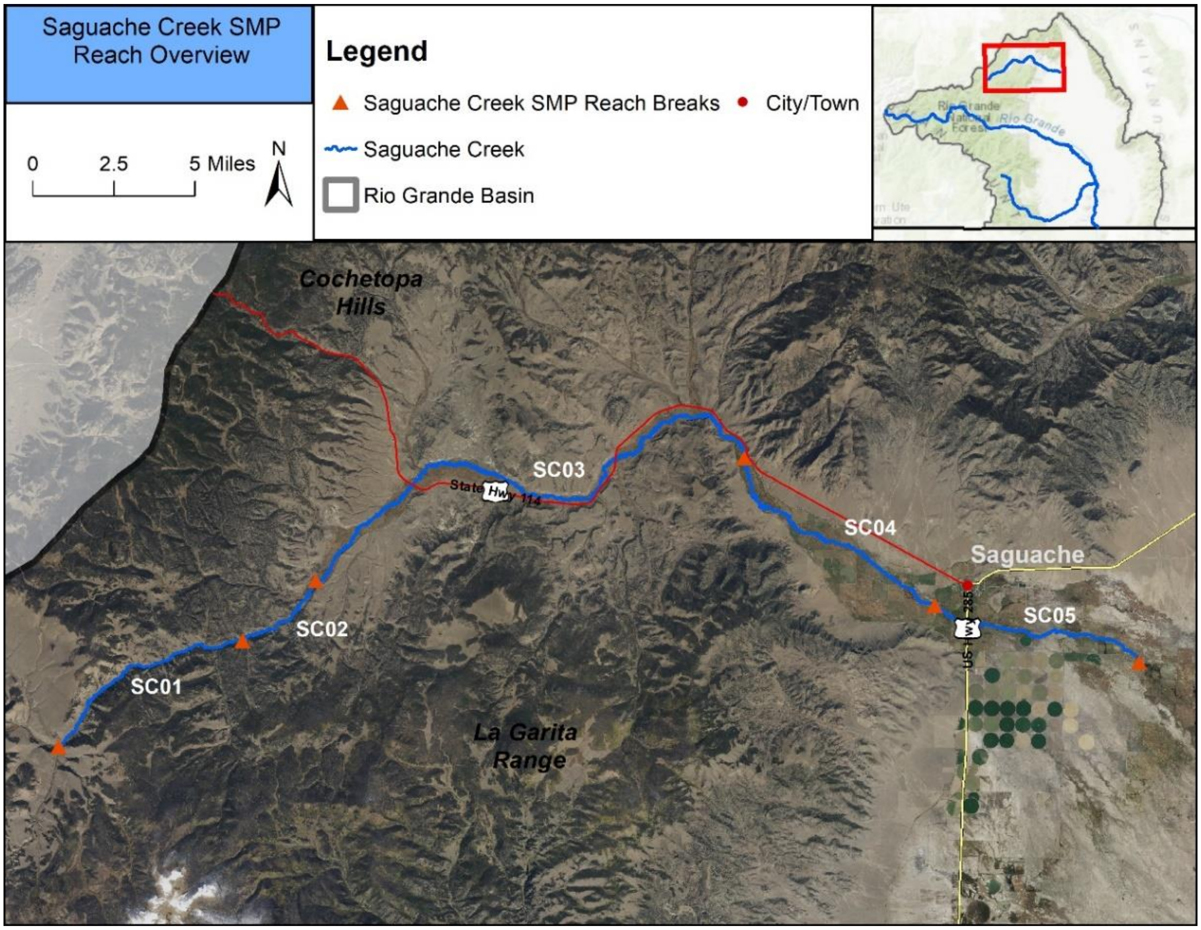


Figure 3.1: Saguache Creek SMP reach overview.

The transition from reach SC04 to SC05 marks the river's transition from a classification of *aquatic life cold 1* to *aquatic life warm 2*. Classifications refer to the stream segment's *aquatic life use* and are designated by the Colorado Department of Public Health and Environment (CDPHE). Water temperature standards, designated by CDPHE, are as follows: Reaches SC01 through SC02 have a *cold stream tier I* (CS-I) standard; reaches SC03 and SC04 have a *cold stream tier II (CS-II)* standard; reach SC05 has a *warm stream tier II (WS-II)* standard (CDPHE, 2018b).

All five study reaches are located in alluvial fill bordered by the La Garita Range and the Cochetopa Hills (Figure 3.1). The upper reaches (SC01 and SC02) are partially confined by steep hillslopes of colluvium and bedrock. The lower reaches continue to flatten in slope and energy as the channel works its way past a few pinching points (SC03) before fanning out onto the broad Alamosa Basin (SC04 and SC05) taking a meander path controlled locally by vegetation and cohesive soils.

Figure 3.2 shows reach condition by assessment as well as the overall reach condition. Overall reach condition was calculated as the mean assessment rating for each reach.

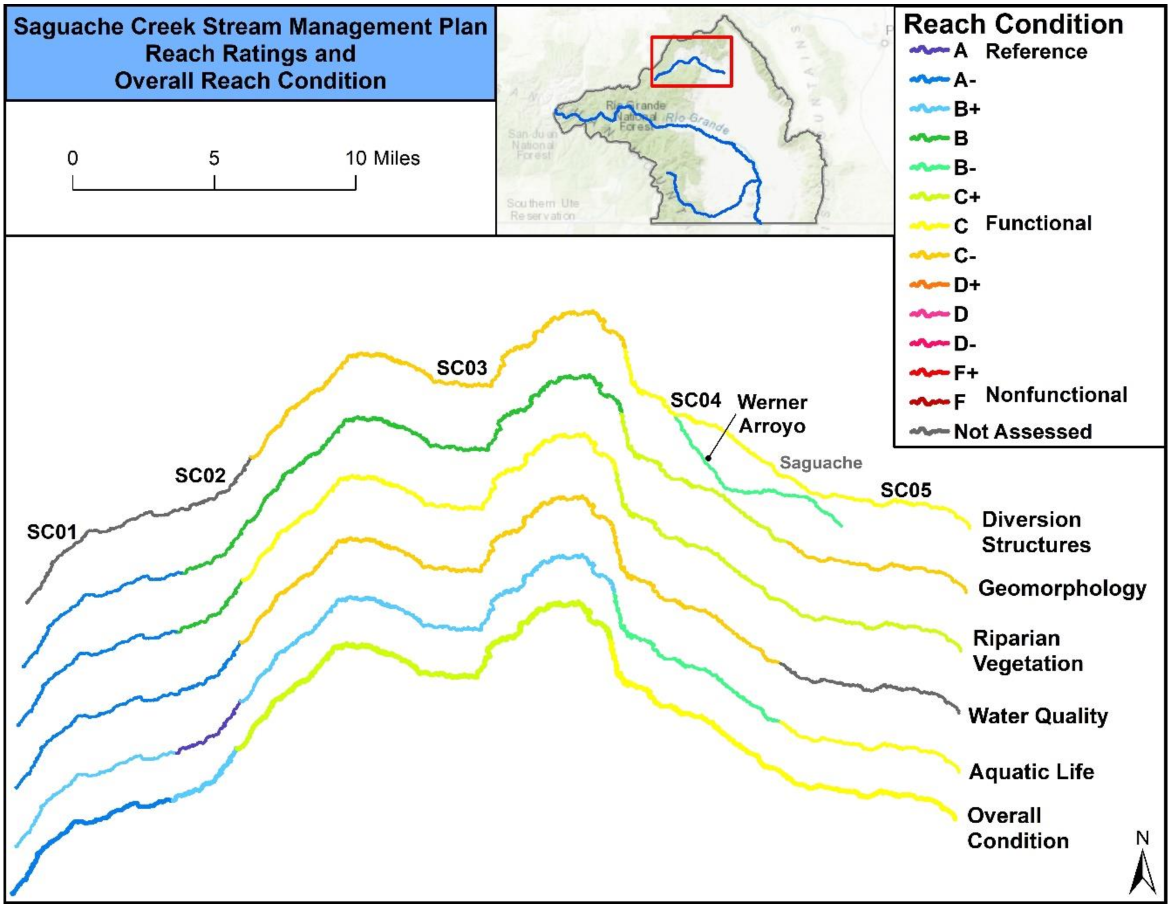


Figure 3.2: Saguache Creek Reach Ratings and Overall Reach Condition

3.1.1 Saguache Creek Diversion Infrastructure Inventory and Assessment

All diversion structures located on the mainstem Saguache Creek and Werner Arroyo were included in this assessment. Figure 3.3 shows lands irrigated by Saguache Creek surface water rights.

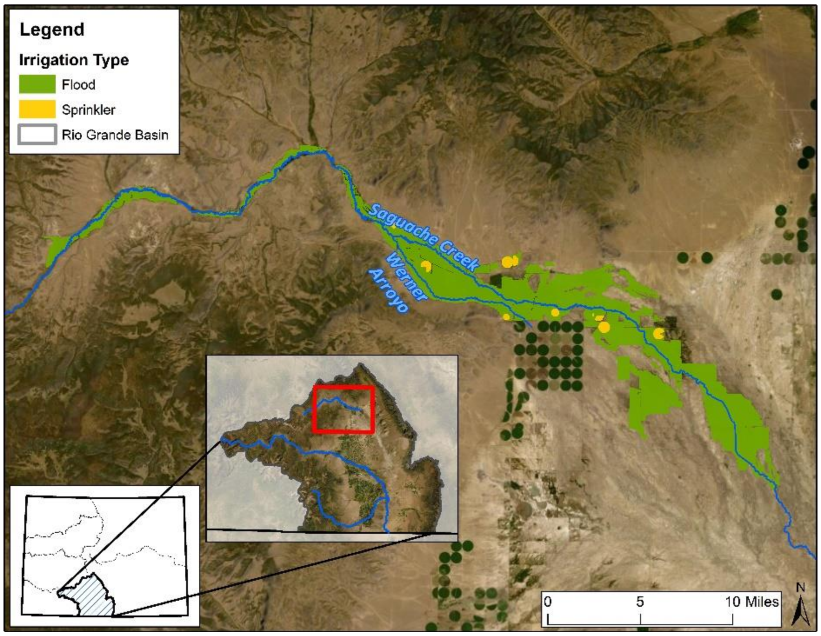


Figure 3.3: Lands irrigated partially or entirely by Saguache Creek surface water rights.

The diversion infrastructure inventory revealed several issues affecting the function of diversion infrastructure (e.g., headworks, diversion dams, measurement devices, and other diversion infrastructure) as well as adjacent riparian and stream conditions. Issues identified included aging and inefficient infrastructure requiring significant maintenance, bank and hillslope erosion resulting in increased sediment accumulation at diversions, headgates, and in ditch systems, sediment transport disruption at diversion dams, which exacerbates erosion, channel migration, and/or incision, and barriers to fish passage at some diversions. The Technical Advisory Team (TAT) recommends maintaining existing and creating new fish passage at diversions within the entire SMP study area to maintain and improve aquatic habitat connectivity. TAT recommendations for improving diversion infrastructure include: 1) Diversion dam improvements for enhanced sediment transport and/or fish passage, 2) Floodplain reconnection and channel stabilization through reshaping and riparian revegetation, and 3) Repair or replacement of structural components including headgates, headwalls, and measurement devices. Additionally, the TAT recommends consolidating the points of diversion for several structures to improve efficiencies and reduce maintenance and sediment transport impacts. Consolidation of the following structures is recommended: the Commodore Ditch and McCree Ditch, Friese Ditch 1 and Munro Ditch 2, Farrington Ditch 2 and Ward Highline Ditch, George Ball Ditch, Wall Ditch and Hearn Ditch, and Slane Scandrett Ditch and Jeep Scandrett Ditch. Consolidation of some structures may not be possible due to legal or water rights-related obstacles. Table 3.2 summarizes several attributes of each diversion structure, including its location and current condition. Each structure's annual irrigated acres and amount diverted are listed based on 2017 diversion records.

Table 3.2: Diversion infrastructure statistics and condition listed by structure.

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	Current Structure Rating	River Miles From Saguache Creek Terminus	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
SC03	Chase Peyton Ditch	1	7.9	2600517	C	74.3	276.18	1902.77	Flood	100/0	
SC03	Middle Ditch-Curtis	18	1.5	2600601	A-	72.5	69.92	159.67	Flood	100/0	
SC03	Hawkins Ditch	3	4	2600557	C	71.5	139.13	667.55	Flood	100/0	
SC03	Elwes Ditch 2	23	2	2600531	C	69.7	127.44	583.15	Flood	100/0	When in priority, the 1.4 cfs decreed to Elwes Ditch 1 (priority 92) is diverted via Elwes D 2.
SC03	Carruthers Ditch	23	3.2	2600514	B-	69.0	189.50	265.79	Flood	100/0	
SC03	Commodore Ditch	23	7.04	2600519	C	66.6	131.56	949.70	Flood	100/0	
SC03	McCree Ditch	13	3.8	2600590	B-	66.1	150.20	1856.16	Flood	100/0	
SC03	Monk Ditch 1	20	7.6	2600605	C	65.0	357.30	1098.07	Flood	100/0	
SC03	North Meadow No 779 Ditch	50	2	2600619	C-	64.6	48.42	606.95	Flood	100/0	
SC03	Monk Ditch 2	99	1.5	2600607	C-	62.0	97.83	136.86	Flood	100/0	
SC03	IL Gotthelf	22	1.2	2600569	C-	59.0	151.14	420.16	Flood	100/0	
SC03	Monk Ditch 3	94	2.5	2600606	C-	57.5	Included in WDID 569	109.49	Flood	100/0	Water right is often diverted via IL Gotthelf
SC03	Hodding Ditch 5	56	1.5	2600564	D	55.6	57.22	407.61	Flood	100/0	
SC03	Hodding Ditch 3	21	1	2600563	D	55.6	29.60	222.15	Flood	100/0	
SC03	Hougland Ditch	39	3.4	2600568	D	54.6	81.34	408.80	Flood	100/0	
SC03	Hougland Creek Ditch	28	1	2600789	C	54.6	5.00	73.59	Flood	100/0	
SC03	Friese Ditch 2	128	1	2600540	D-	53.2	59.95	115.04	Flood	100/0	

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	Current Structure Rating	River Miles From Saguache Creek Terminus	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
SC03	Friese Ditch 1	14	4	2600539	C-	53.1	157.19	608.06	Flood	100/0	
SC03	Munro Ditch 2	38	2.18	2600615	C-	52.9	133.03	383.45	Flood	100/0	
SC03	Munro Ditch 1	30	2.5	2600614	C	51.0	156.53	575.22	Flood	100/0	
SC03	Piquet Ditch 21	105	1	2600633	C-	49.7	N/A	0.00	Flood	100/0	
SC03	Farrington Ditch 1	81	1.4	2600533	C-	45.4	53.65	30.15	Flood	100/0	
SC03	Farrington Ditch 2	135	1	2600706	C	44.9	30.11	122.98	Flood	100/0	
SC03	Ward Highline Ditch	18	3.7	2600692	D	44.4	175.75	1218.98	Flood	100/0	
SC03	Ford Ditch	18	7	2600537	B-	43.4	234.40	4668.09	Flood	100/0	
SC03	Ward Highline Alternate Ditch	18 ap	1.25 ap	2601114	C	43.4	37.95	143.80	Flood	100/0	This structure is an alternate priority.
SC03	Ford Ditch 1 and 2	2	4.4	2600538	C-	43.4	263.44	681.73	Flood & Sprinkler	64/36	
SC04	Laughlin Ditch	77	2	2600583	B	39.4	52.61	273.72	Flood	100/0	
SC04	Irwin Ditch	51	9.6	2600570	C	38.6	177.71	126.94	Flood	100/0	
SC04	Morrison Ditch	26	2.5	2600609	D	38.4	146.45	1828.79	Flood	100/0	This structure serves as an alternate point of diversion for 2 cfs of the Fullerton Ditch 1's priority 11 water right.
SC04	Fullerton Ditch 1 AP	11 ap	3 ap	2600795	C	36.9	N/A	1213.90	N/A	N/A	This structure is an alternate priority.
SC04	Star Ditch	5	12.73	2600677	B	36.0	1427.30	4162.87	Flood & Sprinkler	93/7	
SC04	Big Meadow Ditch	5	5	2600505	B-	34.9	1448.00	1268.45	Flood	100/0	

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	Current Structure Rating	River Miles From Saguache Creek Terminus	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
SC04	Lawrence Ditch 3	7	7.6	2600584	B-	34.8	265.48	3331.29	Flood	100/0	
SC04	Reservoir Enlargement Ditch	7	16.64	2600653	C	33.6	273.60	3737.07	Flood & Sprinkler	38/62	
SC04	Stubbs Gallegos Ditch	12	5.8	2600680	B-	33.5	437.08	807.28	Flood	100/0	
SC04	Russell Ditch 4	8	4.6	2600658	B-	32.3	496.26	821.17	Flood	100/0	
SC04	Mill Ditch	34	1	2600603	C	32.0	34.14	105.13	Flood	100/0	
SC04	Florence Ditch	7A	2.79	2600535	C	30.8	194.39	475.74	Flood	100/0	
Werner Arroyo	Werner Arroya Ditch	N/A	18.6	2600693	A-	24.7	N/A	N/A	N/A	N/A	This structure delivers water to Werner Arroyo. The most senior priorities served by this structure are the Fullerton Ditch 1 and Moses Goff Ditch 1, both of which are priority 11.
Werner Arroyo	Fullerton Ditch 1	11	6.8	2600542	B	24.4	486.65	785.47	Flood	100/0	
Werner Arroyo	Fullerton Ditch 2	76	1.8	2600543	C	24.1	70.28	180.74	Flood	100/0	
Werner Arroyo	Fullerton Ditch 3	11 ap	2 ap	2600707	C-	24.0	140.16	229.09	Flood	100/0	This structure is an alternate priority.
Werner Arroyo	Moses Goff Ditch 1	11	4	2600610	B	23.7	195.50	891.29	Flood	100/0	
Werner Arroyo	Moses Goff Ditch 2	27	1.6	2600611	B-	23.1	62.87	82.91	Flood	100/0	
Werner Arroyo	Gotthelf Samora Ditch	36	1.5	2600550	B	18.3	N/A	449.26	N/A	N/A	
Werner Arroyo	Mountfield Ditch	19	2.9	2600613	B	16.8	149.17	491.11	Flood	100/0	
Werner Arroyo	Mountfield AP Ditch	19 ap	2.9 ap	2600825	B	16.8	N/A	0.00	Flood	100/0	This structure is an alternate priority.

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	Current Structure Rating	River Miles From Saguache Creek Terminus	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
SC05	Malone Sullivan Community Ditch	1	9.86	2600592	C	30.6	394.43	2343.91	Flood	100/0	This ditch services the Malone Sullivan Ditch 1 (ID 592, priority 1), Heimberger Ditch (ID 560, priority 2), Cato Ditch (ID 516, priority 2), Malone Sullivan Ditch 2 (ID 593, priority 6), and Luengen Sullivan Ditch (ID 589, priority 7).
SC05	Jaques Ditch	43	1.8	2600571	A-	N/A	80.24	500.75	Flood	100/0	
SC05	Van Allen Ditch & Downer Ditch 1	27	1.2	2600690	D	N/A	19.52	243.87	Flood	100/0	When in priority, the 2.8 cfs decreed to Downer Ditch 1 (priority 53) is diverted via Van Allen Ditch. Acreage and amt diverted include both structures.
SC05	Malone Ditch	4	2.15	2600591	B-	30.1	179.40	438.83	Flood	100/0	
SC05	Woodard Bros Ditch	13	7.1	2600697	D	29.9	367.35	946.13	Flood	100/0	
SC05	Mears Ditch 3	76	1	2600600	C+	29.1	N/A	172.56	Flood	100/0	
SC05	Ashley Proffit Ditch	9	9	2600501	B-	28.4	467.37	3067.64	Flood	100/0	
SC05	Proffit Company Ditch	10	3.6	2600648	B	27.8	202.17	978.96	Flood	100/0	
SC05	Proffit McDonough Ditch	24	2.2	2600649	B-	27.2	108.14	978.88	Flood & Sprinkler	45/55	
SC05	Quartet Ditch	17A	8.28	2600650	B-	26.2	1100.21	5344.60	Flood	100/0	
SC05	George Ball Ditch	36	18	2600545	D	26.1	1473.62	1233.48	Flood	100/0	
SC05	Wall Ditch	23	6.9	2600691	C-	26.0	415.45	1644.38	Flood & Sprinkler	70/30	

SMP Assessment Reach	Structure Name	Priority	Total Decreed Rate (cfs)	Water District ID (WDID)	Current Structure Rating	River Miles From Saguache Creek Terminus	Acres Irrigated (acres)	Amount Diverted (acre-feet)	Flood, Sprinkler, Both	% Flood/ % Sprinkler	Notes
SC05	**Luengen Ditch**	**91**	**9.6**	**2600588**	**N/A**	**26.0**	**Included in WDID 691**	**Included in WDID 691**	**Flood**	**100/0**	Acreage and amt diverted included in George Ball Ditch, the structure diverting this water when in priority.
SC05	**Hearn Ditch**	**14**	**5.2**	**2600559**	**B**	**25.9**	**381.45**	**2036.24**	**Flood & Sprinkler**	**66/34**	
SC05	**Slane Scandrett Ditch**	**25**	**4.4**	**2600675**	**B-**	**25.2**	**155.28**	**2200.10**	**Flood**	**100/0**	
SC05	**Jeep Scandrett Ditch**	**25**	**3.6**	**2600574**	**B-**	**24.4**	**309.73**	**808.73**	**Flood**	**100/0**	
SC05	**Seitz McClure Ashley Ditch**	**35**	**5**	**2600667**	**B-**	**22.6**	**63.42**	**285.62**	**Flood**	**100/0**	
SC05	**Taylor A Ashley Ditch**	**25**	**2**	**2600682**	**B-**	**22.6**	**159.40**	**83.31**	**Flood**	**100/0**	
SC05	**Braun Bros Ditch 1**	**19**	**3**	**2600506**	**C**	**21.3**	**344.94**	**1736.65**	**Flood**	**100/0**	
SC05	**Nehls Company Ditch**	**32**	**9.12**	**2600616**	**C**	**21.2**	**205.79**	**147.18**	**Flood & Sprinkler**	**48/52**	When in priority, the 1.8 cfs decreed to the Dick Gow Ditch (priority 55) is diverted via Nehls Co Ditch.

*Note: River miles for structures located on Werner Arroyo are from the terminus of Werner Arroyo. Acres irrigated, amount diverted, and percent flood/sprinkler are based on 2017 records. Amounts are rounded to the nearest tenth.

3.1.2 Saguache Creek Aquatic Habitat Assessment Summary

***For a description of R2Cross methodology and caveats, refer to section 2.6**

Six R2Cross sites were completed between Hwy 114 and Braun Bridge. Table 3.3 shows the hydrology nodes used in the aquatic flow needs assessment, summer/winter flow targets, and corresponding instream flow water rights for each reach.

Table 3.3: Hydrology nodes, summer and winter flow targets, and corresponding instream flows by reach.

SMP Reach(es)	Gage/Location Name	Gaged/ Ungaged	Summer Flow Target (cfs)	Winter Flow Target (cfs)	Latitude	Longitude	Corresponding Instream Flow Case No. and Flow Rates (summer/winter) in cfs
SC03	Saguache Creek Near Saguache (SAGSAGCO)	Gaged	24.4	12	38.16344	-106.29066	3-82CW208 (8/5)
SC04	Saguache Creek at County Road 46	Ungaged	7	2	38.07876	-106.16057	N/A
SC05	Saguache Creek at Braun Bridge	Ungaged	12	5	38.05431	-106.04456	N/A

The summer minimum flow (three of three Habitat Criteria met) referenced at the Saguache gage is 24 cfs. The winter minimum is 12 cfs. For the purposes of the SMP, it is assumed that if the recommended minimum instream flow is delivered at the Saguache gage (24 cfs summer and 12 cfs winter), then habitat values for trout would be protected elsewhere on the stream.

Although there are no reservoirs to aid in Saguache Creek flow management, minimum recommended flows should be met, if possible. The life history of brown trout, which are the dominant resident salmonid, is not known for Saguache Creek. It is assumed to be similar to the Rio Grande as follows: Adult Spawning 10/15-11/15; Egg Incubation 10/15-5/1; Egg Hatching 4/1-6/1; Fry Emergence 5/15-6/15 (Nehring & Anderson, 1993). This life history information is important when considering the recommendations below:

- Maintain a minimum 12 cfs winter flow (October through April) measured at the Saguache gage for brown trout spawning, egg incubation, and hatching. Try to avoid unnatural changes in flow particularly during spawning, egg incubation, hatching, and fry emergence.
- Maintain a minimum of 24 cfs summer flow (May through September) measured at the Saguache gage to protect further hatching and fry emergence.

Maintaining the above flow recommendations will also help protect an aboriginal population of Rio Grande chub (a Tier 1 Species of Concern in Colorado) above the Star Ditch diversion. Note: An adjudicated minimum instream flow exists above Sheep Creek (14 cfs May 1 to September 30 and 8 cfs October 1 to April 30) and from Sheep Creek to Star Ditch 5 cfs year-round). These minimum flow water rights are less than but similar to the recent R2Cross recommendations. At a minimum, it is recommended that the adjudicated water rights be upheld.

3.1.3 Saguache Creek Riparian Vegetation Summary

There were a total of five AAs along Saguache Creek, which all occurred within Saguache County (Figure 3.4). The highest elevation site was SCVeg01 at 2,845 meters (9,333 ft), while the lowest elevation site was SCVeg05 at 2,363 meters (7,752 ft). Only SCVeg01 was located on federally managed land (U.S. Forest Service), while SCVeg02, SCVeg03, SCVeg04, and SCVeg05 were located on private properties.

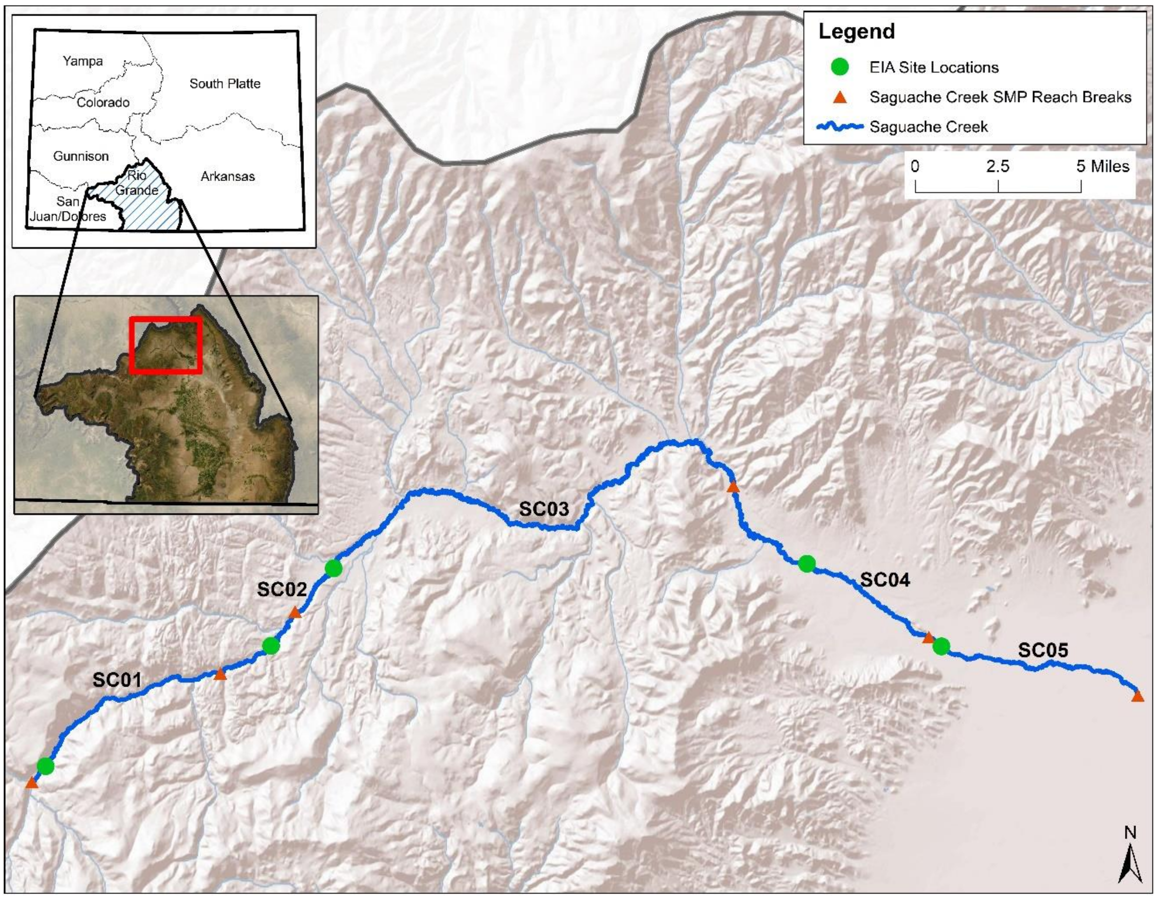


Figure 3.4: Saguache Creek SMP EIA AA locations

Saguache SCVeg01 received an A rating for its overall Ecological Integrity Assessment score. This rating implies an ecological integrity that reflects little human impact and ecological functioning within the bounds of natural disturbance regimes. Management for this site should focus on maintenance of current conditions. SCVeg02, SCVeg04, and SCVeg05 received an overall rating of B for their Ecological Integrity Assessment score, which suggests that these riparian areas have a slight deviation from reference conditions and they predominantly function within the bounds of natural disturbance regimes. According to Lemly et al. (2016), management should focus on preventing further alteration (Table 2.8). SCVeg03 received the lowest score of C+ (Tables 3.4 and 3.5). Recommendations for sites with this score are to focus management on the most impacted ecological attributes, which can be identified by the individual metric ratings.

Table 3.4: Overall scores for all Saguache Creek AAs

Assessment Area	Calc Points	Calc Rating
SCVeg01	3.66	A-
SCVeg02	3.34	B+
SCVeg03	2.28	C+
SCVeg04	2.76	B-
SCVeg05	2.76	B-

Table 3.5: EIA – Individual metric scores for all Saguache Creek AAs

	SC01	SC02	SC03	SC04	SC05
Overall Ecological Integrity Points	3.66	3.34	2.28	2.76	2.76
Overall Ecological Integrity Rank	A-	B+	C+	B-	B-
LANDSCAPE METRICS					
L1. Contiguous Natural Land Cover	A	B	C	C	C
L2. Land Use Index	B	B	C	C	C
BUFFER METRICS					
B1. Perimeter with Natural Buffer	A	A	A	A	A
B2. Width of Natural Buffer	A	B	B	B	A
B3.1. Condition of Natural Buffer - Veg	B	C	B	A	C
B3.2. Condition of Natural Buffer - Soils	A	A	C	B	B
VEGETATION METRICS					
V1. Native Plant Species Cover	B	C-	C-	B	C-
V2. Invasive Nonnative Plant Species Cover	A	A	C	B	B
V3. Native Plant Species Composition	B	B	B	C	B
V4. Vegetation Structure	A	A	C	C	C
V5. Regen. of Native Woody Species **(opt.)**	A	A	N/A	B	A
V65. Coarse and Fine Woody Debris **(opt.)**	A	A	N/A	B	B

A total of 104 plant taxa were encountered, including 98 unique species. The total number of plant taxa encountered at an individual AA ranged from 19 to 46, with an average of 34 plant taxa per site. SCVeg03 had the highest diversity with 46 taxa, while SCVeg04 had the lowest diversity with 19 total taxa encountered (Table 3.6). There was a weak trend observed in species diversity and elevation along Saguache sample sites.

Table 3.6: Total taxa encountered by AA

Assessment Area	# Taxa Observed
SCVeg01	36
SCVeg02	46
SCVeg03	42
SCVeg04	19
SCVeg05	26
Average	**34**

Average relative cover of native species ranged from 72% at Site 2 to 99% at SCVeg01. Noxious species were present at SCVeg03 (6.4% average cover), SCVeg04 (1.3% average cover), and SCVeg05 (1.1%

average cover). Average mean C-values for native species ranged from 4.4 (SCVeg04) to 6.1 (SCVeg01). Average cover weighted mean C-values for native species ranged from 3.8 (SCVeg04) to 5.4 (SCVeg01) (Table 3.7).

Table 3.7: Floristic Quality Assessment (FQA) indices by AA

FQA Indices	SCVeg01	SCVeg02	SCVeg03	SCVeg04	SCVeg05
Mean C-Value (All species)	5.8	4.4	4.0	2.7	3.4
Mean C-Value (Native species)	6.1	5.0	4.9	4.4	4.6
Cover-weighted Mean C-Value (All species)	5.3	3.7	3.7	1.8	3.7
Cover-weighted Mean C-Value (Native species)	5.4	5.1	4.9	3.8	4.5
FQI (All species)	26.2	19.9	14.6	8.7	12.0
FQI (Native species)	26.8	21.3	16.1	10.8	13.8
Cover Weighted FQI (All species)	24.0	16.6	13.0	6.1	13.0
Cover Weighted FQI (Native species)	23.6	21.8	16.1	9.0	13.3
Adjusted FQI	59.8	46.9	44.5	34.2	39.5
Adjusted Cover Weighted FQI	52.5	47.8	44.3	28.9	38.2

The highest elevation sites (SCVeg01, SCVeg02, and SCVeg03) were identified as Rocky Mountain Subalpine-Montane Riparian Shrubland. SCVeg04 and SCVeg05 were identified as Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland. The following Physiognomic Groups represented all sites surveyed along Saguache Creek: Tall Willow Shrubland (60% of plots), Herbaceous Vegetation (30% of plots), and Non-Willow Shrubland (10% of plots).

Reach-level RCA scores derived from the GIS remote sensing vegetation assessment closely matched and helped validate overall EIA scores. In general, RCA scores were very similar to site-level EIA scores through the SMP study area. For more detailed findings from the GIS assessment, see **Appendix E**.

3.1.4 Saguache Creek Water Quality Summary

Water quality impairments were noted within the SMP study area, however water quality is excellent in the upstream reaches. Several tributaries to the mainstem are designated as “outstanding waters” (CDPHE, 2018c). Temperature was the most significant and persistent impairment identified (CDPHE, 2018d). Arsenic exceeds the chronic water quality standard of 0.02 μg/L in reaches SC01 through SC03. The arsenic exceedance is similar to other headwaters streams in the Rio Grande Basin in that the source is thought to be natural geology. Further, elevated arsenic does not appear to adversely affect aquatic life and is therefore not considered to be a significant stressor. In addition to arsenic, reach SC03 is on the 303(d) list for total iron and the M&E list for total phosphorus. SC03 is also on the M&E list for water temperature with many Daily Maximum (DM) Maximum Weekly Average Temperature (MWAT) exceedances. Although water temperature data is not available downstream of SC03, reaches SC04 and SC05 are assumed to experience temperature exceedances as well. Dissolved cadmium and total iron exceed acute state standards for aquatic life in SC04. SC03 has previously but is not currently on the 303(d) list for sediment.

3.1.5 Saguache Creek Aquatic Life Summary

Overall, the stream supports healthy aquatic life. Aquatic macroinvertebrates sampled within the SMP study reaches all received attaining MMI scores and data revealed largely healthy communities. Many macroinvertebrate samples had diverse species assemblages including sensitive taxa. The sample collected in reach SC05 showed an elevated number of pollution tolerant taxa, however the overall MMI score was still in attainment. Although fish data was not used in the Saguache Creek aquatic life assessment ratings, it should be noted that native cold- and warm-water fish populations are known to have declined within the SMP study area.

From the South Fork confluence to Ford Creek, (SMP reaches SC01 – SC03), the river is a cold-water stream inhabited by trout, suckers and dace. Native Rio Grande cutthroat trout have been replaced in the mainstem by nonnative trout but are still present in some tributaries. Native Rio Grande sucker has been extirpated, in part due to competition with nonnative white sucker. Downstream of Ford Creek, (SC04 – SC05), the river transitions to a warm-water stream inhabited by longnose dace, fathead minnow, white sucker, and Rio Grande chub. Research conducted by Bestgen et al. (2003) found a noteworthy relationship between the brown trout and Rio Grande chub abundance in the Creek. An inverse correlation exists between brown trout and chub abundance: brown trout are more abundant in upper Saguache Creek while Rio Grande chub are significantly more abundant in lower portions of the Creek. That is, with greater brown trout abundance, there are fewer chub. Additionally, it is worth noting that CPW will be stocking Saguache Creek with Rio Grande sucker beginning in summer 2020. Stocking will likely take place within reach SC04 where this species as well as chub are likely to thrive. Current basin-wide distributions of native sucker, chub, and cutthroat trout are described in more detail below.

Native Species Distribution

In general, the distribution and abundance of native fish species has declined significantly, with most species retreating from their historic ranges into more isolated and small populations. Species of particular interest within the SMP study area include Rio Grande sucker, chub, and cutthroat trout. The current basin-wide distribution of these species is described below.

The Rio Grande sucker is a small herbivorous fish considered State Endangered in Colorado. The sucker is endemic to the Rio Grande watershed in Colorado and New Mexico. In Colorado, it was historically found in the Rio Grande, Conejos River, Hot Creek, and at McIntire Springs. It now only exists in a few small populations, including where it has been reintroduced to lower-elevation streams on the Rio

Grande National Forest. Rio Grande sucker have been stocked in tributaries to the Conejos River as well as the mainstem of Saguache Creek near the Town of Saguache.

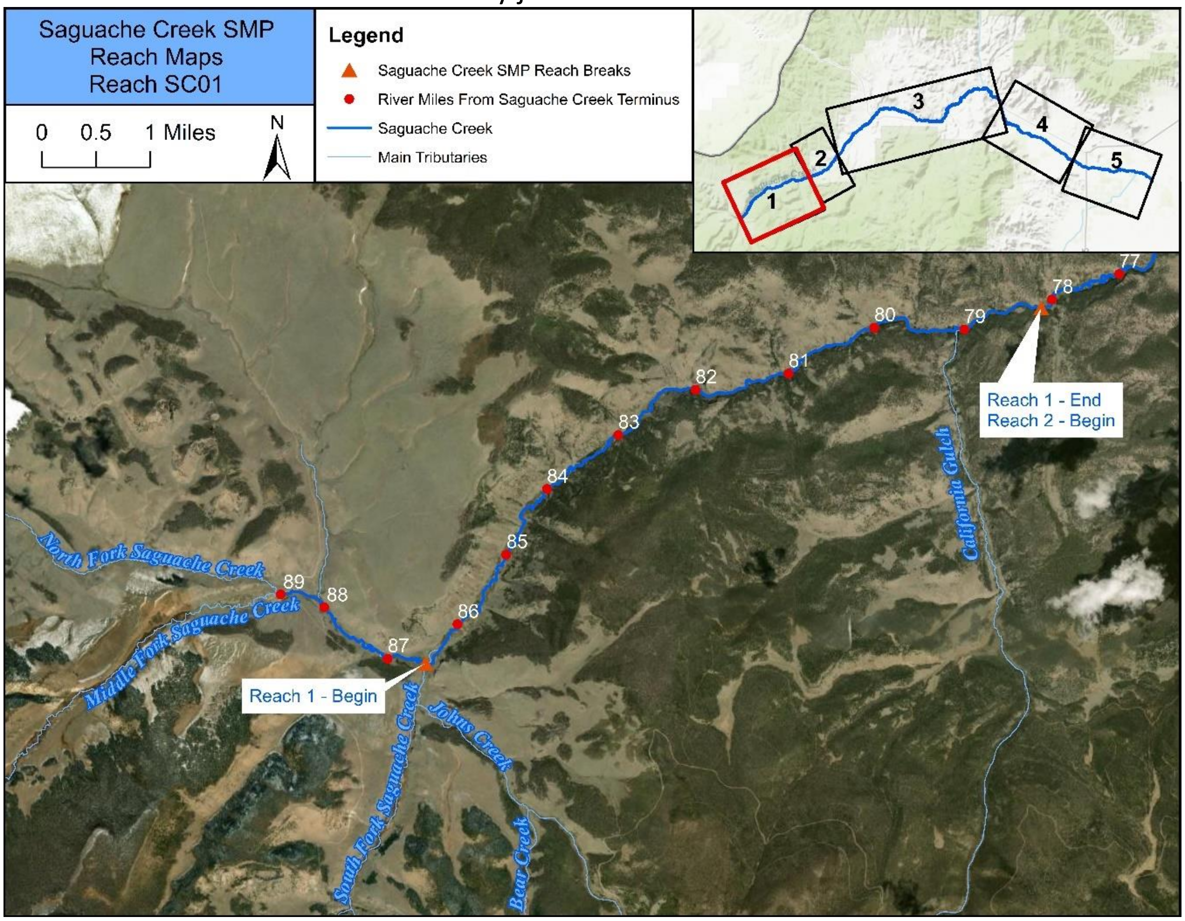
The Rio Grande chub, a Tier 1 Species of Concern in Colorado, is a small insectivore species endemic to the Rio Grande Basin in Colorado and New Mexico, including the SLV Closed Basin. Historically, the species is known to have been present in the Rio Grande, Conejos River, Saguache Creek, and San Luis Creek. Currently, three known aboriginal populations exist – in Baca National Wildlife Refuge, Hot Creek State Wildlife Area, and the Rio Grande between the Rio Grande Canal and the Prairie Ditch diversion. A 2003 study showed Rio Grande chub to be declining and limited to select streams in the Rio Grande Basin (Bestgen et al., 2003). The only large and relatively stable populations at that time were in Hot Creek and Saguache Creek. More recent surveys, however, revealed that a small population of Rio Grande chub are present in the mainstem of the Rio Grande (CPW, 2018). CPW also stocks chub in the mainstem Rio Grande downstream of Monte Vista.

The Rio Grande cutthroat trout is a native salmonid species listed as a Tier 1 Species of Concern in Colorado. Numerous populations exist in the Rio Grande Basin, mostly in lower order, high elevation streams on the Rio Grande National Forest. The historic range of Rio Grande cutthroat trout (RGCT) has dramatically decreased (RGCT, 2013). Significant efforts are underway to maintain and enhance RGCT populations. The Rio Grande Cutthroat Conservation Team, made up of regional aquatic ecologists from state and federal agencies, has conducted and supported population surveys, genetic analyses, fish stocking efforts, and habitat improvements to promote the long-term protection of RGCT. Similar efforts are focused on Rio Grande chub and sucker conservation.

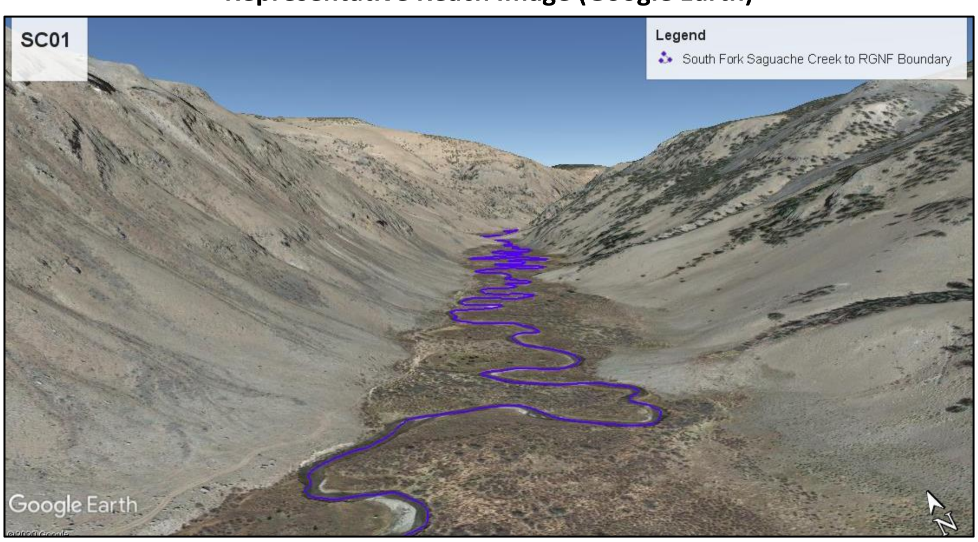
3.2 Conditions Assessment Results by Reach

3.2.1 SC01 – South Fork Saguache Creek Confluence to Rio Grande National Forest Boundary

From the confluence of the South Fork and the Middle Fork Saguache Creek downstream to the eastern Rio Grande National Forest boundary just downstream of California Gulch.



Representative Reach Image (Google Earth)



SC01 Conditions Assessment Overview

Reach: SC01		Major Stream Condition Stressors												
Parameter	**Condition Rating**	**Crossings and diversions**	**Roads and railways**	**Floodplain disconnection**	**Channelization and armoring**	**Fill and floodplain conversion**	**Flow alteration: impoundments**	**Flow alteration: diversions**	**Abandoned mine lands**	**Exotic/naturalized plant species**	**Exotic aquatic species**	**Lack of woody material**	**Hillslope/channel erosion**	**Unknown source**
Geomorphology	A-												X	
Riparian Vegetation	A-													
Water Quality	A-													X
Aquatic Life	B+													
Diversion Structures	N/A													

A	B	C	D	F	Not Assessed

*For an explanation of methodology used to determine reach ratings, see section 2.

SC01 Geomorphology

Reach	Location Description							
SC01	South Fork Saguache Creek Confluence to Rio Grande National Forest Boundary							
Confine-ment	D50	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Partially confined	N/A	N/A	Riffle-pool	Beaver meadow complex	I	0	Coarse Equilibrium & Fine Deposition	Coarse Equilibrium & Fine Deposition
Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate		Overbank Flow Frequency		
1.37%	↔	No Data	No Data	No Data		No Data		
Watershed setting		River Style	Characteristics				Representative Photo	
Response		Meandering planform-controlled discontinuous floodplain	Active channel abuts confining margins for a minority of linear valley distance but is not fully confined. Floodplain and instream geomorphic features characteristic of meandering and lateral migration including multiple bar forms, especially point bars, cutoffs, and cutbanks.					

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
This reach sits in a partially-confined alluvial valley bounded by hills of volcanic origin. Hillslope processes deliver sediment and debris to the valley floor but fans are unlikely to block the corridor. Lateral migration appears to be the dominant process. Primary sediment source is material eroded from the channel banks and floodplain; given the slope and stream power of the modern Saguache Creek, only small a suspended load and bedload is expected from upstream reaches. The channel is generally a SEM stage 1 Creek (a departure from pre-settlement stage 0). The Creek is moderately sinuous through this reach and expected to be dynamic with lateral and down valley movement of meanders as well as activated cut-offs and secondary channels during high water. That said, the system should exhibit an overall meta-stability, meaning that the processes and stressors that drive the Creek's dynamism are in a state of relative equilibrium, under the existing conditions of water and sediment delivery from the watershed (Note: changes in these inputs could lead to instability). The sensitivity of the Creek is moderate but could trend toward high on a local scale in reaches that are straightened, armored, or impacted by infrastructure (e.g., fill, levees, undersized crossings, diversions, etc.).

Stressors	Degree of Geomorphic Impairment
Reach sits in an undeveloped, roadless valley surrounded by USFS land. Stressors are minimal with the exception that the area is likely seasonally grazed. Beavers are not known to be present in abundance but would likely have been historically.	A-

SC01 Riparian Vegetation

This site appears to be in very good condition with an overall EIA rating of A- (3.66). There were no individual metric ratings scoring lower than a B (Table 3.7).

Table 3.7: EIA Scorecard – SCVeg01

SCVeg01 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				3.66	A-
Rank Factor: LANDSCAPE CONTEXT	0.30			3.66	A-
LANDSCAPE METRICS	0.33			3.50	A-
L1. Contiguous Natural Land Cover	1	A	4		
L2. Land Use Index	1	B	3		
BUFFER METRICS	0.67			3.74	A-
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	A	4		
B3.1. Condition of Natural Buffer - Veg	n/a	B	3		
B3.2. Condition of Natural Buffer - Soils	n/a	A	4		
Rank Factor: CONDITION	0.70			3.67	A-
VEGETATION METRICS	1			3.67	A-
V1. Native Plant Species Cover	1	B	3		
V2. Invasive Nonnative Plant Species Cover	1	A	4		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	A	4		
V5. Regen. of Native Woody Species **(opt.)**	1	A	4		
V65. Coarse and Fine Woody Debris **(opt.)**	1	A	4		

The average relative cover of native plants was 99%. The nonnative species encountered generally had minimal absolute cover across all plots. No noxious species were observed within the AA. Regarding Native Plant Species Composition, the average mean C-value for native species at this site was 6.1, and the average cover-weighted mean C-value for native species was 5.4 (Table 3.7). The majority of native species encountered are equally found in natural and non-natural areas. Current land uses observed and approximate cover within the 500 meter buffer include light grazing (80%) and light recreation (20%). Both livestock and elk scat were observed at the site in addition to wild ungulate bedding sites.

Results from the reach-scale RCA assessment indicated heathy riparian areas with a B+ rating. Stressors are mild except for mild grazing impacts. The average of the EIA and RCA ratings is A-.

SC01 Water Quality and Aquatic Life

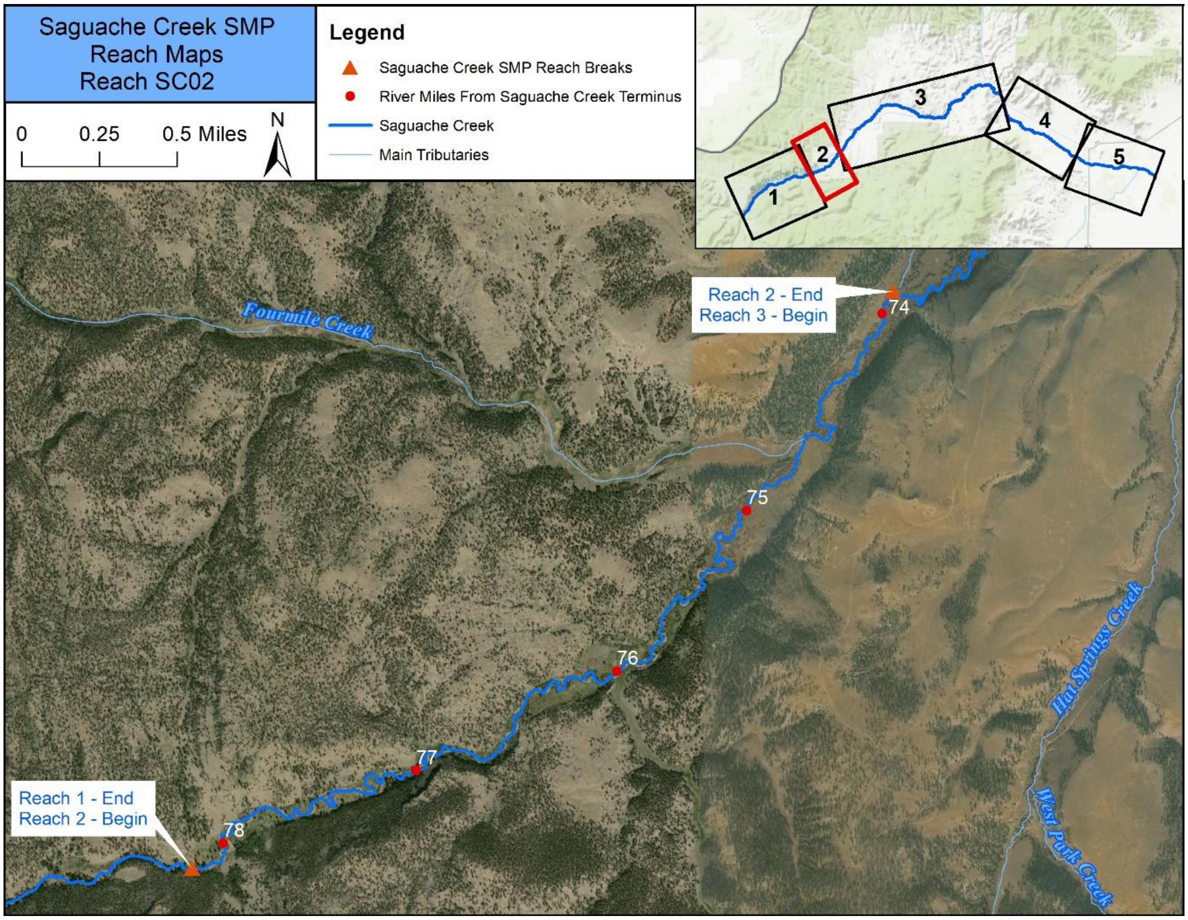
Water Quality		
Temperature	Chemical Conditions	Nutrients
N/A	B	A
Overall Rating		**A-**

Aquatic Life	
Average MMI Score	Overall MMI Rating
76.5	B+
Overall Rating	**B+**

Water quality data in this reach is very good. Nutrients and temperature parameters meet water quality standards. Total arsenic concentrations exceed standards, however, similar to other headwaters streams in the Rio Grande Basin, the source of the arsenic is thought to be natural geology. Further, elevated arsenic does not appear to adversely affect aquatic life and is therefore not considered to be a significant stressor. This reach supports a healthy benthic macroinvertebrate community with an average MMI score of 76.5. Although trout biomass data is not included, this reach is known to supports a healthy trout fishery, with brown trout being particularly abundant.

3.2.2 SC02 – Rio Grande National Forest Boundary to Chase Peyton Ditch

From the eastern boundary of the Rio Grande National Forest, just downstream of California Gulch, to the Chase Peyton Ditch diversion. Fourmile Creek joins the Creek near the lower end of the reach.



Representative Reach Photo

SC02 Conditions Assessment Overview

Reach: SC02		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	B												X	
Riparian Vegetation	B													
Water Quality	A-													X
Aquatic Life	A													
Diversion Structures	N/A													

A	B	C	D	F	Not Assessed

*For an explanation of methodology used to determine reach ratings, see section 2.

SC02 Geomorphology

Reach	Location Description
SC02	Rio Grande National Forest Boundary to Chase Peyton Ditch

Confine-ment	D50* (mm)	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Partially confined	No Data	No Data	Riffle-pool	Beaver meadow complex	I	0	Coarse Equilibrium & Fine Deposition	Coarse Equilibrium & Fine Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.8%	↓	No Data	No Data	No Data	No Data

Watershed setting	River Style	Characteristics	Representative Photo
Response	Meandering planform-controlled discontinuous floodplain	Active channel abuts confining margins for a minority of linear valley distance but is not fully confined. Floodplain and instream geomorphic features characteristic of meandering and lateral migration including multiple bar forms, especially point bars, cutoffs, and cutbanks.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
Reach sits in a partially-confined alluvial valley bounded by hills of volcanic origin. Hillslope processes deliver sediment and debris to the valley floor but fans are unlikely to block the corridor. Lateral migration appears to be the dominant process. Primary sediment source is material eroded from the channel banks and floodplain; given the slope and stream power of the modern Saguache Creek, only small a suspended load and bedload is expected from upstream reaches. The channel is generally a SEM stage 1 Creek (a departure from pre-settlement stage 0). The Creek is moderately sinuous through this reach and expected to be dynamic with lateral and down valley movement of meanders as well as activated cut-offs and secondary channels during high water. That said, the system should exhibit an overall meta-stability, meaning that the processes and stressors that drive the Creek's dynamism are in a state of relative equilibrium, under the existing conditions of water and sediment delivery from the watershed (Note: changes in these inputs could lead to instability). The sensitivity of the Creek is moderate but could trend toward high on a local scale in reaches that are straightened, armored, or impacted by infrastructure (e.g., fill, levees, undersized crossings, diversions, etc.).

Stressors	Degree of Geomorphic Impairment
Reach sits in an undeveloped, roadless valley bordered by USFS land at its upstream end. Stressors are minimal with the exception that the area is likely seasonally grazed. Beavers are not known to be present in abundance but would likely have been historically.	B Land use alterations, biotically impaired (riparian and beavers)

SC02 Riparian Vegetation

Overall this site appears to be in very good condition with an overall EIA rating of B+ (3.34). The only individual metric rating scoring lower than a B were for Condition of Natural Buffer – Vegetation (C), and Native Plant Species Cover (C-) (Table 3.8).

Table 3.8: EIA Scorecard – SCVeg02

SCVeg02 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**3.34**	**B+**
Rank Factor: LANDSCAPE CONTEXT	0.30			**3.15**	**B+**
LANDSCAPE METRICS	0.33			**3.00**	**B+**
L1. Contiguous Natural Land Cover	1	B	3		
L2. Land Use Index	1	B	3		
BUFFER METRICS	0.67			**3.22**	**B+**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	B	3		
B3.1. Condition of Natural Buffer - Veg	n/a	C	2		
B3.2. Condition of Natural Buffer - Soils	n/a	A	4		
Rank Factor: CONDITION	0.70			**3.42**	**B+**
VEGETATION METRICS	1			**3.42**	**B+**
V1. Native Plant Species Cover	1	C-	1.5		
V2. Invasive Nonnative Plant Species Cover	1	A	4		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	A	4		
V5. Regen. of Native Woody Species **(opt.)**	1	A	4		
V65. Coarse and Fine Woody Debris **(opt.)**	1	A	4		

The average relative cover of native plants was 72%. The nonnative species with the highest absolute cover include the following species with cover values for plots 1, 2, 3, and 4, respectively: *Poa pratensis* (37.5%, 37.5%, 62.5%, and 17.5%), and *Phleum pratense* (7.5%, 7.5%, 0%, and 0%). The other nonnative species encountered had significantly lower absolute cover across all plots. No noxious species were observed.

The average mean C-value for native species was 5.0, while the average cover-weighted mean C-value was only 5.1 (Table 3.7). This suggests that most native species at this site are equally likely to be found in natural and non-natural areas. However, they are not typical of high disturbance areas.

Current land uses observed and approximate cover within the 500 meter buffer include management for natural vegetation (50%), light grazing (39%), moderate grazing (10%), and unpaved roads (1%). This site is inaccessible to the general public for recreation and there are few signs of human use. According to the landowner, grazing occurs here infrequently and in moderation (Pers. Comm., landowner). The landowner also noted that wild ungulates such as moose, elk, deer, and antelope are commonly encountered within the AA.

Results from the reach-scale RCA assessment indicated mostly heathy riparian areas with a B rating. Stressors are mild, with some floodplain conversion for grazing and competition from nonnative plant species. The average of the EIA and RCA ratings is B.

SC02 Water Quality and Aquatic Life

Water Quality		
Temperature	Chemical Conditions	Nutrients
N/A	B	A
Overall Rating		**A-**

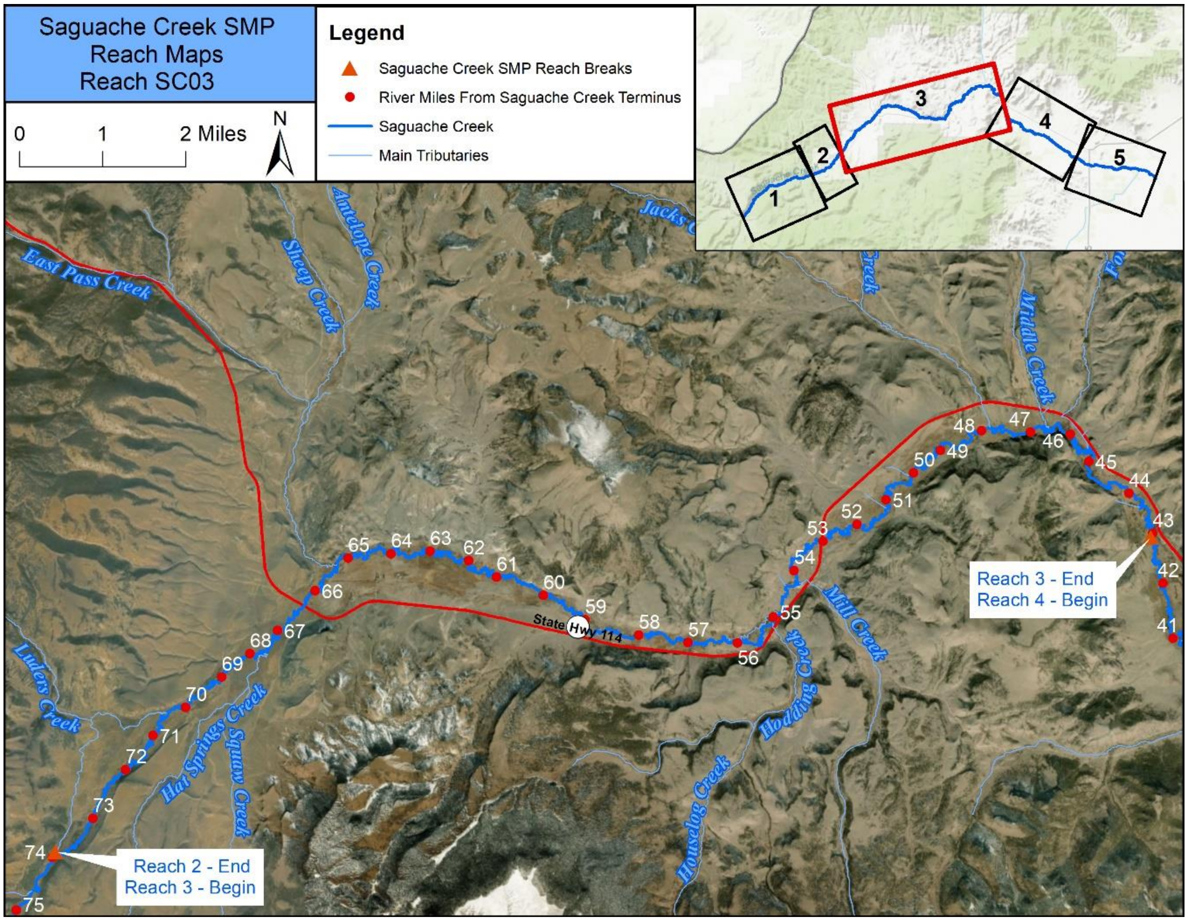
Aquatic Life	
Average MMI Score	Overall MMI Rating
89	A
Overall Rating	**A**

Water quality data in this reach is very good. Nutrients and temperature parameters meet water quality standards. Total arsenic concentrations exceed standards, however, similar to other headwaters streams in the Rio Grande Basin, the source of the arsenic is thought to be natural geology. Further, elevated arsenic does not appear to adversely affect aquatic life and is therefore not considered to be a significant stressor.

This reach supports a near-reference condition BMI community with an average MMI score of 89. This portion of Saguache Creek also supports a healthy trout fishery, with brown trout being particularly abundant.

3.2.3 SC03 – Chase Peyton Ditch to Ford Ditch

From the Chase Peyton Ditch diversion downstream to where an unnamed driveway from Highway 114 crosses the Creek, just downstream of the diversion for Ford Ditch.



Representative Reach Photo

SC03 Conditions Assessment Overview

Reach: SC03		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	B	X				X		X				X	X	
Riparian Vegetation	C		X	X		X				X				
Water Quality	C-				X	X		X					X	X
Aquatic Life	B+	X						X					X	
Diversion Structures	C-													

A	B	C	D	F	Not Assessed

*For an explanation of methodology used to determine reach ratings, see section 2.

SC03 Geomorphology

Reach	Location Description
SC03	Chase Peyton Ditch to Ford Ditch

Confine-ment	D50 (mm)	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Uncon-fined	36	Coarse Gravel	Riffle-pool	Beaver meadow complex	I	0	Coarse Equilibrium & Fine Deposition	Coarse Equilibrium & Fine Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.8%	↓	No Data	No Data	No Data	No Data

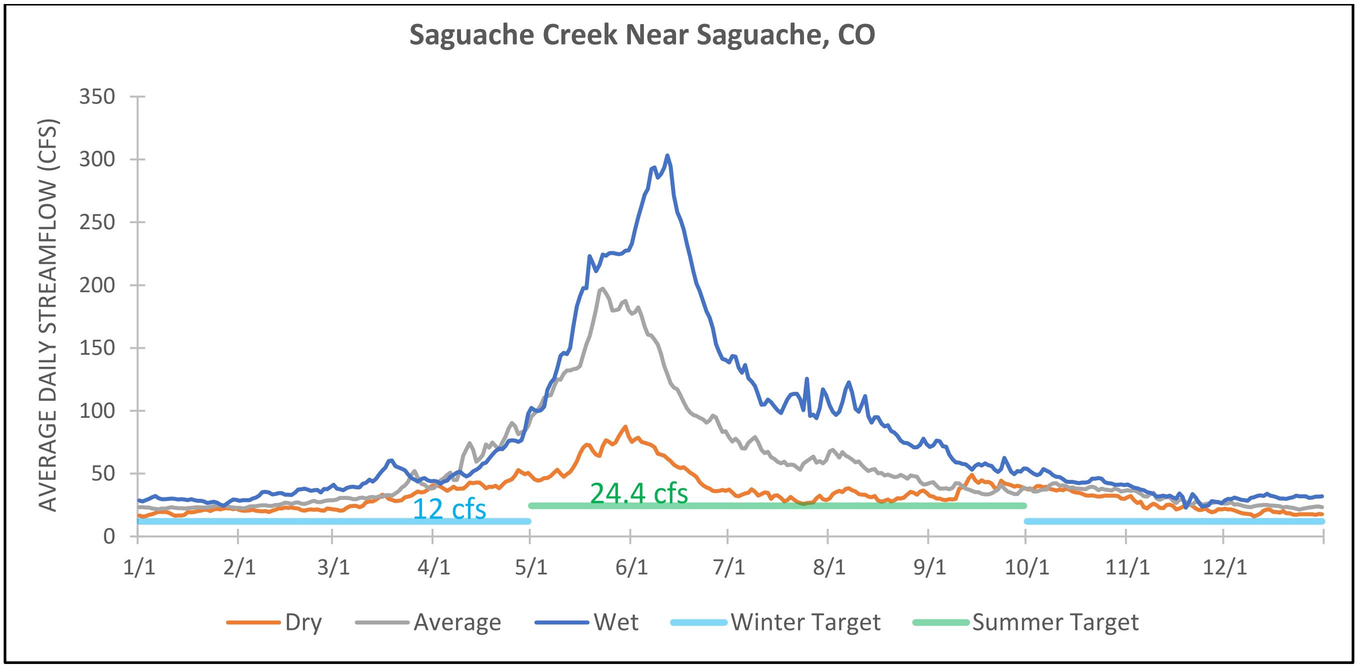
Watershed setting	River Style	Characteristics	Representative Photo
Accumulation	Meandering Coarse Grained Bed	Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward coarse gravels; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
Reach sits in an unconfined alluvial valley bounded by hills of volcanic origin. Hillslope processes delivering sediment and debris to the valley floor have contributed to the modern-day lens of alluvium. Organic and fine deposition from vegetation and overbank flood deposits are widespread. Stream migration and avulsions as the channel slowly aggrades and then regains lower territory have worked over much of the valley bottom. Primary sediment source is material eroded from the channel banks and floodplain of upstream reaches. The base level of the Creek is controlled by the San Luis Valley floor, a geologically closed basin. The Creek is likely already in a state of equilibrium with regard to its slope. The channel is generally a SEM stage 1 Creek (a departure from pre-settlement stage 0). Saguache Creek is highly sinuous through this reach and expected to be dynamic with lateral and down valley movement of meanders as well as activated cut-offs and secondary channels during high water. That said, the system should exhibit an overall meta-stability, meaning that the processes and stressors that drive the Creek's dynamism are in a state of relative equilibrium, under the existing conditions of water and sediment delivery from the watershed (Note: changes in these inputs could lead to instability). The sensitivity of the Creek is moderate but could trend toward high on a local scale in reaches that are straightened, rip rapped, or impacted by infrastructure (e.g., fill, levees, undersized crossings, diversions, etc.).

Stressors	Degree of Geomorphic Impairment
Reach sits in a largely roadless valley. Stressors are minimal. Some of the stream corridor has been converted to pasture and hay field converting historic channels and floodplain wetlands and removing riparian vegetation. A few roads bisect the river corridor with undersized crossing structures. Diversions have altered the hydrologic regime to a small degree. Beavers are not known to be present but would likely have been historically.	B Land use alterations, biotically impaired (riparian and beavers)

SC03 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

Reach SC03	DRY	AVERAGE	WET
Winter	100%	100%	100%
Summer	100%	100%	100%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

SC03 Riparian Vegetation

This site appears to be in fair condition, receiving an overall EIA rating of C+ (2.28). A rating of C suggests the riparian area has several unfavorable characteristics and management is required to maintain or restore certain ecological attributes. In this case, the rating reflects active management for both grazing and non-tilled hayfields. The lowest individual metric ratings it received were for Contiguous Natural Land Cover (C), Land Use Index (C), Condition of Natural Buffer – Soils (C), Native Plant Species Cover (C-), Invasive Nonnative Species Cover (C), and Vegetation Structure (C) (Table 3.9).

Table 3.9: EIA Scorecard – SCVeg03

SCVeg03 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.28**	**C+**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.63**	**B-**
LANDSCAPE METRICS	0.33			**2.00**	**C+**
L1. Contiguous Natural Land Cover	1	C	2		
L2. Land Use Index	1	C	2		
BUFFER METRICS	0.67			**2.94**	**B-**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	B	3		
B3.1. Condition of Natural Buffer - Veg	n/a	B	3		
B3.2. Condition of Natural Buffer - Soils	n/a	C	2		
Rank Factor: CONDITION	0.70			**2.13**	**C+**
VEGETATION METRICS	1			**2.13**	**C+**
V1. Native Plant Species Cover	1	C-	1.5		
V2. Invasive Nonnative Plant Species Cover	1	C	2		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	C	2		
V5. Regen. of Native Woody Species **(opt.)**	1	N/A	NULL		
V65. Coarse and Fine Woody Debris **(opt.)**	1	N/A	NULL		

Contiguous Natural Land Cover was fragmented by a dirt access road running across the southern and western portion of the buffer. This road is the main access route to the hayfields and pastures adjacent to the river on this portion of the property. This metric score could be improved by moving the access road further away from the creek, if possible. The Land Use Index metric was impacted by management around the creek for both hay production and livestock grazing. The plant community includes several species that are more tolerant of these types of disturbances over a long-term period. The Condition of Natural Buffer – Soils metric also reflects a score driven by moderate intensity of human use.

The average relative cover of native species was only 75%, leading to low scores for both Native Plant Species Cover and Invasive Nonnative Species Cover. The nonnative species with the highest absolute cover include the following species with cover values for plots 1, 2, 3, and 4, respectively: *Poa pratensis* (0%, 37.5%, 7.5%, and 0%), *Agrostis stolonifera* (17.5%, 0%, 0%, and 0%), *Taraxacum officinale* (0%, 7.5%, 0%, and 7.5%). Total average cover by noxious species was 6.4%. *Cirsium arvense* was encountered in plots 1-3 with cover values of 0.5%, 17.5%, and 7.5%, respectively.

The average mean C-value for native species was 4.9, while the average cover-weighted mean C-value was only 4.9 (Table 3.7). This suggests that most native species at this site are equally likely to be found in natural and non-natural areas. However, they are not typical of high disturbance areas. Although litter was present across all plots, the depth was consistently minimal across plots which led to a low score for Vegetation Structure. The combination of haying and grazing are likely to cause the lack of litter layering in this system. Further, while three of the four plots were characterized as herbaceous rather than woody (e.g., shrubland) plant associations, it may also be a consequence of current management practices that shrubland communities are reduced along this corridor. Google Earth imagery from 2015 reveals shrubland communities occurring nearby in non-hayed sections of the creek, often where the landscape is not conducive for large machinery to operate.

Current land uses observed and approximate cover within the 500 m buffer include non-tilled hayfields (36%), light grazing (30%), moderate grazing (30%), unpaved roads (2%), and domestic buildings (1%). The overall EIA score of this site is expected given the intensity and type of management activities. The local plant community appears to be somewhat resilient, however, due in part to the high quality condition of the less intensively managed riparian corridor upstream of this location. If portions of the riparian area adjacent to SCVeg03 were rested, it's likely that a mosaic of willows and other native species would reestablish themselves.

Results from the reach-scale RCA assessment indicated significantly impaired riparian areas with a C rating. Stressors include roads, floodplain disconnection, floodplain conversion, and nonnative plant species. The average of the EIA and RCA ratings is C.

SC03 Water Quality and Aquatic Life

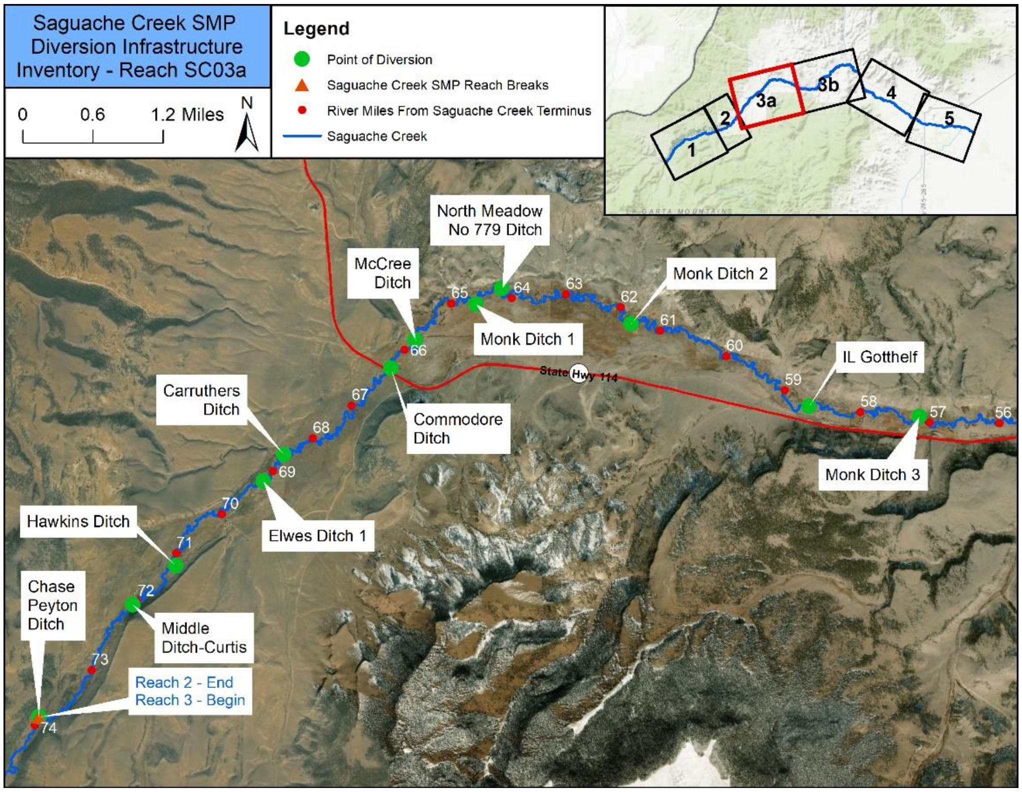
Water Quality		
Temperature	**Chemical Conditions**	**Nutrients**
C	D	C
Overall Rating		**C-**

Aquatic Life	
Average MMI Score	**Overall MMI Rating**
77	B+
Overall Rating	**B+**

Water quality in this reach is fair to poor. The reach is exceeding the water supply use arsenic and aquatic life use total iron standards and both of these parameters are on the 303(d) list. The total arsenic exceedance, however, is similar to other headwaters streams in the Rio Grande Basin. The source is thought to be natural geologic features. Further, elevated arsenic does not appear to adversely affect aquatic life and is therefore not considered to be a significant stressor. This reach is also on the 303(d) M&E list for water temperature. Between May 2013 and June 2019, the Saguache Creek Near Saguache stream gage recorded 37 Daily Maximum (DM) exceedances and 26 Maximum Weekly Average Temperature (MWAT) exceedances. This reach is also on the M&E list for total phosphorus, resulting in a nutrient rating of C.

This reach supports a healthy BMI community with an average MMI score of 77. Trout data was not available, however it should be noted that diversion structures form multiple barriers to fish passage in this reach and reduce aquatic habitat connectivity.

SC03a Diversion Infrastructure



Diversion structures located within the upstream half of SC03.

Chase Peyton Ditch: This is the first diversion structure on Saguache Creek. A stacked rock diversion dam directs water to the headgate, which is located on the north stream bank. A new diversion dam and bank stabilization structures were installed in 2019 in partnership with NRCS. The headgate and flume were not affected as part of those repairs. Bank erosion and meander cutoffs are relatively common on upper Saguache Creek. During spring runoff in 2019, the meander feeding this ditch was cut off, resulting in the stream bypassing the structure (see map in report card). Given the issues identified at this structure, the TAT recommends the following possible long-term solutions to the recent meander cut off: 1) rebuild the stream bank that was breached to redirect flow to the original stream channel and to the headgate; 2) relocate the point of diversion to divert flows just downstream of the current point of diversion. If the point of diversion is relocated, the TAT recommends retaining the original diversion dam and headgate in the event the stream recaptures the original channel.

Middle Ditch-Curtis: A stacked boulder diversion dam directs water to the headgate, which is located on the north bank of the stream. The headgate, diversion dam, and flume were replaced and bank stabilization structures were installed in 2019 through a partnership with the landowner and NRCS. The new diversion dam is built with large boulders and includes surrounding bank stabilization structures (see report card). The bank stabilization included bank reshaping and the installation of rock barbs. No immediate needs for improvement were noted.

Hawkins Ditch: This structure is located at the apex of a meander. Upstream of the headgate, located on the east bank of the stream, the bank is experiencing erosion. There is a minor risk of the upstream meander being cut off due to channel avulsion (see photos in report card). If this occurs, the structure would be significantly impaired. The diversion dam is made up of large boulders and woody debris and is often supplemented with hay bales. The headwall has been damaged and functions poorly. Given the issues identified at this structure, the TAT recommends diversion dam improvements, headwall repair, bank stabilization, and riparian revegetation. The TAT also recommends fish passage and adequate sediment transport in this reach. An improved diversion would reduce debris accumulation and bank erosion, promote sediment transport and fish passage, and increase efficiency. Bank stabilization and riparian revegetation would reduce the risk of channel avulsion and increase bank stability.

Elwes Ditch 2: A stacked rock diversion dam directs water to the headgate, which is located on the east bank of the stream. The channel here is unstable and the meander upstream of this structure could be cut off if erosion continues. The stream is also disconnected from the floodplain in some parts of this reach. The TAT recommends adding wing wall to the headgate to improve its function. The TAT also recommends implementing bank stabilization and revegetation, especially upstream of the headgate, to prevent further erosion and promote floodplain connection in this reach.

Carruthers Ditch: A boulder diversion dam directs water to the headgate, which is located on the west bank of the stream. The diversion is located in the transition zone between two meanders. The headgate is tilted and is being eroded. The stream is disconnected from its floodplain in some areas of this reach. The TAT recommends resetting the headgate and restoring the bank upstream of this structure. Headgate repair would improve efficiency and reduce maintenance. Bank stabilization and riparian revegetation would help protect the headgate, mitigate erosion, and reconnect the stream with its floodplain.

Commodore Ditch: This structure is located just downstream of the Highway 114 bridge. There is no diversion dam for this ditch. Just downstream of Hwy 114, water flows into a short feeder channel on the east bank of the stream and then to the headgate. The headgate functions well. The flume is eroding on its downstream side. The TAT recommends bank stabilization, riparian revegetation, and flume improvement. Stabilization and revegetation would help protect the diversion dam and headgate, as well as the Hwy 114 bridge. Filling the area below the flume would help ensure long-term measurement accuracy.

McCree Ditch: This structure is located just upstream of County Rd 31 CC. The diversion dam is made up of boulders, t-posts, and a large tree. The t-posts are braced against the tree and allow check boards or other materials to be installed for adjustments in head pressure. The diversion dam is located on the downstream end of a meander and directs water to the headgate, which is located on the east bank of the stream. Bank erosion is an issue at this location, particularly upstream of the diversion. Bank stabilization structures have been installed downstream of this structure. Given the issues affecting this structure, the TAT recommends upstream bank stabilization and diversion dam enhancement. Bank stabilization would help protect the headgate. An improved diversion such as an improved rock weir would reduce maintenance while still effectively diverting water at a range of flows. Alternatively, the point of diversion for the Commodore Ditch could be combined with this structure's diversion. Consolidation would reduce maintenance as well as impacts to stream function.

Monk Ditch 1: This structure is located in the transition zone between two meanders. A stacked rock diversion dam with a large post diverts water from the stream to the headgate, located on the south bank of the stream. At the time of inspection, the headgate was removed and the landowner was awaiting the replacement gate. Potentially, the diversion could be cut off due to future channel avulsion. The TAT recommends bank stabilization and riparian revegetation to mitigate this risk.

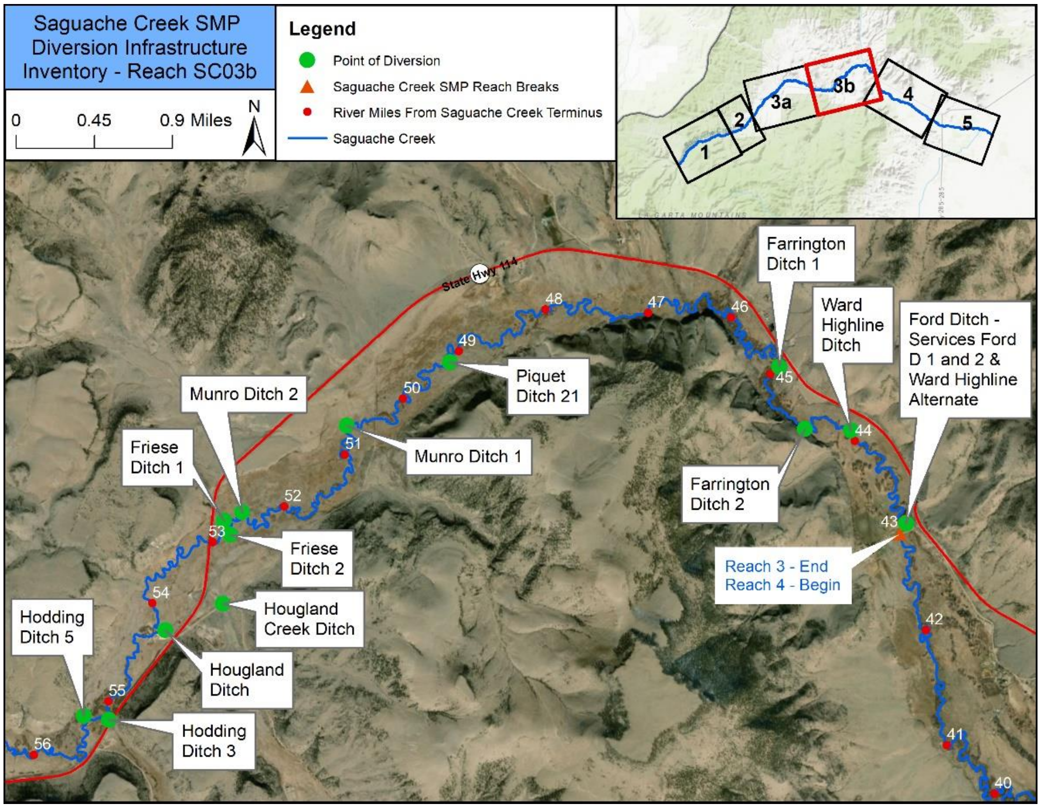
North Meadow No 779 Ditch: This diversion is located at the downstream end of a meander. A small stacked rock diversion dam directs water to a short feeder channel and to the headgate, which is located on the north bank of the stream. The headgate and flume are tilted and function poorly. The TAT recommends resetting the headgate and flume for increased efficiency and implementing bank stabilization and riparian revegetation to minimize the need for channel maintenance and mitigate the potential of a meander cutoff.

Monk Ditch 2: A stacked rock diversion dam directs water to the headgate, located on the south bank of the stream. Upstream of the diversion, the south stream bank is experiencing erosion. The meander upstream of the diversion is also at risk of being cut off. The headgate is tilted and functions poorly. The TAT recommends bank stabilization upstream of the diversion and leveling the headgate. Stabilization would protect the headgate and help prevent the upstream meander from being cut off.

IL Gotthelf: This structure is located at the upstream end of a meander. A boulder diversion dam directs water to the headgate, which is located on the south bank of the stream. The headgate is tilted and its headwall is bulging. The stream is unstable in this location, with the possibility of channel avulsion. The bank just upstream of the diversion is eroding, which may cause issues for this structure in the future. Given these issues, the TAT recommends replacing the diversion dam and repairing the headgate. A new diversion dam would reduce maintenance and improve sediment transport at this location. Headgate improvements would improve ditch efficiency.

Monk Ditch 3: This diversion is located at the apex of a meander. A narrow boulder diversion dam directs water to the headgate, which is located on the north bank of the stream. The headgate is tilted and difficult to operate. The dam constricts the channel, leading to downstream scour and forming a barrier to fish passage at low flows. An island has formed due to the scour pool and subsequent sediment deposition just downstream of the pool. This has caused the channel downstream of the diversion to become wide and shallow. Downstream of the diversion, there are several streambanks that are sloughing and channel avulsion is likely but would not affect downstream structures. The TAT recommends replacing the diversion and resetting the headgate for ease of use. The TAT also recommends creating fish passage at this location. A new diversion could be rebuilt to be wider and shorter to minimize its impact on the stream and allow for fish passage.

SC03b Diversion Infrastructure



Diversion structures located within the downstream half of SC03.

Hodding Ditch 5: This diversion is located on the outside of a meander. A boulder diversion dam directs flow to the headgate, which is located on the north bank of the stream. Upstream of the diversion, the channel is very wide. The diversion has created a small island in its middle that forms two channels, one leading to the headgate. Similar to Monk Ditch 3, a scour pool and island have formed downstream of the diversion dam. The meander downstream of the diversion is eroding. Given these issues, the TAT recommends diversion dam improvement, bank stabilization, and repairing or replacing the flume. A new diversion would allow the ditch to effectively divert water at low flows and reduce its impact on fish passage and sediment transport processes. A new flume would improve accuracy.

Hodding Ditch 3: This structure receives water from Hodding Creek but affects the administration of Saguache Creek water rights. It does not have a headgate. Instead, a culvert directs flow to the ditch. The measurement device could not be located at the time of inspection. The TAT recommends installing a new headgate and measurement device as well as improved access to the structure.

Hougland Ditch: This structure is located on the outside of a meander between Hodding Creek and Mill Creek. A boulder diversion dam directs water to the headgate, which is located on the south bank of the stream. The headgate is tilted and does not function well. The diversion dam is narrow and tall, leading to scour downstream and creating a barrier to fish passage. The meander on which the diversion is located is tightening and may be cut off during a high flow event. The TAT recommends resetting the headgate so that it is level and fixing the headgate's leak. Bank stabilization and riparian revegetation is recommended to mitigate erosion around the headgate and prevent the adjacent meander from being cut off.

Friese Ditch 2: This structure is located just upstream of Friese Ditch 1 at the apex of a meander. There is no diversion as this ditch is a junior priority and the stream is typically flowing sufficiently when it is in priority. The headgate functions very poorly and the flume was removed from the ditch at the time of inspection. Given these issues, the TAT recommends installing a new headgate, measurement structure, and implementing bank stabilization. A new diversion with adjustment and locking capabilities along with a new measurement device would increase efficiency and reduce maintenance. Bank stabilization and riparian revegetation, especially between this structure and Friese Ditch 1, would reduce erosion and prevent future bank failure.

Friese Ditch 1: This diversion is located just downstream of Friese Ditch 2, on the opposite bank and at the apex of a meander. A boulder diversion dam directs water to the headgate, located on the north bank of the stream. The headgate functions but leaks significantly. Downstream of the diversion dam, a scour pool has formed and the north bank of the stream is eroding. The diversion also creates a partial barrier to fish passage. Given these issues, the TAT recommends improving the diversion and repairing the headgate's leak. A new diversion would provide fish passage and mitigate downstream erosion. Alternatively, the point of diversion for Munro Ditch 2 could be combined with this structure's diversion. This would reduce overall maintenance and improve sediment transport processes.

Munro Ditch 2: This diversion is located at the downstream end of a meander. A few boulders form the diversion dam, which functions poorly. The streambank upstream of the diversion is eroding and could cause the stream to bypass the headgate. The flume has sunken and woody vegetation has caused its side walls to collapse. Given these issues, the TAT recommends installing a new diversion, repairing or replacing the flume, and implementing bank stabilization upstream of the headgate to prevent further erosion. A more functional diversion would improve ditch function and flume repairs would improve long-term measurement accuracy. Alternatively, to reduce maintenance and stream impacts, this diversion could be relocated and consolidated with Friese Ditch 1.

Munro Ditch 1: This diversion is located at the apex of a meander in the stream. Accelerated bank erosion is occurring near this structure and contributing to sedimentation at the diversion. A stacked boulder diversion dam directs water to the headgate, which is located on the north bank of the stream. The diversion has led to channel constriction and a disruption to natural sediment transport processes. It also forms a partial barrier to fish passage, depending on flow levels and the configuration of the diversion. The headgate is tilted and the flume is sunken and partially collapsed due to woody vegetation. The TAT recommends replacing the diversion and resetting the headgate and flume to reduce maintenance and improve long-term measurement accuracy. The TAT also recommends creating fish passage and improving sediment transport at this location. A new diversion would reduce maintenance, create fish passage, and improve sediment transport processes. Headgate and flume repairs would improve efficiency and reduce maintenance. Riparian revegetation would reduce bank erosion and mitigate sediment impacts at this structure.

Piquet Ditch 21: A stacked rock diversion dam directs water to the headgate, located on the south bank. The diversion dam is in poor condition, with few boulders remaining, and is unable to divert water at low flows. The headgate also functions very poorly, failing to seal. Accelerated bank erosion is occurring near this structure. The measurement device could not be located at the time of inspection. The TAT recommends replacing the diversion with an improved stacked rock structure, implementing riparian revegetation, and repairing the headgate. An improved diversion would divert water at all flows and headgate repair would eliminate leakage and increase efficiency. Riparian revegetation would reduce bank erosion and mitigate sediment impacts at this structure.

Farrington Ditch 1: This diversion is located on the outside of a meander just southwest of Hwy 114. A boulder diversion dam directs water to a feeder channel, approximately 350 ft long, which is located on the northeast bank. The stream is wide in this location, and thus the diversion dam is supplemented with large hay bales to more effectively divert water from the stream. This diversion limits the stream's sediment transport capacity at this location and creates a barrier to fish passage due to its height. The headgate is difficult to operate because the adjustment handle is too close to the steel frame. The TAT recommends improving the diversion and replacing the headgate handle. A new diversion would reduce maintenance and improve fish passage as well as sediment transport at this location. Replacing the headgate handle would increase efficiency and reduce maintance.

Farrington Ditch 2: This diversion is located on the outside of a tight meander. Bedrock features on the stream's southwest side prevent it from migrating in that direction. A stacked rock diversion dam with a utility pole directs water to the headgate, located on the south bank of the stream. The diversion creates a fish barrier at low flows and disrupts sediment transport capacity at this location. The flume's ability to function is hindered due to sedimentation and dense vegetation. The TAT recommends modifying the diversion to create fish passage and improve sediment transport capacity and cleaning the flume for improved measurement accuracy.

Ward Highline Ditch: This diversion is located in the transition zone between two meanders. Bank erosion is occurring, particularly upstream of the structure. The diversion dam is made up of boulders, t-posts, and a large utility pole spanning the stream. The diversion dam directs water to a short, approximately 50-foot feeder channel and to the headgate. The utility pole provides bracing for the t-posts as well as bridge access across the stream. The diversion causes a significant drop in the stream's elevation, which creates a barrier to fish passage. At high flow, the drop by can be as high as 6 ft. It also causes sediment accumulation upstream of the diversion dam. Although this diversion functions for water users, the TAT recommends replacement to create fish passage at this location. Alternatively, the Farrington Ditch 2 point of diversion could be utilized for this ditch. Consolidating the two structures would reduce maintenance and stream impacts. Riparian revegetation would reduce bank erosion and mitigate sediment impacts at this structure.

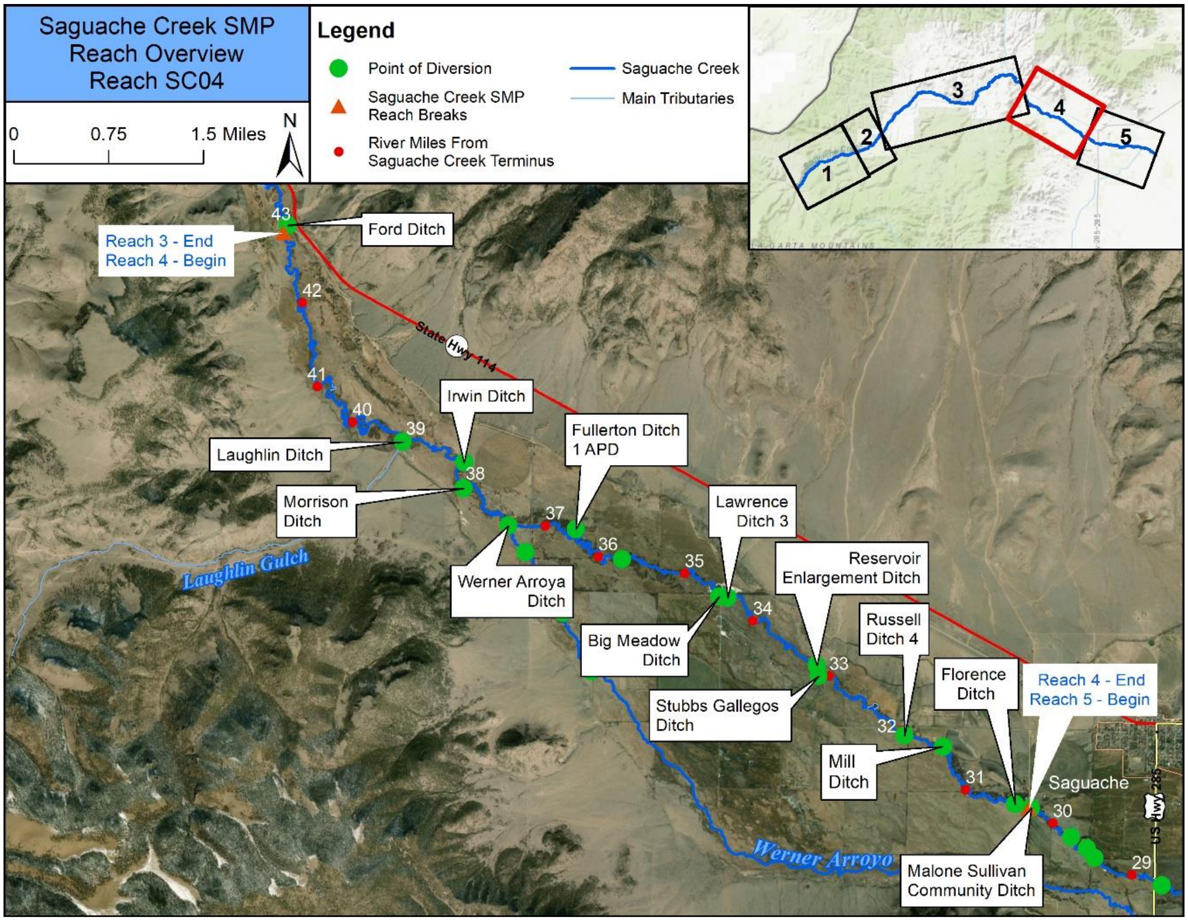
Ford Ditch: This diversion is located on the outside of a meander. A boulder diversion dam on either side of a mid-channel island directs water to a short feeder channel located on the north bank. The headgate functions well but experiences debris accumulation due to its location. The downstream bank of the feeder channel is eroding and could fail during high flows. Given the issues identified at this structure, the TAT recommends installing a trash rack, improving or relocating the diversion, and implementing bank stabilization. A trash rack would mitigate debris accumulation at the headgate. Bank stabilization upstream of the diversion and on the feeder channel would help prevent ditch failure. Diversion improvements using stacked rocks would reduce maintenance. Alternatively, the point of diversion could also be relocated to mitigate erosion and debris accumulation issues.

Ward Highline Ditch-Alt: This ditch shares a diversion dam with the Ward Highline Ditch. Roughly 500 ft downstream of the Ward Highline Ditch headgate, a small stacked rock diversion dam directs water to the headgate. The diversion dam does not function well and debris and sediment accumulate at the headgate. The TAT recommends replacing the diversion with an improved structure. The recommendation of a trash rack at the Ford Ditch would mitigate debris accumulation at this structure.

Ford Ditch 1 and 2: This ditch's point of diversion is shared with the Ford Ditch. Approximately 0.4 miles downstream of the Ford Ditch headgate, the ditch bifurcates and the left branch services the Ford Ditch 1 and 2 headgate an additional 1.1 miles down the ditch. A 2' wide slide gate serves as the diversion dam and the overflow gate. The headgate has no cover and the flume is tilted. The TAT recommends headgate replacement and flume improvement or replacement for improved function.

3.2.4 SC04 – Ford Ditch to County Road 46

From the crossing of an unnamed bridge off Highway 114 downstream to where County Road 46 crosses the Creek, southwest of the Town of Saguache.



Representative Reach Photo

SC04 Conditions Assessment Overview

Reach: SC04		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	C+	X			X	X		X				X	X	
Riparian Vegetation	C+			X		X				X				
Water Quality	C-				X	X		X					X	X
Aquatic Life	B-	X						X				X	X	
Diversion Structures	C													

A	B	C	D	F	Not Assessed

*For an explanation of methodology used to determine reach ratings, see section 2.

SC04 Geomorphology

Reach	Location Description
SC04	Ford Ditch to County Road 46

Confine-ment	D50	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Uncon-fined	No Data	No Data	Riffle-pool	Beaver meadow complex	I	0	Coarse Equilibrium & Fine Deposition	Coarse Equilibrium & Fine Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.8%	↔	No Data	No Data	No Data	No Data

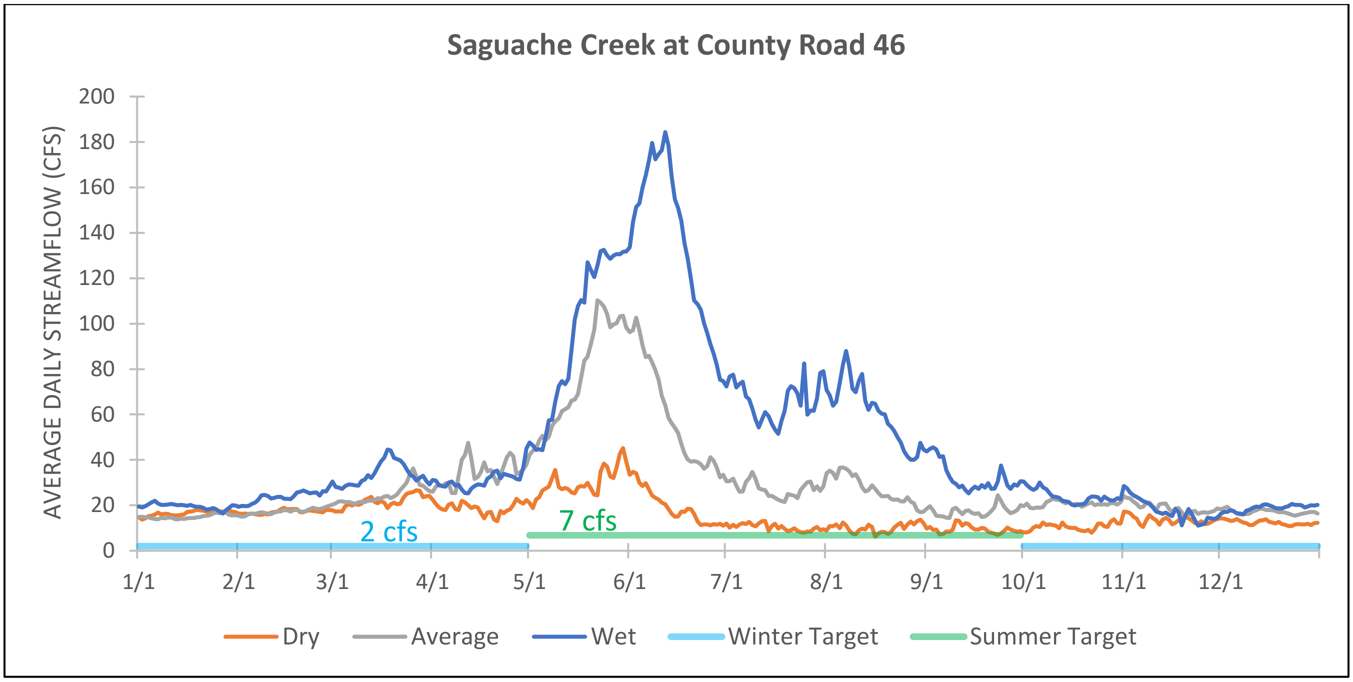
Watershed setting	River Style	Characteristics	Representative Photo
Accumulation	Meandering Fine Grain Bed	Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward gravel; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
Reach sits in a wide alluvial fan formed from rifting (spreading) of the valley floor and contributions of alluvium from the watershed. Organic and fine deposition from vegetation and overbank flood deposits are widespread. Stream migration and avulsions as the channel slowly builds up and then regains lower territory have worked through much of the valley bottom. The base level of the Creek is controlled by the San Luis Valley floor, a geologically closed basin. The Creek is likely already in a state of equilibrium with regard to its slope. SEM stage 1 (a departure from pre-settlement stage 0), except in locations where the Creek has been channelized. High sinuosity and dynamic with lateral and down valley movement of meanders as well as activated cut-offs and secondary channels during high water. System should exhibit an overall meta-stability, meaning that the processes and stressors that drive the Creek's dynamism are in a state of relative equilibrium, under the existing conditions of water and sediment delivery from the watershed (Note: changes in these inputs could lead to instability). The sensitivity is moderate but could trend toward high on a local scale in reaches that are straightened, rip rapped, or impacted by infrastructure (e.g., fill, levees, undersized crossings, diversions, etc.).

Stressors	Degree of Geomorphic Impairment
The predominant stressors impacting this reach are channelization/straightening, the establishment and maintenance of a single threaded channel on the valley floor, the removal of biotic drivers such as wood and beavers, and the change of the valley floor vegetation due to grazing and altered hydrology. In straightened reaches, we may expect the Creek to reclaim its sinuosity during flood flows. On a local scale, we may also expect the Creek to find flow paths around crossings and diversion infrastructure if they clog with sediment and debris.	C+ Land use alterations, biotically impaired (riparian and beavers)

SC04 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

Reach SC04	DRY	AVERAGE	WET
Winter	100%	100%	100%
Summer	100%	100%	100%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

SC04 Riparian Vegetation

Overall, this AA is in good condition with an overall EIA rating of B- (2.76). However, this score suggests that this site has the potential to degrade to a C rating if further alteration from natural conditions occurs. The lowest individual metric ratings it received were for Contiguous Natural Land Cover (C), Land Use Index (C), Native Plant Species Composition (C), and Vegetation Structure (C) (Table 3.10).

Table 3.10: EIA Scorecard – SCVeg04

SCVeg04 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.76**	**B-**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.99**	**B-**
LANDSCAPE METRICS	0.33			**2.00**	**C+**
L1. Contiguous Natural Land Cover	1	C	2		
L2. Land Use Index	1	C	2		
BUFFER METRICS	0.67			**3.48**	**B+**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	B	3		
B3.1. Condition of Natural Buffer - Veg	n/a	A	4		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			**2.67**	**B-**
VEGETATION METRICS	1			**2.67**	**B-**
V1. Native Plant Species Cover	1	B	3		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	C	2		
V4. Vegetation Structure	1	C	2		
V5. Regen. of Native Woody Species **(opt.)**	1	B	3		
V65. Coarse and Fine Woody Debris **(opt.)**	1	B	3		

The Contiguous Natural Land Cover and Land Use Index metrics were impacted by the dual management use of the pasture immediately south of the AA. This pasture appears to be used for both grazing at moderate intensity and non-tilled hayfields. Consequently, when scored, the pasture was categorized as having “intensive use,” excluding it from being classified as an unfragmented area of natural buffer.

While average relative cover of native species was 97%, the average mean C-value for native species was 4.4, and the average cover-weighted mean C-value for native species was 3.8 (Table 3.7). These values suggest that the majority of native species present are commonly found in non-natural areas.

A greater diversity of *Salix* species would be expected if this region weren’t as intensively managed for agricultural purposes. Additionally, many mature *Populus angustifolia* were dead with minimal regeneration observed. This may be the result of fewer floods and a lower water table than experienced historically. Further, overall diversity across sampled plots (19 taxa) was significantly lower than the average diversity of 33 taxa across all AAs sampled along Saguache Creek. All of these attributes led to a low score for Vegetation Structure.

Current land uses observed and approximate cover within the 500 m buffer include non-tilled hayfields (60%), moderate to heavy grazing (38%), and paved roads (2%). In addition to livestock grazing, these pastures also see a fair amount of use by native ungulate based on the quantity of elk scat observed.

Results from the reach-scale RCA assessment indicated significantly impaired riparian areas with a C rating. Stressors include floodplain disconnection, floodplain conversion, and nonnative plant species. The average of the EIA and RCA ratings is C+.

SC04 Water Quality and Aquatic Life

Water Quality		
Temperature	**Chemical Conditions**	**Nutrients**
C	D	N/A
Overall Rating		**C-**

Aquatic Life	
Average MMI Score	**Overall MMI Rating**
68.5	B-
Overall Rating	**B-**

Water quality in this reach is fair to poor with the dissolved cadmium and total iron exceeding acute state standards for aquatic life. This reach is not listed for water temperature. However, due to its proximity to the Saguache Creek Near Saguache stream gage, temperature is assumed to be similar to SC03. Between May 2013 and June 2019, the stream gage in SC03 recorded 37 Daily Maximum (DM) exceedances and 26 Maximum Weekly Average Temperature (MWAT) exceedances.

This reach supports a healthy benthic macroinvertebrate community with an average MMI score of 68.5. Trout data was not available, however it should be noted that diversion structures form multiple barriers to fish passage in this reach and reduce aquatic habitat connectivity.

SC04 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

Laughlin Ditch: This diversion does not have a headgate on the Saguache Creek mainstem. Instead, water is delivered to the ditch via other diversion structures. The ditch crosses Saguache Creek via a 10 ft PVC pipe and delivers irrigation water south of Saguache Creek. Just upstream of this structure, the south bank of the stream is experiencing accelerated erosion. The TAT recommends bank stabilization to prevent further erosion and/or potential damage to this structure.

Irwin Ditch: This diversion is located at the apex of a meander. The channel is relatively stable in this location. A stacked rock diversion dam directs water to the headgate, located on the north bank of the stream. Woody debris and sediment accumulate at the headgate due to the diversion's location as well as in the ditch at County Rd 42 because of the its low gradient. The flume is sunken and may have measurement problems if it is not reset. The TAT recommends resetting the flume to improve its measurement accuracy and installing a trash rack at the headgate. The point of diversion could also be relocated upstream, which would also help reduce debris accumulation.

Morrison Ditch: This structure is located at the downstream end of a meander. A stacked rock diversion dam with two large tree trunks and other woody debris directs water to the headgate, located on the south bank of the stream. The headgate is titled and is difficult to operate. The diversion can form a barrier to fish passage at low flows. During 2019 spring runoff, the recently installed diversion dam was partially washed out. Many of the boulders making up the diversion were washed downstream (see report card). Below the headgate, the ditch is relatively flat, leading to sediment and debris accumulation issues, including at the flume. Beaver activity in and nearby the ditch contribute large quantities of woody debris, presenting a significant maintenance challenge for the landowner and water users. The TAT recommends repairing or replacing the diversion, resetting the headgate, and resetting or replacing the flume to improve measurement accuracy. Resetting the headgate would improve function and ease of use. The TAT also recommends incorporating fish passage if the diversion is modified or replaced. *Note: between this diversion and Fullerton Ditch 1 APD, the stream bifurcates, with Werner Arroyo flowing south of the mainstem. Werner Arroyo diversions are described below.*

Fullerton Ditch 1 APD: This structure is located on the outside of a meander. A stacked rock diversion dam directs water to the headgate, located on the north bank of the stream. The diversion is in an ideal location, but during 2019 spring runoff, it was damaged, with many of the boulders being washed out. The TAT recommends repairing and improving the diversion and installing a trash rack at the headgate. An improved diversion would prevent future failure during high flows and a trash rack would reduce debris accumulation at the headgate.

Star Ditch: This structure is located on the outside of a meander. The diversion dam is a welded steel check board structure with boulders and a metal fence as additional reinforcement. The diversion dam directs water to the headgate, located on the south bank of the stream. The dam functions well, although woody debris accumulation is an issue and the structure has difficulty diverting water during low flows. The headgate is stabilized with large boulders and functions effectively. The TAT recommends modifying the diversion to improve its adjustment capabilities. Modifications would reduce debris accumulation and would allow the ditch to effectively divert water at a range of flows. This ditch also services the priority 25 Gotthelf Ditch No. 5.

Big Meadow Ditch: This structure is located on the outside of a meander. The diversion dam is a combination of boulders, sheet metal, fencing, and concrete. The diversion constricts the stream channel and appears to be causing downstream erosion. The diversion can form a barrier to fish passage, depending on flow and configuration. Debris accumulation is a minor issue on the diversion and at the headgate, which is tilted. The TAT recommends replacing the diversion, repairing or replacing the headgate, and relocating the headgate closer to the diversion. A new diversion would lower maintenance, reduce downstream erosion, and allow for fish passage. Headgate improvements would increase efficiency and relocating the headgate would mitigate debris accumulation.

Lawrence Ditch 3: This diversion is just downstream of the Big Meadow Ditch. The stream is unstable here, and the meander on which this ditch diverts is at risk of being cut off during high flows. Given these issues, the TAT recommends bank stabilization and riparian revegetation upstream and downstream of the diversion dam. This would prevent the ditch from flooding out of its channel and into the stream and help prevent the meander from being cut off.

Reservoir Enlargement Ditch: A diversion dam made of rocks and debris diverts water to the headgate on the north bank of the stream. This ditch has trouble accessing its full decree in low flow conditions. The stream is relatively stable here, however accelerated bank erosion is occurring near this structure. The headgate is in poor condition. The headwall is bulging and the screw gate is bent. Given these issues, the TAT recommends improving the diversion dam, riparian revegetation, and headgate/headwall repair or replacement. An improved diversion and headgate would allow this ditch to access its full decree during low flows and would increase ditch efficiency. Riparian revegetation would reduce bank erosion and mitigate sediment impacts at this structure.

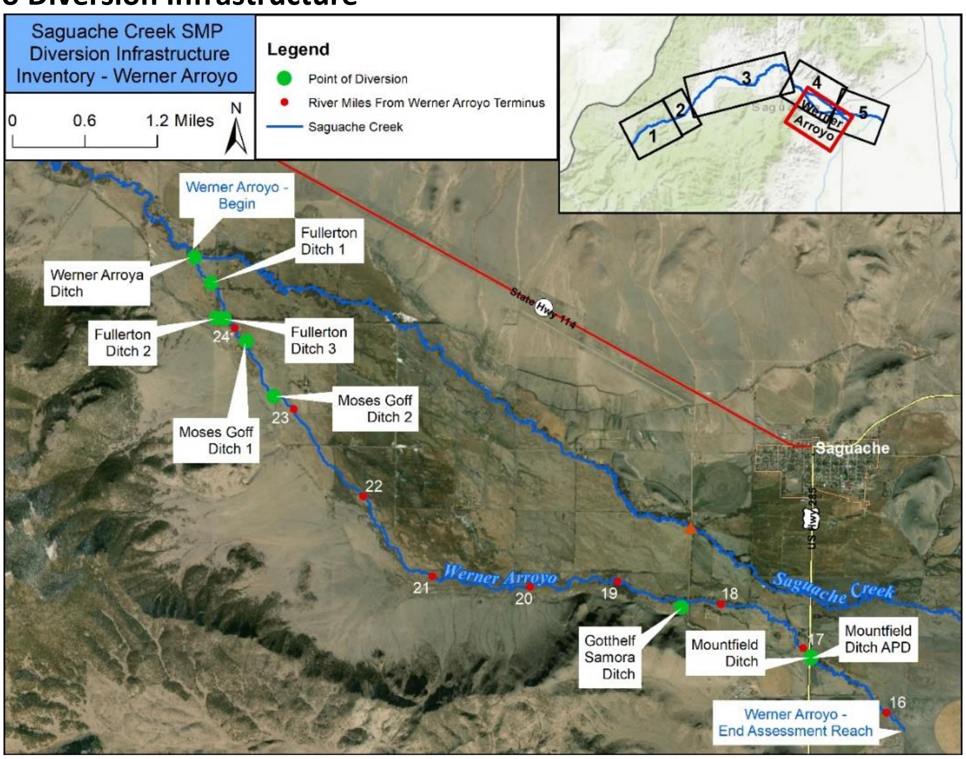
Stubbs Gallegos Ditch: This diversion is located downstream of the Reservoir Enlargement Ditch. The diversion dam, made of boulders and debris, directs water to the headgate on the south bank. Debris accumulates at the headgate and the flume is sunken, partially collapsed, and does not measure accurately. The old diversion dam is downstream of the current dam. It is not serving a purpose and could be removed. The TAT recommends improving the existing diversion dam, installing a trash rack, replacing the flume, and implementing riparian revegetation. An improved diversion, trash rack, and flume would reduce maintenance, mitigate adverse stream impacts, and increase efficiency. Riparian revegetation would reduce bank erosion and mitigate sediment impacts at this structure.

Russell Ditch 4: This diversion is located just downstream of County Rd Z. The diversion dam is a rock structure with t-posts and a large log that directs water to the headgate on the south bank of the stream. It is effective but requires regular maintenance. The headgate is slightly tilted but functions moderately well. The flume is tilted and does not measure accurately. The south bank of the stream is eroding between the structure and County Rd Z. Given these issues, the TAT recommends bank stabilizing and riparian revegetation upstream of the diversion structure, improving the diversion, and stabilizing and leveling of both the headgate and flume. Bank stabilization would reduce erosion and sedimentation at the structure and diversion, while headgate and flume improvements would increase efficiency and reduce maintenance needs.

Mill Ditch: A diversion dam made up of boulders and t-posts directs water to the headgate on the north bank of the stream. The headgate functions poorly due to sediment and woody debris accumulation. The diversion dam functions effectively despite woody debris accumulation. The stream in this location is very sinuous and there is potential for channel avulsion to occur. Given the issues identified at this structure, the TAT recommends bank stabilization and riparian revegetation upstream of the diversion, and installation of a trash rack in front of the headgate. Bank stabilization would help prevent ditch failure and a trash rack in front of the headgate would reduce maintenance. Alternatively, the point of diversion could be relocated downstream to the next meander, where the diversion may require less maintenance. **This ditch also serves Gotthelf Ditch 1, which is a priority 7*.

Florence Ditch: This diversion is located on a tight meander just upstream of County Rd 46. The diversion dam is a boulder structure that functions well but requires regular maintenance (i.e., moving boulders depending on flows). There is potential for bank erosion and/or failure on the north side of the diversion dam. The headgate, located on the south bank of the stream, leaks and is tilted. The flume measures relatively well but has minor leak on its upstream side. The TAT recommends bank stabilization upstream of the diversion, headgate repair or replacement, including installation of new wedges and a handle, and flume repair. Bank stabilization would help prevent the stream bank from failing and headgate and flume improvements would increase efficiency.

Werner Arroyo Diversion Infrastructure



Werner Arroya Ditch: A boulder diversion dam directs water to the main headgate, located on the south bank of Saguache Creek. This structure services the eight ditches located on the Werner Arroyo.

This is a critically important structure for water rights administration on Saguache Creek. The headgate was recently replaced and is in excellent condition. The diversion dam, however, is adversely affected by significant sediment deposition. Given this challenge, the TAT recommends moving the diversion dam downstream. This would mitigate the sedimentation at the diversion.

Fullerton Ditch 1: This is the first diversion on the Werner Arroyo. The diversion dam is a check board structure that directs flow to the headgate, located on the north bank of the channel. This structure functions effectively. No immediate repair needs were identified.

Fullerton Ditch 2: This diversion is just downstream of County Rd 42. A check board diversion dam directs water to the headgate, located on the south bank of the channel. Sediment accumulation is an issue for this ditch, especially below the headgate. Woody debris also impacts the diversion structure and culvert under County Rd 42. The diversion dam can get clogged with woody debris, leading to extensive maintenance and administration challenges on the Werner Arroyo. Although there is no clear long-term solution to the debris accumulation, the TAT recommends regular debris clearing. Additionally, the flume is tilted and the TAT recommends leveling it.

Fullerton Ditch 3: This structure is located downstream of the Fullerton Ditch 2 on the Werner Arroyo. The diversion dam is a combination of a check board structure and stacked rocks, but the check boards were recently removed due to debris accumulation. The headgate leaks and its frame is twisted. The flume is tilted and in poor condition due to vegetative growth and sediment accumulation. The TAT recommends replacing the diversion and headgate and resetting the flume. Improvements to the diversion and headgate would allow the water user to more effectively divert water despite sediment and debris accumulation. Resetting the flume would ensure long-term measurement accuracy.

Moses Goff Ditch 1: The diversion dam is a 2' wide culvert with steel wing walls. The headgate is on the east bank of the stream, and, despite being tilted, it functions effectively. The headgate may require repair in the future, however no immediate repair needs were noted.

Moses Goff Ditch 2: This diversion is located downstream of County Rd Z. Head pressure is adjusted using a 2' wide culvert. Sediment and debris accumulation is a significant issue at this structure. The flume is eroding and may fail in the future. Although there is no clear long-term solution to the debris accumulation, the TAT recommends regular debris clearing. The TAT also recommends stabilization or fill around the flume to prevent further erosion.

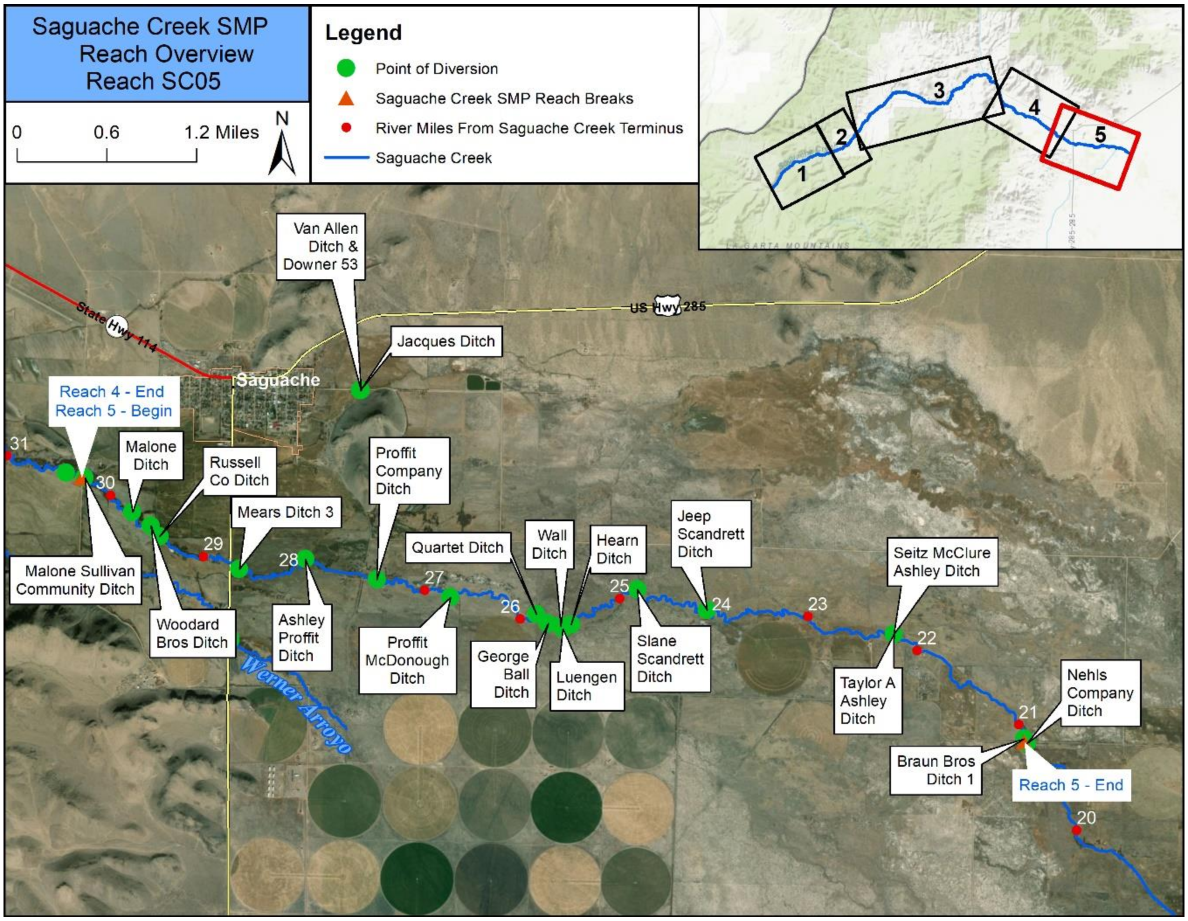
Gotthelf Samora Ditch: The diversion dam is made up of boulders and directs water to the headgate. The channel is relatively stable in this location. No measurement device exists.

Mountfield Ditch: This structure is located just downstream of Hwy 285 on the Werner Arroyo. The diversion dam is a check board structure and functions effectively. Water is diverted to the headgate, located on the north bank, and functions effectively. No immediate repairs needs were noted.

Mountfield AP Ditch: This diversion is serviced by the same diversion as the Mountfield Ditch. It is an alternate priority 19 to the Mountfield.

3.2.5 SC05 – County Road 46 to Braun Bridge

From where County Road 46 crosses the Creek, southwest of the Town of Saguache, downstream to the County Road X crossing (Braun Bridge).



Representative Reach Photo

SC05 Conditions Assessment Overview

Reach: SC05		Major Stream Condition Stressors												
Parameter	Condition Rating	Crossings and diversions	Roads and railways	Floodplain disconnection	Channelization and armoring	Fill and floodplain conversion	Flow alteration: impoundments	Flow alteration: diversions	Abandoned mine lands	Exotic/naturalized plant species	Exotic aquatic species	Lack of woody material	Hillslope/channel erosion	Unknown source
Geomorphology	C-	X		X	X	X		X				X	X	
Riparian Vegetation	C+			X	X	X				X				
Water Quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aquatic Life	C	X						X				X	X	
Diversion Structures	C													

A	B	C	D	F	Not Assessed

*For an explanation of methodology used to determine reach ratings, see section 2.

SC05 Geomorphology

Reach	Location Description
SC05	County Road 46 to Braun Bridge

Confine-ment	D50 (mm)	Bed Comp.	Existing Stream Form	Reference Stream Form	SEM Stage Existing	SEM Stage Ref.	Existing Sediment Regime	Reference Sediment Regime
Unconfined	Upper: 20-29 Lower: Sand	Upper: gravel Lower: Sand and Silts	Riffle-pool	Beaver meadow complex	I	0	Fine Source & Transport; Coarse Deposition	Fine Source & Transport; Coarse Deposition

Valley Slope	Stream Power △	Bed Mobility Threshold Flows	Bed Mobility Frequency	Overbank Flow Estimate	Overbank Flow Frequency
0.3%	↓	No Data	No Data	No Data	No Data

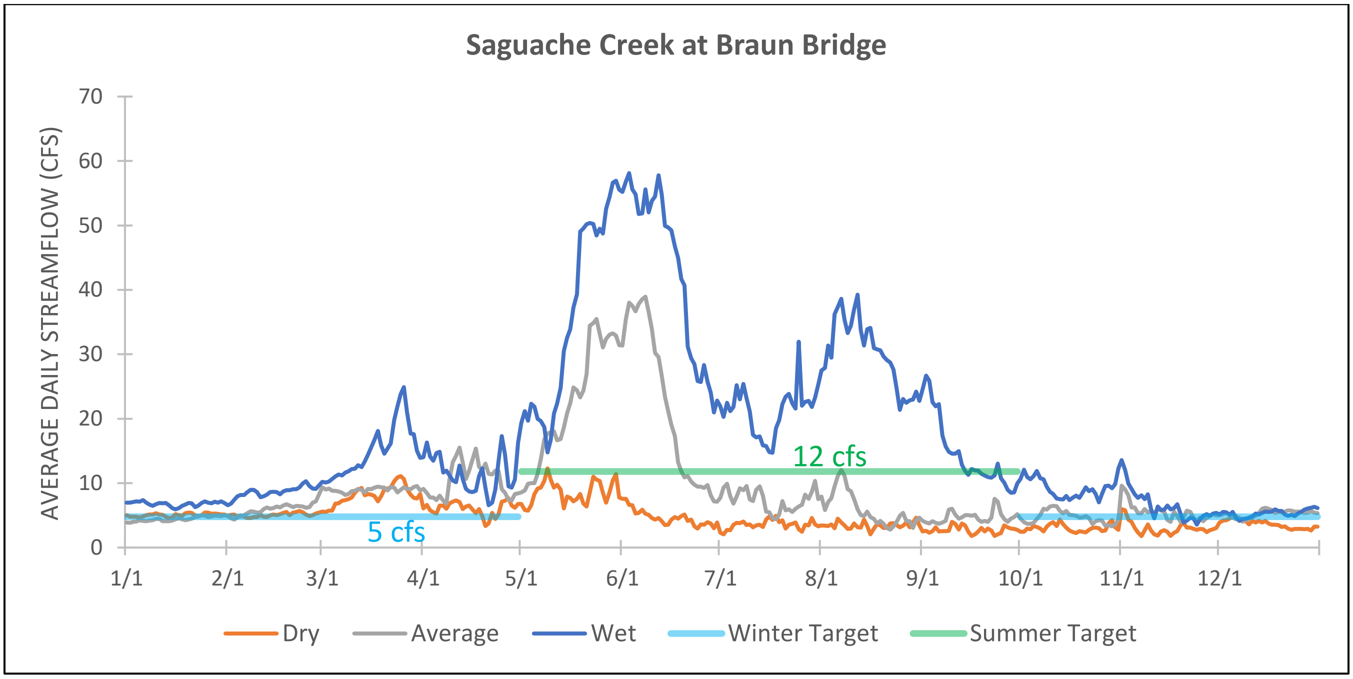
Watershed setting	River Style	Characteristics	Representative Photo
Accumulation	Meandering Fine Grain Bed	Unconfined channel with moderate to high sinuosity, well developed meandering and associated channel and floodplain geomorphic forms. Range of bar types, floodplain features and floodplain textures; substrate sizes tending toward fine gravel and sand; substrate variability depends on habitat-scale geomorphic features such as location in bend, pool, or riffle.	

Setting, Morphology, Channel Evolution, Trajectory, and Sensitivity
Reach sits in a wide alluvial fan formed from rifting (spreading) of the valley floor and contributions of alluvium from the watershed. Organic and fine deposition from vegetation and overbank flood deposits are widespread. Stream migration and avulsions as the channel slowly builds up and then regains lower territory have worked through much of the valley bottom. The base level of the Creek is controlled by the San Luis Valley floor, a geologically closed basin. The Creek is likely already in a state of equilibrium with regard to its slope. SEM stage 1 (a departure from pre-settlement stage 0), except in locations where the Creek has been channelized. High sinuosity and dynamic with lateral and down valley movement of meanders as well as activated cut-offs and secondary channels during high water. System should exhibit an overall meta-stability, meaning that the processes and stressors that drive the Creek's dynamism are in a state of relative equilibrium, under the existing conditions of water and sediment delivery from the watershed (Note: changes in these inputs could lead to instability). The sensitivity is moderate but could trend toward high on a local scale in reaches that are straightened, rip rapped, or impacted by infrastructure (e.g., fill, levees, undersized crossings, diversions, etc.).

Stressors	Degree of Geomorphic Impairment
The predominant stressors impacting this reach are channelization/straightening, the establishment and maintenance of a single threaded channel on the valley floor, the removal of biotic drivers such as wood and beavers, and the change of the valley floor vegetation due to grazing and significantly altered hydrology. Sediment transport is also significantly impaired due to surface water diversions. In straightened reaches, we may expect the Creek to reclaim its sinuosity during flood flows. On a local scale, we may also expect the Creek to find flow paths around crossings and diversion infrastructure if they clog with sediment and debris.	C- Land use alterations, biotically impaired (riparian and beavers)

SC05 Aquatic Habitat Flow Targets

The graph below shows summer and winter flow targets with dry, average, and wet hydrographs.



The table below shows percent of days the reach's summer and winter flow targets are met in each year type:

Reach SC05	DRY	AVERAGE	WET
Winter	51%	72%	94%
Summer	1%	29%	92%

*See section 2.6 for detailed explanation of aquatic habitat methodology and caveats.

SC05 Riparian Vegetation

Overall, this site appears to be in good condition, receiving an overall EIA rating of B- (2.76). However, this score suggests that this site has the potential to degrade to a C rating if further alteration from natural conditions occurs. The lowest individual metric ratings it received were for Contiguous Natural Land Cover (C), Land Use Index (C), Condition of Natural Buffer – Vegetation (C), Native Plant Species Cover (C-), and Vegetation Structure (C) (Table 3.11).

Table 3.11: EIA Scorecard – SCVeg05

SCVeg05 Observer: W. McBride	Wt	Field Rating	Field Points	Calc Points	Calc Rating
Overall Ecological Integrity Score and Rank				**2.76**	**B-**
Rank Factor: LANDSCAPE CONTEXT	0.30			**2.77**	**B-**
LANDSCAPE METRICS	0.33			**2.00**	**C+**
L1. Contiguous Natural Land Cover	1	C	2		
L2. Land Use Index	1	C	2		
BUFFER METRICS	0.67			**3.16**	**B+**
B1. Perimeter with Natural Buffer	n/a	A	4		
B2. Width of Natural Buffer	n/a	A	4		
B3.1. Condition of Natural Buffer - Veg	n/a	C	2		
B3.2. Condition of Natural Buffer - Soils	n/a	B	3		
Rank Factor: CONDITION	0.70			**2.75**	**B-**
VEGETATION METRICS	1			**2.75**	**B-**
V1. Native Plant Species Cover	1	C-	1.5		
V2. Invasive Nonnative Plant Species Cover	1	B	3		
V3. Native Plant Species Composition	1	B	3		
V4. Vegetation Structure	1	C	2		
V5. Regen. of Native Woody Species **(opt.)**	1	A	4		
V65. Coarse and Fine Woody Debris **(opt.)**	1	B	3		

The Contiguous Natural Land Cover and Land Use Index metrics were impacted by the dual management use of the pastures immediately adjacent to the AA (on both sides of the creek). This pasture appears to be used for both grazing at moderate intensity and non-tilled hayfields. Consequently, when scored, the pasture was categorized as having “intensive use,” excluding it from being classified as an unfragmented area of natural buffer.

Condition of Natural Buffer – Vegetation and Native Plant Species Cover scores were the result of an average relative cover of native species of 74%. The nonnative species with the highest absolute cover include the following species with cover values for plots 1, 2, 3, and 4, respectively: *Poa pratensis* was the nonnative species with the highest average cover across plots with cover values of 17.5%, 3.5%, 1.5%, and 17.5% for plots 1, 2, 3, and 4, respectively. Several other nonnative species with low to moderate cover occurred in all plots. The noxious species *Cirsium arvense* was present in all four plots (3.5%, 0.2%, 0.5%, and 0.2% cover), with an average cover of 1.1%.

The average mean C-value for native species was 4.6, while the average cover-weighted mean C-value was only 4.5 (Table 3.7). This suggests that most native species at this site are equally likely to be found in natural and non-natural areas. However, they are not typical of high disturbance areas.

Vegetation Structure was affected by dense *Salix exigua* stands. This willow is tolerant of regular disturbance and when it becomes a woody monoculture can choke out understory diversity. If less grazing and mowing pressure were present, it's possible these *S. exigua* stands would transition to a larger mosaic of woody and herbaceous species.

Current land uses observed and approximate cover within the 500 m buffer include exclusively non-tilled hayfields (35%), and pastures with a management combination of moderate to heavy grazing and non-tilled hayfields (65%).

Results from the reach-scale RCA assessment indicated significantly impaired riparian areas with a C rating. Stressors include bank armoring, floodplain disconnection, floodplain conversion, and nonnative plant species. The average of the EIA and RCA ratings is C+.

SC05 Water Quality and Aquatic Life

Water Quality		
Temperature	**Chemical Conditions**	**Nutrients**
N/A	N/A	N/A
Overall Rating		**N/A**

Aquatic Life	
Average MMI Score	**Overall MMI Rating**
52.2	C
Overall Rating	**C**

Determinations regarding water quality parameters was not possible due to insufficient data.

Sampling results show significant impairment to macroinvertebrate communities (average MMI score of 52.2), however key functional groups remain intact. This MMI score is lower than upstream reaches and close to the impairment threshold. Trout data was not available, however it should be noted that diversion structures form multiple barriers to fish passage in this reach and reduce aquatic habitat connectivity.

SC05 Diversion Infrastructure

***Refer to reach overview map above for diversion structure locations.**

Malone Sullivan Community Ditch: This diversion is located just downstream of County Rd 46. A stacked rock diversion dam directs water to an approximately 450 ft feeder channel that delivers water to a second diversion dam and to the headgate. The headgate currently functions but is at risk of washing out at high flows. The diversion dam on the feeder channel is a check board structure with steel wing walls that directs water to the headgate on the north bank of the stream. Any unused water returns to the stream just downstream of the diversion dam. The diversion's wing walls are bulging and it is difficult to adjust for low flow conditions. The ditch between the headgate and flume was recently cleared and improved. Given the issues identified, the TAT recommends repairing or replacing the diversion and improving the headgate. Diversion improvement would reduce maintenance and improve the ditch's ability access to its full decree at all flows. Headgate reinforcement would prevent it from being washed out.

Jaques Ditch: This diversion is located just upstream of County Rd Z. The headgate is located just downstream of the Van Allen Ditch headgate, which can serve as the diversion dam/control structure for this ditch. Approximately 430 ft downstream of the headgate, this ditch travels under County Rd Z via a culvert. The headgate was recently replaced and functions well. Flow is measured using a staff on the headgate. No immediate repair needs were identified.

Van Allen Ditch & Downer 53 Ditch: This diversion is located just upstream of County Rd Z. The Jaques Ditch headgate serves as the diversion dam, directing water to the headgate, which travels north under County Rd Z via a culvert. The headgate leaks and functions poorly. Downstream of Rd Z where the flume is located, the ditch is very wide. Both Van Allen Ditch & Downer 53 and Jaques Ditch pick up return flows from the Saguache Town drain and the wastewater treatment facility. The TAT recommends repairing the headgate leak to reduce maintenance and improve efficiency.

Malone Ditch: This structure is located on the outside of a short meander. A stacked rock diversion dam directs water to the headgate, located on the north bank of the stream. During 2019 spring runoff, the diversion dam partially washed out. The landowner was able to temporarily repair the diversion dam, but is likely to fail again in the future. The headgate functions moderately well but leaks. The TAT recommends replacing the diversion dam and repairing the headgate leak. A new diversion and headgate would reduce maintenance and increase efficiency.

Woodard Bros Ditch: The diversion dam is a stacked rock structure with a utility pole that directs water to the headgate, located on the south bank. The diversion functions but requires regular maintenance. The headgate leaks and sediment accumulation is an issue at this structure. The TAT recommends repairing the headgate leak, installing a sluice gate, and improving the diversion dam. A new headgate and adjacent sluice gate would increase efficiency and sediment transport capacity. An improved diversion would reduce maintenance needs and help ensure long-term function.

Ashley Proffit Ditch: This structure is located on the outside of a tight meander. A stacked rock diversion dam directs water to the headgate, located on the north bank of the stream. The headgate functions effectively, however it cannot access its full decree at low flows due to leaks in the dam. The meander upstream of this structure could be cut off during a high flow event, which would cause the structure to be bypassed. Given these current issues, the TAT recommends improving the diversion dam with a structure designed to reduce maintenance and enable the ditch to divert at all flows. If the upstream meander is cut off, the TAT recommends relocating the point of diversion accordingly.

Proffit Company Ditch: This diversion is located just downstream of County Rd 48X. A boulder diversion dam directs flow to the headgate on the north bank of the stream. The diversion dam, headgate, and flume were recently improved and are functioning well. However, the channel is unstable in this location and could experience avulsion or migration in the near future. An overflow channel was installed south of the diversion dam to prevent high flows from washing out the bank. Bank stabilization was also installed upstream of diversion dam to keep water from flooding south of the channel. The TAT recommends implementing bank stabilization and riparian revegetation on the south bank upstream and downstream of the diversion. Stabilization and revegetation would mitigate erosion and help prevent future channel avulsion.

Proffit McDonough Ditch: The stream's gradient in this reach is very low and the stream is sinuous, with the potential for meanders to be cut off during high flow events. This structure's headgate is located on the south bank of the stream on the downstream end of a meander. The stream bank around the headgate was recently stabilized to prevent flows from bypassing it. The diversion dam is a stacked rock structure and functions moderately well. Occasionally, sand prevents the headgate from closing completely. The flume is tilted. The TAT recommends bank stabilization and riparian revegetation near this structure and resetting the flume. Stabilization and revegetation upstream of the diversion would help prevent the meander from being cut off and would mitigate erosion. Resetting the flume would improve long-term measurement accuracy.

Quartet Ditch: This structure is located at the apex of a meander. A boulder diversion dam directs water to the headgate, located on the north bank of the stream. The diversion dam effectively diverts the ditch's water users, but debris accumulates on the dam and the structure has led to altered sediment transport, bank erosion, and channel widening downstream of the dam. The dam creates a significant drop in the stream's elevation, forming a fish barrier and leading to a scour pool downstream of the dam. During high flows, it is possible that the stream could intercept a historic channel, causing the stream to bypass the George Ball Ditch headgate. The flume functions but is aging and may fail in the near future. Given these issues, the TAT recommends installing a new diversion, implementing bank stabilization and riparian revegetation, and replacing the flume. A new diversion would reduce maintenance needs, create fish passage, and restore the sediment transport regime. Stabilization and revegetation would help prevent the meander from being cut off and would mitigate erosion. Replacing the flume would improve long-term functionality.

George Ball Ditch: A diversion dam composed of t-posts, a utility pole, and rocks diverts water to the headgate, which is located on the south bank. The headgate leaks and is in poor condition. Woody debris accumulates on the dam, making it difficult to adjust head pressure. The streambank downstream of the diversion is eroding and may cause the entire headgate to wash out at high flows. Additionally, during a high flow event, it is possible that the stream could intercept a historic channel beginning just downstream of Quartet Ditch. If this occurs, it would cause the stream to bypass the

George Ball headgate. The flume measures accurately but is tilted and severely eroded on its downstream side. Given the issues identified at this structure, the TAT recommends implementing bank stabilization and riparian revegetation, repairing the headgate and flume, and installing a new diversion. Stabilization and revegetation upstream would help prevent the meander from being cut off and downstream stabilization would help prevent channel widening and potential dam and headgate failure. Flume repairs would improve long-term functionality. A new diversion would reduce maintenance and allow sediment and debris to pass through the system. Alternatively, the point of diversion could be combined with the diversions belonging to the Wall and Hearn ditches. The three diversions are located within 900 ft of one another. Consolidation of these diversions would reduce both maintenance and sediment transport impacts.

Wall Ditch: This diversion is located on the downstream end of a meander in the stream. The diversion dam is made up of t-posts, roofing metal, and other debris. It is typically removed during the winter. The headgate is located on the south bank and suffers from erosion, with the only remaining wing wall collapsing. The exposed headgate culvert has holes which leak at high flows. The flume measure accurately when a shift is applied, however it is eroding. Given these issues, the TAT recommends replacing the diversion and headgate and repairing or replacing the flume. A new and integrated diversion and headworks would reduce maintenance and improve ditch function. Reinforcing the flume to prevent erosion would improve long-term functionality. Alternatively, this structure could be combined with the George Ball and/or Hearn diversions. Consolidation would reduce maintenance and substantially reduce sediment transport impacts.

Hearn Ditch: This diversion is located at the apex of a meander in the stream. A diversion dam made of t-posts, boulders, and concrete directs flow to a 30 ft feeder channel on the south bank of the stream and to the headgate, which functions well. The diversion appears to limit sediment transport capacity at this location and forms a barrier to fish passage during low flows. The TAT recommends replacing the diversion with an improved structure. A new diversion would improve fish passage and sediment transport capacity. As noted above, this structure could be combined with the Wall and/or George Ball diversions. Consolidation would reduce maintenance and reduce sediment transport impacts.

Slane Scandrett Ditch: This diversion is located on the outside of a meander. The stream is unstable in this location and a historic channel approximately 0.3 miles upstream could be captured during a high flow event. To mitigate this risk, an adjustment gate approximately 480 ft down the ditch allows water to bypass the main headgate and return to the stream. Despite recently installed concrete road barriers, significant erosion was occurring downstream of the diversion dam at the time of inspection. The TAT recommends improving the diversion dam and implementing bank stabilization and riparian revegetation. A new diversion could be designed to direct flow away from the bank and reduce erosion and maintenance needs. Alternatively, combining the diversion dam with that of the Jeep Scandrett may improve this ditch's function and reduce maintenance. Stabilization and revegetation would also reduce erosion.

Jeep Scandrett Ditch: A diversion dam of boulders and woody debris directs water to the headgate, located on the north bank of the stream. The diversion is located on the outside of a tight meander. The diversion dam functions poorly during low flow, collects debris, and does not have adequate sediment transport capacity. The TAT recommends improving the diversion to more effectively divert water and to improve sediment transport. Alternatively, combining the diversion dam with that of the Slane Scandrett may improve this ditch's function and reduce maintenance.

Seitz McClure Ashley Ditch: This structure is located at the apex of a meander. The diversion dam is a welded steel check board structure which also services the Taylor A Ashley Ditch. A catwalk was installed on the diversion to improve access for maintenance. Sediment accumulation is an issue for this structure. The TAT recommends installing a sluice gate on the stream's north bank. A sluice gate would improve the sediment transport and reduce ditch maintenance at this location.

Taylor A Ashley Ditch: See the Seitz McClure Ashley Ditch diversion description above, as the diversion point is the same for both ditches. The headgate is adjacent to that of the Seitz McClure Ashley Ditch and is stabilized by a steel headwall. As described above, the TAT recommends installing a sluice gate.

Braun Bros Ditch 1: This structure is located just upstream of County Road X and Braun Bridge. The diversion dam is a check board structure with a recently installed catwalk. It is shared with the Nehls Company Ditch. The headgate, located on the north bank of the stream, functions moderately well but is hindered by sediment and woody debris accumulation. During 2019 spring runoff, the stream left the channel, flooding the adjacent field and leaving significantly less flow available for diversion. The bank was reinforced using compacted soil (see report card). The TAT recommends riparian revegetation upstream of the diversion and installation of a sluice gate adjacent to the headgate. Revegetation would mitigate upstream erosion and flooding and a sluice gate would improve sediment transport.

Nehls Company Ditch: This structure shares a diversion dam and primary headgate with Braun Bros Ditch 1. The ditch travels under County Road X and the headgate is just downstream of the road. A small check board structure is used to create head pressure. Any flow not diverted here remains in the Braun Bros Ditch 1. As described above, the TAT recommends implementing riparian revegetation upstream of the diversion and installing a sluice gate adjacent to the headgate.

4. Saguache Creek SMP Implementation Strategy

4.1 Saguache Creek SMP Goals and Priority Action Items

The vision for implementation of the Saguache Creek Stream Management Plan is *to balance diverse ecological, agricultural, cultural, and recreational needs to support a healthy watershed and its sustainable use*. The goals and associated action items and projects listed below are based on community values identified during stakeholder engagement activities and stream condition assessment results. Action items and projects are organized under the primary goal which they will help meet. This implementation strategy was developed with input and support from the Technical Advisory Team (TAT). The TAT recognizes that the projects list below is dynamic. As conditions change, project details may also change and new projects will be identified in the future.

*Note: Refer to Table 4.1 for relative costs of priority projects. For action items that may include multiple projects, cost estimates are per site.

Table 4.1: Range of project costs.

Relative Cost	Range
Low	<$10,000
Medium	$10,000 – $100,000
Medium-High	$100,000 – $250,000
High	$250,000 – $1,000,000
Very High	>$1,000,000

Goal A. Improve function and reduce maintenance of irrigation infrastructure, both for water users and river health.	
Target – Fully functioning, low maintenance diversion structures with little or no impairment to river function. Riparian restoration and fish habitat improvements should be considered as part of any improvements.	**Performance Indicators** – Continued monitoring and documentation of infrastructure function.
Justification – The diversion infrastructure assessment identified significant need for infrastructure improvements. Some structures do not function well for water users, and, in some cases, negatively affect stream health and function.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Hawkins Ditch Improvement Project	This project includes improvements to the diversion dam, including fish passage, bank stabilization to protect headgate and increase channel stability, and riparian revegetation.	Reach 3	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat; increased sediment transport capacity.	Medium
Elwes Ditch 1 Improvement Project	This project includes improvements to the diversion dam, including fish passage, bank stabilization to prevent meander cutoff and improve channel stability, improvements to wing walls on headgate, and riparian revegetation.	Reach 3	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat; increased sediment transport capacity.	Medium
Monk Ditch 1 Improvement Project	Bank stabilization is recommended to protect this ditch's headgate and prevent the structure from being cut off. This project will implement bank stabilization and improve the diversion dam to create fish passage.	Reach 3	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat; increased sediment transport capacity.	Medium
North Meadows No 779 Ditch Improvement Project	This project will involve resetting the headgate and flume as well as bank stabilization and riparian revegetation to protect the headgate and minimize channel/structure maintenance.	Reach 3	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Hodding Ditch 5 Improvement Project	This project will result in diversion dam improvements to divert water more effectively at low flows, improve sediment transport, provide fish passage, bank stabilization, replacement of flume.	Reach 3	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Friese Ditch 1 Improvement Project	This project will result in diversion dam improvements for enhanced sediment transport and fish passage, bank stabilization and riparian revegetation, headgate repairs.	Reach 3	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Munro Ditch 2 Improvement Project	This project will address erosion and channel instability through bank stabilization upstream of the headgate.	Reach 3	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Munro Ditch 1 Improvement Project	This project will result in headgate replacement, flume improvements, and diversion dam improvements for enhanced sediment transport.	Reach 3	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Morrison Ditch Improvement Project	This project involves diversion dam improvements to enhance sediment transport. Flume repair or replacement will also be included.	Reach 4	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Fullerton Ditch 1 AP Improvement Project	This project will improve the diversion dam to repair damage, improve sediment transport, and allow for fish passage.	Reach 4	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Big Meadow Ditch Improvement Project	This project involves replacing the diversion dam to mitigate debris accumulation and improve sediment transport. The headgate and flume will also be replaced.	Reach 4	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Lawrence Ditch 3 Improvement Project	This project involves bank stabilization upstream and downstream of the diversion dam to prevent the ditch from flooding out into the stream and to prevent the meander from being cut off. Fish passage and riparian revegetation will also be included.	Reach 4	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Reservoir Enlargement Ditch Improvement Project	The project will repair or replace the headgate. The diversion dam will be improved to allow this ditch to access its full decree during low flows.	Reach 4	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Mill Ditch Improvement Project	This project will result in bank stabilization upstream of the diversion, diversion dam improvements including fish passage, and a trash rack for the headgate.	Reach 4	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Florence Ditch Improvement Project	This project will result in repair or replacement of the headgate, including new wedges and a handle. The stream bank upstream of the diversion dam will be stabilized to prevent the bank from washing out.	Reach 4	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Werner Arroya Ditch Improvement Project	This project will result in diversion dam improvements to improve sediment transport. One potential solution is to move the diversion dam downstream to address the sedimentation issue.	Werner Arroyo	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Fullerton Ditch 2 Improvement Project	This project will result in diversion dam replacement to create less hydraulic jump and create fish passage. Additionally, the flume will be leveled	Werner Arroyo	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium-High
Fullerton Ditch 3 Improvement Project	This project will result in diversion dam improvements to divert water more effectively and improve sediment transport. The headgate and flume will also be repaired and reset.	Werner Arroyo	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Moses Goff Ditch 2 Improvement Project	This project will reorient or relocate the diversion dam to improve efficiency and sediment transport. The flume will be stabilized or filled to prevent further erosion.	Werner Arroyo	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Malone Sullivan Community Ditch Improvement Project	This project will repair or replace the diversion dam to allow the ditch to access to its full decree at low flows.	Reach 5	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium-High
Woodard Bros Ditch Improvement Project	This project will address the leaky headgate and result in the installation of a sluice gate to address sediment accumulation.	Reach 5	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Proffit McDonough Ditch Improvement Project	This project will result in the installation of bank stabilization structures upstream of the diversion to prevent the meander from being cut off.	Reach 5	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Quartet Ditch Improvement Project	This project will result in diversion dam improvements for sediment transport and to mitigate debris accumulation. The flume will also be reset or replaced.	Reach 5	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
George Ball Ditch Improvement Project	This project will address a headgate leak through repair or replacement. A new diversion dam will be installed that requires less maintenance and allows sediment and debris to pass through the system. Bank stabilization and riparian revegetation will be implemented downstream of the diversion dam to prevent channel widening and potential dam and headgate failure.	Reach 5	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium-High

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Wall Ditch Improvement Project	This project will result in diversion dam replacement with a low maintenance structure that is integrated with the headgate. The headgate and flume will also be repaired or replaced.	Reach 5	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Braun Bros and Nehls Company Ditch Improvement Project	This project will result in bank stabilization paired with riparian revegetation to mitigate upstream erosion and reduce sedimentation. A sluice gate will be installed on the diversion dam to improve sediment transport and reduce ditch maintenance. The project applies to both the Braun Bros and Nehls Company ditches as they share the same point of diversion.	Reach 5	B, C, D, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat; increased sediment transport capacity.	Medium

Figure 4.1: Middle D-Curtis Ditch diversion and headgate on Saguache Creek.

*Although diversion structures are listed individually, infrastructure improvement projects may be grouped and completed in phases. Irrigation infrastructure projects listed here are top priorities, however improvement needs exist on other structures as well. For a detailed assessment of each diversion structure and its condition, visit this webpage: https://riograndeheadwaters.org/stream-management-plans.

Goal B. Maintain or improve bank and channel stability, especially near important wildlife habitat and critical infrastructure such as homes, diversion structures, roads, and bridges.	
Target – Improved stream function through localized bank stabilization, riparian vegetation reestablishment, sediment transport, and floodplain connection.	**Performance Indicators** – Monitoring of geomorphic condition indicators, including channel morphology, bank stability, and sediment balance.
Justification – Results from the conditions assessment and historic imagery analysis show accelerated erosion and channel instability with impacts on critical infrastructure.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Stone Cellar Stream Crossing Improvement	Improve the Saguache Creek stream crossing near Stone Cellar Campground. This may include channel hardening, bank stabilization and riparian revegetation.	Reach 1	C, D, F, and G	Improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	Low
Flying X Cattle Company Streambank Stabilization and Restoration Project	To address streambank and channel instability, this project will result in the installation of bank stabilization structures, channel shaping, riparian revegetation, and floodplain reconnection for approximately 0.2 stream miles. The project area is just downstream of the Highway 114 bridge.	Reach 3	C, D, F, and G	Improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	Medium-High
Bank Stabilization and Infrastructure Resiliency	This project will implement bank stabilization downstream of the Rio Grande National Forest boundary to reduce erosion, protect infrastructure, and promote channel stability.	Reaches 3 through 5	C and D	Improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	Medium-High
Bank Stabilization and Fish Habitat Enhancement	This project will result in bank stabilization and riparian revegetation including fish habitat enhancements.	Reaches 3 through 5	C, D, F, and G	Improved floodplain connectivity, natural channel processes, riparian vegetation condition, and water quality; enhanced aquatic habitat.	Medium-High

Figure 4.2: Bank and channel instability downstream of the Middle Creek confluence.

Goal C. Maintain and improve the function of floodplains, associated alluvial aquifers, and natural channel processes.	
Target – Improved floodplain connection where appropriate. Allow for channel migration where possible.	**Performance Indicators** – Floodplain function allowing for mitigation of flood flows and augmentation of baseflows. Improved riparian areas and geomorphic condition indicators.
Justification – Functional floodplains maintain connection between uplands and river corridors and contribute to alluvial aquifer storage.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Saguache Creek Corridor Conservation Easements	This project will further existing efforts to continue acquiring conservation easements on private lands within the active river corridor. Easements can help preserve the ecological integrity of working lands which provide valuable ecosystem services and support stream health.	All	D, E, and F	Easements can help preserve the ecological integrity of working lands which provide valuable ecosystem services and support stream health. As new easements are secured, river corridor protection is expanded, providing substantial natural resources and river health benefits. Benefits may include increased streambank and channel stability, improved riparian vegetation condition, and enhanced alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	Variable
Upper Saguache Creek Wet Meadow Restoration	Implement targeted wet meadow restoration using temporary wood grade structures (TWGS) and other restoration techniques on upper Saguache Creek and tributaries to the Creek.	Reaches 1 and 2; tributaries	B, D, E, and F	Increased streambank and channel stability; improved riparian vegetation condition and water quality; enhanced alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	Medium

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Saguache Creek Alluvial Aquifer Restoration Initiative	Implement wetland restoration and other restoration techniques to maintain and improve alluvial aquifers, including wet meadows and active floodplains, for water storage, bank stability, and sediment filtration. Efforts are recommended to focus on areas where localized recreational impacts occur (e.g., Stone Cellar Campground).	All	B, D, E, and F	Increased streambank and channel stability; improved riparian vegetation condition and water quality; enhanced alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	Medium
Saguache Creek Floodplain Reconnection	Implement floodplain reconnection and channel restoration projects, integrating these projects with diversion structure improvements when possible.	Reaches 3 through 5	B, D, E, and F	Increased streambank and channel stability; improved riparian vegetation condition and water quality; enhanced alluvial aquifer storage, thereby mitigating impacts of groundwater withdrawal on streamflow depletion.	Medium

Goal D. Maintain and improve the extent and condition of riparian areas.	
Target – Riparian areas with diverse species and age classes that contribute to overall stream health and wildlife habitat, including imperiled species.	**Performance Indicators** – Colorado Natural Heritage Program Ecological Integrity Assessment (EIA) score; SLV HCP, riparian area function, in conjunction with floodplain and river channel function.
Justification – Healthy and highly functioning riparian areas are critical to overall stream health. Importantly, intact riparian vegetation provides stream shading and provides a buffer against changes in water temperature. Maintaining and improving riparian vegetation will support overall stream health and complements other objectives.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Saguache Creek Riparian Revegetation	Targeted riparian revegetation, focusing on Reach SC03 through SC05.	Reaches 3 through 5	B, C, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium
Saguache Creek Riparian Fencing	Installation of fencing to protect riparian vegetation, where possible.	All	B, C, F, and G	Improved riparian vegetation condition and water quality; bank stabilization; enhanced aquatic habitat.	Medium

Figure 4.3: Riparian vegetation near the Fourmile Creek confluence.

Goal E. Work toward aquifer sustainability and mitigate impact of groundwater withdrawal on streamflow depletion.	
Target – Improvements in aquifer sustainability and implementation of projects to minimize impacts of groundwater withdrawal on streamflow.	**Performance Indicators** – Aquifer level monitoring, as required by Division 3 groundwater rules and regulations.
Justification – Groundwater withdrawal has a modeled impact on streamflow, as shown by the Rio Grande Decision Support System groundwater model.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Groundwater Management Subdistrict 5	Continue groundwater conservation efforts underway through groundwater management Subdistricts. For the purposes of the Saguache Creek SMP, the focus is Subdistrict 5.	Reaches 3 through 5	C, D, E, and J	Improved riparian vegetation condition, water quality, and floodplain connectivity; enhanced aquatic habitat.	N/A
Saguache Creek Groundwater Conservation Easements	Explore additional groundwater conservation strategies, including groundwater conservation easements.	Reaches 3 through 5	C, D, and J	Groundwater conservation easements would help reach sustainable aquifer levels and may improve riparian vegetation condition and water quality.	Variable

Goal F. Maintain or improve water quality, with a focus on compliance with State water quality standards.	
Target – Improve water quality, particularly reducing heavy metal concentrations and temperature exceedance, where feasible.	**Performance Indicators** – Heavy metal concentrations, water temperature, and other standard water quality parameters.
Justification – Excellent water quality is crucial to the health of the Saguache Creek. Although there are few water quality concerns, it is recognized that maintaining excellent water quality is critically important for supporting aquatic and river health for all water users.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Saguache Creek Water Quality Improvements	Targeted riparian revegetation and bank restoration to improve water quality, especially temperature and turbidity, through stream shading and sediment reduction.	Reaches 3 through 5	A, D, and G	Reduced sedimentation and maintenance of irrigation infrastructure; improved riparian vegetation condition and floodplain connectivity; enhanced fish habitat.	Medium
Saguache Creek Sediment Reduction	Sediment reduction from Saguache Creek tributaries. This may include bank stabilization and check structures.	Reaches 3 and 5	A, D, and G	Reduced sedimentation and maintenance of irrigation infrastructure; improved riparian vegetation condition and floodplain connectivity; enhanced fish habitat.	Medium

Goal G. Maintain or improve long-term sustainability of Saguache Creek fisheries and associated aquatic habitat.	
Target – Protect and build upon Saguache Creek fisheries by continuing current management and prioritizing projects that enhance both cold- and warm-water fisheries, including imperiled species.	**Performance Indicators** – Colorado Parks and Wildlife fish surveys, macroinvertebrate MMI scores, water quality monitoring.
Justification – Saguache Creek supports remarkable recreational fisheries, which supports local anglers and outfitters, and bolsters the local economy.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Saguache Creek Fall Fish Surveys	Conduct fry shocking in fall to better understand species life stage information.	All	J	Improved understanding of fish life stages to inform seasonal flow targets.	Low (annually)
Saguache Creek Rio Grande Cutthroat Trout Restoration	Rio Grande cutthroat trout restoration in tributaries and upper Saguache Creek watershed. This may include fish habitat restoration or the installation of barriers.	Tributaries	N/A	N/A	Medium-High
Saguache Creek Fish Passage Improvements	Maintain and improve fish passage, particularly at diversion structures, throughout Saguache Creek. Creating fish passage, where possible, will improve habitat connectivity for cold- and warm-water fish species.	Reaches 3 through 5	A and B	Improved sediment transport and function of irrigation infrastructure; increased bank and channel stability.	Medium-High

Goal H. Improve infrastructure to support recreational access and use on the Saguache Creek.	
Target – Improve current access locations and construct new infrastructure, where appropriate, to enhance recreational opportunities, with a focus on sustainable infrastructure.	**Performance Indicators** – Number of new or improved river access locations; number of people utilizing the river for recreation.
Justification – Recreational access and safety improvements were identified as high priorities for community stakeholders. Opportunities exist to better support recreational activities on Saguache Creek, particularly for fishing access.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Saguache Creek Recreational Hazards Rectification	Remove hazardous fencing and install recreation-friendly fencing, especially near Stone Cellar Campground.	All	G	Improved access and stewardship of Saguache Creek fisheries.	Low
Saguache Creek Recreational Signage Improvements	Install signage to indicate stream access locations and river hazards. If possible, local organizations and state and federal agencies should coordinate to ensure consistency in signage formatting.	All	G	Improved access and stewardship of Saguache Creek fisheries.	Low
Saguache Creek Fishing Easements	This project would result in new fishing easements on Saguache Creek. Rocky Mountain Angling Club (RMAC) provides a helpful model for such arrangements.	Reaches 3 through 5	G	Improved access and stewardship of Saguache Creek fisheries.	Low (annually)

Goal I. Collect additional streamflow data and continue snowpack monitoring to better characterize Saguache Creek hydrology and improve streamflow forecasting.	
Target – Strategically install instrumentation and collect additional data to improve available streamflow and snowpack information.	**Performance Indicators** – Additional high-quality streamflow and snowpack data.
Justification – A lack of streamflow data, particularly on tributaries to Saguache Creek, was identified. Additional streamflow data will aid in understanding current hydrology, including surface-groundwater dynamics, and water management.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Saguache Creek Streamflow Data Collection	Installation of new stream gages to better capture streamflows on Saguache Creek. A new stream gage was installed just upstream of County Rd 48X in spring 2020 (Saguache Creek at Cemetery Road Near Saguache). The recently installed gage will aid in water rights administration, provide valuable data for the Rio Grande Decision Support System (RGDSS) and improve aquatic species monitoring and the overall understanding of the Creek's hydrology. Additionally, gages at County Rd 46, Braun Bridge and/or the most upstream crossing at Hwy 114 would also improve administration and provide data for RGDSS.	Reaches 3 through 5	G	Additional streamflow data will improve ability meet aquatic habitat flow targets.	Medium
Saguache Creek Groundwater Monitoring Wells	This project involves conducting a pilot project including three groundwater monitoring wells. Three potential wells have already been identified, but the wells may be changed and/or added to. Additionally, new well locations may be identified based on data needs identified in the pilot study.	Reaches 4 and 5	E	Improved understanding of groundwater dynamics on lower Saguache Creek will improve the calibration of the RGDSS groundwater modeling and aid Subdistrict 5 in groundwater conservation decision making.	Medium

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Saguache Creek Streamflow Forecasting Improvement	This project will build upon snowpack and climate measurement tools to improve streamflow forecasting. While forecasting capabilities have greatly improved in recent years, opportunities for improvement remain. In particular, consistent Airborne Snow Observatory snowpack data collection and assimilation into models such as WRF-Hydro will continue to enhance forecasting accuracy. Identification and planning for potential climate impacts such as dust-on-snow events is also recommended.	All	G and E	Improved streamflow forecasting will improve ability meet aquatic habitat flow targets and aid subdistrict 5 in groundwater conservation decision making.	Medium (annually)

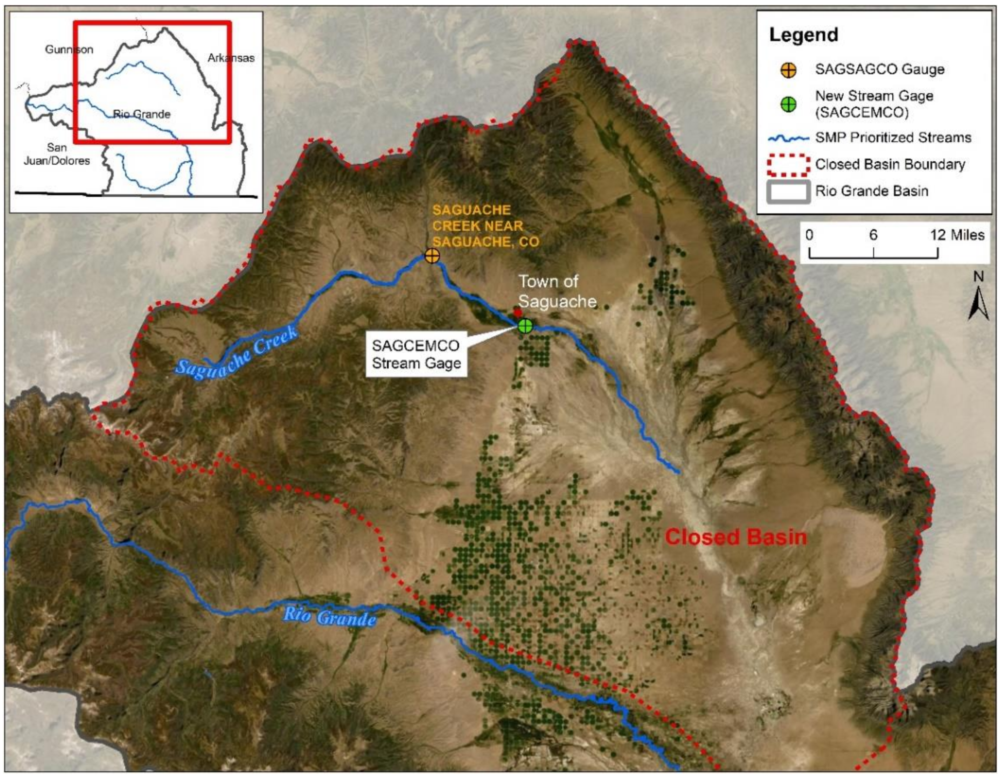


Figure 4.4: Recently installed stream gage (SAGCEMCO) near the Town of Saguache.

Goal J. Consider flow targets identified in the Aquatic Habitat Needs Assessment.	
Target – Utilize partnerships and flexible, voluntary agreements among water managers to meet aquatic habitat flow targets, when possible, to improve aquatic habitat.	**Performance Indicators –** Stream gage data to track progress toward aquatic habitat flow targets.
Justification – Meeting aquatic habitat flow targets, where possible, will improve aquatic species habitat while also supporting the local economy.	

Action Item/Project	Description	Applicable Reach(es)	Additional Goals Met	Associated Benefits	Approximate Cost
Saguache Creek Aquatic Habitat Flow Restoration	The purpose of this action item is to monitor flow targets using stream gage data and explore opportunities to better meet targets, where possible.	All	G	Increased monitoring and ability to meet aquatic habitat flow targets will provide benefits for Saguache Creek fisheries.	Low (annually)

5. Potential Funding Sources for SMP Implementation

A list of potential funding sources was developed to support implementation of the Saguache Creek SMP. This list is intended to be used as a reference and starting point for funding priority projects. It should be noted that there are likely numerous other applicable sources of funding. Table 5.1 lists funding sources and the types of projects expected to be eligible under each source.

Table 5.1: Potential funding sources for priority SMP projects and action items.

Funder	Description of Grant Program(s)	Eligible SMP-Related Projects/Action Items
Bureau of Reclamation (BOR)	BOR administers the WaterSMART program, which houses several grant programs including planning, research, and water efficiency projects.	This program primarily funds infrastructure-related projects to improve water efficiency. Other programs support baseline data collection, basin studies, and watershed planning.
Colorado Department of Public Health and Environment (CDPHE)	CDPHE administers grant funds to address water quality issues, especially projects that address water quality impairments on the 303(d) list.	Restoration or mitigation projects related to water quality. In the event of a Compliance on Consent (COC) order, funds are available for Supplemental Environmental Projects (SEP) that mitigate water quality issues, especially those associated with the COC order.
Colorado Healthy Rivers Fund	This grant program is administered through Colorado Water Conservation Board in association with the Water Quality Control Division and the Colorado Watershed Assembly.	On-the-ground projects "that contribute to cleaner water, healthier wildlife habitat, and improved recreation," including river restoration and riparian re-vegetation.
Colorado Parks and Wildlife (CPW)	CPW's Wetlands and Wildlife Program	Wetlands restoration, including streambank restoration and floodplain reconnection projects. Infrastructure projects that support wetland and/or wildlife habitat.
Colorado Water Conservation Board (CWCB)	There are numerous grant and loan programs administered by the CWCB. Among others, these include the Watershed Restoration, Colorado Water Plan (CWP) grants, and the Water Supply Reserve Fund (WSRF) program.	CWCB grant programs cover a wide range of potential projects, from stream restoration to water infrastructure. Loans are also available for entities such as ditch companies.
Great Outdoors Colorado (GOCO)	GOCO grants fund habitat restoration, land conservation, recreation and outdoor planning, and stewardship.	Boat ramps and other recreation infrastructure. River and wetland restoration and conservation activities, including conservation easements.
National Fish and Wildlife Foundation (NFWF)	NFWF primarily funds wildlife-related projects. The Foundation also has a significant restoration focus.	Stream corridor restoration, especially wildlife-related projects.
Natural Resource Conservation Service (NRCS)	NRCS has several funding programs including the Environmental Quality Incentive Program (EQIP), Targeted Conservation Plan (TCP), National Water Quality Initiative (NWQI), and Regional Conservation Partnership Program (RCPP).	Bank stabilization, diversion and ditch infrastructure improvements, and wildlife habitat enhancement.
RESTORE Colorado Program (Restoration and Stewardship of Outdoor Resources and the Environment)	RESTORE Colorado is a strategic funding partnership between GOCO, NFWF, CWCB, CPW, Gates Family Foundation, and Colorado Department of Natural Resources.	Enhancement and restoration of hydrology and connectivity for native species including aquatic habitat restoration and fish barrier installation/removal. Enhancement and restoration of riparian and wetland habitats, including managing grazing in riparian areas, invasive species removal, and wet meadow restoration.

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7. List of Appendices

The following is a list of SMP appendices. The appendices, which include the recreational use and flow needs assessment conducted by American Whitewater and other background reports used to develop the SMP are available as PDFs at: https://riograndeheadwaters.org/stream-management-plans. The full riparian vegetation and geomorphology reports are also available at this site.

- **A. Assessment of Streamflow Needs for Supporting Recreational Water Uses on the Rio Grande and Conejos River**
- **B. Channel Migration Analysis**
- **C. SMP Tracer Gravel Study**
- **D. Stream Classification System Summaries**
- **E. Botany Survey and Analysis**
- **F. Water Quality and Aquatic Life Data**