VOLUME 2 • JANUARY 2022

GUNNISON

Basin Implementation Plan

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What is the Basin Implementation Plan?

The Basin Implementation Plan, developed in a collaborative process by basin stakeholders, focuses on the current and future water needs in the Gunnison Basin, the vision for how needs will be met, and the strategies and projects that provide a pathway to success. The initial Gunnison Basin Implementation Plan was completed in 2015, and this is the first update of that plan.

THE EXAMPLE BIP CONSISTS OF TWO VOLUMES:

VOLUME 1:	VOLUME 2:
A summary of the Gunnison Basin's current and future water resources, focusing on goals, projects, and a strategic vision to meet future water needs.	A comprehensive analysis of four specific sectors of interest including climate change, watershed health, weather modification, and project implementation.

SECTION 1. INTRODUCTION

The Gunnison Basin Implementation Plan (Gunnison BIP) Volume 2 was created by the Gunnison Basin Roundtable (Gunnison BRT) for submittal to the Colorado Water Conservation Board (CWCB). It is designed to support regional water planning through the roundtable process established by the Colorado Water for the 21st Century Act. The Gunnison BIP builds on previous roundtable work to propose and fund projects for meeting water needs. The Gunnison BIP also provides critical grassroots input to the forthcoming Colorado Water Plan.

To encourage locally driven and balanced solutions to water supply challenges, the plan identifies water projects through targeted analyses of water issues in the basin. The Gunnison BIP includes analyses of water shortages, water availability under variable hydrologic conditions, and various site-specific water supply issues. The ultimate purpose of the plan is to better identify water priorities in the basin and highlight proposed projects that will excel at meeting these priorities soon.

The Gunnison BIP process continues the important public education, participation, and outreach work that the Gunnison BRT has been engaged with for almost 15 years. The creation of the Gunnison BIP included targeted technical outreach to refine information on water needs and projects. It also included public outreach with local stakeholders to gather input on key elements of the plan. The Gunnison BRT's ongoing outreach and education efforts will be critical throughout the development of the Clean Water Plan.

The structure of this Volume 2 document is a compilation of additional analyses conducted by the Gunnison BRT in four different sectors of interest:

- Section 2: Basin Projects
- Section 3: Climate Change
- Section 4: Watershed Health
- Section 5: Weather Modification

The BRT has developed a strategic vision for meeting future water supply challenges in the basin, and consideration of the information in these four sectors will inform basin stakeholders as they plan for and implement projects in the basin. Each section goes into depth regarding the individual topics and their relationship to the Gunnison Basin, and serves to supplement the information provided in Volume I of the Gunnison BIP.

SECTION 2. BASIN PROJECTS

The Gunnison BRT worked diligently to identify projects during the BIP Update process that aim to meet the water needs of agricultural producers, water managers, municipal providers, the environment, recreational users, and the community at-large.

Early in the BIP Update process the BRT identified the need for project implementation as the best way to meet their overarching goal to **protect existing water uses in the Gunnison Basin**. Tom Alvey is quoted from an early stakeholder meeting as follows:

> *I certainly do not want to minimize the importance of modeling for our determination of needs in the Gunnison basin, but regardless of the scenario, we are water short throughout the basin. The nuances of the effects of variations in the supply timing and amounts are less important than the fact that we need to stretch our water as far as we can already. Any potential project that we would be likely to approve would improve either our efficiency or our storage capacity. Most of the projects we have funded in the past and likely in the future are targeted at maintaining or improving our existing infrastructure. That's the most important part of avoiding worse shortages in the future.*
>
> - Tom Alvey, BIP subcommittee member and Gunnison Basin Fruit Grower.

The Gunnison BRT has established a project tiering system to help prioritize projects for implementation. This section first quantifies the urgency for projects by outlining the growing water supply gaps under five water planning scenarios. To address the gaps, the Gunnison BRT has developed six metrics to rank project suitability to determine how quickly the project can start, whether the project is multi-beneficial, and how well the project aligns with existing state, basin, and local water plans. Together, these six metrics are used to characterize the overall project tier ranking.

While the subcommittee identified 345 new projects in 2020, it is important to note that a significant number of necessary projects remain un-identified. The projects list represented in the BIP update is a "snap-shot" of projects identified by the BRT subcommittee. Likely many projects remain unidentified for multiple reasons including:

- Small domestic water supply systems are often managed by limited public works staff or by volunteer or community boards who are not closely connected to the BRT process. These users may be unaware of the BIP update and often remain unaware of needed projects until problems manifest. This sector of projects is likely underrepresented on the projects list.
- Larger municipal water projects are often funded through enterprise funds or local tax dollars. Certain municipalities are reluctant to place all or even some of their projects on the BIP list because funding is secured or will be budgeted within a capital improvement plan. Placing these projects on the BIP projects list doesn't provide any value to the project proponents, although the projects themselves represent significant project needs within Gunnison Basin communities.
- On-farm and near-farm irrigation efficiency projects are likely under-represented on the projects list. Irrigation efficiency projects are on-going within the basin. Many projects utilize public cost share of some kind. The US Department of Agriculture/Natural Resource Conservation Service's Environmental Quality Incentives Program is one of several funding sources available. The image to the right shows an example of an on-farm irrigation efficiency project in the North Fork area that was funded by the USDA/NRCS EQIP along with significant administrative capacity provided by the Colorado River Water Conservation District. Many projects are privately funded by farm business capital, especially when public cost share programs or grants aren't nimble enough to keep up with markets or shifting agronomic practices. On-farm efficiency represents an important tool for the Basin moving forward. The Gunnison BRT fully supports projects within this sector.

Image of a recent on-farm irrigation efficiency project in the North Fork area.

- Environmental and Recreational (E&R) projects that will be identified as our communities grow. Demand for water-based recreation is increasing within the Gunnison Basin as the population grows in many of our communities. Many identified projects that improve water management and efficiency in the basin have the potential to also improve E&R attributes.

The impacts of climate change, Colorado River issues, the economics of agricultural production and cultural shifts within the community will require that the Gunnison BRT remain nimble and attentive to community needs moving forward. The Gunnison Basin project list included with the BIP Update is extensive, however, the Gunnison BRT remains fully aware that there are many important projects that are not identified on our projects list. While this section outlines a snapshot of projects identified during the BIP Update, many more worthwhile projects remain unidentified.

Basin Gaps

The Gunnison Basin is no stranger to gaps between water demand and water supply. Many geographical areas within the larger basin experience supply shortages on an annual or near-annual basis. The modeling provided in the Technical Update supports this. Further refinements were made to the Technical Update during the BIP Update process that altered some of the results. Additional information on the refinements to the Technical Update is provided in Appendix A. Many in the basin are particularly concerned with the frequent supply gaps in the agricultural sector, the increasing municipal sector gaps forecasted, and the E&R gaps expected to manifest more often in the planning scenarios.

Figure 1 below demonstrates the modeled scenarios in the BIP Update and the subsequent agricultural gaps. Note that even in the Baseline scenario there are multiple years of agricultural water shortage. More information on the agricultural demand gaps can be found in Volume 1.

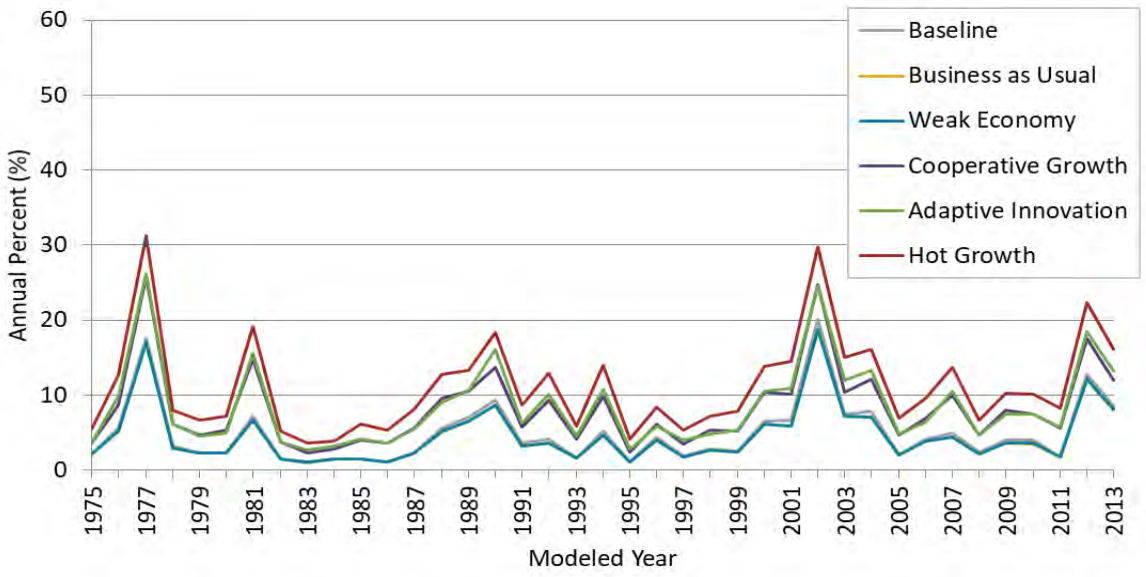


Figure 1. Gunnison Basin Annual Agricultural Gaps Analysis Based on the Five Planning Scenarios

Figure 2 below demonstrates the modeled scenarios in the BIP Update and the subsequent municipal and industrial (M&I) gaps. Note that the Baseline scenario only experiences a small municipal gap in model runs using data from 1977 (an incredibly dry year). However, there are multiple years of municipal water shortage in the other scenarios. More information on the M&I demand gaps can be found in Volume 1.

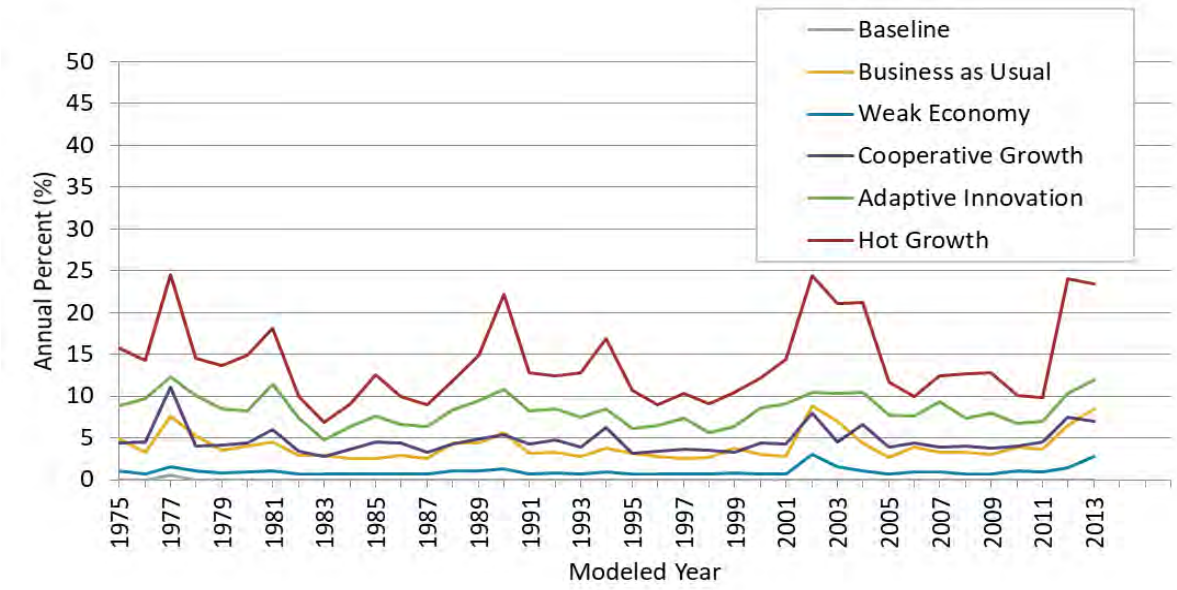
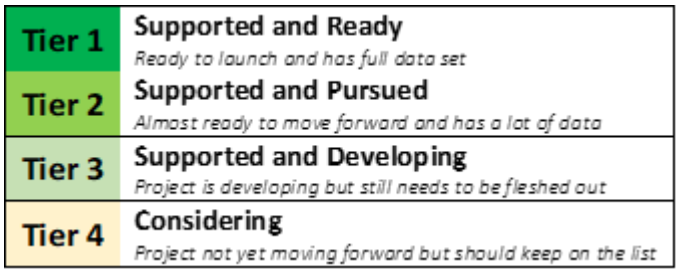


Figure 2. Gunnison Basin M&I Historical Incremental Gap Analysis Based on the Five Planning Scenarios

Even in above-average water years, agricultural water users' experience shortages in some parts of the basin based on local hydrology, lack of storage and inadequate infrastructure. This suggests that agricultural efficiency and supply projects will be impactful. While the M&I sector is not currently experiencing supply gaps, this is expected to change in the future especially for the climate-impacted scenarios. This calls for timely implementation of water projects to address future need.

Project Tiering

A new feature of the projects list for the BIP Update is the assignment of "tiers" to projects. Projects are assigned a tier of 1 through 4 based on project readiness, with tier 1 projects being projects that are ready for implementation (see description of tiers in the graphic). The Gunnison Basin projects list has a significant number of "Tier 1" projects. This reflects the diversity of projects within the basin and the frequency of water shortages within the basin. Agricultural and E&R water uses are chronically water short within the Gunnison Basin in many areas, and municipal uses experience chronic shortages during many future planning scenarios. Table 1 demonstrates the project tiering associated with the Gunnison Basin projects list as well as the estimated costs for those projects with an identified cost.



To determine the overall tier classification, projects were evaluated on the metrics described below and in the following subsections:

- Timeline: how quick can the project begin
- Basin alignment: how well does the project meet basin needs outlined in the BIP
- Local plan alignment: how well does the project meet local master planning initiatives
- Water Plan alignment: does the project meet the criteria of the Water Plan
- Minimum criteria: how well does the project meet the 21 criteria identified by the Gunnison BRT
- Need: does the project have a basin-wide impact

Table 1. Final Project Tiering

Project Tier	Number of Projects	Associated Costs
Tier 1	131	$511,662,000
Tier 2	103	$610,914,000
Tier 3	111	$182,729,000
Tier 4	0	-
Total	**345**	**$1.3 billion**

TIMELINE TIER

The key variable when classifying the timeline project tier is funding. Nearly all the projects on the projects list are implementable with adequate funding. An important assumption made during our analyses is that implementation includes the necessary planning, permitting, and design, rather than projects that are at the bid/construction phase. Project implementation may take years and beginning the project implementation process includes many elements prior to construction, especially given the large number of projects on our list that will have a federal nexus of some kind (funding, public lands, ESA, etc.) within the Gunnison Basin. For many projects a significant and cumbersome permitting process is unavoidable. The timeline tier structure is outlined in the graphic below while the number of projects per timeline tier is shown in Table 2.

Project Phase	Tier 1	Tier 2	Tier 3	Tier 4
Timeline for Implementing project phase selected from drop-down (below):	Ready to launch projects that are immediately implementable (within one year) were funding to be made available or if funds have already been secured; does not apply for a "Concept" project.	Projects that could launch within two years were funding to be made available or if funding is in the process of being secured; does not apply for a "Concept" project.	Needs two to five years to launch were funding to be secured.	Not shown or longer than five years to implementation.

Table 2. Projects within each level of the timeline tier

Timeline Tier	
Tier 1	96
Tier 2	239
Tier 3	10
Tier 4	0

BASIN ALIGNMENT

All of the projects on our projects list align with the Gunnison BIP. Projects that are not in alignment with the BIP were excluded. Ultimately, the goal of the list is to provide a set of projects that can be implemented to help meet basin needs, address local concerns, and support our goals. The basin alignment tier structure is outlined in the graphic below while the number of projects per basin alignment tier is shown in Table 3.

Plan Alignment	Tier 1	Tier 2	Tier 3	Tier 4
Basin Plans	Strongly aligns with Basin Implementation Plan.	Somewhat aligned with Basin Implementation Plan.	Not as well aligned with Basin Implementation Plan.	Not shown.

Table 3. Projects within each level of the Basin Alignment Tier

Timeline Tier	
Tier 1	345
Tier 2	0
Tier 3	0
Tier 4	0

LOCAL PLAN ALIGNMENT

One outcome from this process is the recognition of the significant amount of local planning efforts that have occurred within the Gunnison Basin since the last BIP. Especially those efforts related to master planning for irrigation infrastructure improvements. Additionally, for many entities and project proponents simply identifying a project for the list demonstrates that some level of planning and stakeholder discussions have taken place. The local plan alignment tier structure is outlined in the graphic below while the number of projects per local plan alignment tier is shown in Table 4.

Plan Alignment	Tier 1	Tier 2	Tier 3	Tier 4
Local Plans	Extensive local planning, organizational support and water rights support the project.	Some local planning or organizational support for the project; water rights may or may not be explicitly identified.	Not clearly identified in any local plan, organizational effort; water rights concerns are noted; may be under consideration or going through a permitting process.	Not shown.

Table 4. Projects within each level of the Local Plan Alignment Tier

Timeline Tier	
Tier 1	224
Tier 2	101
Tier 3	20
Tier 4	0

WATER PLAN ALIGNMENT

The Water plan alignment tier set a very high bar for tier 1 status. Meeting each of the criteria described at times is hard to justify for projects. However, Tier 2 status of meeting at least 2 criteria is a low bar in the Gunnison Basin given the dominance of agricultural water use. For example, improvements to agricultural water use often incorporates elements of the E&R sector. These E&R needs are not always identified, but the broad assumption was made that decreasing demand or improving supply through infrastructure improvement will allow more water to be utilized within a stream reach for other uses. Further analysis of individual projects would likely create more variety amongst this tiering criterion. The Gunnison BRT is committed to multi-beneficial projects where applicable and those entities seeking funding should, where possible, search for any potential multi-use benefits prior to looking to the roundtable for funding. The water plan alignment tier structure is outlined in the graphic below while the number of projects per water plan alignment tier is shown in Table 5.

Plan Alignment	Tier 1	Tier 2	Tier 3	Tier 4
Local Plans	Extensive local planning, organizational support and water rights support the project.	Some local planning or organizational support for the project; water rights may or may not be explicitly identified.	Not clearly identified in any local plan, organizational effort; water rights concerns are noted; may be under consideration or going through a permitting process.	Not shown.

Table 5. Projects within each level of the Water Plan Alignment tier

Timeline Tier	
Tier 1	24
Tier 2	321
Tier 3	0
Tier 4	0

MINIMUM CRITERIA

To justify the appropriate project tier, a set of core data was identified to help determine which projects might be closer to implementation. A recommended list of 21 criteria was identified including project name, location, and classification; as well more in-depth criteria such as the estimated yield, estimated costs, and estimated capacity. Table 6 is a list of all the criteria that a project should seek to identify. For many projects the core data were already identified by a lead proponent or other stakeholder. Some projects however have few core data generated. It should be noted that some core data may be quite difficult to obtain. Figure 3 identifies the breakdown of these projects and how they align within the tiering. The minimum criteria tier structure is outlined in the graphic below while the core data categories are shown in Table 6. The number of projects per core data category is shown in Figure 3.

Plan Alignment	Tier 1	Tier 2	Tier 3	Tier 4
Meets Core Data Needs (list of 21)*	Includes all 21 criteria.	Meets critical subset; (16) designated critical data fields.	Provides only a few details; critical subset is not complete.	Not shown.

Table 6. Projects Core Data Categories

Project Tier	Number of Projects	Associated Costs
1	Project ID	Y
2	Project Name	Y
3	Project Description	Y
4	Key_Word_1	Y
5	Status	Y
6	Lead Proponent	Y
7	Lead Contact	Y
8	Municipal Ind Need	Y
9	Agricultural Need	Y
10	E&R Need	Y
11	Admin Need	Y
12	Latitude	Y
13	Longitude	Y
14	Lat Long Flag	N
15	County	Y
16	Water District	Y
17	Estimated Yield	N
18	Yield Units	N
19	Estimated Capacity	N
20	Capacity Units	N
21	Estimated Cost	Y

*blue data not considered in tiering

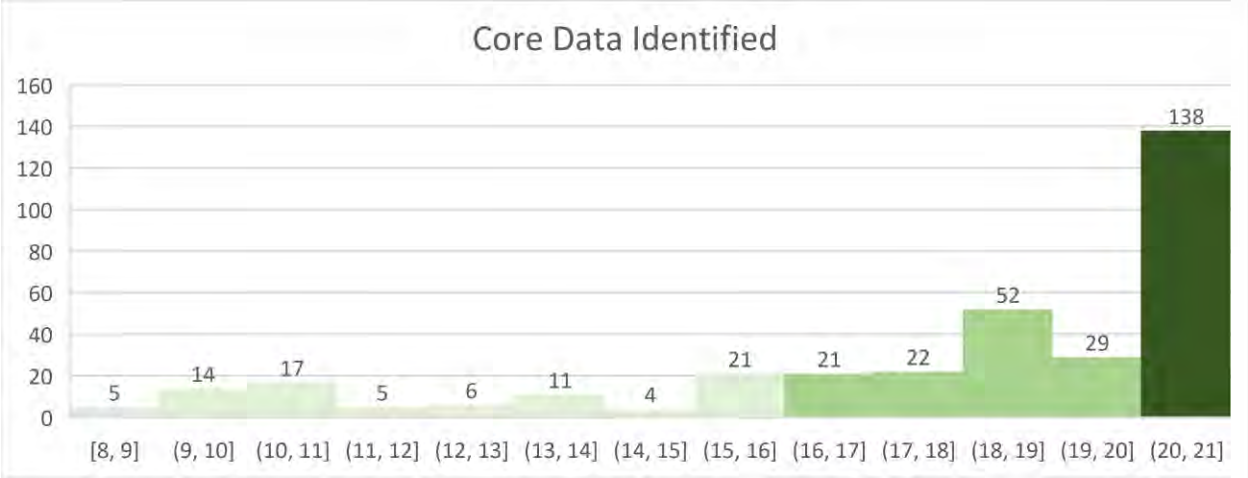


Figure 3. Core Data Fields Identified by Project (i.e., 138 projects had 20 or 21 criteria identified

PROJECT NEED

Assigning a tier to "Need" or project "Criticality" is a difficult task. An individual user may find a small headgate repair absolutely critical, but on a basin scale the project may have little impact on water use and not "close the gap" in a basin scale model. The criteria provided for the tier suggest that tier 1 projects should have significant basin wide impact and not implementing the project could cause severe impact to the basin if the project didn't move forward. With this tier 1 criterion in mind five projects were identified as tier 1 within this category:

1. GUN-2020-0114 - Paonia Reservoir Sediment Removal and Outlet Modification Project:
   This project represents an infrastructure improvement and storage recovery project that easily meets the Tier 1 criteria for need. Without this project moving forward significant agricultural production in the North Fork Valley is at risk of losing access to supplemental irrigation supplies that are critical to crop production.

   GUN-2020-0224 – Additional Weather Modification: Additional weather modification within the basin to support local water users, the environment, and the State of Colorado. Expanding the existing weather modification program would help to protect existing water uses in the Gunnison basin and increase supplies for agricultural uses to reduce shortages.
2. GUN-2020-0248 - Gunnison BRT Demand Management Engagement: The Gunnison BRT may want to take a more proactive approach towards Demand Management or other Colorado River issues. This project is intentionally left relatively vague. The Gunnison BRT is not confident that Demand Management as contemplated within the Upper Basin DCP will be a feasible strategy within the Gunnison Basin. However, the Gunnison BRT is committed to investigating and supporting programs that increase basin wide resilience for the Colorado River.

3. GUN-2020-0249, GUN 2020-0250, and GUN 2020-0251 - Phase 1, Phase 2, and Phase 3-Basin wide wildfire risk mitigation project: This multi-phase project will focus on critical water supply infrastructure and the risks associated with large uncontrolled wildfire and subsequent changes to hydrology, hydraulics, and sediment/debris transport post fire. The three projects represent differing phases to emphasize, understand, and begin to address the massive issue of watershed health within the Gunnison basin. The Gunnison BRT believes that water health issues are likely some of the most critical issues facing the Gunnison basin. Refer to Section 4: Watershed Health for more information on these projects and forest health issues in the basin.

4. GUN-2020-0252 Basin wide emphasis on Watershed Health projects: Restoring headwater floodplains and adjacent wetlands is one of the best proactive ways to address both water quality and water supply, while improving recreation and habitat for aquatic and terrestrial species. This IPP acts as a placeholder for any projects yet to be identified that focus on watershed health and any of the following impacts of such projects: 1.) Improved Water Quality 2.) Snowpack/storm flow attenuation 3.) Flood Reduction

4.) Habitat Resiliency. Similar to the projects above this critical project focuses on watershed health and projects related to watershed health that may come forward. Specifically, this project emphasizes restoring natural infrastructure.

The projects described above are considered critical on a basin scale and fall broadly into two categories. The first is landscape level understanding and implementation of watershed health, the second is Colorado River issues. The Gunnison BRT believes that projects in these categories represent the issues that could, in the short term, most negatively impact the Gunnison Basin and impact the ability to achieve our primary goal to protect existing water uses in the Gunnison Basin. The project need tier structure is outlined in the graphic below while the number of projects per project need tier is shown in Table 7.

Plan Alignment	Tier 1	Tier 2	Tier 3	Tier 4
Criticality	Critical to basin (would cause severe impact to the basin if the project didn't move forward; (Basin Priority and/or Emergency Need); Has clear metrics for tracking and completion date.	Significant basin effort (fully aligns with basin goals); implementation or plan would advance basin goals; has clear metrics for tracking and completion date.	Project could be of basin interest but may not as directly advance basin goals; may not have clear metrics and/or may not have a clear end date or objectives.	Not shown.

Table 7. Projects within each level of the Project Need tier

Project Need Tier	
Tier 1	7
Tier 2	318
Tier 3	20
Tier 4	0

Analysis of Project Categorization

Project tiering is a tool used to demonstrate how the projects roughly prioritize within the basin. Understanding the breakdown of the types of projects and how they are categorized can help guide the basin in better understanding what needs exist. Many times, constituent projects require studies to determine the most impactful projects to implement. Other times the necessary actions are obvious structural practices that can be built. Categorizing the various project types can be helpful in understanding the needs of the basin. This compilation is a snapshot in time as the type of projects evolve or different needs change within the basin. Figure 4 demonstrates how our projects breakdown by category. Note that many projects could easily be categorized under multiple criteria or a different criterion. Additionally, the applied categories are not a part of the Core Data, but simply an assumption made by utilizing the Core Data provided for each project.

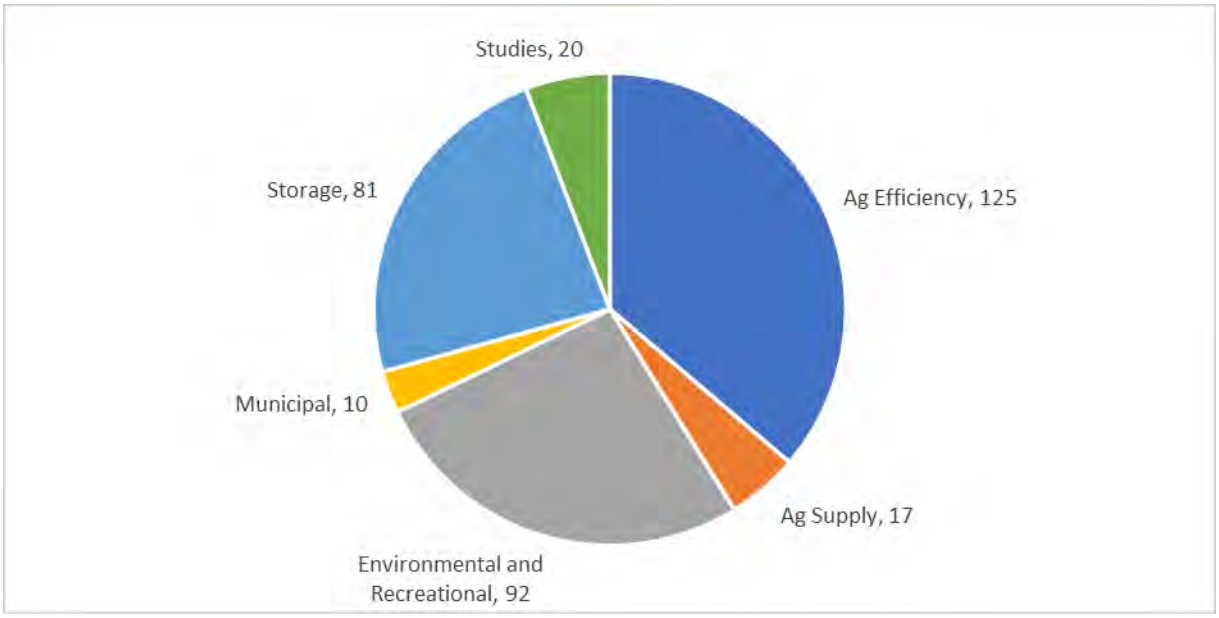


Figure 4. Identified Projects Breakdown by Category

Understanding that the largest category of identified needs of the basin are either ag efficiency (36%) or E&R (26%, watershed health falls in this category as well) helps to demonstrate that the basin has a fairly strong grasp on project needs based on the significant agricultural shortages in the planning scenarios and risk to E&R under climate change. The cost allocation to these projects can be seen in Figure 5. This helps demonstrate the allocation of projects versus amount of funding when compared to Figure 4 (above).

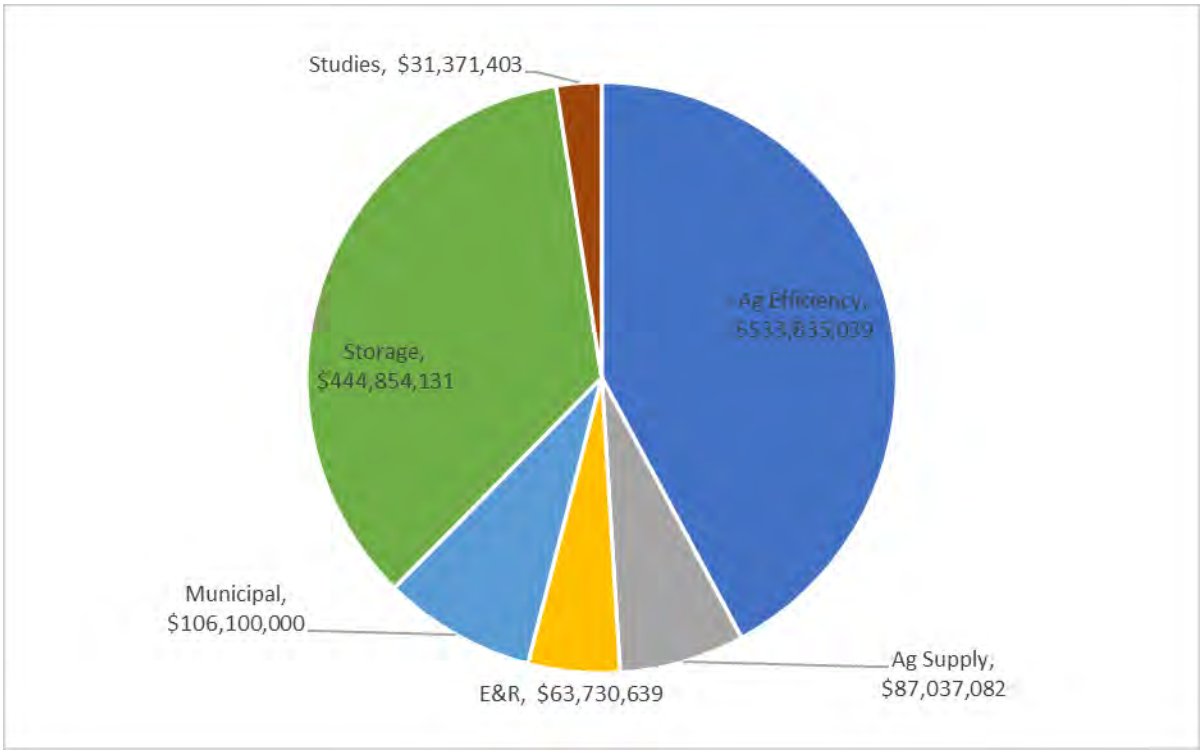


Figure 5. Total Project Costs by Category

One large take-away from the data in Figure 5 is that ag efficiency and storage are the largest categories by cost. The agricultural efficiency cost makes sense based on the total water usage in the basin (97% of total usage, see Volume 1). Water use in the Gunnison Basin is dominated by agriculture and many projects are related to or adjacent to existing infrastructure associated with existing agricultural uses. The storage cost component is dominated by a single large project (Ram's Horn Reservoir, $250M) with a significant number of smaller storage projects and storage rehabilitation projects. During this BIP Update the basin did not model specific projects and their ability to close water supply gaps. However, the emphasis on efficiency and storage indicates that project proponents are focused on closing gaps in their individual supplies through efficiency and storage. In addition to closing supply gaps, improvements to agricultural infrastructure benefits other water use sectors as well. If the Ram's Horn Reservoir project is not pursued the need for storage to close gaps across the basin still exists and the per acre-foot cost of multiple smaller storage reservoirs could potentially be greater for multiple dispersed projects.

In the ag efficiency category well over half of the projects are ready to be implemented pending funding, as funding is the major hurdle to project implementation. Table 8 breaks down the number of efficiency projects and their costs by tier. Table 9 compares efficiency project costs to total project costs that have been identified.

Table 8. Projects within each level of the Water Plan Alignment tier

Tier	Number of Projects	Cost
Tier 1	69	$432,166,363
Tier 2	37	$68,149,726
Tier 3	19	$33,518,950
	Total	**$533,835,039**

Table 9. Ag Efficiency Projects as Compared to Total Project Costs

Tier	Number of Projects	Cost	Percent of Total
Tier 1	$432,166,363	$511,661,577	84%
Tier 2	$68,149,726	$610,914,310	11%
Tier 3	$33,518,950	$182,729,353	18%
Total	**$533,835,039**	**$ 1,305,305,240**	**41%**

Understanding how basin needs breakdown by cost is important, however spatial data can also help tell the story of project needs within the basin. Table 10 begins to describe spatially the ag efficiency projects within the basin.

Table 10. Ag Efficiency Projects by Water District

Water District	Number of Projects
28	8
40	64
41	19
42	5
59	10
62	7
68	6
Basin wide	**6**

Water district 40 and 41 include the Uncompahgre Valley Water Users Association and the North Fork of the Gunnison. These two water districts encompass the largest concentration of irrigated lands within the basin and subsequently account for many of the identified efficiency projects.

Highlighted Projects

The Gunnison Basin projects list is by no means a comprehensive list of projects. Many projects remain unidentified; however, the following projects are highlighted in this document as a means of emphasizing the type of projects we believe may begin to address the myriad water supply issues faced by the basin.

BOSTWICK PARK/UVWUA/TU PL-566

Bostwick Park Water Conservancy District, as lead project sponsor, along with Co-sponsors, Uncompahgre Valley Water Users Association, Cimarron Canal and Reservoir Company and Trout Unlimited have applied to the 2020 Watershed and Flood Prevention Operations Program (WFPO) and been awarded planning funds to complete an Environmental Assessment of numerous projects within the Gunnison Basin. The projects shown in Table 11 are included within that WFPO application and are currently well into the planning stages. It should be noted that at the time of drafting this document these projects are in an alternatives analysis stage and may change significantly.

Table 11. Projects within the existing WFPO application

Project ID	Project Name	Estimated Cost	Project Tier
GUN-2020-0044	M&D Canal Stabilization	$9,300,000	Tier 1
GUN-2020-0190	Cimarron Canal Piping Through Wells basin (above Coal hill)	$4,454,333	Tier 1
GUN-2020-0192	East Lateral	$4,008,000	Tier 1
GUN-2020-0193	Coal Hill	$3,403,000	Tier 1
GUN-2020-0194	Cimarron Headgate Temperature Loggers and Electric Fish Screen	$1,172,283	Tier 1
GUN-2020-0195	West Lateral Piping	$2,188,000	Tier 1
GUN-2020-0253	Slide Point	$3,551,430	Tier 1

Additionally, should the current efforts to utilize federal watershed authority funds prove functional in addressing supply needs, the basin has identified project 0155 shown in Table 12 as a placeholder for Gunnison BRT support of additional applications and projects. Additionally, project 0222 is on the projects list because the Redlands Water and Power Company (RWPC) could potentially utilize the planning funds available thru this funding source to identify the significant needs of their organization as well as the impacts that infrastructure projects might have upon the Gunnison basin. Project 0222 is one of many potential projects that could be executed using these funds.

Table 12. Project placeholders for future watershed authority applications

Project ID	Project Name	Estimated Cost	Project Tier
GUN-2020-0155	Watershed Authority projects and applications to USDA	$50,000,000	Tier 2
GUN-2020-0222	RWPC PL-566 Project	$20,000,000	Tier 3

SMALL RESERVOIR REHABILITATION PROJECTS

GUN-2020-0040 – Vouga Reservoir Repair and Automation

The Vouga Reservoir project is highlighted for a number of reasons including:

- Private ownership: Many smaller storage structures within the Gunnison Basin are held by private landowners or small mutual ditch companies. Often the cost of rehabilitation exceeds the wherewithal of the users, and it can be difficult to justify the large grant needs for improvements necessary to rehabilitate, increase or restore the decreed volumes.
- Small, high elevation storage is increasingly important to the Gunnison basin and emphasizing the importance of these structures will help the basin meet future supply gaps.

Regardless of ownership or end use, small storage reservoirs within the basin have been and will remain an important mechanism for Gunnison Basin water users to address existing and future gaps.

At multiple times during this process the importance of small reservoir rehabilitation projects has been raised. Small reservoirs are common in higher elevations within the basin, especially those areas tributary to the North Fork of the Gunnison River and the Surface Creek drainage. Many of the reservoirs were constructed early in the agricultural history of the basin and are beginning to show their age. Many reservoirs have fill restrictions of some kind placed upon them by the Division of Dam Safety. Additional example projects include:

GUN-2020-0263 – Blanche Park Reservoir

The Blanche Park reservoir is scheduled for completion of rehabilitation later this year and will restore 125-acre feet of capacity.

GUN-2020-0244 – Leroux Creek Reservoirs

The Leroux Creek Reservoirs project includes 28 separate reservoirs in varying stages of repair and rehabilitation.

NORTH FORK FARMER'S DITCH IMPROVED DIVERSION (2020-0088)

Primarily an agricultural project anticipated to improve river health and function, including improved safety for recreationalists. This project is an outcome of the Stream Management Planning efforts undertaken by the North Fork Water Conservancy District (NFWCD), West Slope Conservation Center, and partners. These entities investigated diversion infrastructure within the river reach from the confluence of Muddy and Anthracite Creeks to the confluence with the Gunnison River. Importantly, the outcome from this the planning efforts was the identification of several multi-benefit projects. One of the most impactful multi-benefit projects would be project 2020-0088. This project would improve diversion operations and management for irrigation purposes while also improving recreational safety and addressing fish passage issues at certain flow regimes.

PAONIA RESERVOIR REHAB (2020-0114)

Paonia Reservoir was designed to store 21,000 AF of water, which is used for irrigation, flat-water recreation, fishing, augmentation, and improved late season flows to the North Fork of the Gunnison. Over the last fifty years, the reservoir has lost 24% of its total capacity due to sedimentation build up. The goal of this project is to investigate long-term sediment management options, with the intent of minimizing future losses and possibly restoring current capacity losses. Without improvement to the outlet works the Fire Mountain Canal Company and NFWCD risk losing certain elements of control of reservoir releases which could result in considerable water quality impact for the river and downstream users. The total cost of the project is $8 million and carries a tier 1 designation with a pressing need for implementation. The project is currently in the implementation phase, however additional phases of the project are necessary.

RESERVOIR SUPPORTED ON-FARM EFFICIENCY

Multiple projects on the Gunnison Basin projects list are categorized as agricultural irrigation efficiency projects. Efficiency projects are not all created equal, however. A significant number of irrigated lands within the Gunnison Basin are supported by supplemental water made available through storage projects. Efficiency increases on acreage that is supported by supplemental reservoir water have the potential to have a greater impact on the agricultural gap. In specific circumstances the potential also exists for water conserved through efficiency projects to be re-timed and/or leased to E&R and municipal uses. These types of transactions can be complicated but the original action that must be taken in order to conserve water is for efficiency projects to be implemented on acreage that has reservoir storage. Further analysis may be necessary to determine the extent of reservoir support for identified fields. Eventually a metric of cost per ac-ft of conserved reservoir water could be determined to better focus efficiency efforts towards closing agricultural gaps on a basin scale.

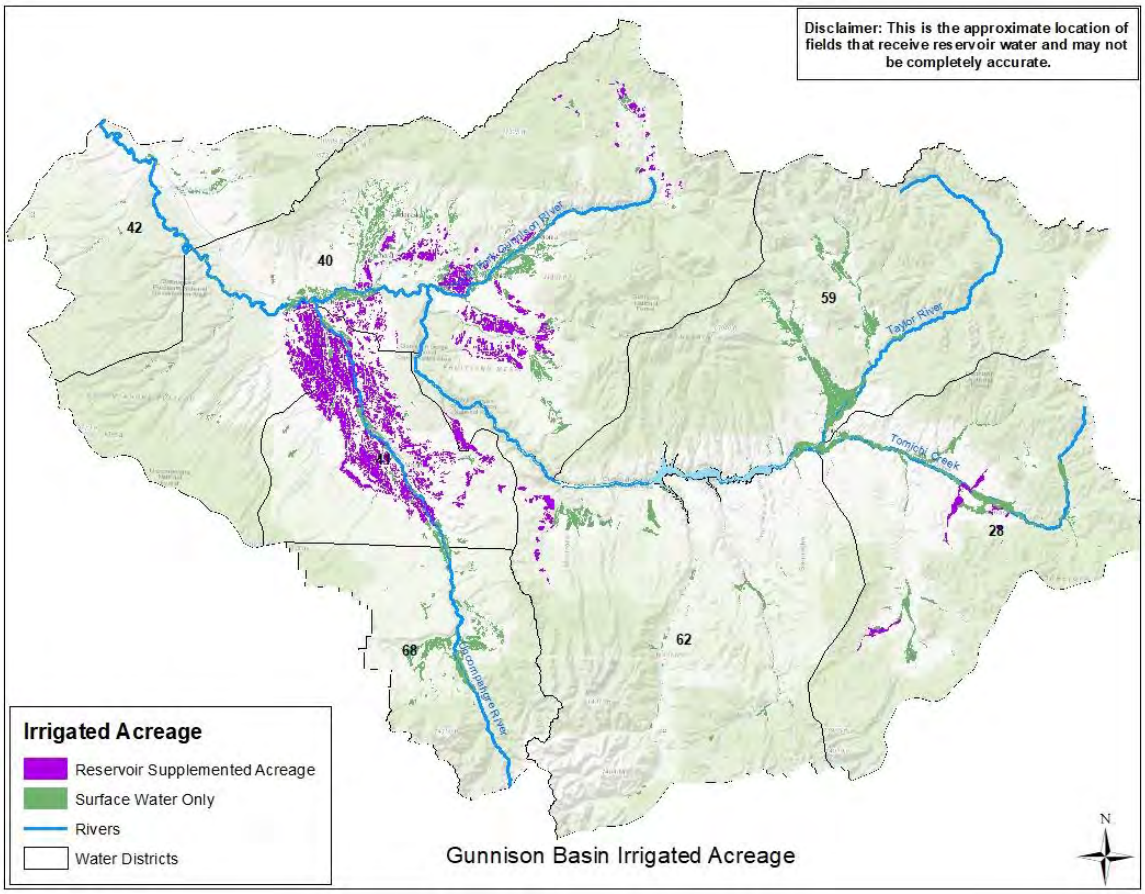


Figure 6. Irrigated acres with and without direct reservoir support

SALINITY HABITAT BANK

GUN-2020-0217 – Habitat Replacement Bank for salinity control program

Establishment of a habitat bank could provide a common location or mechanism for entities within the Gunnison Basin who are required to replace habitat lost during salinity control projects. Creating a bank could streamline an increasingly burdensome requirement within the salinity control program to replace habitat lost due to piping and lining irrigation canals. A habitat bank would allow participating entities in salinity control projects to purchase credits within the bank or make improvements on pre-identified lands to offset habitat losses appurtenant to their projects. The concept of a singular habitat bank does not have the full support of the Gunnison Basin Roundtable. Concerns exist that a bank would not result in habitat replacement as designed by the Salinity Program and credits might be created or purchased in areas where wetlands already exist, new wetlands would need additional diversions from already stressed sources, or are not in the vicinity of the salinity project. Overall, the GBRT would like to see habitat

replacement plan requirements altered to better meet the realities of land ownership, water availability, and address in-stream habitat needs.

Important aspects of this project include:

- Increasing certainty for participating entities. Habitat replacement represents significant uncertainty when engaging with the salinity control program. Often times the entity applying for funds does not have the financial or administrative capability for identifying and vetting lands for habitat replacement prior to applying for funds and committing to 50-year agreements.
- Decreasing financial risk to irrigators and irrigation providers engaging with the salinity control program. Habitat replacement represents a significant technical and administrative burden that currently requires a conservation easement be placed on the property. This, as well as other aspects, of the habitat requirements risk delaying project implementation. Delayed project implementation often results in increased materials and construction costs.
- This project represents a potential opportunity for a project within the Gunnison Basin to partner with land trust organizations. Conservation easements on agricultural lands are mentioned numerous times within the 2015 BIP as a mechanism for achieving our basin goals, and that theme carries forward to the BIP update. This project, while not specifically conserving agricultural lands, represents a partnership between water users and conservation organizations.

UPLAND AND ALPINE WATER RETENTION RESTORATION

GUN-2020-0035 – Upland and Alpine Water Retention Restoration

Wet meadows or process-based restoration in appropriate areas can increase the volume of water naturally stored in the hydrologic system and could represent projects that serve multiple purposes and benefit water use sectors across the basin.

This project represents an important outcome from the Integrated Water Management Planning efforts by the Upper Gunnison River Water Conservancy District. Additionally, there is significant momentum amongst stakeholders in the basin to utilize natural infrastructure such as beaver dams (and analogues) to restore the natural storage capacity of high elevation meadows. This project represents an important step in executing projects in higher elevations that improve watershed health.

A common theme throughout this process and across geographies within the Gunnison Basin is the critical need to address watershed health on a landscape level. Please refer to the Section 4 for more information about watershed health projects in the Gunnison Basin.

COW CREEK PIPELINE

GUN-2020-0152 – Cow Creek/ Ridgway Reservoir pipeline and flow stabilization reservoir

This project is a pipeline to capture a conditional water right. Utilizing diurnal flows to increase storage in Ridgway Reservoir and provide replacement water for existing and future absolute water rights. This is a phased storage project projected to help both municipal and agricultural users.

UNCOMPAHGRE VALLEY WATER AND LAND COMMITTEE

GUN-2020-0151 – Uncompahgre Valley "Water and Land Committee" group

Planning for tomorrow in the Uncompahgre Valley is an important issue based on the evolving and changing landscape. The formation of a working group to tackle big questions pertaining to land management and water uses was formed. The objectives of the group are:

- Affect water and land use policy to maintain sustainable water supplies for future generations.
- Facilitate prudent and responsible water and land resource management.
- Educate citizens about efficient and effective use of water and land resources.

In order to meet the objectives of the group a strong mission of "facilitate discussion among all stakeholders to positively affect growth through sustainable best practices, policies and education, with the goal of managing the Uncompahgre Valley's water resources for all users." The committee is comprised of cities, counties, land development groups, agricultural water users and growers, federal agencies, and private entities. The planning group will be able to target needs of the basin, develop projects based on

those needs, and execute implementation to help further the mission of positively affecting growth. This project aligns within the basin and state for development, education and outreach, and planning for a changing future.

Projects & Basin Goals

The projects identified, updated and/or carried over from the 2015 BIP strive to meet the goals and the objectives of the Gunnison BRT, specifically the overarching goal of the BRT to *protect and maintain existing water uses in the basin*. A significant effort in this BIP Update effort identified new projects, updated information on projects from 2015, and developed better cost and yield information. Processing project information at a basin-wide scale, as summarized above, provides the basin with information as to the types of projects the basin would like to pursue in the future; projects that are ready for implementation; and funding needed to implement projects. Additionally, categorization of the projects helps the basin see how projects that can be used to meet and/or support identified goals in the basin. Implementation of the wide range of projects identified in the project database will be needed to meet the goals and needs in the basin.

As discussed above, agricultural efficiency projects made up the largest majority of the projects in the database, and show the need for infrastructure improvements in the Gunnison basin. Both of the BRT's Goal 3 (*improve agricultural water supplies to reduce shortages*), and Goal 8 (*restore, maintain, and modernize critical water infrastructure*) can be met from implementing agricultural efficiency projects. These projects typically entail piping or lining of different canals in the basin, which can help reduce shortages while updating aging infrastructure.

Developing storage projects included in the basin's project database support several goals, including Goal 3 and 8. Storage projects included both repairing existing reservoirs and constructing new reservoirs. Storage projects are a critical piece of meeting the GRBT's goals, as municipalities, agricultural users, and recreational users struggle with water shortages, especially during the late summer near the end of the growing season. As noted above, stored supplies can be stretched further when implemented in areas with higher irrigation efficiencies. Implementing agricultural efficiency projects in conjunction with storage projects would maximize the benefit from both types of projects.

The environmental and recreational category includes a variety of projects such as modernizing in-channel infrastructure, adding signage to make it safer for boaters, improving diversion functionality for the irrigators, improving water quality, and rehabilitating river corridors. Additionally, there are several projects that focus on watershed and forest health throughout the basin. These environmental and recreational projects meet Goal 5 (*quantify and protect environmental and recreational uses*), Goal 6 (*maintain and/or improve water quality*), Goal 7 (*describe and encourage relationships between agricultural and environmental recreational water uses*), and Goal 8. A significant portion of the total projects identified in the basin are environmental and recreational in focus, indicating the basin understands the existing and potential future risk to important environmental and recreational attributes in the basin and has identified projects to mitigate these risks.

Educational projects were included in the database to meet Goal 9 (*create public education, outreach, and stewardship processes involving water resources)* of the BRT. Projects ranged from Gunnison hydrology summer camps to the creation of new groups to provide outreach and education to the public.

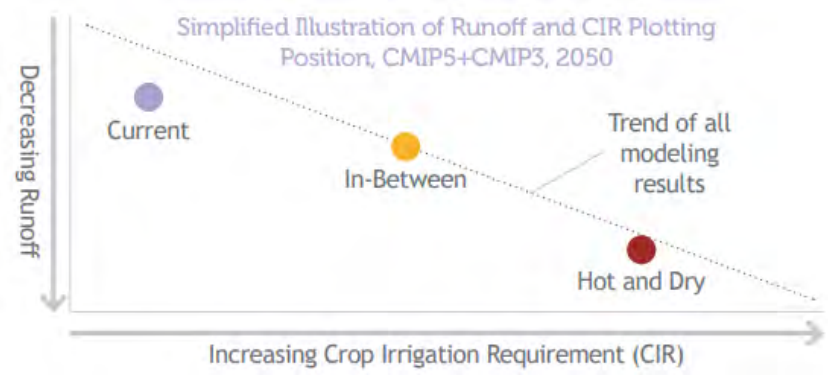
Identification of these projects in the database was an important step to meeting the Gunnison BRT's goals, however, actual project implementation is the best way to meet the BRT's goals and is part of the BRT's strategic vision for the basin.

SECTION 3. CLIMATE ADJUSTED CONDITIONS IN THE GUNNISON BASIN

Climate-adjusted conditions is just one of many drivers used to project future water supply and demands in the Planning Scenarios within the Technical Update. Three of the five Planning Scenarios include assumptions related to a hotter and drier future climate, which lead to an increase in agricultural and municipal demands and a reduction and shift in the timing of runoff. The following summarizes information on how the climate-adjusted conditions could impact the water supply and demands in the Gunnison Basin.

Climate Adjusted Conditions in the Technical Update Planning Scenarios

The CWCB sponsored several studies and investigations on the potential impact of climate change and its effect on the future of water supply and use in Colorado. Most notable was the development of the Colorado Climate Plan (CCP), which focuses on observed climate trends, climate modeling, and climate and hydrology projections to assist with the planning and management of water resources in Colorado. The CCP discusses the most recent global climate projections (CMIP5) and recommends the integration of these results with the previous global climate projections (CMIP3) to provide a representative range of potential future climate and hydrological conditions. Each of the climate projections have an equal probability of occurring in the future; together the projections provide a range of possible future conditions.



Supported by the information from the CCP, the Colorado Water Plan identified two future potential climate projection scenarios for incorporation into the Technical Update that have the overall effect of increasing crop irrigation water requirement and decreasing the amount of runoff (i.e., natural flow). Projection scenarios that capture this combined effect are better indicators of the stress that may be experienced by the overall water system in the future compared to individual projections that are selected for a specific increase in temperature or decrease in precipitation. The Colorado Water Plan selected the projection scenarios using a grouping of individual representative of "Hot and Dry" and "Between 20th Century Observed and Hot and Dry" (referred herein as "In-Between") conditions.

- "Hot and Dry" is defined as the 75th percentile of climate projections for crop irrigation requirements, and the 25th percentile for natural flows; only 25 percent of projections have lower natural flows and 25 percent of projections have higher crop irrigation requirements.

- "Between 20th century-observed and hot and dry" (referred to as "In-Between") is defined as the 50th percentile for both natural flows and crop irrigation requirements. This scenario represents the middle of the range in terms of severity.

- For comparison, historical or current conditions, which represent no change in runoff or in crop irrigation requirements, fall at roughly the 9th and 67th percentiles; meaning that 91 percent of individual projections show increases in crop irrigation requirements and 67 percent show reductions in runoff.

The average change in temperature associated with the climate projections across the state results in an increase of 3.78°F (2.0 °C) for In-Between conditions and 4.15 °F (2.3 °C) for Hot and Dry conditions. The average change in precipitation across the state results in 5 percent increase in precipitation for In-Between conditions and a 1 percent decrease for Hot and Dry conditions. The average statewide monthly impact to temperature and precipitation for each of the climate-adjusted conditions is reflected in Figures 7 and 8 below.

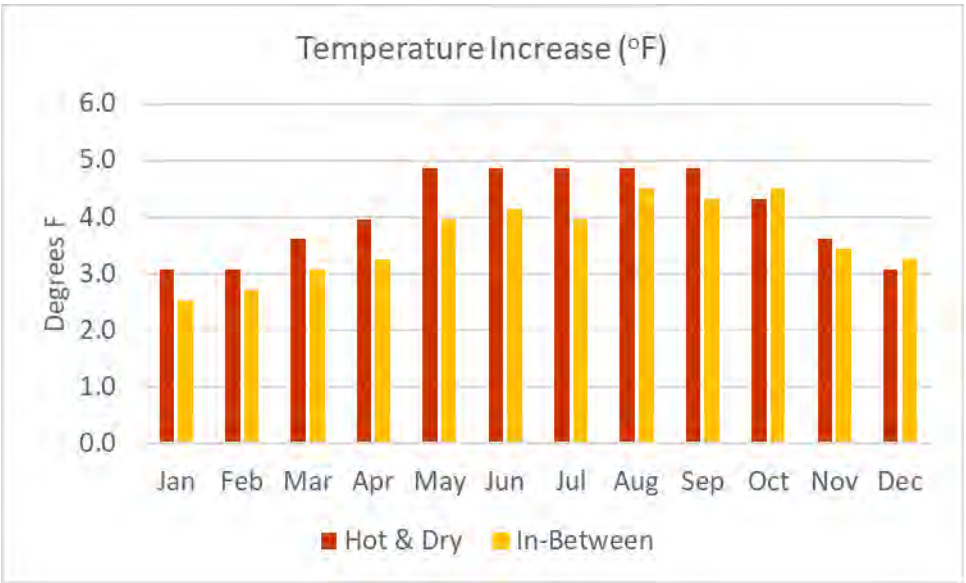


Figure 7. Average Statewide Increase in Temperature

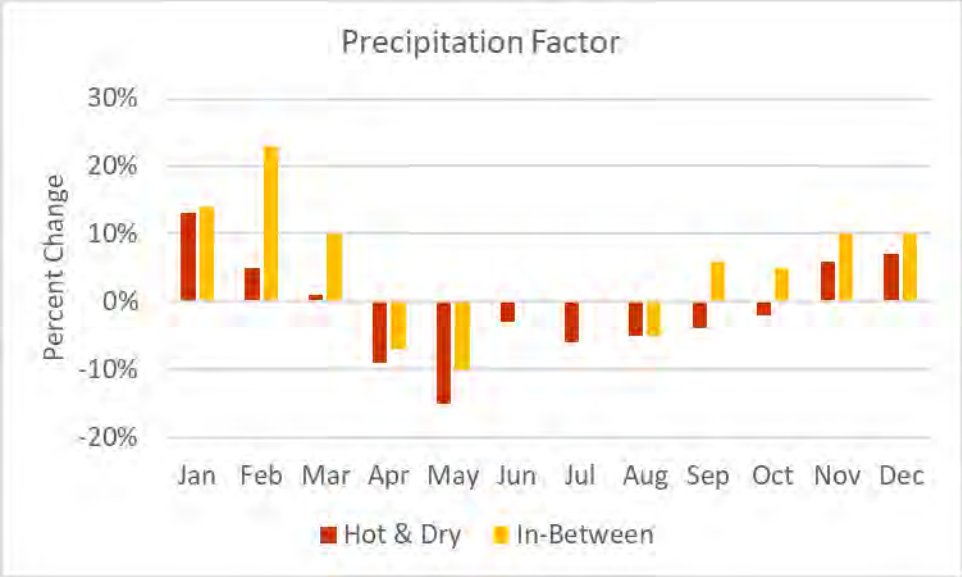
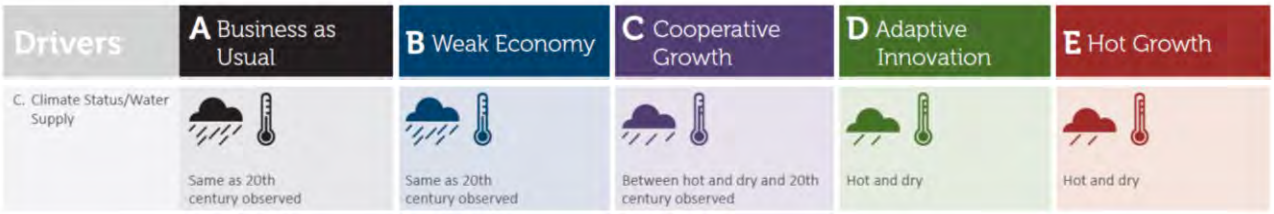


Figure 8. Average Statewide Change in Precipitation

The effort to process the projected changes in temperature and precipitation and downscale the information for use in the Technical Update was completed through the Colorado River Water Availability Study Phase II (CRWAS-II) project[1]. This effort resulted in:

- A time series of factors for each Water District reflecting the relative change in crop irrigation water requirement (CIR) under each climate projection
- A time series of natural flow at over 300 gaged locations throughout the state reflecting the climate-adjusted runoff at each location

Guided by the descriptions of the Planning Scenarios in the Colorado Water Plan, the climate-adjusted projections were incorporated into three of the five Planning Scenarios. As reflected in the graphic below, the Cooperative Growth scenario assumes In-Between climate-adjusted conditions will occur by 2050, and the Adaptive Innovation and Hot Growth scenarios assume the Hot and Dry climate-adjusted conditions will occur by 2050. The remaining two scenarios, Business as Usual and Weak Economy, assume climate conditions and variability similar to the observed conditions of the 20th century will continue in the future (i.e., current conditions).



The following sections discuss how the climate-adjusted data was applied to the agricultural and municipal demands and the water supply and highlight the impact of these climate-adjusted conditions on the Gunnison Basin.

Impact on Agricultural Demands

The impact of the projected change in temperature and precipitation was translated into factors that reflect the relative change to CIR under each climate projection, as summarized above. A time series of change factors was developed for each Water District; the factors were then limited to the 95th percentile to eliminate large outliers that occurred due to the down-scaling process. The CIR change factors were applied directly to each ditch's CIR developed under current climatic conditions to estimate CIR for use in Planning Scenarios that considered climate-adjusted conditions. The climate-adjusted CIR was then divided by historical system efficiencies to estimate the agricultural demand[2] for water at the headgate to meet the full CIR.

Overall, the climate-adjusted conditions generally show a greater summer warming effect in basins at higher elevations, therefore factors in the Upper Gunnison Basin are generally greater than those developed near Delta. Additionally, the scenarios tend to show greater warming effects during years that were historically cooler and/or had higher precipitation, inversely resulting in lower factors during drought periods (i.e., periods that historically were already hot and dry).

In the Gunnison River Basin, CIR is projected to increase due to climate change by 22 percent and 30 percent on average for the In-Between and Hot and Dry climate conditions, respectively. A 32 percent and 43 percent average increase to IWR was projected for the In-Between and Hot and Dry conditions, respectively, for the Upper Gunnison River and the Upper Uncompahgre River basins. More moderate increases to CIR of 9 percent and 12 percent were estimated for irrigated lands at lower elevations. Table 13 reflects the average CIR factor for each Water District in the Gunnison Basin.

[1] Refer to the *Temperature Offsets and Precipitation Change Factors Implicit in the CRWAS-II Planning Scenarios* (Technical Update Volume 2, Section 14) memorandum for more information on the development of the climate-adjustments.

[2] Refer to the *Current and 2050 Planning Scenario Agricultural Diversion Demand* (Technical Update Volume 2, Section 3) memorandum for more information on the development of the agricultural demand.

Table 13. Average CIR Factors by Water District

Basin	Water District	In-Between	Hot and Dry
Tomichi Creek	28	1.27	1.36
North Fork of the Gunnison River	40	1.09	1.13
Lower Uncompahgre River	41	1.08	1.11
Lower Gunnison River	42	1.08	1.13
East River	59	1.27	1.37
Upper Gunnison River	62	1.37	1.50
Upper Uncompahgre River	68	1.37	1.49
Basin-wide Average		**1.22**	**1.30**

Figure 9 reflects the average annual CIR factor for the basin compared to the total annual CIR in the basin. As noted above, factors are generally higher during historically cooler and wetter years, as reflected in the late 1990s. Conversely, factors are lower during historically hotter and drier years such as 2012.

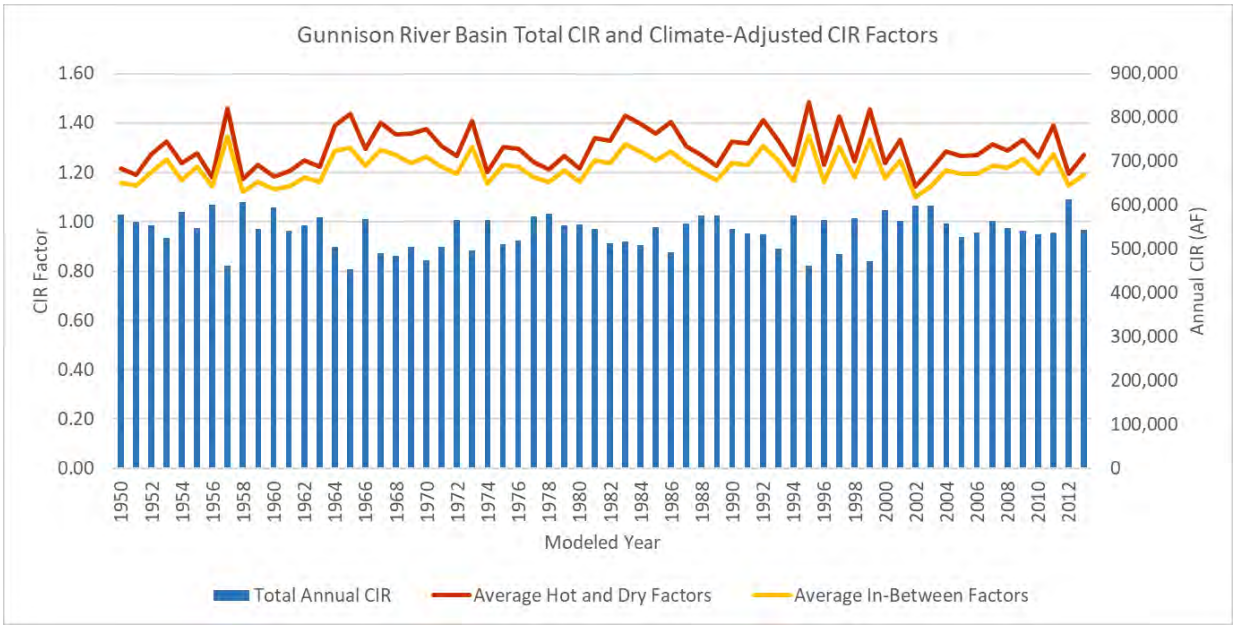


Figure 9. Gunnison Basin Annual CIR and CIR Factors

Additional considerations regarding CIR and agricultural demands include the following:

- CIR is reduced by 10 percent in the Adaptive Innovation scenario to account for technological innovations that may mitigate the increased CIR due to climate adjustments.
- Projected increases in temperature may extend the current growing season, however the extent of this change was not analyzed in the Technical Update. As such, the CIR in the early and late growing season increased due to the factors, but the growing season was not extended in response the climate-adjusted conditions in this effort.
- Although producers may change crop types in the future in response to climate-adjusted conditions, changes to crop types are also influenced by regional, national, and world markets. Due to the many assumptions and implications associated with projected changes, no crop types were changed in the Technical Update.
- Other agricultural drivers, such as urbanization of irrigated land and improved efficiencies, were considered in the Planning Scenarios along with the climate-adjusted conditions. All the drivers have an impact on the amount of CIR and agricultural demand estimated in the basin.

Impact on Municipal Demands

The Technical Update uses population multiplied by per-capita rate of use (in terms of gallons per capita per day or "GPCD") to develop the future municipal demands[3] for the Planning Scenarios. The rate of use was disaggregated into five categories in order to apply separate drivers to specific categories:

- Residential (Single Family & Multi-Family) Indoor
- Non-Residential Indoor
- Residential (Single Family & Multi-Family) Outdoor
- Non-Residential Outdoor
- Non-Revenue Water

Changes in climate primarily influence outdoor aspects of municipal demands, due to impacts on landscape vegetation irrigation water needs, similar to increases in crop demands. For the Technical Update, it was assumed that indoor demands and non-revenue water are not affected by climate changes.

Although the CIR factors were prepared for use with irrigated agriculture crops rather than municipal landscaping, they are appropriate to use for irrigated lawns and landscape vegetation and are the best available information at this time. To estimate the impacts of changing climate on future outdoor demands for the Technical Update analysis, the Water District factors were translated to county factors. In areas where multiple Water Districts cover a single county, the current geographic population distribution was used to weight the Water District factors based on the relative population distribution. These factors were applied to outdoor demands at a county level to represent the average annual change in outdoor demand in the year 2050 due to the climate status. Table 14 reflects the CIR change factors used for each county in the Gunnison River basin.

Table 14. CIR Factors by County

Basin	In-Between	Hot and Dry
Delta	1.16	1.22
Gunnison	1.16	1.22
Hinsdale	1.16	1.22
Mesa	1.13	1.21
Montrose	1.16	1.22
Ouray	1.16	1.22

Figure 10 demonstrates the influence of the climate driver on per capita water demands, with outdoor demands increasing by 8 to 13 gpcd with the climate change factors applied. This equates to a 6 to 8 percent increase in overall GPCD on average across the Planning Scenarios.

[3] Refer to the *Current and Projected Planning Scenario Municipal and Industrial Demands* (Technical Update Volume 2, Section 1) memorandum for more information on the development of the municipal demand.

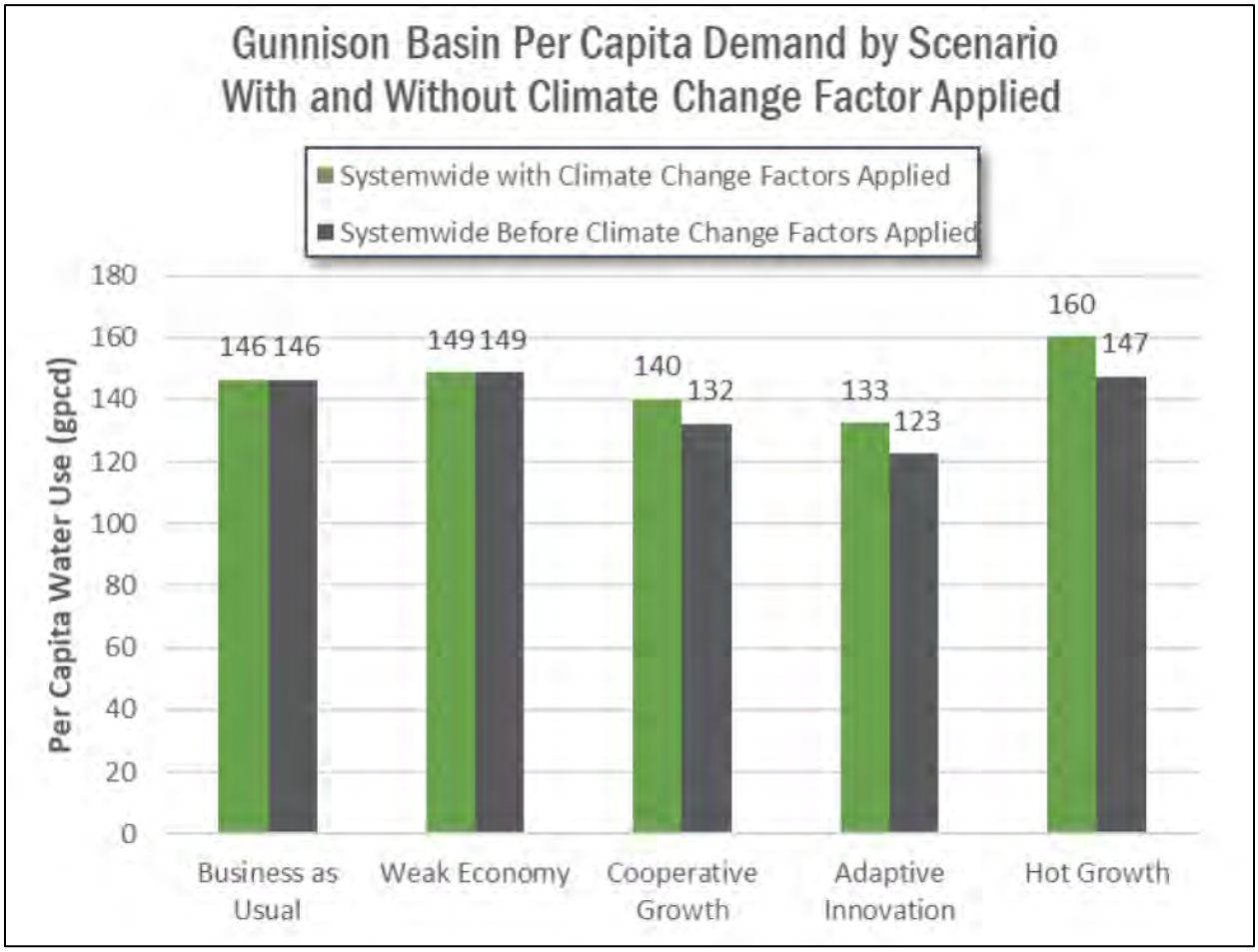


Figure 10. Impact of GPCD Adjustment in the Gunnison Basin

The following are important considerations about implementing the climate-adjusted conditions along with other drivers to create the municipal demand:

- The CIR adjustments are just one of many drivers used to adjust municipal demands across the Planning Scenarios, and only impacts two of the five categories within the use rate value. As such, it is not appropriate to apply the county factors to the overall GPCD nor to the overall municipal demand.
- The adjustments assume that amount and type of vegetative cover and the irrigation methods and management remain the same in the future as today. Other driver adjustments should be considered in the future modeling, to reflect potential changes in land use, including landscaping characteristics that may be influenced by climate changes (e.g., a shift toward vegetation that needs less water).

Impact on Hydrology

In addition to increasing agricultural and municipal demands, projected changes to temperature and precipitation impact the amount of runoff or natural flow[4] in the basin. As noted above, the CRWAS-II effort translated the impact from the climate-adjusted conditions into a time series of natural flow at over 300 gaged locations throughout the state reflecting the climate-adjusted natural flow at each

[4] Natural flow is the amount of water in the river absent the effect of man and serves as the foundation of the StateMod water allocation models

location. Although the impact of the climate projections varied across the state, natural flow under the climate projections generally indicates an overall decline in total natural flow and a temporal shift to earlier runoff.

Overall natural flow in the Gunnison River Basin is projected to decrease by approximately 86,000 af annually, or 4 percent, on average over the 1975 to 2012 period due to In-Between climate-adjusted conditions. Natural flow in the basin is projected to decrease by approximately 370,000 af annually, or 16 percent, on average over the same period due to Hot and Dry climate-adjusted conditions. Figure 11 reflects the annual natural flow for current and climate-adjusted conditions. As shown, there are a few years when the In-Between conditions result in higher natural flows compared to current conditions. More frequently, however, the climate-adjusted conditions result in less annual natural flow compared to current conditions.

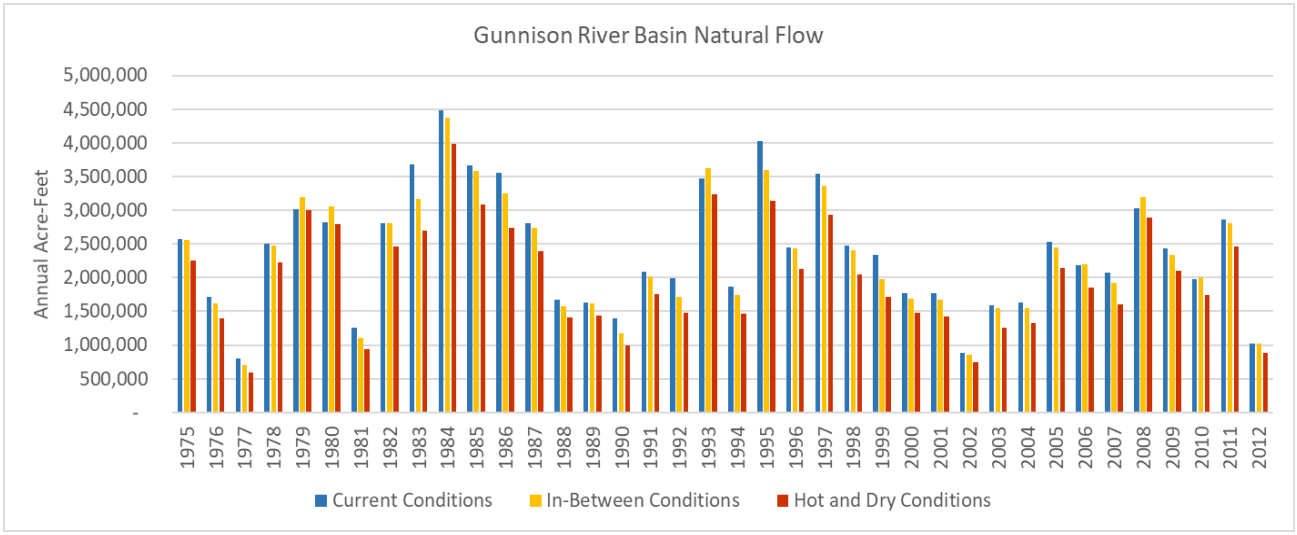


Figure 11. Gunnison Basin Annual Natural Flow

In addition to the change in overall flow, the climate-adjusted conditions project a shift to an earlier runoff. Figure 12 reflects the average monthly natural flow at the Gunnison River near Grand Junction gage. As shown, runoff under current conditions generally occurs over May and June. The climate adjusted conditions shift the runoff to be predominantly in May and project a substantial reduction in flows in June and July. This projected shift in runoff timing will likely impact water availability to meet agricultural and municipal demands throughout the year and likely reduce late season streamflow.

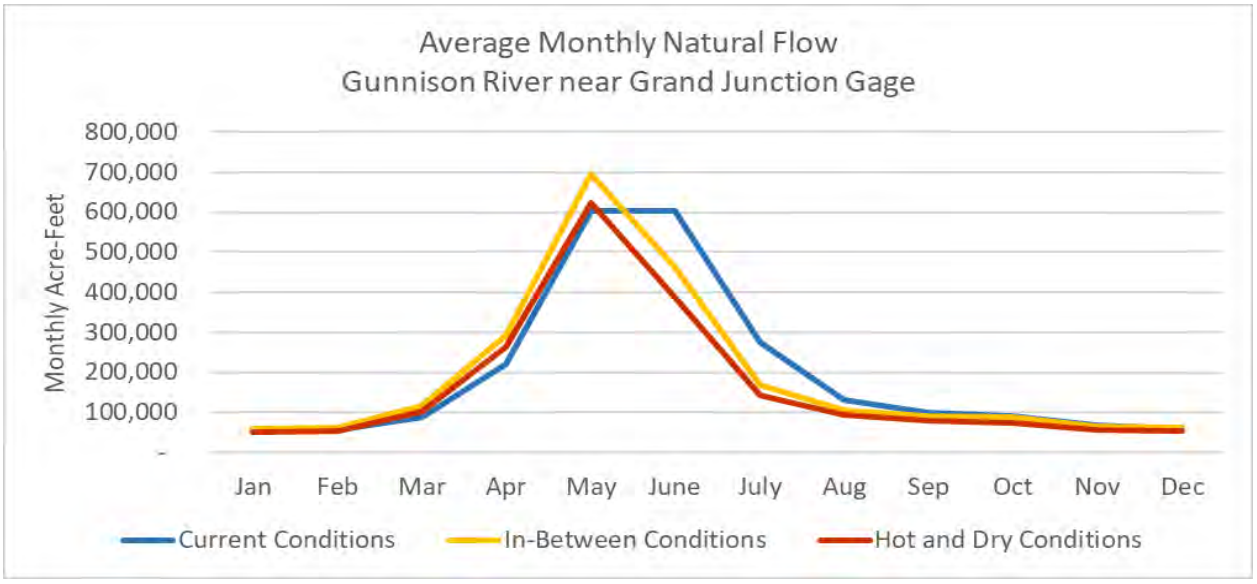


Figure 12. Average Monthly Natural Flow – Gunnison River near Grand Junction Gage

The previous graphics reflect the basin-wide impact from climate-adjusted hydrology; however, conditions and the impact vary across the basin. The following summarizes the impact to hydrology at two gage locations in the basin: Gunnison River near Gunnison and the Uncompahgre River at Colona.

As shown on Figure 13, natural flow at the Gunnison River near Gunnison gage location is projected to decrease by approximately 7,800 acre-feet per year (1 percent) and 64,000 acre-feet per year (11 percent) due to In-Between and Hot and Dry conditions, respectively. The peak runoff is projected to shift from June to May under both climate-adjusted conditions (Error! Reference source not found.).

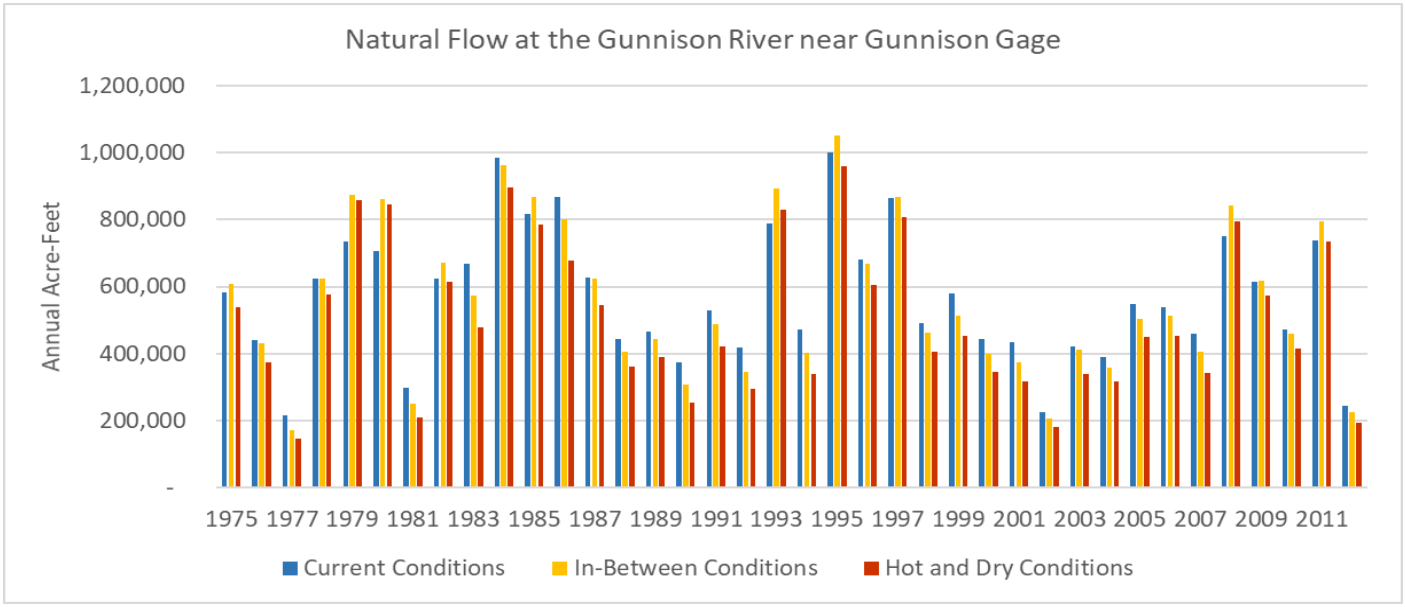


Figure 13. Annual Natural Flow – Gunnison River near Gunnison Gage

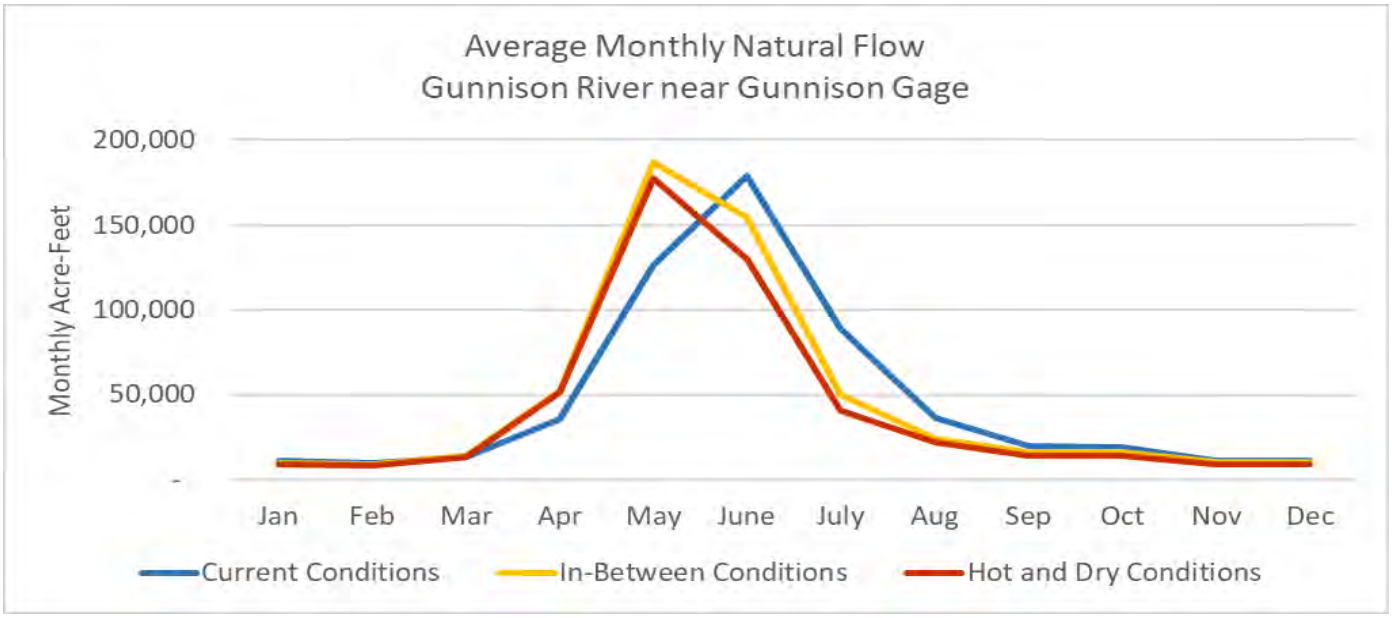


Figure 14. Average Monthly Natural Flow – Gunnison River near Gunnison Gage

As shown on Figure 15, natural flow at the Uncompahgre River near Colona gage location is projected to decrease approximately 32,000 acre-feet per year (14 percent) and 57,000 acre-feet per year (25 percent) due to In-Between and Hot and Dry conditions, respectively. The runoff is projected to shift from a clear peak in June to an extended runoff over May and June under both climate-adjusted conditions (**Error! Reference source not found.**).

Figure 15. Annual Natural Flow – Uncompahgre River at Colona Gage

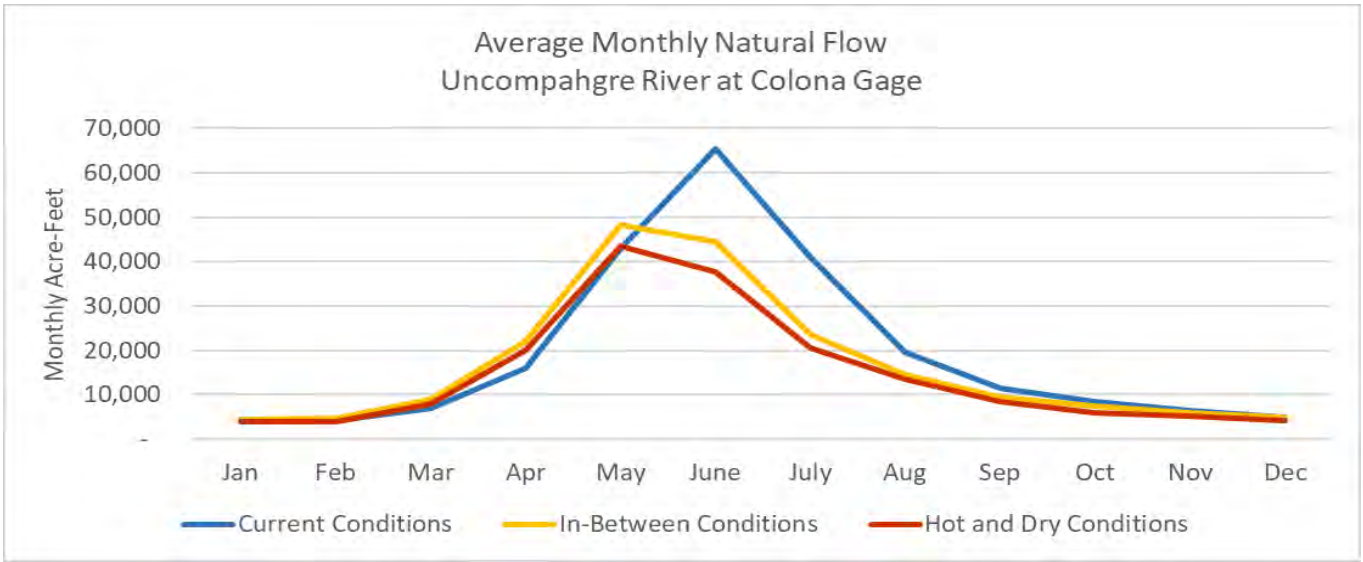


Figure 16. Annual Monthly Natural Flow – Uncompahgre River at Colona Gage

The climate-adjusted natural flow is not equivalent to the simulated physical streamflow at these locations, as the simulated streamflow reflects depletions and return flows associated with agricultural, municipal, and industrial demands and storage operations. However, the change in natural flow has a significant impact on the amount of physical streamflow in the river and the amount of water that is available to store and meet demands.

Additional considerations regarding climate-adjusted natural flow include the following:

- These climate-adjusted natural flow projections reflect just two potential future conditions selected to provide a range of potential future conditions.
- The methodology for developing the climate-adjusted natural flow relies on the historically observed cycle of wet, average, and dry hydrology. Extended periods of high runoff or drought years beyond that historically observed in the 20th century were not included in the analysis.

SECTION 4. WATERSHED HEALTH

Gunnison Basin Watershed Health Overview

The Colorado Water Plan explains that "forests and riparian corridors provide ecosystem services for watersheds that help protect, restore, and sustain water quality and quantity. Healthy, forested watersheds absorb rainfall and snowmelt and allow it to runoff slowly, recharge aquifers, sustain streamflow, and filter pollutants."[5] At the same time, the Colorado Water Plan addresses the need to adapt to predicted climate change impacts (increases in droughts, wildfires, variable snowpack, and more severe floods), by maintaining and restoring watershed health. Since the Colorado Water Plan was released in 2015, there have been numerous national and international reports on the need to restore and maintain watershed health to protect water security as temperatures continue to rise and snowpack decreases.[6] There is unrealized potential for utilizing natural systems (forests, floodplains, and wetlands) as solutions to buffering more extreme weather events, improving water supply reliability, and to support biodiversity.

Restoring headwater floodplains and adjacent wetlands is one of the best proactive ways to address both water quality and water supply, while improving recreation and habitat for aquatic and terrestrial species. It also directly addresses the Colorado Water Plan goal of "support the development of multipurpose projects and methods that benefit environmental and recreational water needs as well as water needs for communities or agriculture" by improving water quality delivered to municipal systems and reducing sedimentation of reservoirs and headgates.[7] Specific benefits from healthy watersheds include:

- Improved Water Quality. Restoring the natural filtration and water storage capacity of floodplains and wetlands addresses sedimentation and pollution runoff, two of the biggest water quality issues in Colorado.[8] While wetland areas help to filter out pollutants, restoring native riparian vegetation canopy in riparian corridors can also decrease water temperature through shading streams, a key water quality issue for aquatic life.[9] Improved water quality benefits municipal water providers by reducing water treatment needs and reduces sedimentation in ditches.
- Snowpack/Streamflow Attenuation. The Gunnison Basin is experiencing a shift towards earlier peak runoff as demonstrated in Figure 17. We are anticipated to continue experiencing more frequent events that contribute to earlier snowmelt, including dust and rain on snow events. Earlier peak runoff can lead to shortages in our late summer and fall stream flows. Rapid runoff may also lead to increases in stream sediment, can impact diversion and ditch infrastructure, and can provide challenges for managing developed floodplains. Recharge of aquifers occurs when healthy watersheds allow for slow infiltration of runoff into soils, floodplains, and wetlands. Healthy natural stream systems and restored headwater floodplains and wetlands attenuate flows, decrease erosion/sediment loading, and provide natural storage during spring run-off that is released to streams in the low-flow summer months.[10]

[5] CWP at 7-4 (emphasis added).
[6] A Natural Solution to Water Security, 2017.
[7] CWP at 6-157.

[8] The Flow Regulation Services of Wetlands, Kadykalo & Findlay, Ecosystem Services, 2016.
[9] Can riparian vegetation shade mitigate the expected rise in stream temperatures due to climate change during heat waves in a human-impacted pre-alpine river? Trimmel et al 2018. "One of the most influential factors regulating stream temperature is riparian vegetation . . .by reducing the solar radiation input at the river surface by shading." This study affirmed the importance of shading and riparian vegetation along riverbanks for aquatic biodiversity and the added value of helping mitigate climate change effects on water temperature.
[10] A Geospatial Approach for Identifying and Exploring Potential Natural Water Storage Sites, Holmes et al 2017.

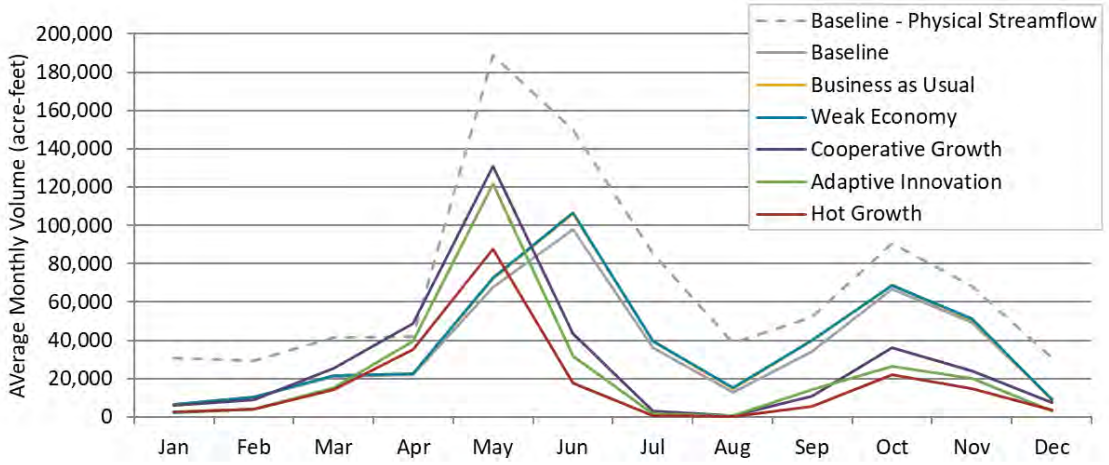


Figure 17. Shift to earlier peak runoff under climate adjusted scenarios

- Flood reduction. Floods are the most common and widespread natural hazard in Colorado. Flood prone areas have been identified in all 64 counties and almost all municipalities (267 out of 271).[11] Restoring headwater floodplains and wetlands upstream from cities, towns, and transportation infrastructure prone to flooding can reduce losses from flood events.[12]
- Habitat Resiliency. Riparian and wetland areas on floodplains are hotspots for biological diversity and provide both refuge and movement corridors for approximately 80% of Colorado's wildlife species during all or part of their life cycle. These habitat areas serve as buffers and critical refuge for many species during disturbances such as droughts and wildfires. Conserving broader floodplain habitats beyond the stream channel is an insurance policy to protect valuable fisheries, wildlife-dependent recreation, and the many other water quality and flood hazard mitigation benefits that depend on intact, high-functioning riparian habitats. Lush riparian areas provide grazing opportunities for livestock and native wildlife.

CHALLENGES FOR WATERSHED HEALTH

Gunnison Basin watersheds face challenges from both man-made and natural impacts. The Gunnison Basin is experiencing impacts from wildfire, erosion, drought, flooding, and other natural events that have been exacerbated by climate change. Human impacts can cause erosion, low flows, and elevated stream temperatures (amongst other impacts). Water resource managers can enhance watershed resiliency to buffer against some of these impacts. Where mitigation is not possible, actions can be taken for water resource users to adapt to changing conditions.

WILDFIRE AND FOREST HEALTH

Forest health, wildfire and water are inseparably linked. Forests filter water as it descends the mountain from snowmelt and summer monsoon storms. The forest's vegetation and soils hold water, protecting it from evaporation, and slowly releasing it to the landscapes, ecosystems and people that rely on it. Dying, overstocked, or intensely burned forests are damaged, translating to impairments that ripple throughout the watershed. Wildfire - in its natural state - cleanses the forest of dead material, opens cones, releases seed, removes insects and disease, releases nutrients and through the mosaic effect of most periodic burns, infuses the forest with a greater diversity of habitat. Woody debris on the forest floor is consumed as flames scorch the ground, preventing fuels from accumulating to produce hotter, more damaging blazes. As fire releases nutrients in the form of ash, soils become more habitable to plants that revegetate the forest floor. When fire is delayed or suppressed, fuels accumulate, allowing fire to burn too intensely. The canopy burns, trees are killed rather than singed, soils are damaged and destabilized, giving way to erosion which not only wreaks havoc downstream but delays regeneration as the foundation of regrowth washes away with each storm. Forestry work

[11] CWCB Flood page.

[12] Association of State Wetland Managers, Importance of Natural Floodplains webpage. University of Oregon, Economic and Employment Impacts of Forest and Watershed Restoration in Oregon., 2011

that mimics the forest's natural state of health by removing excess, unhealthy trees encourage stands that are resilient to wildfire, provide ample habitat for wildlife, and provide clean air, water, and beauty for people.

The frequency and severity of wildfires is increasing across the West. When a large-scale wildfire burns at a high intensity soil can become hydrophobic, increased the level and intensity of surface water runoff. This hydrophobicity increases the chance of flash floods and larger peak runoff events.

Consequentially these large events also have impacts on water quality, often resulting in elevated levels of heavy metals, ash, and soil. These extreme runoff events paired with vegetation loss can lead to stream degradation, including elevated stream temperatures due to loss of riparian vegetation. These impacts often affect water users. They can disrupt municipal water systems by causing increased costs for water treatment and in extreme circumstances water suppliers may need to cut off supply sources to avoid becoming overwhelmed with sedimentation. Irrigators may need to turn off ditches during precipitation events to prevent siltation of ditches and fields. Importantly, wildfire treatments may also impact watershed health and must be carefully crafted to avoid causing the results they are designed to mitigate.

EROSION

Erosion is a significant watershed health challenge. High volumes of stormwater can erode stream banks and hillsides, causing loss of topsoil and impacting water quality. Reduction in topsoil reduces the ability to store nutrients and water in a predominantly agricultural driven basin. The reduction in stored nutrients within the soil structure leads to more synthetic inputs and less natural mycorrhizal fungi for strong crop and plant growth. Topsoil erosion within a municipal watershed leads to higher filtration needs at the water treatment plant and the constant struggle of permit compliance within the small facilities ability to operate at a high capacity. Critically, large scale erosion across a watershed (i.e., from poorly constructed roads) can result in a lowering of the water table. Contouring bank sedimentation can lead to build up of large deposition and filling in of naturally occurring streams and reservoirs reducing capacity and ability to carry and store water effectively. Stream aggradation and degradation pose significant challenges to many natural hydrologic functions.

DROUGHT

Drought impacts water resources in a range of ways. Reduced streamflow provides less water to divert and also for aquatic ecosystems. Lower flows can increase concentrations of pollutants, lead to increased stream temperatures, increased turbidity of the stream section, and result in dry ups of springs and reduced groundwater availability where drought persists. Wetland habitat is reduced due to the drying of streambeds and waterways and habitat is lost. Vegetation and crops may require more water during drought periods, increasing water needs when water supply is scarce.

FLOODING

Flooding is linked to drought and watershed health but has lasting downstream impacts after events. The impacts of flooding are expected to increase as climate change drives more intense events, but also from normal events occurring within degraded and poorly managed watersheds. All of this coupled with sedimentation, nutrient management, and loss of biodiversity leads to water quality impacts on the streams, crop growth and municipal supplies.

USE IMPACTS

Human uses impact our watersheds in a number of ways. Human impacts may include:

- Road and Trail Construction. Most of the watershed area degradation (numerous road crossings with undersized culverts etc.). Roads have numerous impacts on hydrologic function. They increase the drainage density of and act as a preferential pathway for surface water and can divert a stream from the natural channel. Roads reduce the amount of water that infiltrates into groundwater system and can accelerate erosion. Road density is often used as a key element to assess watershed health.
- Recreational Impacts. Recreationalists may impact watersheds by removing vegetation in the riparian areas or creating new trails that intersect streams. Loss of aquatic life and terrestrial wildlife from water quality impacts and human interaction impact the recreational benefits to the basin. Fish and wildlife diversity are a key assessment tool for recreational use or basin designation for rehabilitation.

- Grazing. Grazing may cause hoof shear and erosion of stream banks when concentrated. Overgrazing may cause a loss of vegetation and topsoil leading to erosion.
- Mining. Mining impacts on watershed health may include a loss of vegetation, erosion, and water quality impacts associated with acid mine drainage.
- Timber Harvest. Timber harvest can alter the forest composition of a watershed in a manner that alters sediment and hydrologic regimes. Harvesting practices can cause soil compactions and a loss of woody debris recruitment for stream habitats.
- Irrigation Diversions. Water withdrawals can diminish habitat and impact riparian forest health.

Projects to Address Watershed Health and Infrastructure Concerns

There are two types of projects that may help the Gunnison basin respond more readily to changing watershed conditions and resulting impacts on water users. The roundtable can either mitigate impacts through addressing various aspects of watershed health and enhance watershed resiliency (these opportunities typically exist higher up in a watershed) or focus on measures to adapt to specific impacts lower down in the watershed near the point of diversion. For instance, a municipality concerned about potential wildfire impacts could look at options for vegetation treatment and fuel buffers but may find these options too cost prohibitive (requiring upkeep that is expensive once harvestable yield is removed) and/or socially challenging (prescribed burns every summer causing air quality impacts, areas closures, etc.). They could also assess options for sedimentation ponds, for alternate water supply intakes, or even an alternate water supply source (i.e., an emergency groundwater well).

Below are proposed projects that aim to enhance the Gunnison Basin's resiliency and ultimately the ability to adapt to changes in the watershed. The projects focus on wildfire mitigation, ecosystem restoration and enhancement, and stream restoration and enhancement.

WILDFIRE RISK ASSESSMENT & MITIGATION OPTIONS

As discussed above, wildfire has devastating impacts on water resources. Post-wildfire impacts include mass sedimentation, increased soil hydrophobicity, and changes to water quality. The proposed basin-wide wildfire risk mitigation project will focus on critical water supply infrastructure and the risks associated with large un-controlled wildfire and subsequent changes to hydrology, hydraulics, and sediment/debris transport post fire.

Phase 1 of the project will seek to identify locations of critical surface water diversion structures and/or storage reservoirs for agriculture and municipal water systems in the Gunnison basin and their tributary relationship to "zones of concern" or areas where large un-controlled wildfires are possible. Phase 1 would create a Zones of Concern Map following a similar approach for map creation as was used in the Chafee County Wildfire Risk Assessment with an emphasis on water supply infrastructure. Phase 1 would further identify priority sub-basins and priority infrastructure at specific and acute risk of failure post fire, based upon size (acres or population), specific proximity to likely wildfire impacted areas, or other criteria. Phase 1 should be adjusted/amended to meet the necessary criteria for federal funding of forest/watershed health treatment activities.

Phase 2 of the project would look at specific high value and high risk water resource infrastructure and identify the best options to build resiliency against potential wildfire impacts. Assessment options may include identifying options for redundancy in water supply intakes, sedimentation ponds, and alternate water supply sources near to the point of diversion (or a range of different approaches designed to mitigate impacts at the intake). The assessment would consider whether fuel breaks could be an effective treatment option for high-value and localized infrastructure where critical infrastructure warrants the need for continual treatment. Phase 2 would consider a range of options similar to the approach taken in the Fish Creek Critical Community Wildfire Protection Plan.

Phase 3 of the project would utilize the outcomes from phase 1 and phase 2 to implement specific recommendations from phase 2 and create “actions plans” to protect prioritized infrastructure.

PROCESS BASED RESTORATION PROJECTS

Restoration of natural systems support late season flows, helps to mitigate the impact of drought cycles, and provides environmental benefits. Existing natural systems, such as riparian areas, floodplains and wetlands act to slow runoff and promote groundwater recharge; effectively storing water and releasing it slowly back to the surface water system. In this way, these natural systems fill a role similar to traditional reservoirs.

Scaling up this type of project in Colorado’s source watersheds can improve our long-term water security in the face of increasing hydrologic variability. These restoration projects work to build resiliency and lessen the impacts of drought, earlier runoff (retaining water up high), wildfire (wetlands act as natural wildfire buffers and can create defensible space), and flood (slowing the movement of water across the landscape).

The proposed Watershed Assessment to Prioritize Multi-Benefit Projects will focus on identifying key locations to use process based restoration build watershed resiliency against watershed health impacts. Projects will be identified to address key areas where landscape restoration techniques could be used to restore wetlands, reduce erosion and head cutting, and/or restore water tables. Watershed restoration projects should be identified that reverse erosion, head cutting, and lowering of the water table. These projects could be designed to restore natural stream and river processes (hydrology, sediment routing, nutrient cycling) by reconnecting incised degraded streams with their floodplains and adjacent wetlands (if historically present) so that more frequent inundation of the floodplain occurs. An emphasis will be put on enhancing natural storage including wet meadows and wetland complexes. Examples of such projects include the wet meadows restoration projects across the Gunnison basin. Projects should be designed to restore the historic width of the floodplain to allow riparian vegetation to be naturally hydrated.

Phase 1- Conduct a basin-wide assessment to determine the best opportunities for headwater floodplain and wetland restoration projects. These multi benefit projects will provide improved drinking water quality from source watersheds as well as improved aquatic and terrestrial wildlife habitat.

Phase 2- Prioritize projects with the most potential to enhance watershed benefits. For example, degraded streams that are above reservoirs and/or significant diversion points will likely have greater opportunities to be restored with a fully functioning floodplain as opposed to places lower in the watershed.

Phase 3- Implement priority projects that meet multiple stakeholder objectives in critical areas. These phase 3 projects when applicable should include assessments of existing PBRs in the basin.

STREAM AND RIPARIAN RESTORATION PROJECTS

Many existing Gunnison BRT projects focus on restoring another important component of watersheds - stream corridors. These projects focus primarily on increasing in-channel habitat complexity with placement of logs and boulders and may include stabilizing a re-graded channel and planting riparian vegetation. These types of projects can address typical E&R goals of improving fish habitat and fishing recreation and should also be recognized as supporting broader watershed health. These projects can be implemented in conjunction with consumptive water use projects such as diversion modifications.

Relationship to Goals and Strategies of the Basin

Identified within Volume 1 of the BIP update are goals for the Gunnison Basin. All of these goals relate either directly or indirectly to watershed health. Using the basin goals as a guide, the Gunnison BRT can work on identifying strategies to address watershed health impacts, potentially through a working group of the roundtable that can identify projects and processes that will help the basin meet our goals. Working with community members to help identify the importance of watershed health from a forest health, erosion, drought, flooding, and use impacts for improved agricultural, environmental, recreational, and municipal uses. Identified projects must be implemented to ensure the protection of our streams and wetlands while also addressing broader water supply issues where possible.

SECTION 5. WEATHER MODIFICATION IN THE GUNNISON BASIN

The following summarizes the general approach and results from an analysis that investigated the potential increase in streamflow if the existing weather modification (i.e., cloud seeding) programs were expanded in the Gunnison Basin. The analysis is intended to provide high level estimates of increases to streamflow and does not consider the meteorological, financial, or operational feasibility of an expanded program. Any expansion of the weather modification program in the Gunnison Basin needs to be thoroughly investigated and analyzed prior to implementing.

Summary of Existing Programs

There are two weather modification programs that impact the mountainous regions in the Gunnison Basin: The Upper Gunnison Program and the Grand Mesa Program. Figure 18 reflects the general impact area for each program and locations[13] of active cloud seeding generators.

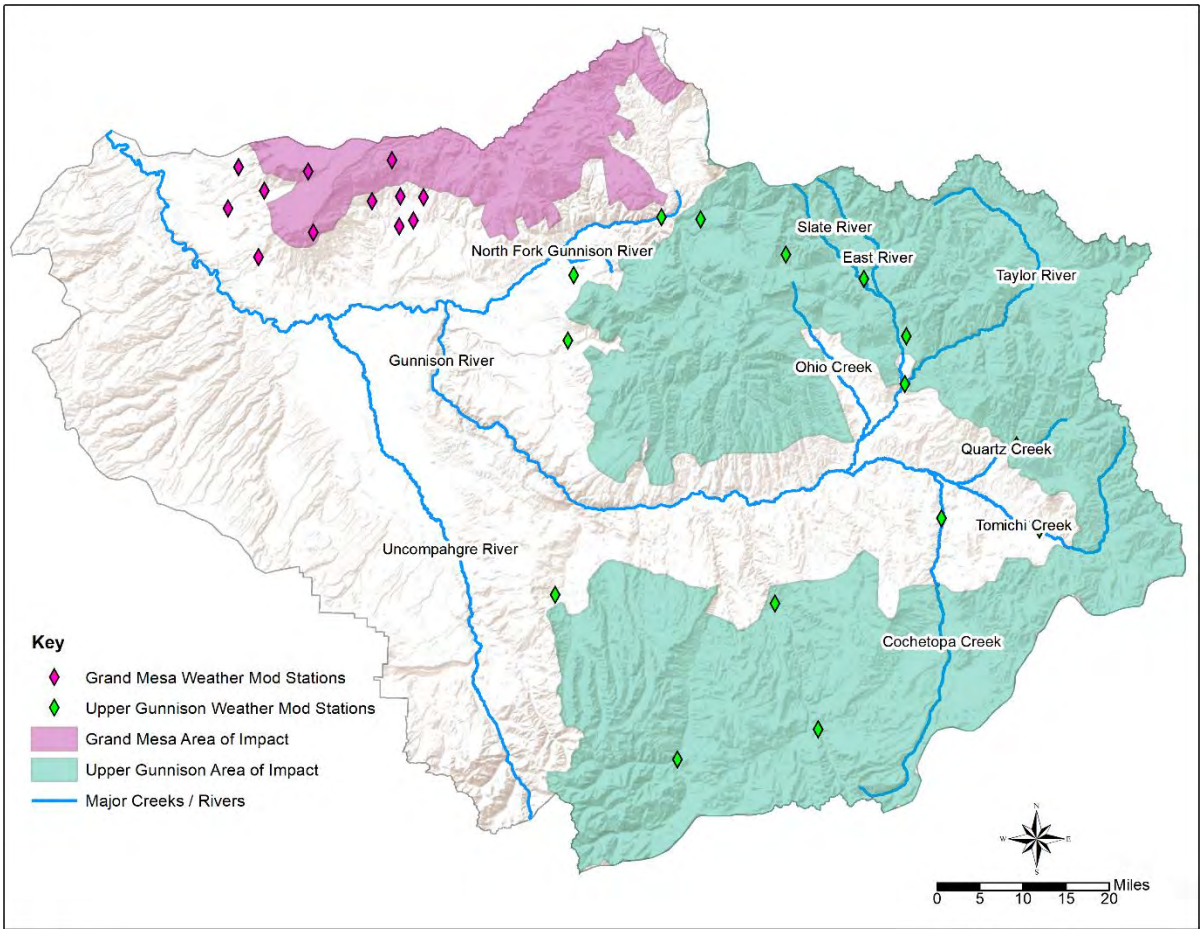


Figure 18. Gunnison Basin Cloud Seeding Program Impact Areas

[13] Source: Impact Areas and Grand Mesa station locations within the Gunnison River basin sourced from the CWCB Weather Modification Program website; Upper Gunnison station locations sourced from the Annual Cloud Seeding and Evaluation Report for the Upper Gunnison River Basin (2019-2020 Winter Season)

The North American Weather Consultants conducted the cloud seeding program in the Upper Gunnison River basin for the 18th operational year in the winter of 2019 and 2020 and documented the results of this year's program operations in the *Annual Cloud Seeding and Evaluation Report for the Upper Gunnison River Basin (2019 – 2020 Winter Season)* report. The program includes 16 cloud seeding generators and one remote generator dispersed throughout the Upper Gunnison River basin. Generators that emit silver iodide seeding material are generally located at high elevations, ranging from 6,225 to 10,357 feet in elevation.

The Water Enhancement Authority (WEA) has conducted a cloud seeding program in the Grand Mesa area for over 25 years with the goal of augmenting natural precipitation with the impact area to increase snowpack. This year's program operations are documented in the *Winter-Spring Time Cloud Seeding Over the Grand Mesa of Colorado (2019-2020)* report. The Grand Mesa program includes 19 cloud seeding generators; 6 are remote generators located at high elevations and the remaining 13 are lower output generators manually operated by residents generally below 7,000 feet in elevation.

Approach

The general approach to this effort was to use information from the existing weather modification programs in the Gunnison Basin and project the program's impact on streamflow to other sub-basins outside of the current program boundary. The Grand Mesa report estimated the effectiveness of the current year's operations at improving snowpack, but it does not translate those results down to an increase in streamflow. The Upper Gunnison report, however, provides information on the estimated increase in snowpack and resulting streamflow of the long-term program. Using information from this report, spatial analyses were performed for river sub-basins in the current program area, and those outside of the program boundary that may benefit from an expanded program, to provide a basis for the projection of the streamflow results. The analysis provides an estimate of the increased streamflow if the sub-basin characteristics, program operation, and snowpack yield are consistent for basins outside the current program boundary.

Program Results

In both programs, atmospheric conditions, including wind speed, temperature, stability, cloud condition, and moisture content, are monitored to identify "seed-able storms" and determine optimal conditions to operate the generators. Generators are operated during seed-able storms to increase snowfall and snowpack in the program area. As noted in the Upper Gunnison report, evaluating the results of the program for a single year is difficult due "the large natural variability in the amounts of precipitation that occur in a given area from season to season, and between one area and another during a given season". As such, regression analyses performed over several years are used to estimate the increase in snowpack from the program. Depending on the regression technique used, the best estimates for increased snowpack of the Upper Gunnison program, including the 2019 – 2020 season, range from 5 to 16 percent, which is consistent with the long-term results from similar programs. Similarly, the Grand Mesa report indicates about a 10 percent increase in the amount of water in snow (snow water equivalent) for the 2019 – 2020 season.

The Upper Gunnison report does not correlate the increase to snowpack to the increase in streamflow annually; however, the report does include the results of a NAWC study from 2010 that estimated the increase to streamflow during the runoff period (April to July) attributable to cloud seeding operations. The study estimated increases to streamflow as a result of cloud seeding at the Gunnison River near Gunnison location (USGS ID 09114500) and into Blue Mesa Reservoir corresponding to snowpack increases of 6 and 11 percent. Using the results from the multi-linear regression technique, Table 15 reflects the estimated increase in streamflow in April through July at the two locations for the two levels of increased snowpack.

Table 15. Estimated Increase to Streamflow due to Increased Snowpack

Location	Snowpack Increase	Streamflow Increase
Gunnison River Near Gunnison	6%	8% (28,036 AF)
	11%	14.5% (51,339 AF)
Inflow to Blue Mesa Reservoir	6%	8.5% (57,730 AF)
	11%	15.5% (105,839 AF)

Accounting for drainage area and precipitation, the increase in streamflow can be estimated for the sub-basins that drain to these locations. Table 16 and Figure 19 reflects the six primary sub-basins that contribute streamflow to Blue Mesa Reservoir and the relative percentage of the contributing inflow from each sub-basin based on comparison of drainage area and average precipitation. Note that these are high-level estimates; the contributing flow from these sub-basins varies seasonally; and explicit analysis of seasonal or annual recorded streamflow was not conducted for this effort.

Table 16. Estimated Contributing Streamflow to Blue Mesa Reservoir by Sub-basin

Sub-basin	Percent of Total Streamflow Increase at Blue Mesa Reservoir
Taylor River	22%
East River	23%
Ohio Creek	8%
Quartz Creek	8%
Tomichi Creek	20%
Cochetopa Creek	19%

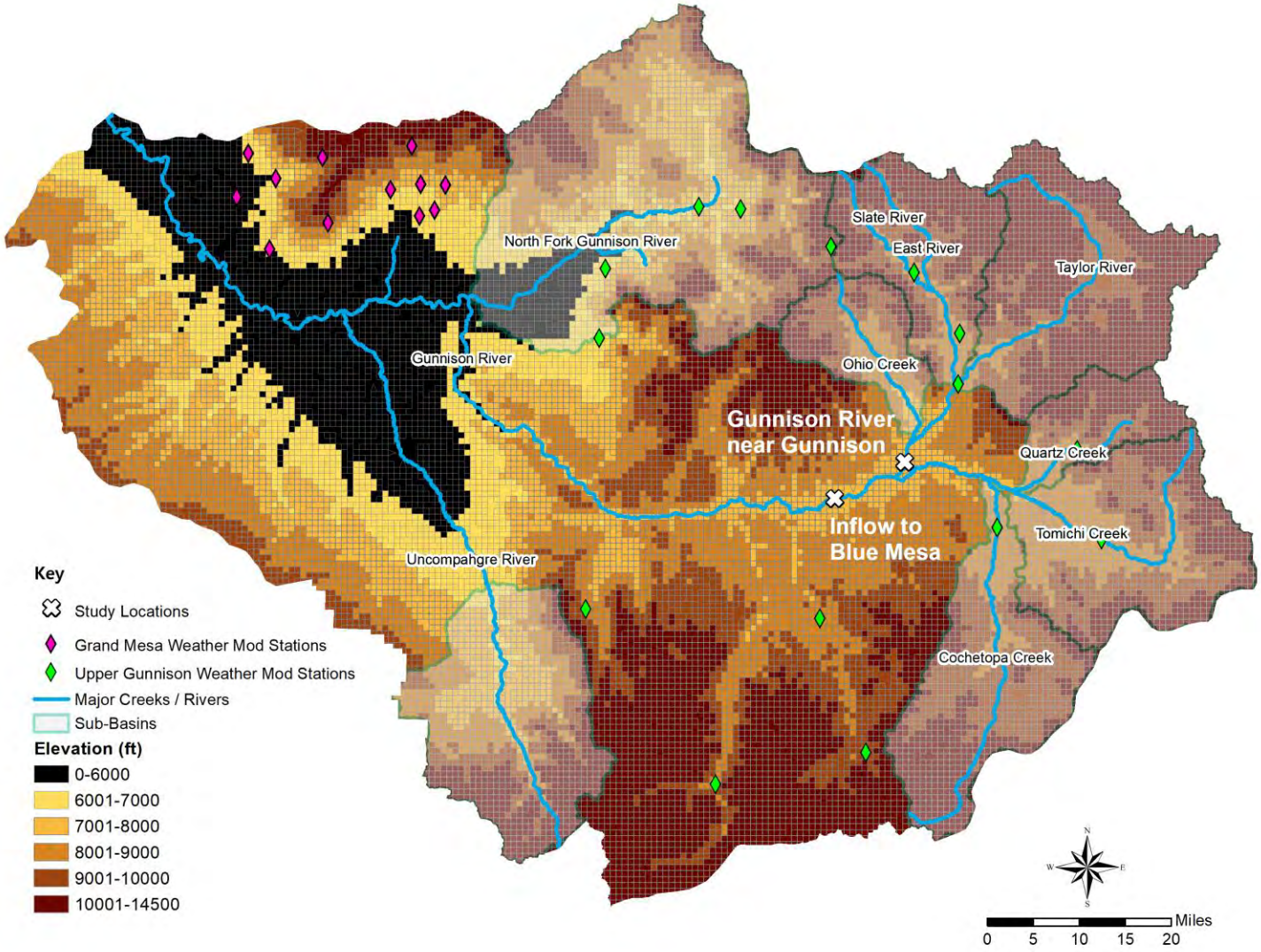


Figure 19. Gunnison Basin Drainage Area Mapping

Potential to Expand Program

As reflected in Figure 18, the existing programs in the basin cover the Upper Gunnison Basin generally east of the Uncompahgre River basin and south of Blue Mesa Reservoir; north and east of Blue Mesa Reservoir; and the Grand Mesa on the northern edge of the basin. As such, expanding these programs would likely include areas between the two program impact areas (i.e., North Fork of the Gunnison River) on the north or areas to the west of the existing program area on the southern edge of the basin. In addition, any expansion of the program would need to occur in sub-basins with land higher than approximately 6,000 feet in elevation. With these criteria in mind, two example sub-basins were selected to investigate the potential increase in streamflow if the program were to be expanded: the Upper Uncompahgre River Basin and the North Fork of the Gunnison River. Headwaters of these sub-basins are generally at an elevation high enough to potentially support the installation of a generator and drainage areas are large enough to produce an increase in streamflow (i.e., yield) on par with other sub-basins already in the program.

The drainage area and average precipitation of these sub-basins were calculated and compared to the drainage area and average precipitation of sub-basins already in the program in order to identify a comparable sub-basin. Additionally, runoff in the sub-basins were compared to identify sub-basins that had a similar runoff pattern and timing. Table 17 reflects the sub-basin in the current program area used to estimate the streamflow increase in each of the expanded sub-basins.

Table 17. Sub-basin Comparisons

Current Program Sub-Basin	Expanded Program Sub-Basin
Taylor River	Upper Uncompahgre River Basin
East River	North Fork of the Gunnison River

The yield from the comparable sub-basin was then scaled based on the difference in drainage area and average precipitation to estimate the increase in streamflow and yield from an expanded weather modification program if it were to be implemented in these sub-basins. As the North Fork of the Gunnison Basin likely already partially benefits from nearby cloud seeding generators, the estimated yield in the basin was reduced by half. Table 18 reflects the estimated increase in yield attributable to a 6 and 11 percent increase in snowpack that may occur if an expanded weather modification program was implemented in these two sub-basins.

Table 18. Estimated Potential Increase of Yield from an Expanded Program

Sub-Basin	Estimated Streamflow Increase with 6% Increase to Snowpack	Estimated Streamflow Increase with 11% Increase to Snowpack
Upper Uncompahgre River Basin	13,100 AF	23,900 AF
North Fork of the Gunnison River	13,400 AF	24,600 AF
Total	26,500 AF	48,500 AF

Note that this approach makes several assumptions which need to be thoroughly investigated prior to implementing an expanded weather modification program:

- Assumes the meteorological conditions in these sub-basins can support a cloud seeding program
- Assumes hydrological conditions will continue into the future (i.e., no impact from climate-adjusted conditions)
- Assumes a cloud seeding program is financially and operationally feasible in the sub-basins
- Assumes the sub-basins in the expanded area would produce similar increases to streamflow and yield to sub-basins in the current area
- Assumes the sub-basins are topographically similar and have similar rates of snow melt and runoff in the spring

As there are differences between the comparable sub-basins and climate-adjusted conditions will likely occur in the future, there is a high likelihood that the estimated yield from the expanded sub-basins would be less than the amount provided in Table 18. A reasonable reduction to the yield to account for these factors, however, cannot be determined.

APPENDIX A: GUNNISON BASIN – CURRENT AND 2050 PLANING SCENARIO WATER SUPPLY AND GAP REVISED RESULTS

Prepared by: Wilson Water Group

Analysis for Basin Implementation Plans

Technical Memorandum

Prepared for:

Colorado Water Conservation Board

Project Title:

Gunnison Basin
Current and 2050 Planning Scenario
Water Supply and Gap Revised Results

Date: June 14, 2021

Prepared by: Wilson Water Group
Reviewed by: Brown & Caldwell

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Section 1: Introduction

This technical memorandum summarizes changes to modeling inputs and results from the 2019 Technical Update that were conducted during the Basin Implementation Plan update process. The original model approach and results as well as other water supply-related analyses were documented in Volume 2 of the Technical Update in a memo entitled "Current and 2050 Planning Scenario Water Supply and Gap Results".

The approach and results were presented to stakeholders throughout the State and to the Basin Roundtables and feedback was obtained regarding areas where the approaches to developing the agricultural, municipal, and industrial demands or the modeling could be improved or refined. This technical document summarizes these revisions to inputs and/or results that affect the Gunnison Basin.

The following should be noted regarding this effort:

- The revisions were based on stakeholder input and may not include every aspect of the Technical Update. For example, one basin may only have revised M&I demands whereas another basin may only have revisions to modeling operations.
- Revisions to West Slope basins also impact the transbasin import supply gap estimated for basins that receive imports; revised import supply gaps are also included in the sections below if applicable.
- This document provides only a summary of the revisions; review specific spreadsheets and modeling datasets available on the Colorado Water Plan website for further information on revisions.
- The revised information herein supersedes any previously developed information. Documentation and reports relying on the information from September 2019 will reflect a note to this effect, but the documentation will not be updated.
- The revised information will be used in the Basin Implementation Plan Volume 1 and 2 reports and the Update to the Colorado Water Plan.

1.1 DELIVERABLES

The revised model results are provided both within this document and in separate Excel spreadsheets for each basin. The General Contractor Team for the Technical Update has developed several spreadsheets of more localized results at the Water District level for basins that have requested this detail. These spreadsheets have also been updated and provided to the Local Experts in each of those basins. Additionally, revised streamflow results were loaded into the Flow Tool and made available to the Local Experts. Lastly, the model input and output files were delivered to the General Contractor and made available to the public via the Colorado Water Plan website. These spreadsheets, modeling datasets, the revised Flow Tool, and this documentation serve as the deliverables for this effort.

1.2 DISCLAIMER

The technical data and information generated are intended to help inform decision making and planning regarding water resources at a statewide or basin-wide planning level. The information made available is not intended to replace projections or analyses prepared by local entities for specific project or planning purposes. The information or datasets provided are from a snapshot in time and cannot reflect actual or exact conditions in any given basin or the state at any given time. While the Technical Update and Basin

Implementation Plan strives to reflect the Colorado Water Conservation Board's (CWCB) best estimates of future water supply and demands under various scenarios, the reliability of these estimates is affected by the availability and reliability of data and the current capabilities of data evaluation. Moreover, the Technical Update and Basin Implementation Plan cannot incorporate the varied and complex legal and policy considerations that may be relevant and applicable to any particular basin or project; therefore, nothing in the Technical Update, Basin Implementation Plan, the associated Flow Tool or Costing Tool is intended for use in any administrative, judicial or other proceeding to evince or otherwise reflect the State of Colorado's or the CWCB's legal interpretations of state or federal law.

Furthermore, nothing in the Technical Update, Basin Implementation Plan, or any subsequent reports generated from these datasets is intended to, nor should be construed so as to, interpret, diminish, or modify the rights, authorities, or obligations of the State of Colorado or the CWCB under state law, federal law, administrative rule, regulation, guideline or other administrative provision.

Section 2: Gunnison Basin Revised Results

The following sections reflect the revisions implemented in the Gunnison Basin and the resulting agricultural and M&I demands, water supply, and gaps modeled results. As discussed above, refer to the original 2019 Technical Update documentation for more information on the demands and gaps in each basin.

2.1 GUNNISON BASIN OPERATIONAL REVISIONS

2.1.1 TAYLOR PARK RESERVOIR OPERATIONS

Revisions to the Gunnison Basin were limited to model operations, primarily associated with Taylor Park Reservoir operations, and demands at Redlands Canal. On November 2, 2020, an amended decree for Taylor Park Reservoir was signed (2011CW31). The amended decree prompted a revision to the Technical Update to reflect the terms of the amended decree, specifically regarding the operation of the reservoir under drought conditions. Taylor Park Reservoir storage targets and summer minimum flow releases are based on projected inflow to the reservoir. Winter minimum flow releases are set based on storage at the end of October. This information was used to develop storage targets and releases targets for each scenario. Based on conversations with the Division 4 office, the model was also revised to better represent the interaction between Uncompahgre Valley Water User Association's (UVWUA) water in Taylor Park and Blue Mesa Reservoir to more accurately represent water stored under UVWUA's first and UGRWCD's second fill storage rights in Taylor Park Reservoir. These revisions had the effect of increasing the stored water in Taylor Park, as reflected in Figure 1.

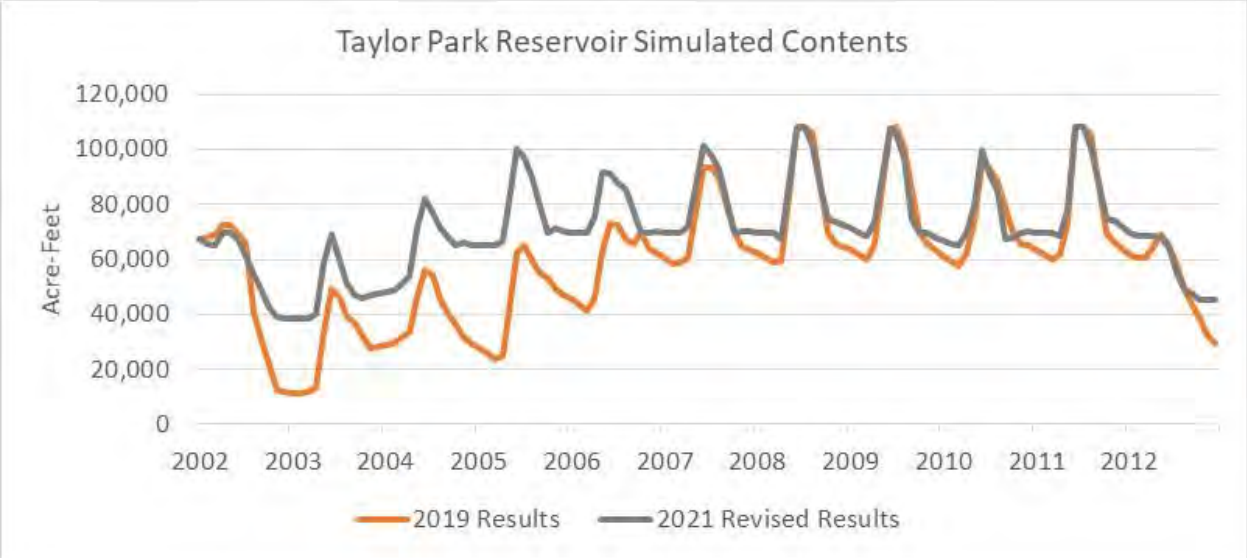

Figure 1: Taylor Park Reservoir Simulated Contents - Current Conditions

2.1.2 REDLANDS CANAL OPERATIONS

The Redlands Canal diverts for both irrigation and power generation. Although the diversions are from the Gunnison River, the return flows contribute to flows in the Colorado River; therefore, Redlands Canal is represented in both models. The baseline demands used in the model were developed based on historical patterns of diversions. The total Redlands Canal demand and the split between the power demand (approximately 96 percent) and the irrigation demand (approximately 4 percent), were revised in both the Gunnison and the Colorado Basin based on input from the Gunnison Basin Implementation Plan (BIP) Local Expert. Figure 2 reflects the average monthly revised total demand for Redlands Canal compared to the previously modeled demand. Note that demands for power were not adjusted across the Planning Scenarios, therefore this demand is used under Current and Planning Scenario conditions.

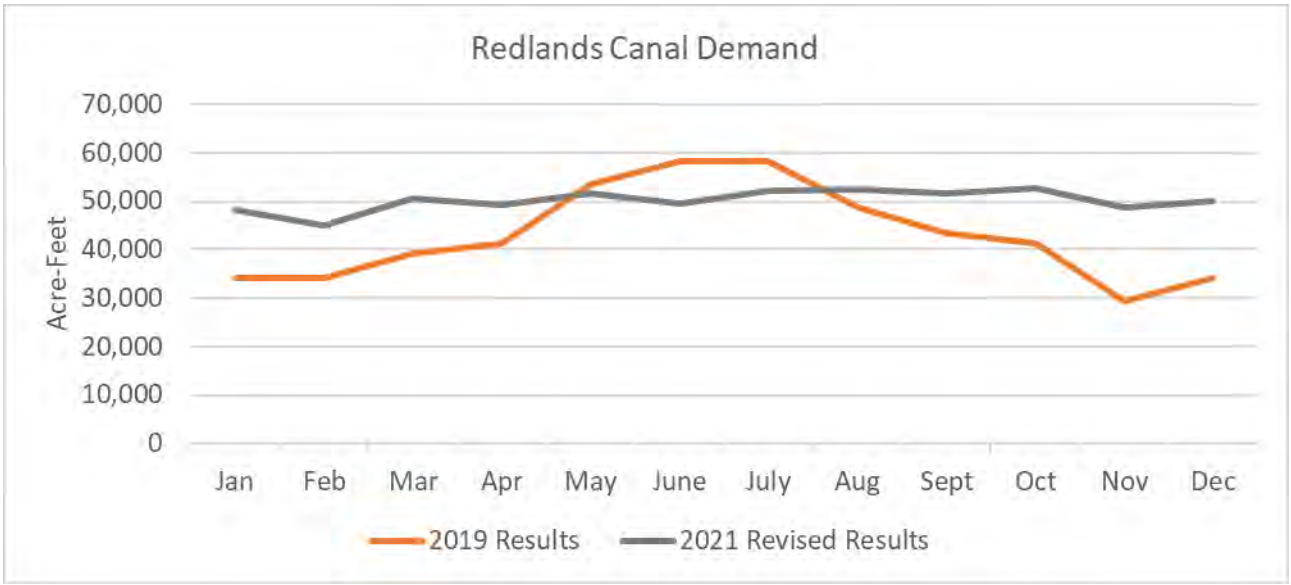

Figure 2: Redlands Canal – Average Monthly Total Demand

2.1.3 GUNNISON WHITEWATER COURSE

Lastly, during review of the Gunnison water allocation model, it was noted that the Gunnison Whitewater Course RICD was at the wrong location in the model. The RICD location was moved upstream in the model to the correct location during the revision effort. Figure 3 reflects the streamflow at the two locations compared to the RICD demand during a dry year (2001) under Current conditions. The impact of this revision will be greater shortages to the RICD than previously modeled during low flow conditions.

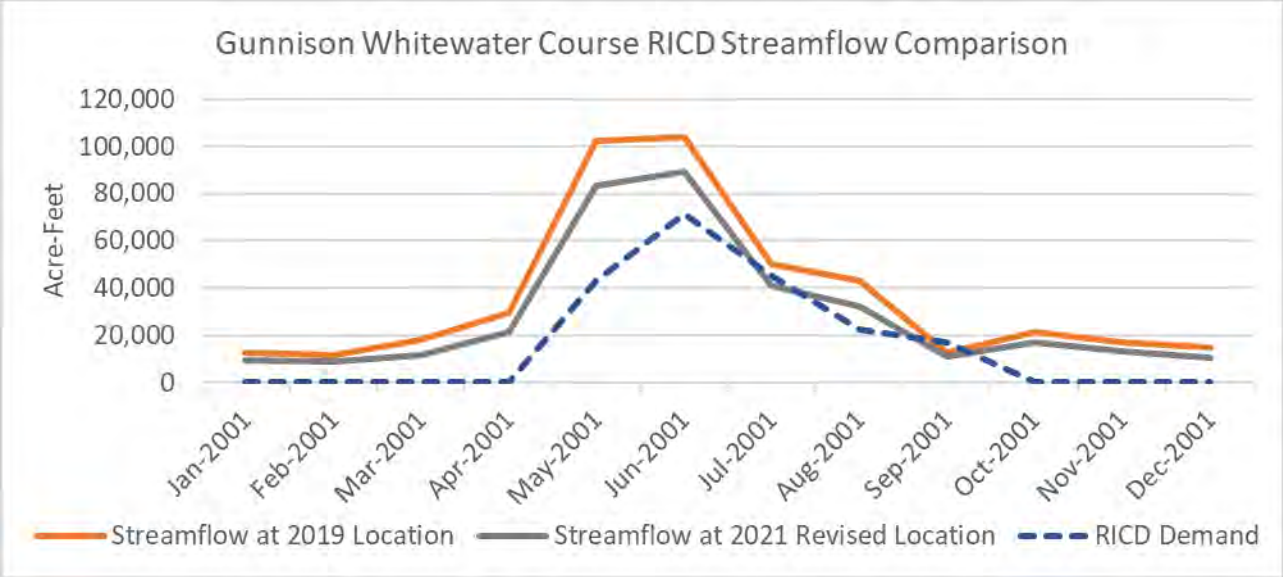

Figure 3: Gunnison Whitewater Course RICD - Dry Year Streamflow Comparison

2.2 GUNNISON BASIN REVISED WATER SUPPLY AND GAP RESULTS

The following tables reflect the revised demand, water supply, and gap results based on the revised demand and operations in the Gunnison Basin. There was between a one to two percent change in the agricultural demand and gap, both on average and during critically dry years, due to the revisions to Redlands Canal and reservoir operations. The revisions did not impact the M&I demand in the basin; however, they did result in a slight reduction to the M&I gap. The revised reservoir operations led to an increase in water availability to the Project 7 municipal entities, which led to a reduction to the overall M&I gap in the basin across the Planning Scenarios.

As discussed in the 2019 Technical Update, the Gunnison Basin benefits from the delivery of a small amount of imported transbasin supplies from the Colorado River and Southwest basins. Revisions to these source basins did not impact the transbasin import supply gap associated with these deliveries; the information presented in the 2019 Technical Update for this gap remains unchanged.

Table 1: Gunnison Basin Agricultural Water Supply and Gap Summary

	Agricultural Results	Baseline	Business as Usual	Weak Economy	Coop. Growth	Adaptive Innovation	Hot Growth
Average	Average Annual Demand (ac-ft)	1,795,979	1,677,031	1,677,031	1,967,056	1,307,243	2,040,585
	Average Annual Demand Increase from Baseline (ac-ft)	-	-	-	171,078	-	244,606
	Average Annual Gap (ac-ft)	87,719	76,542	76,701	158,508	110,421	222,343
	Average Annual Gap Increase from Baseline (ac-ft)	-	-	-	70,789	22,702	134,625
	Average Annual Percent Gap	5%	5%	5%	8%	8%	11%
	Average Annual CU Gap (ac-ft)	43,508	38,009	38,087	75,491	63,679	104,286
Critically Dry Maximum	Demand In Maximum Gap Year (ac-ft)	1,836,939	1,715,434	1,715,434	1,833,451	1,249,156	1,906,485
	Increase from Baseline Demand (ac-ft)	-	-	-	-	-	69,546
	Gap In Maximum Gap Year (ac-ft)	368,779	322,248	322,372	473,293	326,602	596,800
	Increase from Baseline Gap (ac-ft)	-	-	-	104,514	-	228,020
	Percent Gap In Maximum Gap Year	20%	19%	19%	26%	26%	31%

Table 2: Gunnison River M&I Water Supply and Gap Summary

	M&I Results	Baseline	Business as Usual	Weak Economy	Coop. Growth	Adaptive Innovation	Hot Growth
Average	Average Annual Demand (ac-ft)	17,012	24,763	19,133	22,888	26,393	34,057
	Average Annual Demand Increase from Baseline (ac-ft)	-	7,751	2,121	5,876	9,381	17,045
	Average Annual Gap (ac-ft)	2	994	188	1,066	2,207	4,770
	Average Annual Gap Increase from Baseline (ac-ft)	-	992	186	1,064	2,205	4,768
	Average Annual Percent Gap	0%	4%	1%	5%	8%	14%
Critically Dry Maximum	Demand In Maximum Gap Year (ac-ft)	17,012	24,763	19,133	22,888	26,393	34,057
	Increase from Baseline Demand (ac-ft)	-	7,751	2,121	5,876	9,381	17,045
	Gap In Maximum Gap Year (ac-ft)	90	2,452	819	2,758	3,324	8,690
	Increase from Baseline Gap (ac-ft)	-	2,362	729	2,668	3,234	8,600
	Percent Gap In Maximum Gap Year	1%	10%	4%	12%	13%	26%

Table 3: Gunnison River Water Supply and Gap Summary

	Agricultural and M&I Results	Baseline	Business as Usual	Weak Economy	Coop. Growth	Adaptive Innovation	Hot Growth
Average	Average Annual Demand (ac-ft)	1,812,991	1,701,794	1,696,164	1,989,944	1,333,636	2,074,642
	Average Annual Gap (ac-ft)	87,721	77,537	76,889	159,574	112,628	227,114
	Average Annual Percent Gap	5%	5%	5%	8%	8%	11%
Critically Dry Max	Demand In Maximum Gap Year (ac-ft)	1,853,951	1,740,197	1,734,567	1,856,339	1,275,549	1,940,542
	Gap In Maximum Gap Year (ac-ft)	368,869	324,700	323,191	476,052	329,926	605,489
	Percent Gap In Maximum Gap Year	20%	19%	19%	26%	26%	31%