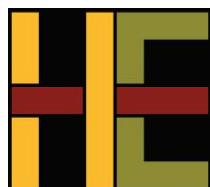


# **Economic Impacts of Irrigation Water Curtailment Scenarios for the Upper Gunnison Basin**

**Harvey Economics**



September 30, 2020

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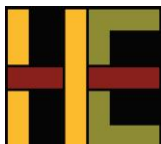
**Harvey Economics**

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# EXECUTIVE SUMMARY

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This study projects the economic impacts from curtailment of water rights in the Upper Gunnison Basin, whether voluntary pursuant to a Drought Contingency Plan or involuntary as a result of a Colorado River Compact curtailment. About three quarters of the water rights in the Basin are post-Compact.<sup>1</sup> The mission of the Upper Gunnison River Water Conservancy District is “To be an active leader in all issues affecting the water resources of the Upper Gunnison River Basin”. Because of the additional uncertainty facing water users in the Basin caused by the potential for curtailment, the District felt the need to consider the impacts of curtailment on its water users, and so commissioned Harvey Economics to perform this study. Since irrigators are the primary Upper Gunnison Basin water users, the study emphasizes agriculture and secondarily, recreation, tourism and environmental resources.

Recognizing the considerable uncertainty about a voluntary or involuntary curtailment at the time this report was prepared, HE selected three alternative irrigation curtailment programs and three program durations for each:

**Table S-1.**  
**Irrigation Curtailment Scenarios and Durations**

Scenario	Magnitude of Curtailment	Duration (years)
1	30%	one, three, five
2	50%	one, three, five
3	100%	one, three, five

Unlike other impact studies of this type, the Upper Gunnison Basin impact analyses were based on primary, site-specific data. With the help of the District Board, HE selected six ranchers for in-depth interviews in different sub-basins, representing about 25 percent of the total irrigated acreage in the Basin in 2018. Through these interviews, we determined how local ranchers would adjust their irrigation and cattle operations in response to the three curtailment scenarios and durations, and how that would affect their individual finances.

The rancher interviews brought out Upper Gunnison Basin-specific issues which would represent additional challenges as ranchers attempted to address irrigation curtailment. Of particular importance, the timing of the curtailment vs. the normal wet/dry cycles, the sandy soil conditions, and the seasonal timing of the irrigation water will likely increase the impacts beyond the ranchers’ immediate operational changes. Quantification difficulties,

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<sup>1</sup> “Post-Compact” water rights are water rights not perfected prior to the signing of the 1922 Colorado River Compact.

infrastructure costs, potential conflicts with existing agreements, viability of cattle operations are also noteworthy issues that should be considered.

Under Scenario 1 involuntary curtailment, direct effects on operations are likely to be relatively modest for a one-year program but will increase for a three- and five-year program as negative impacts carry over and worsen. Under Scenario 2, agricultural impacts are projected to be moderate for the one-year curtailment, but increasingly severe for multiple year curtailments. The direct impacts of a 100 percent Post-Compact water right curtailment would be substantial to profound.

The effects were estimated for each of the sub-basins, then aggregated to the full Upper Gunnison Basin. The direct effect of irrigation curtailment varies considerably from sub-basin to sub-basin within the Upper Gunnison Basin as indicated for Scenario 1, three-year program below:

**Table S-2.**  
**Selected Direct Effects on Ranching Sector, Scenario 1, Three-Year Involuntary Curtailment by Sub-Basin**

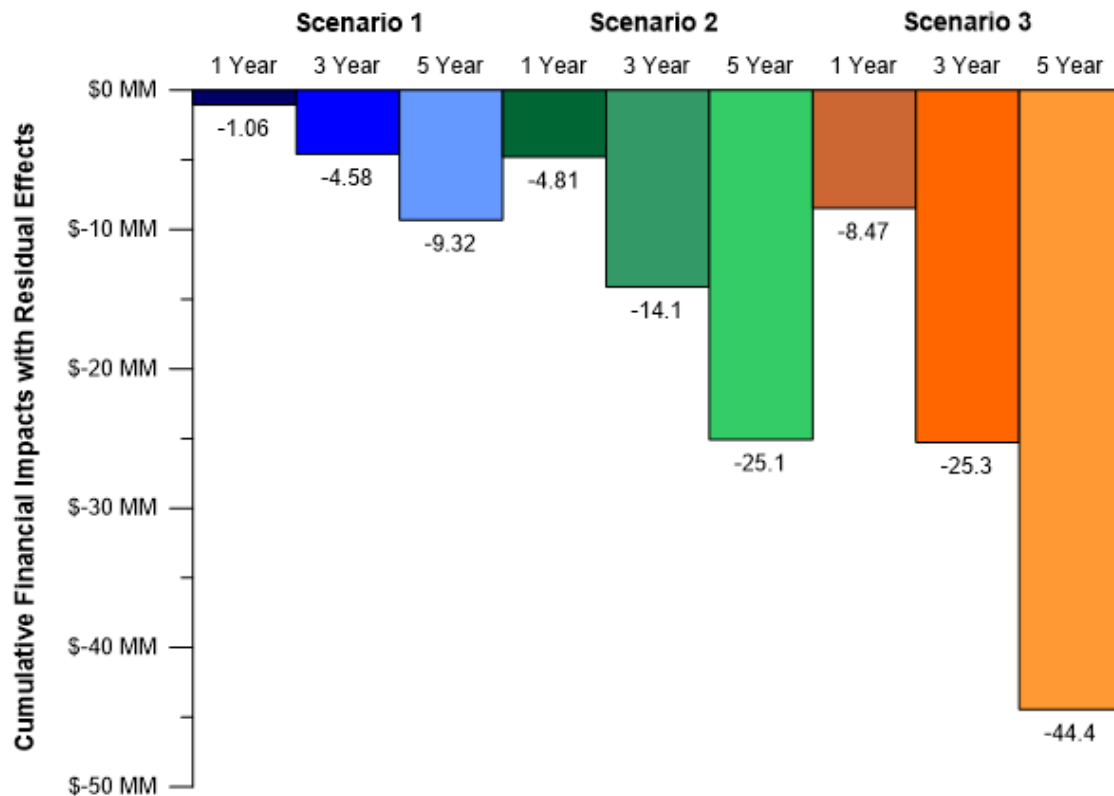
Sub-Basin	Baseline Hay Production (Tons)	Percent Change		Change in Net Operating Profit
		Hay Production	Cattle Inventory	
Tomichi	17,840	-2%	-2%	(\$49,000)
East	15,090	-34%	-10%	(\$210,000)
Ohio	9,420	-7%	-6%	(\$692,000)
Gunnison Mainstem	7,280	-4%	-5%	(\$284,000)
Cochetopa	6,090	-2%	-2%	(\$35,000)
Cebolla	2,070	-21%	-7%	(\$52,000)
Lake Fork	1,380	-21%	-7%	(\$35,000)
Taylor	780	-34%	-10%	(\$11,000)

The Tomichi and Cochetopa sub-basins are projected to absorb the Scenario 1, three-year curtailment by adjusting their operations with little net economic effect. Conversely, this same program would likely have much larger effects, a 34 percent reduction in the hay production in the East sub-basin. These sub-basins would try and keep their cattle herds intact by purchasing hay elsewhere. The change in net operating profits would be largest in the Ohio, East and Gunnison Mainstem sub-basins. The Tomichi, Cochetopa and Taylor sub-basins would likely incur more modest financial impacts than the other sub-basins.

Residual effects would likely cause additional negative impacts on the Upper Gunnison Basin agricultural sector, decreasing ranchers' financial performance under an involuntary curtailment. Direct and residual financial impacts are depicted in Exhibit S-1.



**Exhibit S-1.**  
**Financial Impacts of Involuntary Water Curtailment Scenarios on Upper Gunnison Basin Ranchers**



A voluntary program, depending on its terms and funding, could reduce or eliminate the direct and residual economic effects on Upper Gunnison Basin Ranchers. The dollar amount required to induce those ranchers to participate is subject, not only to the economic losses indicated here, but also the market and hydrologic conditions, the imminence of a Colorado River Compact curtailment, other terms of the program, among other factors. The minimum, probably understated, starting point for compensation for recognized economic loss suggests a preliminary range of \$102 to \$207 per AF of consumptive use saved to meet the goals of the scenarios described in this report.

HE discussed impact mitigation with the ranchers, and certain limited opportunities exist. Sprinkler irrigation would be unattractive for a host of reasons, but the timing of irrigation and increased fertilization might hold promise. Reduction in irrigated lands is a possibility under separate study.

Impacts on recreational and environmental resources were examined on a broad, qualitative basis. With the help of Wilson Water Group, HE estimated the percent change in stream flows for average and dry year conditions.

Recreational impacts stemming from these changes in stream flows would vary. Boating would be largely unaffected since that activity is concentrated in the Taylor and Lake Fork sub-basins. Fishing would clearly be affected. Increased flows in summer would generally be beneficial, but especially in dry years. Excessive flows would make wade/walking difficult in spring, and reduced return flows might impact fish populations.

Environmental effects would be mainly positive, especially in dry years, due to increased summer flows. These flows would help reduce stream temperatures, increase stream connectivity and reduce the incidence of dry up points. However, reduced return flows in the fall and winter might be a problem, deserving further study.

Total impacts from changes to the agricultural economy are quantified; impacts on the touristic sector are addressed in a qualitative manner. Scenario 1 economic impacts from an involuntary curtailment are summarized below:

**Table S-3.**  
**Economic Impacts of Scenario 1 Involuntary Water Curtailment**

	Direct Effects	Secondary Effects	Total Economic Impacts
<b>One-Year Program</b>			
Gross Output (M)	-\$1.1	-\$0.3	-\$1.4
Employment	0	-18	-18
Personal Income (M)	\$0	-\$0.5	-\$0.5
<b>Three-Year Program (Cumulative)</b>			
Gross Output (M)	-\$4.6	-\$3.3	-\$7.9
Employment	-33	-18	-51
Personal Income (M)	-\$1.3	-\$1.9	-\$3.2
<b>Five-Year Program (Cumulative)</b>			
Gross Output (M)	-\$9.3	-\$8.5	-\$17.8
Employment	-43	-27	-70
Personal Income (M)	-\$3.3	-\$3.9	-\$7.1

Although significant to some ranchers, Scenario 1 would likely create a modest impact on the County economy. Scenario 2 would cause losses to gross retail sales of about 4 to 8 percent for the County if the curtailment lasted three or five years, respectively. Scenario 3 impacts to the local economy would be considerable, with wages and salaries declining 6 to 10 percent during three- or five-year curtailments, respectively. The five-year program effects are likely understated but difficult to quantify, given the uncertainties that might arise.

A voluntary program would produce very different economic impacts, depending upon its funding and terms. Direct and residual effects on the ranchers might be reduced or eliminated. Ranch employment and related income would decline. Secondary impacts could be modest on the whole, except different businesses and people will be affected; those businesses and residents supplying agriculture would be negatively affected while consumer-oriented

businesses might benefit. Beyond the tipping point, impacts of the voluntary and involuntary programs will be more similar; monies and people will likely leave the region.

It is important to look beyond the aggregate economic statistics to fully understand the economic implications of irrigation water curtailment in the Upper Gunnison Basin. Ranching is one of few basic economic activities in this region, meaning that cattle sales brings new money into the area to support the economy. Damage to agriculture in this region would also mean a less diverse economy, one more dependent on the other major basic sectors, recreation and tourism.

A substantial economic effect on the Basin ranching sector can also lead to broader sociological impacts. Agriculture and the ranching families have been staples for the area for a long time. Water curtailments along with aging demographics and the temptation to sell out for land development might speed up the retirement of working ranches in the area.

Less irrigation will also have impacts on the groundwater table and those who rely on that resource. This would include domestic wells, but also the Gunnison County municipalities with their businesses and residents. Those impacts are not captured in the economic impact analysis.

Finally, the increased “browning” of Upper Gunnison Basin, both in geographic extent and duration, will have an additional negative impact on the region. While this phenomenon is likely to occur, its actual effects would be difficult to assess.

Overall, the longer term curtailment programs present greater impacts, but are difficult to quantify.

## **Considerations for a Voluntary Program**

This study has focused on the impacts of curtailment. Even so, the results of this study point to program characteristics which might help its formulation:

- a. A shorter curtailment might be preferred.
- b. The amount of curtailment matters.
- c. Compensation beyond revenue loss will be necessary.
- d. A curtailment program will work better for some Upper Gunnison sub-basins
- e. One size does not fit all.
- f. Flexibility will be key.

This study suggests that an effective voluntary program should be site-specific and responsive to the range of influences on irrigation in the region.

# PROLOGUE

## Background and Purpose

---

This report identifies and estimates the economic impact of water supply curtailment and a demand management program upon key water using sectors of the Upper Gunnison River Basin. Harvey Economics (HE) prepared this report and conducted the underlying research and analyses under a contract with the Upper Gunnison River Water Conservancy District (“Upper Gunnison District” or “District”). Dr. Julie Shiflett, an agricultural economist, assisted HE with the primary data collection efforts as part of this project.

Why is this a concern to the citizens of the Upper Gunnison Basin, and, in particular, the ranching community?

*Since 2000, the certainty and security of the Colorado River water supply have been called into question. The entire Colorado River Basin is currently in the worst hydrologic cycle in the historic record. Between 2000 and 2018, the Basin has experienced the driest year on record (2002), and the driest consecutive two-year period on record (2012 and 2013). It has also experienced above-average runoff only five out of 19 years and withstood a decline in storage levels at the two largest reservoirs in the Colorado River Basin -Lake Mead and Lake Powell to less than half of full capacity. Further, recently published data indicate a likely continuation of the trend of reduced flows and increased demand throughout the Colorado River Basin. Regardless of whether this is an extended drought or the new normal hydrology, the potential impacts to the state and its citizens are significant.<sup>1</sup>*

The Gunnison River is a major tributary of the Colorado River. In 1922, the seven Colorado River Basin states and the United States signed the Colorado River Compact (1922 Compact).<sup>2</sup> The 1922 Compact provides that “The states of the Upper Division<sup>3</sup> will not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75,000,000 acre feet for any period of ten consecutive years reckoned in continuing progressive series . . .”<sup>4</sup>, and further provides that the Upper Division States must contribute to the United States’ treaty obligation to

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<sup>1</sup> Colorado Water Conservation Board, *Support and Policy Statements Regarding Colorado River Drought Contingency Plans, Demand Management, and Compact Administration*, November 15, 2018 available at <https://dnrweblink.state.co.us/cwcb/0/edoc/209095/SUPPORTANDPOLICYSTATEMENTSFINAL11-15-18.pdf?searchid=a0210e79-2c01-40f7-beec-1f66486946ca> (CWCB Policy Statement).

<sup>2</sup> Colorado Revised Statutes § 37-61-101. Article III(a) of the Compact apportions from the Colorado River to the Upper Basin and to the Lower Basin respectively the exclusive beneficial use of 7,500,000 acre-feet of water per year.

<sup>3</sup> Colorado, New Mexico, Utah, Wyoming.

<sup>4</sup> 1922 Compact, Article III(d).

Mexico,<sup>5</sup> To comply with the 1922 Compact, the Upper Division states must meet the obligations defined in Article III(c) and Article III(d).

In 1948, the Upper Division states, United States, and Arizona signed the Upper Colorado River Compact (1948 Compact).<sup>6</sup> Although it is implied in Article III(d) and Article IX, the 1922 Compact contains no provision specifically requiring curtailment. Article IV of the 1948 Compact, however, provides “In the event curtailment of use of water by the States of the Upper Division at any time shall become necessary in order that the flow at Lee Ferry shall not be depleted below that required by Article III of the Colorado River Compact, the extent of curtailment by each state of the consumptive use of water . . . shall be determined by the Commission.” The Upper Colorado River Commission (UCRC) established by the 1948 Compact is authorized to “make findings as to the necessity for and the extent of the curtailment of use” required by Article IV.<sup>7</sup> The UCRC is also authorized to determine the “extent of curtailment by each State of the consumptive use of water” allocated to it under the 1948 Compact.

Alarmed by the sustained drought, the Colorado River Basin states, and the United States acting through the Bureau of Reclamation, began in 2013 to develop a Drought Contingency Plan (DCP). In the Spring of 2019, the states and the Bureau entered into a series of agreements that provided for a DCP for each basin. The Upper Basin<sup>8</sup> DCP has two principal elements: drought operation of certain Upper Basin reservoirs and a Demand Management Program (DMP). To date, the Upper Basin DCP agreements do not define a DMP or even guarantee that one will be established. The Colorado Water Conservation Board (CWCB) has initiated investigation of a demand management program that, if implemented, will consist of “voluntary, temporary, and compensated reductions in consumptive use of waters that otherwise would deplete the flow of the Upper Colorado River System for the specific purpose of helping assure compact compliance.”<sup>9</sup>

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<sup>5</sup> *Id.*, Article III(c). In 1944 the United States signed a treaty with Mexico that guarantees the delivery of 1.5 million acre-feet of Colorado River water to Mexico each year.

<sup>6</sup> Colorado Revised Statutes § 37-62-101.

<sup>7</sup> 1948 Compact, Article VII(d)(8).

<sup>8</sup> In the 1922 Compact “Upper Basin” is defined by hydrologic boundaries while “Upper Division” is defined by geographic boundaries, but both refer to the four states noted above.

<sup>9</sup> CWCB Policy Statement. The other Upper Division States are also investigating the feasibility of a DMP. All four states will have to participate for the DMP to be successful.

# SECTION 1

## Introduction and Methodology

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This report consists of the following sections:

*Executive Summary*—Summary and conclusions.

*Prologue*—HE provides the study background and purpose for doing the work

*Section 1*--Scenarios are defined and methodology for conducting the study is discussed in this section.

*Section 2*—This section describes the rancher interview process and responses which drive the study conclusions.

*Section 3*—We identify and project the immediate or direct economic effects on the agricultural sector in the Upper Gunnison Basin as well as the residual economic effects that the ranchers are likely to experience with a demand management program.

*Section 4*—The full economic impacts of water curtailment or demand management programs from changes to Basin agriculture are provided in this section.

*Section 5*—HE addresses recreational and environmental effects from reductions in agricultural water diversions and subsequent increases in streamflow in this section.

### Acknowledgements

We extend our gratitude to each of the ranchers and their families that directly contributed to this impact study. Their full and active participation gives tangible meaning and credibility to this work. They cannot be named because HE made a commitment of confidentiality.

For non-agricultural impacts, we received help from several sources. Wilson Water Group provided the streamflow changes, which drove the recreational and environmental impact evaluation. HE also thanks those who participated in the recreation and environmental interviews: Mark Schumacher, Julie Nania, and Dan Brauch.

This study was prepared with guidance and direction from Sonja Chavez and Frank Kugel, present and former General Managers, respectively, of the Upper Gunnison District, and John McClow, General Counsel to the District. Board members Julie Nania, Andy Spann, Julie Vlier, and Sub-Basin Coordinator Jesse Kruthaupt were especially helpful as well. The design of this study was reviewed with the Upper Gunnison District Board and the Gunnison County Stockgrowers Association.

## Scenario Definitions and Assumptions

There are potentially three scenarios or alternative futures in which compact compliance could have an impact on irrigators in the Upper Gunnison Basin.

In the first alternative future, the ten-year average flow at Lee Ferry falls below the required amount (a “Compact deficit”) and the Upper Colorado River Commission (UCRC) makes a finding that curtailment of consumptive uses in the Upper Division states is necessary to comply with the 1922 Colorado River Compact. Under this future, the Colorado State Engineer is authorized to adopt regulations enabling the State “to meet its compact commitments,” including regulations that require curtailment of diversions of post-1922 Compact water rights.

In the second alternative future, hydrologic forecasts convince the UCRC and the states of the Upper Division that a Compact deficit at Lee Ferry is sufficiently imminent that a preemptive curtailment of consumptive use is necessary to maintain compact compliance. Presumably, with a UCRC finding that curtailment is necessary to maintain compliance, the State Engineer can administer curtailment of post 1922 Compact water rights within the state.

In this report, these scenarios are analyzed as involuntary curtailment.

The third alternative future is the implementation of a Demand Management Program (DMP) to avoid or mitigate the risk of involuntary compact curtailment. The type of program being evaluated is a proactive arrangement under which voluntary, temporary, and compensated reductions in consumptive use would be made, with the resulting water savings shepherded to special storage accounts in Upper Basin reservoirs under the control of the UCRC. Releases from these accounts would be limited to addressing a Compact deficit.

Each of the three alternative futures would result in a reduction of water use in the Upper Gunnison Basin. The first two result in involuntary curtailment of post-1922 Compact water rights, where irrigators are forced to reduce their diversions. The duration of such curtailment is uncertain, because it is entirely dependent upon hydrology. Under the third alternative future, irrigators may choose to reduce diversions under all of their water rights, for whatever period they choose, in exchange for compensation that is intended to reimburse them for the economic cost of such reduction. This raises important questions for the Upper Gunnison River Basin:

- 1) What is the size of the economic loss that the first two alternative futures might inflict upon Upper Gunnison ranchers?
- 2) What is the magnitude of compensation that might induce a rancher to participate in a DCP, or how could that be determined?
- 3) What is the effect of the reduction in agricultural activity on the overall economy of the Upper Gunnison Basin?
- 4) What affect will this have on other water using sectors in the Basin?

This Study sheds light on these issues, focusing primarily on ranching in the Upper Gunnison Basin, and secondarily on recreation and environmental effects from changes in stream flows.

As of this writing, there is considerable uncertainty about whether a DMP will be adopted by a sufficient number of stakeholders to be successful, or the potential for involuntary curtailments to prevent or respond to a Compact deficit. To conduct this impact study, HE was required to make certain assumptions about reductions in water availability. We selected three scenarios in an attempt to bound the possibilities, illustrated in Table 1-1.

**Table 1-1.**  
**Upper Gunnison Basin Water Curtailment Scenarios**

Scenario	Reduction in Post-Compact Water Diversions
1	30%
2	50%
3	100%

Under a voluntary program, pre-Compact as well as post-Compact water might be curtailed. Of course, it is unreasonable to predict how much water will be offered under a voluntary program, since that program has not been finalized. For the purposes of this study, HE assumes that sufficiently attractive program terms, including funding, will be available to produce the diversion curtailments represented by these three scenarios. The worst case is represented by a 100 percent reduction, assumed to be the result of curtailment under a severe shortage.

The duration of the curtailments is also uncertain under the mandatory curtailment or the voluntary curtailments. The UCRC will determine how long the mandatory curtailment needs to last as well as the size of the annual curtailment. Under a voluntary program, the Drought Contingency Plan (DCP) will presumably establish a duration for the program, but the ranchers will ultimately decide how long they want to participate in that program. Again, to bound the possibilities, HE assumed that each scenario reduction would last one year, three years or five years. In sum, we examined impacts as follows in Table 1-2.

**Table 1-2.**  
**Upper Gunnison Basin Scenarios and Durations**

Scenario	Magnitude of Curtailment	Duration (years)
1	30%	one, three, five
2	50%	one, three, five
3	100%	one, three, five

The period of curtailment is not likely to exceed five years because the need to overcome the storage deficits, when they are determined, is likely to be urgent.



## Agricultural Impact Methodology

The approach for estimating the economic impacts of DCP on the agricultural sector of the Upper Gunnison Basin was largely based upon primary data, rancher interviews, and a building up from sub-basins to the full Upper Gunnison Basin. The specific steps and data sources are described below.

**Step one.** HE met with representatives of the Upper Gunnison Board to review the detailed plan of study, select the ranchers to be interviewed and the curtailment scenarios. Given the importance of ranchers' understanding of this study, this group suggested that HE discuss the study plan and rancher involvement with the Gunnison County Stockgrowers Association. During that meeting, various observations about the impacts of agricultural water curtailments were offered and reported in the impact section of this report.

**Step two.** HE collected and reviewed secondary data collection to: (1) establish a baseline for agricultural and economic conditions; (2) gather information about baseline agricultural water diversions and use; and (3) better understand the DCP being currently considered and likely demand management responses in Colorado. We gathered Gunnison County agricultural and economic statistics from Federal and state sources. Regarding agricultural water use, Upper Gunnison River Basin Watershed Assessment and Management Planning – Phase I Final Report, December 2019, was particularly helpful. Wilson Water Group also supplied baseline water diversion and consumptive use data.

**Step three.** The impact analyses in the study were largely based on a series of interviews conducted with ranchers in three of the Upper Gunnison sub-basins. Each of these three sub-basins maintains considerably different irrigation practices. During these interviews, HE and the ranchers discussed likely rancher response to the three scenarios and the three different durations for each. The rancher interview responses were then reviewed, and follow-up interviews were conducted in some instances to make sure HE understood the responses. Given its importance, the rancher interview process is addressed in more detail in the next section of this report.

**Step four.** The interviews were then tabulated and aggregated by sub-basin. These were compared with secondary sources and sub-basin estimates were then adjusted slightly in some instances to better reflect known totals.

**Step five.** The results of the rancher interviews were extrapolated to the sub-basin where those ranches resided. Next, the results of the three sub-basins were applied to the remaining five sub-basins in the Upper Gunnison Basin based on similar agricultural and hydrologic conditions. With the impacts of each sub-basin estimated, the direct agricultural economic impacts of the three curtailment scenarios and durations in the full Upper Gunnison Basin were projected.

From the primary data collection, HE learned that the agricultural impacts are not simply confined to operational decisions in response to reduced water supply. In this location, soil conditions, elevation, hydrologic variation, and other site-specific factors lead to further

impacts beyond rancher control which must be accounted for and which we have termed ‘residual effects.’

The direct impacts and residual effects are presented in Section 3 of this report.

## **Recreational and Environmental Impact Methodology**

A secondary element of curtailment impacts relates to changes in stream flows and reservoir storage and the effects these changes might have on recreation, tourism and the environment. Reduced agricultural consumptive use will mean larger stream flows which might produce positive or negative effects depending on the particulars of the change. Reduced return flows must also be considered. HE has addressed these potential impacts in a generalized sense; given Board direction and limited study resources, this study’s focus was on agriculture.

The recreational and environmental evaluation approach HE followed emphasized changes in flows. We provided Wilson Water Group with the diversion changes for each sub-basin under each scenario and for the three durations. They provided percentage changes in stream flows and storage for each major tributary in each sub-basin. With this information, HE interviewed representatives from the tourism and recreational sector in Gunnison County and those knowledgeable about water-based environmental conditions. This portion of the impact analysis reports on the results and implications of these interviews.

## **Study Limitations**

There are always the basic uncertainties of the future with any impact projections, but those unknowns are especially pronounced in this study. We do not know what a voluntary DMP will look like, or if it will be supported or implemented. We do not know whether mandatory curtailment to prevent or respond to a Compact deficit will occur. At this writing, we only know that the threat is out there, and the State of Colorado and the other Upper Division states hope to develop a DMP to address it. For this reason, our impact study has attempted to bound the possibilities, but the future might occur outside those bounds.

HE conducted interviews with only six ranches in the Basin, and certainly more interviews would have improved the accuracy of our impact estimates. Given the required depth and duration of those interviews and the study scope, this small number is explainable. Even with those interviews, there was a wide range of responses when faced with a reduced water supply. Those ranches did, however, represent roughly a quarter of the Upper Gunnison’s total irrigated acreage and they were geographically diverse.

The hypothetical nature of mandatory or voluntary water curtailment leads to hypothetical responses on the part of the ranchers. When faced with actual curtailment, we cannot be sure that the ranchers would adjust their operations in the manner they described to us. In fact, a voluntary program introduces two uncertainties: the rancher must hypothesize the full terms of the voluntary program as well as his or her response at that point in time. Finally, the stream flow modelling work is very preliminary. Hence the impact evaluations on the recreational and environmental resources should be considered as generalized and preliminary.

HE projected economic impacts under a range of curtailments, durations and sub-basin locations to bound the results. In this vein, this study provides a foundation for policy actions or future demand management program planning.

## SECTION 2

### Rancher Interviews

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This section describes the interview process HE conducted and the results which were applied in this study. These interview results were the foundation for the impact analyses presented in later sections of this report.

#### Survey Design Plan

The purpose of the interviews was primarily to learn how ranchers in the Upper Gunnison Basin would change their agricultural practices and business operations in response to a curtailment of water supplies. Would they choose to reduce irrigated acreage or deficit irrigate? How would cattle operations change? How would the ranch's expenditures and revenues change? What is the point in water curtailment when a rancher ceases operation? With an understanding and application of the rancher responses, HE could prepare the agricultural economic impact analysis, found in the next section of this report.

**Ranch selection for interviews.** HE met with the District team and certain District Board members in mid-June 2019. As a refinement to the scope, the group agreed upon the need for individual rancher interviews in addition to a public meeting. The thinking was that folks would want to learn about the study in a group setting but would be more willing to share individual ranch operation data one-on-one. We agreed that Board members and staff would select two ranches from three representative sub-basins. The sub-basins were picked as areas that would represent variations in ranching operations within the greater Gunnison basin. The two ranches from each sub-basin would provide two different perspectives from a similar natural environment and the total irrigated acres would represent a meaningful portion of irrigated acres in the greater basin. The Board members picked ranchers likely to be interested in participating and with sufficient records of their operation and an understanding of Basin ranching in general. In total, the six ranches interviewed accounted for almost 16,000 irrigated acres or 28 percent of the total acres irrigated in the Upper Gunnison Basin in 2018.

**Recruitment.** A Board member and a Sub-Basin Coordinator, ranchers themselves, were selected to be the rancher coordinators. These ranchers reached out to the prospective participating ranchers and obtained commitments to participate in the survey. Certain challenges associated with the time of year (hay season) and schedule coordination were overcome. Interviews were conducted over a three-day period in mid-September 2019.

**Confidentiality.** Confidentiality was of utmost importance for the ranchers and the integrity of this study. The nature of the study necessitated a comprehensive understanding of each rancher's operations, including production, sales and finances. We especially needed to know how they would react when faced with curtailment, including effects on their operations and finances. As such, HE developed a questionnaire that explored all the corners of the private ranch business. The Gunnison ranching community is small and individual ranch operators have every reason to keep ranching operations absolutely private. HE committed to preserving full confidentiality to obtain the information required for this study. Our data management plan

was to extrapolate the detailed individual ranch data to sub-basins and then aggregate the data by sub-basin to represent the full Upper Gunnison Basin.

**Survey execution and tabulation.** The surveys were completed by two HE representatives in person at each ranch over a three-day period. Each meeting required two to four hours. Ranchers in attendance at the meetings ranged up to 8 people. Each participant group compiled operational and financial data before the meeting. Each was thoughtful in their responses and circumspect about demand management and the compact shortage issue. Following these meetings, notes were compared and consolidated. Where responses appeared inconsistent, HE interviewers went back to the ranchers for clarification.

Following the data collection trip, and once all available data was collected, HE tabulated the information by ranch and by sub-basin. The data was entered into a model built for extrapolation. The participant sample was diverse in size and operations which allowed for a useful variety of answers

## **Rancher Survey Results**

The survey results consisted of three parts: baseline information about the individual ranch operations; projected changes in ranch operations and finances due to water curtailment; and observations about additional impacts.

**Baseline ranch operations.** HE gathered information about water rights, diversions and use, acres irrigated, hay yields, cattle herds and sales, labor requirements, and financial data related to ranch revenues, expenditures and profits. This information was used to estimate baseline conditions for each sub-basin which were then aggregated to the full Upper Gunnison Basin. HE cannot divulge the sub-basin baseline data due to disclosure constraints, but the baseline information for the full Upper Gunnison Basin is provided in Table 2-1.

**Table 2-1.**  
**Baseline Agricultural Operations in the Upper Gunnison Basin, 2018**

Baseline Agricultural Operations	
<u>Acreage</u>	
Total Irrigated Acres	55,181
Irrigated Acres in Hay Production	41,084
<u>Water</u>	
Percent Water Rights Pre Compact	25
Percent Water Rights Post Compact	75
Applied per Acre	No Answer
Consumptive Use per Acre	No Answer
<u>Hay Production</u>	
Tons per Year	60,150
Tons per Irrigated Acre in Hay Production	1.46
<u>Cattle</u>	
Number of Cow/ Calf Pairs (Inventory)	18,160
Number of Cattle Sold	13,110
<u>Ranch Revenues (Avg Yr)</u>	
Cattle Sales	\$16,700,000
Total Revenues	\$18,400,000
Total Revenue per Irrigated Ranch Acre	\$334
Cattle Revenue/ Cattle Sold	\$1,274
Cattle revenue per Irrigated Acre	\$303
<u>Ranch Expenses (Avg Yr)</u>	
Total Expenses	\$16,700,000
Total Expenditures per Irrigated Ranch Acre	\$302
Purchases in Gunnison County	29%
Purchases throughout Rest of Colorado	64%
<b>OPERATING NET PROFIT</b>	<b>\$1,770,000</b>
<u>Labor</u>	
Average Number of Non-Family Persons Working on Ranch	151
Annual Payroll of Ranch Workers (Total Labor)	\$2,990,000
Payroll per Person	\$19,900

Baseline agricultural conditions developed from the surveys were compared with the US Census of Agriculture and the National Agricultural Statistical Survey for Gunnison County, and adjusted somewhat. Minor differences remain since the Federal data was from 2017 and pertained to the full Gunnison County, whereas the survey took place in 2018 and the Upper Gunnison Basin within the survey refers to a geographic area that includes parts of three counties.

**Anticipated operational changes with water curtailment.** During the interviews, HE described each of the water curtailment scenarios and the three time period durations, and then asked how each element of ranch operations might change in response. Average hydrologic conditions were presumed by the respondents. This portion of the survey is provided in Table 2-2, below.

**Table 2-2.**  
**Rancher Survey Questions Related to Operational Changes.**

Please indicate <u>changes</u> to annual operations under each scenario:			
(Numbers or %)	One Year	Three Years	Five Years
Acres Irrigated <sup>2</sup>			
Inches/acre Applied			
Hay Yield/acre			
Cow/calf Pairs <sup>2</sup>			
Cattle Sold			
Total Revenue			
Operating Expenses			
Workers on Ranch			

The geographic location of the eight sub-basins within the Upper Gunnison Basin is shown in Exhibit 2-1. The answers by sub-basin which HE received are found in Appendix 1, set forth in Tables A-1, A-2 and A-3, for scenarios 1, 2 and 3, respectively. The interview responses for the Tomichi, Ohio and East sub-basins represent weighted (by irrigated acreage) averages from the participating ranches in each of those sub-basins. The Gunnison mainstem sub-basin is assumed to resemble the Tomichi and the Ohio sub-basin responses with equal weighting. The Cochetopa sub-basin is assumed to have similar characteristics to the Tomichi sub-basin. The Taylor sub-basin is considered to have a similar nature to the East sub-basin. The weighted average of all the interviews was applied to the remaining two sub-basins where less intensive irrigation occurs<sup>1</sup>.

<sup>1</sup> Based on discussions with Erin Wilson, Wilson Water Group, and John McClow, General Counsel to the District, December 2019.

**Exhibit 2-1.**  
**Locations of the Eight Sub-Basins within the Upper Gunnison River Basin.**

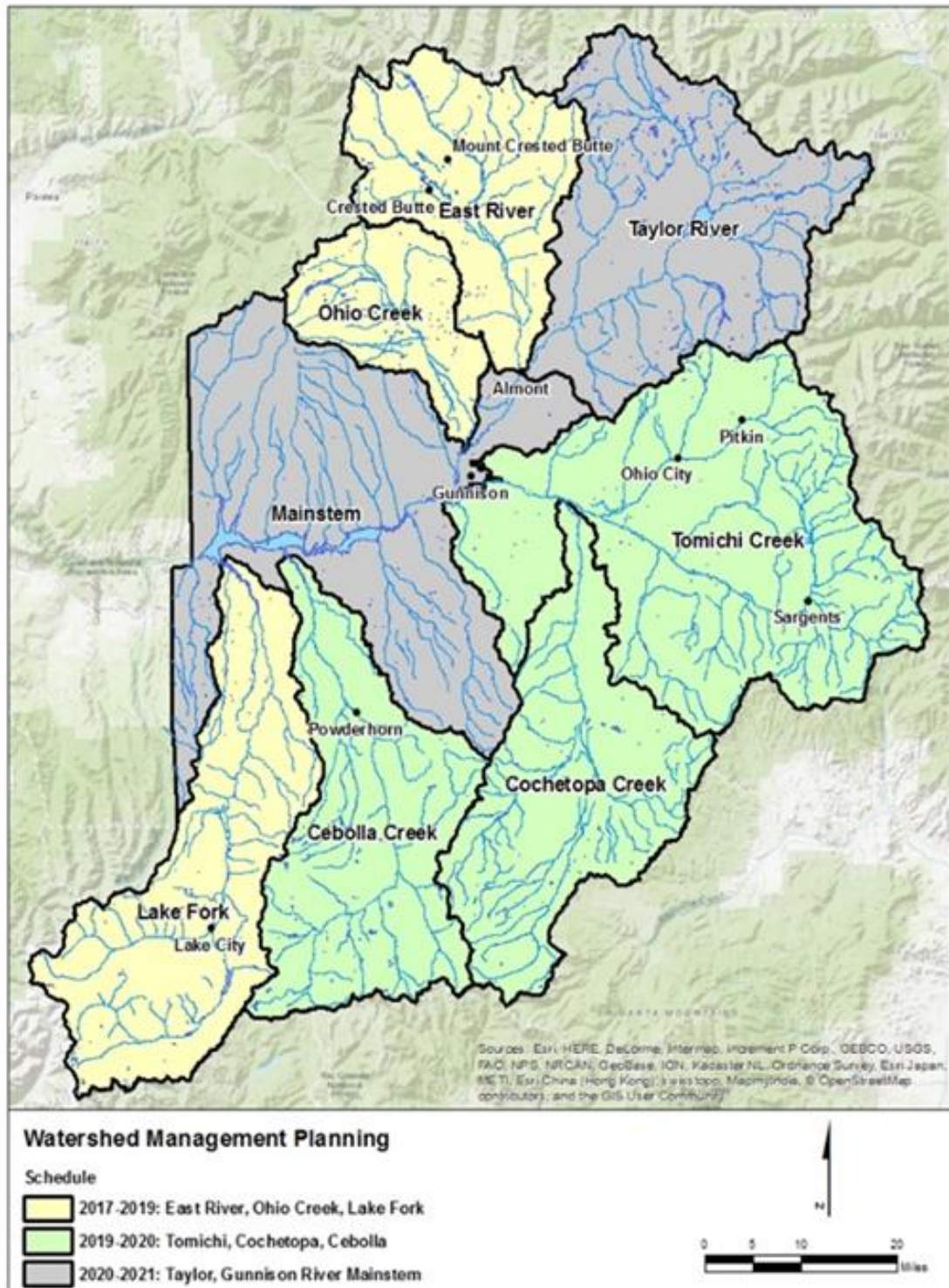
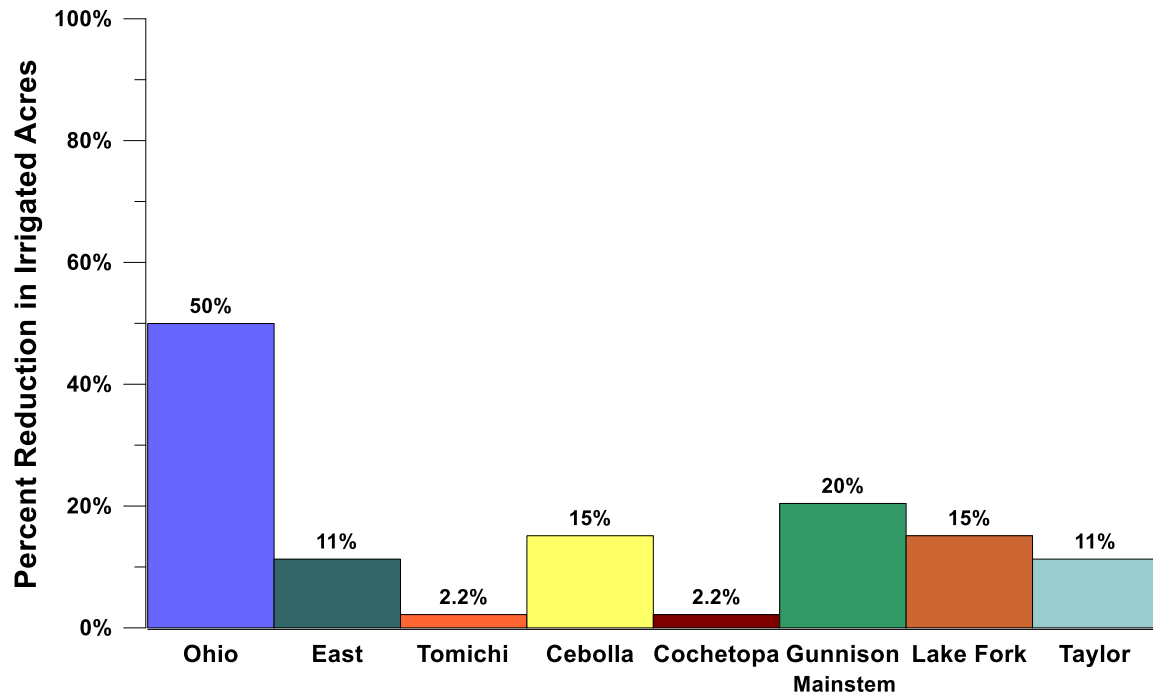




Exhibit 2-2 illustrates the percent change in irrigated acreage by sub-basin under Scenario 2 curtailment a one-year duration.

**Exhibit 2-2.**

**Percent Change in Irrigated Acreage under Scenario 2 Curtailment, by Sub-Basin for a One-Year Curtailment.**



Much can be learned from the rancher interviews about likely responses to possible water curtailment scenarios:

1. The ranchers' reactions to the three water curtailment scenarios were quite different from sub-basin to sub-basin. Conditions in the respective Upper Gunnison sub-basins differ which would help explain different responses.
2. Responses to the same water curtailments differed even from rancher to rancher within the same sub-basin. Considering that all the ranchers interviewed in this region irrigate for hay and raise cattle for sale, this might be surprising. We are reminded again that the agricultural community is composed of very different, very independent operators, and when faced with a new challenge, they will not react monolithically.
3. Under the Scenario 1, a 30 percent Post-Compact curtailment, the response is likely to be relatively modest in the Tomichi sub-basin even if the curtailment lasts five years. Conversely, a one-year curtailment would have noticeable negative effect in the Ohio sub-basin, and these negative effects would become substantial for a curtailment three or more years in length. The East sub-basin would likely have minor effects for a one-year curtailment, but large impacts if the curtailment lasted three or more years. If the 30 percent curtailment in Post-Compact water were applied throughout the Upper Gunnison Basin, the changes to agricultural operations would be evident but

manageable for a one-year curtailment, but more substantial for a three- or five-year curtailment.

4. If a Scenario 2, 50 percent curtailment of Post-Compact water were to be adopted or imposed, the impacts appear to be sustainable only for one year in the Tomichi sub-basin but very substantial or overwhelming in other sub-basins, especially for a multi-year curtailment.
5. The ranchers' operational responses under a voluntary program will depend on the parameters of that program. Although the irrigated acreage and hay production would likely decline by the percentages indicated, it is possible that the ranchers might not reduce their cattle herds as much in they can buy replacement hay at a price that makes financial sense. A widespread demand management program might render that infeasible, so the results might be the same as the involuntary curtailment.
6. Under a worst-case 100 percent curtailment of Post-Compact water, negative impacts for just one year would exceed 50 percent reduction in ranch operations in most instances. Under this scenario for any amount of time, few, if any, working ranches would be likely to remain in business.
7. When reviewing the three water curtailment scenarios and durations, we asked ranchers at what point during a curtailment would closing operations make sense. Each rancher had a different response, but on average, many working ranchers will reach that point during the three-year Curtailment under Scenario 2, the 50 percent reduction. Most ranchers indicated they could sustain a curtailment for a year, though even for a year, a 100% reduction in post-compact water would cause much financial hardship. Those operations which don't rely on the financial viability of the cattle operations would likely keep operating beyond the so-called tipping point.
8. The tipping point will be different under a voluntary program. Depending upon the program parameters, ranchers might suspend operations for a period and come back in business when the voluntary program ends. This will be more difficult for longer duration programs.

Direct agricultural impacts will be further discussed in the next report section.

## **Additional Rancher Survey Responses**

During the rancher interviews, HE asked several open-ended questions and the ranchers themselves brought up a number of noteworthy issues.

**Soil conditions.** The ranchers described the ramifications of local soil conditions for a land fallowing curtailment. The sandy soil in the sub-basins loses moisture quickly. If the land is not irrigated, it requires extra time to bring the soil moisture up to a point suitable for raising hay. Ranchers suggested that it could take one year or more to bring the soil back to full productivity after a fallowing year; some suggested a cumulative effect with longer fallowing curtailments, i.e. two to three years or longer to recover from a three-year fallowing curtailment.

**Curtailment year vs. hydrologic cycle.** The impacts of any curtailment in the Upper Gunnison Basin will be affected by the hydrologic condition at inception or conclusion of the curtailment. If the irrigation water is reduced in a dry year, ranchers suggest the impacts will be greater. Following a curtailment, ranchers contend that wetter hydrologic conditions will be especially important, or impacts will be larger.

**Timing of irrigation water.** Ranchers maintain that actual weeks when the irrigation water is available during the irrigation season makes a big difference to hay yields per acre. It is essential to have enough irrigation water early in the growing season to establish a hay crop in this region. If the reduced water supply is not available early, impacts will be greater.

**Infrastructure costs.** When irrigation water is reduced, irrigators will need to assess the ditch system infrastructure to determine whether the water can move through the system at lower levels. Modifications to turn-outs might be needed, for example. These capital costs are in addition to typical or increased operating costs.

**Quantification difficulties.** Ranchers were concerned about how the water savings would be quantified within the sub-basin and the Basin as a whole. They presently utilize informal and adaptive systems for managing water within ditch and tributary systems. The interviews also indicate a preference for deficit irrigation as opposed to fallowing acreage, which will also prove challenging for quantifying consumptive use reduction.

**Potential conflict with existing agreements.** Ranchers also pointed out that implementation of water curtailment needs to comply with various types of existing agreements landowners currently have in place. Certain properties have agreements to maintain Gunnison sage grouse breeding grounds, or leks; these might require enough growth to maintain shelter. Ranchers in this region typically have U.S. Forest Service (USFS) allotment agreements which require a certain amount of productive lowland to justify the allotment in the publicly owned uplands. Although these allotments are 10 years in duration and have some flexibility, ranchers cannot afford to lose their allotments. Some ranchers in the area have conservation easements requiring that the property be utilized for agricultural purposes. In each of these instances, the terms of specific agreements will need to be reviewed before the property owner enters into any curtailment agreement. It is unknown whether these agreements represent a constraint.

**Effects on cattle operations.** Ranchers pointed out the management of cattle herds would be affected in several ways. With declining hay yields and output on property, the ability to maintain cattle numbers and cattle related financial returns are constrained. Conversely, the need to maintain the genetics and consistency of the herd and support marketing agreements will factor into herd and sales decisions. Predicting these decisions much in advance will be challenging. A voluntary program might offer more flexibility in the herd maintenance decision.

**Potential participation in a voluntary curtailment.** During the interviews, we discussed a voluntary curtailment and the prospects for rancher participation. There was neither support for nor resistance to such a curtailment on its face, pending explanation of all curtailment program components in detail. Importantly, ranchers indicated that all the irrigators

in a ditch system (and perhaps the whole tributary system), would need to participate because of the informal nature of water management in much of the region. There was considerable concern expressed that there would not be adequate voluntary, compensated participation and thus the curtailment would not be able to be enacted.

**Land development pressure.** Ranchers pointed out that, in the Upper Gunnison Basin, agricultural landowners are subject to pressure to sell out or otherwise develop their lands for recreational or other purposes. Land values are driven up by these other uses, and ranchers must be aware of other opportunities to simply cash out. This might render a voluntary compensated curtailment, more attractive, but that might lead to a more rapid transition of the region out of agriculture altogether.

**Browning the landscape.** Ranchers stated that one result of a fallowing program or curtailment will be a “browning” of the landscape, more extensively and for longer periods of the year. This was viewed as a negative outcome for the ranchers, not to mention Basin residents and tourists.

**Mitigation of negative agricultural effects.** We asked the ranchers if there were any actions they could take to mitigate the negative impacts of water curtailment. Converting from the present practice of flood irrigation common in the Upper Gunnison Basin to sprinkler or drip irrigation would be the most obvious major action for accommodating reduced water supplies. Unfortunately, this practice will not easily work with the highly transmissive soils and sands in the region and the single hay cutting per year that cannot support the financial investment<sup>2</sup>. The sprinkler systems would also negatively affect the groundwater tables. The groundwater supplying municipal and other domestic users relies on extensive irrigation and return flows. Sprinkler systems also work best on flat ground unlike the Upper Gunnison Basin. Crop conversion potential is limited by the climate, elevation and cattle orientation of the present operators.

Timing of irrigation might be a more realistic mitigation measure, assuming water would be available when needed. The ranchers suggested the key to a successful growing season in the Upper Basin was getting the ground completely wet the first time early in the season. Some ranchers mentioned this would be their main goal; to spread the water diligently and irrigate aggressively in the beginning of the season while expecting some water shortages throughout the season.

Another idea for mitigation would be to stop irrigating some land. This is concerning to some ranchers as there is no guarantee of how long it might take for that land to return to regular production levels. There is a current pilot study in the Upper Gunnison Basin examining this very issue. The study is implementing fallowing on some land, then evaluating how long it takes to return to regular production levels once irrigation. This is an important consideration in the Upper Gunnison Basin.

Ranchers had other mitigation ideas. Extra fertilization of land would help, but this would increase yearly operational expenses. Another idea for impact mitigation would be to stop

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<sup>2</sup> Meeting with the Stockgrowers Association, August 2019; and Erin Wilson, November 2019.

selling hay and keep that hay on site for cattle. If the reduction in Post-Compact water was more intense or for a longer time period, ranches might reduce the cow herd to just the best cows, eventually reducing numbers to have enough available pasture.

**Longer term effects of multi-year curtailments.** Ranchers are particularly concerned about the impacts of curtailment programs which last multiple years, especially beyond three years. Recovering the moisture from dry land over that time will be a problem. Challenges with the BLM leases will arise. The loss of the green landscape in this region, the declining groundwater table were also cited as concerns with a longer term curtailment program.

**Compensation.** Compensation was a topic that ranchers were reluctant to address directly. When pressed, they suggested that all their financial impacts would need to be considered, but that this might not be enough to induce voluntary participation. There was a suggestion that some level of compensation could be worked out under some scenarios and would be related to percentage loss of revenues, plus a percentage of the cumulative economic loss in the following years, plus the business risk they were undertaking to reduce operations. In general, all the Ranchers indicated that they would be more likely to settle on compensation if the curtailment was shorter term and lower percent reduction.

## **SECTION 3**

### **Direct and Residual Economic Effects on Upper Gunnison Basin Agriculture**

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This section provides HE's projections of the direct and residual economic impacts to agriculture as a result of the water curtailment assumed under the three scenarios representing the DCP requirements as they might be applied to the Upper Gunnison Basin in Colorado. Direct effects or impacts are those which result from rancher responses to the curtailment scenarios and the corresponding duration. Residual effects account for those additional impacts affecting ranchers and the agricultural economy beyond the immediate actions which ranchers will take. Both direct effects, and direct effects with residual effects, are identified in this section.

The direct effects are projected by applying the scenario-driven operational changes indicated from the rancher survey to the baseline conditions described in previous sections. These calculations are performed for each of the eight sub-basins. The effects on each of the sub-basins are then aggregated to derive the projected effects on the full Upper Gunnison Basin. This procedure was repeated for each of the three scenarios and the three program durations for each.

Under a voluntary program, the direct and residual impacts will still occur, but they will be mitigated, depending upon the terms of the program and the extent of compensation. The starting point is the total amount of direct and residual impacts that will be compensated, as will be discussed further below.

For ease of presentation purposes, this report addresses the full Upper Gunnison Basin first and then the differences among the sub-basins.

#### **Direct Effects for the Full Upper Gunnison Basin**

The direct economic impacts of irrigation curtailment without mitigation payments are addressed first below, followed by a discussion of the direct impacts with a mitigation payment program.

**Scenario 1.** Table 3-1 presents the direct economic effects of Scenario 1, a 30 percent curtailment of Post-Compact water, on the Basin under one-, three- and five-year program durations.

**Table 3-1.**  
**Direct Economic Impacts of Scenario 1 on the Upper Gunnison**  
**Basin for One-, Three- and Five-Year Involuntary Curtailment**

Agricultural Operation Measures	Baseline Conditions	One Year Program	Three-Year Program		Five-Year Program			
			Average Annual		Total Program	Average Annual		Total Program
			Change	Percent	Change	Change	Percent	Change
<b>Total Irrigated Acres</b>	55,181	-3%	-2,627	-5%	-7,880	-2,739	-5%	-13,693
<b>Hay Production (Tons)</b>	59,947	-7%	-7,429	-12%	-22,288	-10,957	-18%	-54,784
<b><u>Cattle</u></b>								
Number of Cow/Calf Pairs (Inventory)	17,352	-8%	-940	-5%	-2,819	-777	-4%	-3,885
Number of Cattle Sold	12,939	-3%	-1,464	-11%	-4,393	-2,158	-17%	-10,792
<b><u>Ranch Finances</u></b>								
Total Revenues	\$17,683,847	-2%	-\$1,534,084	-9%	-\$4,602,253	-\$2,343,080	-13%	-\$11,715,400
Total Expenses	\$16,327,138	3%	-\$167,434	-1%	-\$502,303	-\$673,040	-4%	-\$3,365,202
Net Profit (Revenues - Expenses)	\$1,356,708	-72%	-\$1,366,650	-101%	-\$4,099,950	-\$1,670,039	-123%	-\$8,350,197
Financial Change			N/A		-\$4,099,950	N/A		-\$8,350,197
<b><u>Labor</u></b>								
Average Number of Persons Working on Ranch	153	0%	-11	-7%	-33	-9	-6%	-43
Annual Payroll of Ranch Workers (Total Labor)	\$3,034,006	0%	-\$429,420	-14%	-\$1,288,259	-\$652,493	-22%	-\$3,262,466

Note: Scenario 1 represents a 30 percent curtailment in Post-Compact water availability in an average year

Under the one-year Scenario 1 curtailment, direct effects on operations are likely to be relatively modest, except for ranch finances under an involuntary curtailment. Ranchers can be expected to reduce irrigated acreage by a small amount, but hay production will decline somewhat more since ranchers would attempt to deficit irrigate under that one-year curtailment. The cattle herd and cattle sales would also decrease by a small amount. The number of hired labor is not likely to change. However, financial effects will be somewhat more adverse. Revenues will decline slightly, but expenses will increase slightly with additional expenses and management of the irrigation systems so that net ranch profits will go down by two thirds. These direct financial effects can be reduced or eliminated under a voluntary program.

If the Scenario 1 curtailment lasts three years, the direct effects increase somewhat on an annual average basis as the negative ranch conditions carryover year to year. Hay production is projected to decline by 12 percent on average for each of the three years with similar declines in cattle sales. About 7 percent of the hired labor force is expected to be laid off. As in the one-year program, ranch finances under involuntary curtailment are more negatively affected, almost wiping out annual profits for the Basin ranching sector.

Aggregating each of the three years, the total direct negative effects of the three-year program become substantial. Hay production declines would be about 22,000 tons, or more than one third of the baseline, and total cattle sales would be about 4,400 head less, or one third of the baseline amount. Comparing the revenues and expenses in the base case to revenues and expenses under the curtailment conditions, the change in the financial position of the ranchers is revealed. In total, ranchers in aggregate would be almost \$4.1 million worse off financially than they would have been without the involuntary curtailment program after three years.

Altogether, ranchers in the Upper Gunnison Basin would in total be slightly above break even in profits for the period. Again, these direct financial effects can be reduced or eliminated under a voluntary program.

Assuming a five-year program for the Scenario 1 curtailment, the negative effects increase again on an average annual basis. About 11,000 tons of hay are lost on average each year during this period. About 2,200 less cattle are sold annually. Ranches are now losing money on a cash basis on average during this five-year period. Cumulative effects of a five-year program might well grow worse in the fourth and fifth years.

Over the five-year program, about one quarter of the irrigated acreage will go out of production, more than 50,000 tons of hay will not be produced, and 10,000 fewer cattle will be sold. In aggregate, ranchers will experience a net negative change in their financial position of about \$8.4 million dollars over the five-year period. Based on data and information supplied during the interviews, HE believes that Scenario 1 will be survivable for most, if not all, Upper Gunnison ranches.

**Scenario 1 with mitigation payments.** The Scenario 1 direct effects can be substantially reduced or eliminated, with mitigation payments under the voluntary program, depending upon the terms and program structure. If the program fully compensates ranchers for lost direct profits for a three-year duration, Scenario 1 reduction, that would amount to about \$4.1 million. Of course, ranchers would not experience a direct financial loss if they received this amount in compensation. However, 33 hired ranch workers would lose their jobs and direct income of about \$1.3 million. There would also be indirect and induced economic impacts, which are addressed in the next report section.

**Scenario 2.** The direct effects of Scenario 2, a 50 percent curtailment, are set forth in Table 3-2.



**Table 3-2.**  
**Direct Economic Impacts of Scenario 2 on the Upper Gunnison Basin for One-, Three- and Five-Year Involuntary Curtailment**

Agricultural Operation Measures	Baseline Conditions	One Year Program	Three-Year Program			Five-Year Program		
			Average Annual		Total Program	Average Annual		Total Program
			Change	Percent	Change	Change	Percent	Change
Total Irrigated Acres	55,181	-17%	-9,197	-17%	-27,591	-7,394	-13%	-36,971
Hay Production (Tons)	59,947	-26%	-23,746	-40%	-71,239	-29,294	-49%	-146,472
<u>Cattle</u>								
Number of Cow/Calf Pairs (Inventory)	17,352	-43%	-2,892	-17%	-8,676	-2,325	-13%	-11,626
Number of Cattle Sold	12,939	-32%	-5,202	-40%	-15,607	-6,369	-49%	-31,845
<u>Ranch Finances</u>								
Total Revenues	\$17,683,847	-38%	-\$7,837,741	-44%	-\$23,513,224	-\$9,141,290	-52%	-\$45,706,452
Total Expenses	\$16,327,138	-13%	-\$3,566,972	-22%	-\$10,700,916	-\$4,706,525	-29%	-\$23,532,625
Net Profit (Revenues - Expenses)	\$1,356,708	-331%	-\$4,270,770	-315%	-\$12,812,309	-\$4,434,766	-327%	-\$22,173,828
Financial Change			N/A		-\$12,812,309	N/A		-\$22,173,828
<u>Labor</u>								
Average Number of Persons Working on Ranch	153	-16%	-25	-17%	-76	-20	-13%	-102
Annual Payroll of Ranch Workers (Total Labor)	\$3,034,006	-26%	-\$1,137,696	-37%	-\$3,413,089	-\$1,444,153	-48%	-\$7,220,766

Note: Scenario 2 represents a 50 percent curtailment in Post-Compact water availability in an average year

A one-year program under Scenario 2 causes moderate negative effects. Irrigated acreage would be reduced by 17 percent, but hay production would be down 26 percent due to deficit irrigation. Cattle sales and revenues would be expected to decline by one third, but since expenses would fall much less, net profits swing from \$1.4 million under baseline conditions to a loss of \$3.1 million under Scenario 2 involuntary curtailment. The hired work force would be reduced by 16 percent. The Upper Gunnison Basin would incur negative economic effects, but the ranching sector should be able to survive this level of impact for a year.

If Scenario 2 were to last three years, the impacts would increase on an average annual basis because the negative conditions would carry over to subsequent years. The average annual effects are large: a 40 percent decline in hay production and cattle sales; and income and annual losses exceeding \$4.3 million or 24 percent of revenues.

Considering the aggregate effects of a three-year Scenario 2 program, the financial position of the ranching sector would deteriorate by about \$13 million as a whole. Given these results, a portion of ranch operations would logically close without outside intervention and mitigation. The tipping point, or point where the ranch would shut down, would be an individual choice depending on the circumstances and alternative each ranch would face.

A Scenario 2 program lasting five years would result in losses of half the hay production and cattle sales on average each year over the period. Under involuntary curtailment, the financial position of the ranching sector would be diminished by almost \$22 million if the ranchers remained in business. Two thirds of the hired workforce would be laid off. Most of the ranches would likely cease operations rather than enter into a five-year, Scenario 2 program.

**Scenario 2 with mitigation payments.** The Scenario 2 direct effects with mitigation payments would be would exhibit a similar pattern to Scenario 1. Direct economic impacts can be substantially reduced, but not eliminated, with mitigation payments under the voluntary program, depending upon the terms and program structure. If the program fully compensates ranchers for lost direct profits for a three-year duration, Scenario 2 reduction, compensation for direct effects would amount to about \$12.8 million. Of course, ranchers would not experience a direct financial loss if they received this amount in compensation. However, 76 hired ranch workers would lose their jobs and direct income of about \$3.4 million. Also, this does not account for the long term, direct impacts of ranching operations that permanently close. Indirect or induced impacts are addressed in the next section.

**Scenario 3.** This scenario would require curtailment of all Post-Compact water for the Upper Gunnison Basin irrigators, or about 75 percent of their total irrigation water supply. The direct economic impacts of this worst-case, Compact curtailment<sup>1</sup> scenario are shown in Table 3-3.

**Table 3-3.**  
**Direct Economic Impacts of Scenario 3 on the Upper Gunnison Basin for One-, Three- and Five-Year Involuntary Curtailment**

Agricultural Operation Measures	Baseline Conditions	One Year Program	Three-Year Program			Five-Year Program		
			Average Annual		Total Program	Average Annual		Total Program
			Change	Percent	Change	Change	Percent	Change
Total Irrigated Acres	55,181	-55%	-11,879	-22%	-35,637	-9,283	-17%	-46,416
Hay Production (Tons)	59,947	-74%	-45,404	-76%	-136,212	-46,272	-77%	-231,360
Cattle								
Number of Cow/Calf Pairs (Inventory)	17,352	-59%	-3,594	-21%	-10,782	-2,377	-14%	-11,886
Number of Cattle Sold	12,939	-37%	-6,466	-50%	-19,398	-8,194	-63%	-40,968
Ranch Finances								
Total Revenues	\$17,683,847	-74%	-\$13,432,921	-76%	-\$40,298,763	-\$13,903,426	-79%	-\$69,517,131
Total Expenses	\$16,327,138	-32%	-\$5,922,422	-36%	-\$17,767,267	-\$6,273,987	-38%	-\$31,369,937
Net Profit (Revenues - Expenses)	\$1,356,708	-577%	-\$7,510,499	-554%	-\$22,531,496	-\$7,629,439	-562%	-\$38,147,194
Financial Change			N/A		-\$22,531,496	N/A		-\$38,147,194
Labor								
Average Number of Persons Working on Ranch	153	-63%	-34	-22%	-101	-23	-15%	-116
Annual Payroll of Ranch Workers (Total Labor)	\$3,034,006	-64%	-\$2,014,644	-66%	-\$6,043,931	-\$2,133,103	-70%	-\$10,665,517

Note: Scenario 3 represents a 100 percent curtailment in Post-Compact water availability in an average year

If the Compact curtailment were only to last one year, the direct effects would be major. Hay production would decline by almost three quarters. Cattle sales would decline by more than one third; ranchers would try and hold on to their best cattle, purchasing hay where they could. Revenues would decline more than expenses, causing a \$6.5 million loss for Upper Basin ranches under an involuntary curtailment. Most of the hired workforce would be laid off that year. These major impacts would take the ranches in weaker financial positions to the point where continuing operations would be nearly impossible without substantial mitigation or

<sup>1</sup> Under either of the two scenarios described at page 1-3.

support from financial institutions. Still, some ranches might be able to survive this level of irrigation curtailment for a year.

The opportunity to continue ranching dims considerably under a three-year, Scenario 3 curtailment. Hay production is reduced by three quarters, and half the cattle herd is sold on average yearly for each of the three years. The majority of the herds are gone at the end of the third year. Financial conditions become unsustainable on average; only operators not dependent on the ranch's financial viability would survive.

If the Scenario 3 Call were to last five years (i.e., a worst case of the worst case), few, if any, working ranches would survive. Ranches operated for non-financial purposes might continue, although this is uncertain.

**Scenario 3 with mitigation payments.** Under this worst-case scenario, an involuntary mitigation program does not make sense, given the magnitude of direct effects and permanent loss of ranching activity in the Basin. In fact, these losses provide the rationale for pursuing a voluntary program at a less stringent level of curtailment.

**Tipping point.** Based upon the rancher interviews and an examination of the acreage and revenue projections under each scenario and program duration, HE has determined that few, if any, Upper Gunnison Basin ranch operations will close down under Scenario 1, whether the program is one, three or five years in duration. Under Scenario 2, we believe that almost all ranch operations can withstand the one-year program, but that as many as half the ranching operations will close under a three-year program and two thirds will close under a five-year program. Regardless of program duration, HE believes that essentially all working ranches will cease operations under a Scenario 3 curtailment.

It should be noted that in this region, the prospect of shutting down a ranch and selling the land might be more attractive than in other ranching areas in Colorado. Land prices are heavily influenced by development and recreational activities, rendering the “cashing out” option more enticing.

Under a compensated mitigation program, the tipping point can be moved out in terms of level of curtailment or duration, but only up to a point. Ranchers will not permanently cease operations under a compensated program if they believe that the land, irrigation system and cattle herd can be recovered in a reasonable period of time and dollar investment. Of course, each rancher will view that differently.

## **Direct Effects by Sub-Basin**

The direct effect of irrigation curtailment varies considerably from sub-basin to sub-basin within the Upper Gunnison Basin. For presentation purposes, this report discusses the Scenario 1, 30 percent curtailment, and the Scenario 2, 50 percent curtailment, one and three-year programs, respectively, as these are the most likely to occur. These programs are indicative of the variation that can be expected among the sub-basins under other scenarios and durations.

The description of direct impacts under a compensated mitigation program for the full Upper Gunnison Basin apply to the sub-basins.

**Selected scenario 1 effects.** Table 3-4 provides key direct effects on the ranching sector by sub-basin for a one-year, Scenario 1 program.

**Table 3-4.**  
**Selected Direct Effects on Ranching Sector, Scenario 1, One-Year Program by Sub-Basin**

Sub-Basin	Baseline Hay Production (Tons)	Percent Change		Change in Net Operating Profit
		Hay Production	Cattle Inventory	
Tomichi	17,840	0%	0%	\$0
East	15,090	-20%	0%	(\$243,000)
Ohio	9,420	-5%	-13%	(\$471,000)
Gunnison Mainstem	7,280	-2%	-10%	(\$181,000)
Cochetopa	6,090	0%	0%	\$0
Cebolla	2,070	-12%	-6%	(\$45,000)
Lake Fork	1,380	-12%	-6%	(\$30,000)
Taylor	780	-20%	0%	(\$13,000)

Note: Scenario 1 represents a 30 percent curtailment in Post-Compact water availability in an average year

The Tomichi and Cochetopa sub-basins are projected to absorb the 30 percent, one-year curtailment by adjusting their operations with little net economic effect. Conversely, this same program would likely have much larger effects, a 20 percent reduction, in the hay production in the East and Taylor sub-basins. With a one-year program, these sub-basins would attempt to keep their cattle herds intact by purchasing hay elsewhere. Ranchers in the Ohio sub-basin would react differently by reducing their herds more than hay production. The change in net operating profits would be largest in the Ohio, East and Gunnison Mainstem sub-basins under an involuntary curtailment. The Tomichi, Cochetopa and Taylor sub-basins would likely incur fewer financial impacts than the other sub-basins from a one-year, Scenario 1 curtailment.

Table 3-5 identifies the projected annual average direct effects on the ranching sector or a Scenario 1 curtailment lasting three years, by sub-basin.

**Table 3-5.**  
**Selected Direct Effects on Ranching Sector, Scenario 1, Three-Year**  
**Curtailment by Sub-Basin**

Sub-Basin	Baseline Hay Production (Tons)	Percent Change		Change in Net Operating Profit
		Hay Production	Cattle Inventory	
Tomichi	17,840	-2%	-2%	(\$49,000)
East	15,090	-34%	-10%	(\$210,000)
Ohio	9,420	-7%	-6%	(\$692,000)
Gunnison Mainstem	7,280	-4%	-5%	(\$284,000)
Cochetopa	6,090	-2%	-2%	(\$35,000)
Cebolla	2,070	-21%	-7%	(\$52,000)
Lake Fork	1,380	-21%	-7%	(\$35,000)
Taylor	780	-34%	-10%	(\$11,000)

Note: Scenario 1 represents a 30 percent curtailment in Post-Compact water availability in an average year

Like the effects shown in Table 3-4, the Tomichi and the Taylor sub-basins are likely to experience modest effects and relatively less impact compared with the other sub-basins. The Ohio, East and Gunnison Mainstem are likely to experience more financial effects, followed by the Cebolla, Lake Fork, and Taylor sub-basins. These financial effects can be reduced or eliminated under a voluntary program.

**Selected scenario 2 effects.** Table 3-6 presents key direct effects on the ranching sector by sub-basin for a one-year, Scenario 2 program.

**Table 3-6.**  
**Selected Direct Effects on Ranching Sector, Scenario 2, One-Year**  
**Program by Sub-Basin**

Sub-Basin	Baseline Hay Production (Tons)	Percent Change		Change in Net Operating Profit
		Hay Production	Cattle Inventory	
Tomichi	17,840	-8%	-15%	(\$291,000)
East	15,090	-34%	-37%	(\$699,000)
Ohio	9,420	-58%	-59%	(\$2,067,000)
Gunnison Mainstem	7,280	-25%	-48%	(\$907,000)
Cochetopa	6,090	-8%	-15%	(\$209,000)
Cebolla	2,070	-29%	-43%	(\$169,000)
Lake Fork	1,380	-29%	-43%	(\$113,000)
Taylor	780	-34%	-37%	(\$36,000)

Note: Scenario 2 represents a 50 percent curtailment in Post-Compact water availability in an average year

All the sub-basins are negatively affected by the Scenario 2 curtailment with a one-year duration, but some experience a much greater impact than others. The Tomichi and Cochetopa sub-basins are expected to experience moderate impacts, but the other sub-basins are likely to experience much more severe effects, especially the East, Ohio, and Gunnison Mainstem sub-basins. Again, these direct financial effects can be reduced or eliminated under a voluntary program.

Table 3-7 sets forth the Scenario 2 effects, showing the annual average for a three-year duration program.

**Table 3-7.**  
**Selected Direct Effects on Ranching Sector, Scenario 2, Three-Year Annual Average Program by Sub-Basin**

Sub-Basin	Baseline Hay Production (Tons)	Percent Change		Change in Net Operating Profit
		Hay Production	Cattle Inventory	
Tomichi	17,840	-25%	-8%	(\$563,000)
East	15,090	-58%	-33%	(\$585,000)
Ohio	9,420	-62%	-20%	(\$1,718,000)
Gunnison Mainstem	7,280	-38%	-17%	(\$878,000)
Cochetopa	6,090	-25%	-8%	(\$403,000)
Cebolla	2,070	-49%	-23%	(\$156,000)
Lake Fork	1,380	-49%	-23%	(\$104,000)
Taylor	780	-58%	-33%	(\$30,000)

Note: Scenario 2 represents a 50 percent curtailment in Post-Compact water availability in an average year

The annual average effects during a three-year, Scenario 2 curtailment are substantial for all the sub-basins, but less for Tomichi and Cochetopa. The impacts are huge for the other sub-basins.

## Residual Effects

In the previous section, we described a host of important considerations that will have a potentially additive negative impact on the Upper Gunnison Basin ranching sector if water curtailment occurs:

- Soil conditions—one to three years for each program year to bring the land back to baseline productivity.
- Curtailment year vs. hydrologic cycle—risk of dry year prior to program inception and dry year after program completion.
- Timing of irrigation water—need the remaining irrigation water to come early in season.
- Infrastructure costs—potential for additional capital costs.
- Potential conflict with existing agreements—Colorado Parks and Wildlife (CPW), USFS, conservation easements.
- Cattle markets—Prices, etc.

The likelihood is high that one or more of these external influences will negatively impact Upper Gunnison Basin ranchers under water curtailment beyond the ranchers' immediate operational response.

HE believes that some adjustment to the direct rancher effects is warranted to reflect these residual effects and must be considered in any voluntary compensation program. We

assume that in addition to the direct negative effects of curtailment, the operating financial deficits will increase by the percentages provided in Table 3-8.

**Table 3-8.**  
**Residual Effects Adjustment to Financial Impacts on Upper Gunnison Basin Ranchers**

	Year 1	Year 2	Year 3	Year 4	Year 5
<b>Additional Negative Financial Impact</b>	10%	15%	20%	25%	30%

HE has subjectively, but conservatively, determined these residual effect adjustments. Based upon the rancher interviews, the effects on the agricultural sector could well be much worse the longer the program continues for some operations due to drying soil conditions, deteriorating hay market conditions, and a host of other factors. Given our inability to quantify these uncertainties, HE has adopted a conservative approach to estimating residual effects of curtailment. Regardless, these estimates are reflected in total impacts to avoid understating the economic impacts.

Table 3-9 applies these residual effects to the direct financial impacts for the Basin by scenario and program duration.

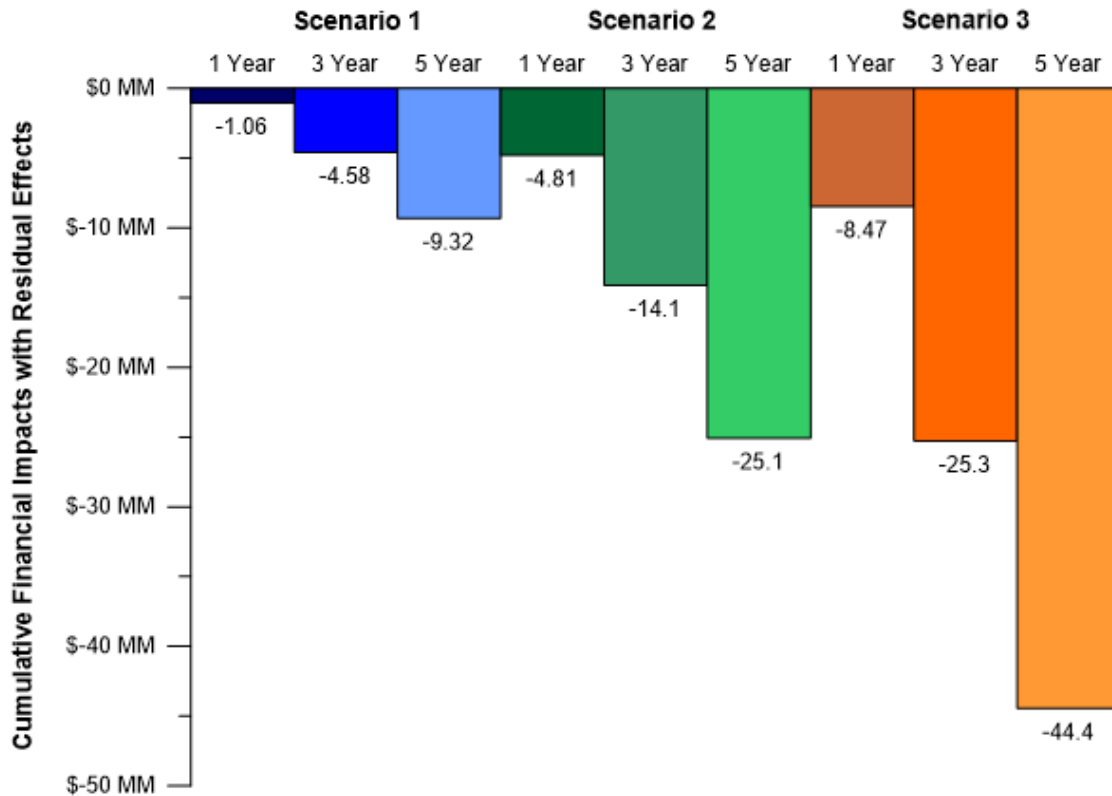
**Table 3-9.**  
**Direct and Residual Financial Impacts on Upper Gunnison Ranchers by Program Duration Under an Involuntary Curtailment**

Scenario	Program Duration		
	1 Year	3 Years	5 Years
<u>Scenario 1</u>			
Direct Effects	(\$983,000)	(\$4,100,000)	(\$8,350,000)
With Residual Effects	(\$1,060,000)	(\$4,577,000)	(\$9,318,000)
<u>Scenario 2</u>			
Direct Effects	(\$4,492,000)	(\$12,812,000)	(\$22,174,000)
With Residual Effects	(\$4,806,000)	(\$14,119,000)	(\$25,072,000)
<u>Scenario 3</u>			
Direct Effects	(\$7,827,000)	(\$22,531,000)	(\$38,147,000)
With Residual Effects	(\$8,474,000)	(\$25,269,000)	(\$44,443,000)

Exhibit 3-1 illustrates the total financial impacts to Upper Gunnison Basin ranchers under the three water curtailment scenarios.

**Exhibit 3-1.**

**Financial Impacts of Involuntary Water Curtailment Scenarios on Upper Gunnison Basin Ranchers**



**Potential Compensation under Voluntary Mitigation Program**

With the information gathered for this report and the calculations of direct and residual financial impacts on the ranchers in the Upper Gunnison Basin, it is logical to make a further computation of the compensation required to induce voluntary participation. However, there are significant issues and drawbacks in making such a calculation:

- a) The market and hydrologic conditions known prior to an agreement on participation would be critical in establishing a dollar amount that would induce ranchers to participate.
- b) The perceived imminence of a Colorado River Compact deficit and involuntary curtailment will affect the acceptability of a dollar compensation figure.



- c) All other terms and protocols of the voluntary program will greatly influence the acceptability of a compensation amount.
- d) The ranchers indicated great reluctance to suggesting a dollar figure during interviews.

The unit of measure for compensation will likely be an issue as well. From the rancher's standpoint, it would make sense to compensate for each acre-foot of water that is not diverted, as opposed to a dollar per irrigated acre retired. The former would allow flexibility for deficit irrigation. The ratio of AF of consumptive use to AF diverted varies in the Basin.

With the above caveats and qualifications, HE has derived the following estimates of a starting point for required compensation in Table 3-10.

**Table 3-10.**  
**Preliminary Range of Minimum Required Compensation for Irrigation Curtailment in the Upper Gunnison Basin, Dollars per Acre Foot not Diverted**

	Program Duration		
	1 Year	3 Years	5 Years
<b>Scenario 1</b>	\$52	\$62	\$68
<b>Scenario 2</b>	\$138	\$111	\$108
<b>Scenario 3</b>	\$116	\$115	\$120

The above compensation numbers are lower than might be expected in part because they represent the average, so at least half the irrigated water under each scenario will not be adequately compensated with these amounts. To get a better idea of the compensation required to produce all the savings indicated under each scenario, HE estimates that at least 50 percent more money than the above figures would be required. For example, under Scenario 2, one year program, \$207 per AF of consumptive use would be required to produce all the savings contemplated under that scenario.

Further, the above estimates are likely understated for many Upper Gunnison Basin ranchers for a host of reasons:

- a. As explained earlier, the financial losses are driven largely by the ranchers' strategy with respect to cattle sales and herd size and only indirectly related to curtailment of diversions. Thus, a relatively modest dollar amount will compensate for the losses at a 30 percent compensation level because ranchers will not vary cattle sales strategy so much. That strategy is highly variable.

- b. In this study, we have assumed 100 percent participation. In reality, the more successful operations will require much higher compensation to participate.
- c. HE has projected direct financial losses based on survey data, but the residual loss values are subjectively estimated. Ranchers might reasonably estimate their residual losses much higher. This is especially true for the longer term curtailment programs.
- d. These figures account for estimated direct and residual financial losses to the ranching community, not necessarily an amount that would induce program participation.

Compensation per AF diverted is affected in a complex manner by a number of factors, including rancher cattle herd and deficit irrigation responses to particular curtailment levels, cumulative water curtailments after losses have been incurred, and tipping point effects. As indicated earlier, financial impacts vary substantially from sub-basin to sub-basin and from rancher to rancher. Hence, basin-wide averages might work for some, but not for others.

## **SECTION 4**

# **Recreational and Environmental Impacts from Irrigation Curtailment**

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This section addresses the effects of reduced irrigation on recreation, tourism and the environment in the Upper Gunnison Basin. As less water is applied to ranch lands for hay and pasture, more water will be left in the various streams, tributaries, and possibly storage facilities in the Basin for certain periods of the year. This additional water might affect recreational activities and certain aquatic and related habitat environmental resources, potentially in a positive manner.

This section explores that possibility. First, we project the change in diversions associated with each of the scenarios and durations described in Section 1. With modelling results from Wilson Water Group (WWG), we estimate percentage change in stream flow for each sub-basin compared with average year and dry year conditions. Next, we summarize the investigation we performed to identify the impacts the estimated changes in flows might have on recreational activity and environmental resources. We then conclude with a qualitative assessment of the likely impacts of the various irrigation water curtailment scenarios on recreational and environmental resources.

### **Flow Changes from Irrigation Curtailment Scenarios**

The changes in stream flows are based on two considerations: the irrigation water curtailment scenarios and the ranchers' reaction to those scenarios. At the outset of this study, we defined a range of water curtailment scenarios and a range of duration for each. Of course, these scenarios would reduce diversions according to the limits each scenario assumes. Based on the survey, we also know that ranchers will greatly reduce or eliminate irrigation efforts entirely when faced with relatively large curtailments, either voluntarily or involuntarily. This will result in further reductions in diversions, leaving even more water in the streams.

The reduced diversions from the scenarios were calculated based on the water rights of the ranchers in each of the Upper Gunnison sub-basins. On average, about 75 percent of the water rights for irrigation are Post-Compact rights, with the other 25 percent Pre-Compact or other sources. Under Scenario 1, for example, a 30 percent Post-Compact reduction would result in 22.5 percent less agricultural diversions, following these computations:

$$100-[75(.7)+25]=22.5$$

The actual water rights of the surveyed ranchers in the three sub-basins were utilized in these calculations and an average hydrological year was assumed. The reduced irrigation percentages were applied to the known total diversions in each sub-basin to estimate the reduced diversions and thus increased stream flows.

An adjustment was applied to these figures when the total amount of irrigated acres times the average diversion per acre fell below the stream flows based strictly upon the constrained exercise of the water rights. This adjustment occurs as irrigators approach a tipping point and begin to curtail their operations.

Table 4-1 indicates HE's projected irrigation diversions and the percent reduction by sub-basin under each of the scenarios. The change in diversions is substantial, even under a 30 percent curtailment.

**Table 4-1.**  
**Change in Irrigation Diversions and Percent Reduction under**  
**Curtailment Scenarios by Upper Gunnison Sub-Basin**

Sub-Basin	Scenario	One-Year Program		Three-Year Program (Avg)		Five-Year Program (Avg)	
		Diversions (AF)	Percent Reduction	Diversions (AF)	Percent Reduction	Diversions (AF)	Percent Reduction
Ohio	Baseline	68,637	0%	68,637	0	68,637	0%
	30% Reduction	50,057	27%	48,632	29%	47,206	31%
	50% Reduction	34,339	50%	31,477	54%	28,616	58%
	100% Reduction	11,446	83%	10,016	85%	8,585	87%
East	Baseline	134,305	0%	134,305	0%	134,305	0%
	30% Reduction	104,762	22%	83,138	38%	69,251	48%
	50% Reduction	85,067	37%	46,312	66%	28,543	79%
	100% Reduction	0	100%	0	100%	0	100%
Tomichi	Baseline	139,815	0%	139,815	0%	139,815	0%
	30% Reduction	109,292	22%	109,292	22%	109,292	22%
	50% Reduction	88,943	36%	88,943	36%	88,090	37%
	100% Reduction	38,071	73%	38,071	73%	37,136	73%
Cebolla	Baseline	29,979	0%	29,979	0%	29,979	0%
	30% Reduction	23,127	23%	21,014	30%	19,612	35%
	50% Reduction	18,290	39%	14,362	52%	12,371	59%
	100% Reduction	4,103	86%	3,987	87%	3,794	87%
Cohcetopa	Baseline	93,821	0%	93,821	0%	93,821	0%
	30% Reduction	73,339	22%	73,339	22%	73,339	22%
	50% Reduction	59,684	36%	59,684	36%	59,112	37%
	100% Reduction	25,547	73%	25,547	73%	24,920	73%
Gunnison Mainstem	Baseline	130,007	0%	130,007	0%	130,007	0%
	30% Reduction	99,383	24%	98,493	24%	97,604	25%
	50% Reduction	76,888	41%	75,104	42%	72,787	44%
	100% Reduction	30,883	76%	29,991	77%	28,515	78%
Lake Fork	Baseline	18,340	0%	18,340	0%	18,340	0%
	30% Reduction	14,148	23%	12,856	30%	11,998	35%
	50% Reduction	11,189	39%	8,786	52%	7,568	59%
	100% Reduction	2,510	86%	2,439	87%	2,321	87%
Taylor	Baseline	17,255	0%	17,255	0%	17,255	0%
	30% Reduction	13,459	22%	10,681	38%	8,897	48%
	50% Reduction	10,929	37%	5,950	66%	3,667	79%
	100% Reduction	0	100%	0	100%	0	100%

Source: Baseline diversions from Wilson Water Group, 2017; and HE, 2019.

From this information, WWG projected changes in the flows of the sub-basin tributaries using StateMod hydrology models previously developed for the District. The projected stream flow changes are based on historical flow and diversion information. WWG selected 2005 as the representative average year and 2004 as the representative dry year. This modelling should be considered approximate and preliminary; monthly flows by sub-basin are highly variable and complicated by return flows and interactivity between sub-basins. According to WWG, the Gunnison Mainstem watershed by itself contributes little additional flows to the system, compared with the streamflow generated by the tributaries. The models cannot predict flow changes to the Gunnison mainstem with enough accuracy to report them here. Hence, the modelling prepared for this report should be viewed as broadly suggestive and not precise.

Tables 4-2, 4-3 and 4-4 compare stream flow changes under the three curtailment scenarios to average hydrologic conditions by month for each sub-basin. The average three-year curtailment is reported here, since these results are not substantially different from the one-year curtailment or the annual average five-year curtailment. The percentage changes are positive as the streams rise and negative as streams diminish when return flows from irrigation are absent.

**Table 4-2.**  
**Percent Change in Stream Flows under a Scenario 1 Three-Year**  
**Curtailment by Sub-Basin, Compared with Average Hydrologic**  
**Conditions**

Average Years - 30% Reduction in Post-Compact Water Rights - 3 Year Program								
Month	Ohio	East	Cochetopa	Tomichi	Cebolla	Lake Fork	Taylor	Blue Mesa Inflow (Cumulative)
January	-4%	-5%	-5%	-5%	-1%	-1%	0%	-3%
February	-4%	-4%	-5%	-4%	-1%	0%	0%	-2%
March	-2%	-2%	27%	3%	0%	0%	0%	0%
April	6%	0%	13%	5%	1%	0%	0%	2%
May	17%	2%	65%	54%	4%	0%	0%	4%
June	20%	5%	74%	35%	9%	1%	1%	6%
July	19%	8%	-21%	68%	10%	1%	1%	7%
August	31%	-4%	-4%	-2%	-6%	0%	0%	-3%
September	-37%	-9%	-7%	-6%	-3%	-1%	0%	-4%
October	7%	-9%	-4%	-8%	-4%	-1%	0%	-4%
November	-19%	-12%	-12%	-18%	-4%	-1%	0%	-9%
December	-9%	-9%	-11%	-14%	-3%	-1%	0%	-6%

**Table 4-3.**  
**Percent Change in Stream Flows under a Scenario 2 Three-Year**  
**Curtailment by Sub-Basin, Compared with Average Hydrologic**  
**Conditions**

Average Years - 50% Reduction in Post-Compact Water Rights - 3 Year Program								
Month	Ohio	East	Cochetopa	Tomichi	Cebolla	Lake Fork	Taylor	Blue Mesa Inflow (Cumulative)
January	-7%	-9%	10%	-5%	-2%	-1%	0%	-4%
February	-7%	-7%	16%	-3%	-2%	-1%	0%	-3%
March	-3%	-3%	30%	3%	-1%	0%	0%	0%
April	12%	0%	14%	7%	2%	1%	0%	2%
May	37%	4%	241%	99%	7%	1%	1%	9%
June	46%	9%	156%	64%	17%	1%	1%	12%
July	45%	15%	-63%	106%	21%	2%	2%	15%
August	92%	-6%	2%	0%	-9%	0%	0%	-4%
September	172%	-14%	-15%	-11%	-4%	-2%	0%	-5%
October	18%	-15%	-8%	-13%	-7%	-1%	0%	-6%
November	-31%	-21%	-22%	-30%	-7%	-2%	0%	-14%
December	-15%	-15%	-20%	-24%	-6%	-2%	0%	-11%

**Table 4-4.**  
**Percent Change in Stream Flows under a Scenario 3 Three-Year**  
**Curtailment by Sub-Basin, Compared with Average Hydrologic**  
**Conditions**

Average Years - 100% Reduction in Post-Compact Water Rights - 3 Year Program								
Month	Ohio	East	Cochetopa	Tomichi	Cebolla	Lake Fork	Taylor	Blue Mesa Inflow (Cumulative)
January	-12%	-17%	4%	-12%	-4%	-2%	0%	-8%
February	-12%	-13%	6%	-10%	-3%	-1%	0%	-6%
March	-4%	-5%	26%	4%	-1%	-1%	0%	-1%
April	19%	0%	17%	18%	3%	1%	0%	5%
May	61%	7%	763%	231%	13%	2%	1%	16%
June	74%	14%	360%	137%	29%	2%	2%	22%
July	76%	25%	58%	470%	38%	3%	3%	31%
August	150%	-9%	12%	4%	-14%	0%	0%	-5%
September	415%	-19%	-18%	-10%	-5%	-2%	0%	-6%
October	27%	-22%	-12%	-6%	-10%	-2%	0%	-8%
November	-50%	-31%	-26%	-46%	-11%	-3%	-1%	-22%
December	-24%	-23%	-18%	-38%	-9%	-3%	-1%	-17%

The percentage changes in stream flow under average hydrologic conditions prompt a few observations:

- The stream flow changes are minimal for Lake Fork and Taylor sub-basins, because the streams are largely unaffected by irrigation, but large for the Ohio, Tomichi and Cochetopa during the irrigation season, especially under Scenarios 2 and 3.
- The highest percentage increases in stream flow varies among the sub-basins mostly because baseline flows vary greatly, especially in late summer and fall.
- Under Scenario 3 and possibly under Scenario 2, stream flows in the Ohio, Cochetopa and Tomichi sub-basins increase so much during the irrigation season that over-banking or flooding might occur, causing further potential impacts to ranchers.

- d. The percentage change in return flow patterns also vary substantially among the sub-basins.
- e. In November, the loss in return flows is substantial in the Ohio and in the Tomichi sub-basins under Scenarios 2 and 3.

Tables 4-5, 4-6 and 4-7 compare stream flow changes under the three curtailment scenarios to dry year hydrologic conditions by month for each sub-basin. Again, the annual three-year curtailment is reported here.

**Table 4-5.**  
**Percent Change in Stream Flows under a Scenario 1 Three-Year**  
**Curtailment by Sub-Basin, Compared with Dry Hydrologic Conditions**

Dry Years - 30% Reduction in Post-Compact Water Rights - 3 Year Program								
Month	Ohio	East	Cochetopa	Tomichi	Cebolla	Lake Fork	Taylor	Blue Mesa Inflow (Cumulative)
January	-4%	-2%	4%	-2%	-1%	-1%	0%	-2%
February	-3%	-1%	26%	3%	-1%	0%	0%	-1%
March	0%	0%	19%	3%	0%	0%	0%	0%
April	6%	0%	2%	3%	1%	0%	0%	1%
May	42%	4%	75%	47%	5%	1%	1%	6%
June	21%	10%	-8%	30%	17%	1%	1%	7%
July	10%	-4%	-23%	18%	4%	0%	1%	0%
August	-100%	0%	13%	13%	-6%	1%	0%	-1%
September	-7%	7%	4%	64%	1%	0%	0%	1%
October	15%	-6%	0%	-3%	-5%	-1%	0%	-3%
November	-14%	-8%	-12%	-13%	-5%	-1%	0%	-7%
December	-6%	-6%	-8%	-7%	-3%	-1%	0%	-5%

**Table 4-6.**  
**Percent Change in Stream Flows under a Scenario 2 Three-Year**  
**Curtailment by Sub-Basin, Compared with Dry Hydrologic Conditions**

Dry Years - 50% Reduction in Post-Compact Water Rights - 3 Year Program								
Month	Ohio	East	Cochetopa	Tomichi	Cebolla	Lake Fork	Taylor	Blue Mesa Inflow (Cumulative)
January	-7%	-4%	16%	-2%	-2%	-1%	0%	-3%
February	-6%	-3%	23%	2%	-2%	-1%	0%	-2%
March	-1%	0%	18%	3%	0%	0%	0%	0%
April	11%	0%	3%	5%	1%	0%	0%	1%
May	85%	7%	177%	95%	10%	1%	1%	12%
June	73%	17%	47%	82%	31%	2%	1%	16%
July	43%	-2%	-26%	25%	8%	0%	1%	4%
August	205%	4%	17%	27%	-6%	2%	0%	2%
September	11%	4%	3%	57%	1%	0%	0%	1%
October	31%	-12%	4%	4%	-7%	-2%	-1%	-5%
November	-24%	-18%	-20%	-23%	-8%	-2%	0%	-12%
December	-10%	-13%	4%	-9%	-5%	-2%	0%	-8%

**Table 4-7.**  
**Percent Change in Stream Flows under a Scenario 3 Three-Year**  
**Curtailment by Sub-Basin, Compared with Dry Hydrologic Conditions**

Dry Years - 100% Reduction in Post-Compact Water Rights - 3 Year Program								
Month	Ohio	East	Cochetopa	Tomichi	Cebolla	Lake Fork	Taylor	Blue Mesa Inflow (Cumulative)
January	-14%	-10%	5%	-10%	-4%	-2%	0%	-7%
February	-12%	-8%	15%	-4%	-3%	-1%	0%	-5%
March	-1%	-1%	16%	4%	-1%	0%	0%	0%
April	18%	0%	7%	16%	2%	1%	0%	3%
May	137%	11%	492%	246%	19%	2%	2%	23%
June	129%	28%	273%	295%	54%	3%	2%	33%
July	80%	8%	41%	84%	18%	1%	2%	15%
August	4202%	9%	33%	67%	-7%	5%	0%	8%
September	65%	-3%	6%	99%	3%	1%	0%	2%
October	38%	-22%	6%	16%	-11%	-2%	-1%	-8%
November	-45%	-32%	-35%	-42%	-12%	-4%	-1%	-20%
December	-20%	-24%	3%	-16%	-9%	-3%	-1%	-14%

The percentage changes in stream flow under dry year hydrologic conditions suggest some similar and some very different effects compared with average year conditions:

- Under dry year conditions, like average year conditions, the stream flow changes are minimal for the Lake Fork and Taylor sub-basins, but large for the Ohio, Tomichi and Cochetopa during the irrigation season, especially under Scenarios 2 and 3.
- The peak percentage increase in stream flows occur in May under Scenario 1, but from continue for May through September for Scenarios 2 and 3 under dry conditions.
- Because stream flows are very low in the Upper Gunnison Basin in dry years, percentage increases can be quite large in some summer months in the Ohio, Cochetopa, and Tomichi sub-basins. The potential for flooding is reduced, given very low baseline flows.
- The percentage change in return flow patterns also varies substantially among the sub-basins under dry conditions, similar to average conditions.
- The loss in return flows in the Ohio and Tomichi sub-basins can be very severe, even drying up streams, under dry conditions in all Scenarios.

### **Preliminary Evaluation of the Economic Effects of Stream Flow Changes on Recreation, Tourism and Environmental Resources**

HE performed a preliminary analysis of the effects the three irrigation curtailment scenarios might have on recreational and environmental resources in the Upper Gunnison Basin. We interviewed three individuals with considerable local knowledge regarding recreational and environmental resources:

- Mark Schumacher—Owner of Three Rivers Resort and operator of a fishing and boating outfitting business.



- Daniel Brauch—Aquatic Biologist, Colorado Parks and Wildlife, Gunnison office.
- Julie Nania—Water Program Director, High Country Conservation Advocates,

Once acquainting each individual with the curtailment scenarios and the stream flow changes projected by WWG, we discussed the potential impacts these stream flow changes might have on recreational and environmental resources. What follows is a synthesis of their observations, coupled with HE's analysis of stream flow changes.

**Boating in the Upper Gunnison Basin.** Boating in this Basin makes an important contribution to the economic base of the region.<sup>1</sup> A total of 16,822 commercial boating days, one person on a float trip or kayak per day, was reported in 2018. The direct economic effects of their expenditures have been estimated at \$2.2 million, and total economic impacts were projected to be \$5.7 million in 2018. About half the boat trips per year are with commercial operators and half are completed by private boaters. The season runs from May to September, although June and July are generally prime in this area.

The bulk of the boating activity takes place in the Taylor sub-basin. This stream is largely unaffected by irrigation, so curtailments will have no measurable direct impact on boating activity there. Stream flows here are determined mostly by releases from Taylor Park Reservoir.

Some boating occurs on the Gunnison Mainstem, and irrigation curtailment will increase flows in the summer months. Given the confluence effects, flows could reach levels too high for boating in the early summer months under average hydrologic conditions, especially for Scenarios 2 and 3. The season might also last longer, which would be a benefit. Boating conditions would clearly improve with irrigation curtailment in the summer during dry years.

Paddle boarding has become popular in Gunnison County, especially on the East River. Impacts would be similar to those on the Gunnison Mainstem.

Regardless, most of the boating activity would not be directly affected by the irrigation curtailments. Curtailment scenarios are temporary and the hydrologic conditions upon which they would be superimposed cannot be predicted by tourists or recreationists making future plans to visit. Impacts, therefore, are expected to be minimal.

**Fishing.** Fishing is an important component of the recreational economy in the Upper Gunnison Basin.<sup>2</sup> HE estimates that Gunnison County fishing accounts for more than \$25 million in direct spending and \$40 million in total economic impacts, although the bulk of those effects likely occur outside Gunnison County.

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<sup>1</sup> Colorado River Outfitters Association, Commercial River Use in the State of Colorado, 1988-2018. HE summarized statistics for the Gunnison – Upper (Town Run), Gunnison – Lake Fork and Taylor Rivers.

<sup>2</sup> Colorado Parks and Wildlife, 2019 Statewide Comprehensive Outdoor Recreation Plan. Colorado Parks and Wildlife. The Economic Impacts of Hunting, Fishing and Wildlife Watching in Colorado, 9/26/2008.

HE estimated statistics using both reports.

Commercial fishing is concentrated in the Gunnison Mainstem and the Taylor River due to access and more consistent flows. Fishing occurs in almost all the sub-basins but is restricted by access to the streams. Walk/wading is the predominant fishing method, although some boat fishing occurs. Fishing can occur in April and extend into November, if the stream flows are not too high nor too low. June through September are the most active months for fishing in this area.

Stream flows, of course, are vital to fishing activity for the angler and the fish. Fish movement up and down streams improve fish quality and numbers. Stream flow volumes are a critical determinant of water temperature; fish become still as water temperature rises. Low flows can result in fish kill due to excessive temperatures.

Projected stream flow changes from the irrigation curtailment scenarios will have varied, even contradictory effects on angling activity during average hydrologic conditions. Excessive flows in early to mid-summer can render wading difficult and stream velocity can create adverse fishing conditions. More importantly, fishing conditions will likely improve for mid- to late summer with more flow creating cooler water temperatures and more fish movement. Reduced return flows in the fall might be an issue for anglers. Colorado Parks and Wildlife has periodically advised that certain stream reaches in the Upper Gunnison Basin be shut down for fishing during low flow, high air temperature periods of the year.<sup>3</sup>

The direct impacts of irrigation curtailments upon angling will likely become more pronounced during dry hydrologic conditions. The increase in stream flows will be a very important benefit from spring through the summer. During 2018, Trout Unlimited worked with irrigators to reduce diversions for that dry year to help the fisheries.<sup>4</sup> However, the decreased return flows will be a problem, perhaps a critical one, for some sub-basins in the dry years.

As discussed earlier, stream flows in the Ohio, Cochetopa and Tomichi sub-basins will be most affected by irrigation curtailment. Of these, the Ohio and Tomichi have limited public access, hence relatively less angling. However, the Cochetopa has good fishing and good access, and it will be subject to the impacts of increased stream flows and decreased return flows as discussed above. Even so, the Taylor and Lake Fork, where much fishing occurs, will be largely unaffected by irrigation curtailment.

The temporary nature of the irrigation curtailment programs will reduce the positive effects of the increased summer flows somewhat because visiting anglers will have an insufficient basis to plan their trips to Gunnison County. This is truer of the one-year program and less true of the three- or five-year programs, however.

**Environmental resources.** The aquatic environment, including vertebrates, invertebrates and habitat, will be impacted by the projected changes in stream flows due to irrigation curtailment. Animal and plant species are affected by stream volume, velocity and temperature. In average or better than average water years, most sub-basin creeks maintain

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<sup>3</sup> Dan Brauch, Colorado Parks and Wildlife, February 2020.

<sup>4</sup> Dan Brauch, Colorado Parks and Wildlife, February 2020.

fish populations. Most streams within the Upper Gunnison are reasonably healthy with current levels of diversions.

Water temperature is a critical factor to the health of fish and other aquatic species.<sup>5</sup> Low flows in the Tomichi and the East Rivers have periodically created fish health concerns. Cooler stream temperatures with increased native stream flows benefit the aquatic environment.

Increased flows generally improve stream connectivity and the elimination of dry-up stretches. Movement through the stream system improves fish health and reproduction. stream connectivity. In dry years, the Cochetopa River has sections that get de-watered for approximately a mile. Ohio has a similar problem; in dry years, there are certain spots that get de-watered. Also, the elimination of dry-up points in the East and Tomichi sub-basins would benefit the aquatic environment.

For much of the Upper Gunnison Basin, fish and other critical species are high up in the watershed, above and unaffected by irrigation diversions. This would include the boreal toad.

The environmental effects of irrigation curtailment stream flow changes would be largely dependent on timing of those changes as well as location. Up to a point, reduced streamflow due to reduced return flows might not be much of a problem in winter as species stay in place. The higher flows in spring might have uncertain effects on spawning. The reduced return flows might be a problem and deserve further study on a site-specific basis. Minimum stream flows will need to be maintained. However, the benefits of higher mid-summer flows on the aquatic environment, especially in dry hydrologic periods, are substantial.

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<sup>5</sup> Julie Nania, High Country Conservation Advocates, February 2020.

## SECTION 5

# Total Economic Impacts of Irrigation Curtailment Scenarios in the Upper Gunnison Basin

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This section draws upon the direct impacts identified and described in Sections 3 and 4 to derive the total economic impacts to the Upper Gunnison Basin and Colorado. Since economic data is reported by political jurisdiction, this study presumes Gunnison County to be representative of the Basin. Total economic impacts include indirect and induced effects, also referred to as secondary impacts or secondary effects. Total impacts from changes to the agricultural economy are quantified and discussed. Total impacts on the touristic sectors are addressed in a qualitative manner.

### Secondary and Total Agricultural Impacts

**Secondary impacts.** Secondary impacts include indirect and induced economic impacts. Indirect impacts refer to those businesses that sell to, or buy from Upper Gunnison Basin ranchers, i.e. fertilizer dealers, implement dealers, etc., sometimes referred to as “satellite” businesses. Induced effects refer to the circulation of money through transactions from ranchers and satellite businesses and their employees among various retail and service providers which comprise the local economy.

Economists have devised methods for capturing these secondary effects through models of transactions within a given economy. These transactions are then aggregated into multipliers which estimate all the economic changes from a single change in the target sector, in this case, agriculture. In other words, for every dollar of change in the agricultural sector, there will be \$1.72 of changes in total economic output for Gunnison County. There are multipliers for gross economic output, employment and income.

For this study, we applied a set of multipliers from the U.S. Bureau of Economic Analysis for Colorado Region 10, the Central Western Slope, that includes Gunnison, Delta, Hinsdale, Montrose, Ouray and San Miguel counties. This group encompasses the bulk of the area where Upper Gunnison Basin ranchers would purchase goods; we added Saguache County since we learned ranchers buy hay from that area.<sup>1</sup>

**Secondary impacts under involuntary vs. voluntary curtailments.** The pattern and magnitude of secondary impacts will differ, depending on whether the curtailments are voluntary or involuntary. Under involuntary curtailment, rancher expenditures and income attributable to the curtailment will be lost to the region.

However, Upper Gunnison Basin ranchers will be compensated under a voluntary program for some or all of their direct economic loss. These ranchers will be spending less on agricultural

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<sup>1</sup> Rancher interviews, September 2019.

expenses, i.e. satellite industries, but will continue to spend monies in the local area as induced expenses. The secondary economic impacts under a voluntary program will be complex; monies not spent on the ranch operations might be used to pay down debt, maintain personal consumption, or make out-of-region expenditures. Thus, secondary impacts under a voluntary curtailment program are likely to be much less than an involuntary program, although different businesses will be affected. And once the tipping point is reached, the regional economic impacts between the voluntary and involuntary curtailments will be similar, since monies are likely to leave the region.

**Total agricultural impacts under involuntary curtailments.** Total impacts include direct changes in Basin rancher financial outcome plus the secondary effects discussed above, based on changes in rancher' revenues. HE calculated direct, secondary and total economic impacts for each scenario under the one-, three- and five-year durations.

Scenario 1 impacts are presented in Table 5-1.

**Table 5-1.**  
**Economic Impacts of Scenario 1 Involuntary Water Curtailment**

	Direct Effects	Secondary Effects	Total Economic Impacts
<b>One-Year Program</b>			
Gross Output (M)	-\$1.1	-\$0.3	-\$1.4
Employment	0	-18	-18
Personal Income (M)	\$0	-\$0.5	-\$0.5
<b>Three-Year Program (Cumulative)</b>			
Gross Output (M)	-\$4.6	-\$3.3	-\$7.9
Employment	-33	-18	-51
Personal Income (M)	-\$1.3	-\$1.9	-\$3.2
<b>Five-Year Program (Cumulative)</b>			
Gross Output (M)	-\$9.3	-\$8.5	-\$17.8
Employment	-43	-27	-70
Personal Income (M)	-\$3.3	-\$3.9	-\$7.1

Assuming Scenario 1, the 30 percent water curtailment, lasts for one-year, total economic impacts are estimated to be \$1.4 million in loss to the region. There would be fewer than 20 lost jobs and less than \$550,000 loss in personal income. The regional economic losses increase to \$4.6 million over the full three-year period, and \$9.3 million during the five-year curtailment period. As stated earlier, the longer term programs bring greater uncertainty which can lead to more impact than we have indicated.

Scenario 2 impacts are presented in Table 5-2.

**Table 5-2.**  
**Economic Impacts of Scenario 2 Involuntary Water Curtailment**

	Direct Effects	Secondary Effects	Total Economic Impacts
<b>One-Year Program</b>			
Gross Output (M)	-\$4.8	-\$4.8	-\$9.7
Employment	-25	-101	-126
Personal Income (M)	-\$0.8	-\$3.1	-\$3.9
<b>Three-Year Program (Cumulative)</b>			
Gross Output (M)	-\$14.1	-\$17.5	-\$31.6
Employment	-76	-70	-147
Personal Income (M)	-\$3.4	-\$9.2	-\$12.7
<b>Five-Year Program (Cumulative)</b>			
Gross Output (M)	-\$25.1	-\$34.8	-\$59.9
Employment	-102	-95	-197
Personal Income (M)	-\$7.2	-\$16.8	-\$24.0

Under Scenario 2, during a 1-year program, the economic loss to the region is projected to be \$9.7 million in gross sales, 126 lost employment positions, and \$3.9 million loss in personal income. Over a three-year period, Scenario 2 is projected to result in a \$14.1 million reduction in total sales; this figure would increase to \$25.1 million with the five-year program.

Scenario 3 impacts are presented in Table 5-3.

**Table 5-3.**  
**Economic Impacts of Scenario 3 Involuntary Water Curtailment**

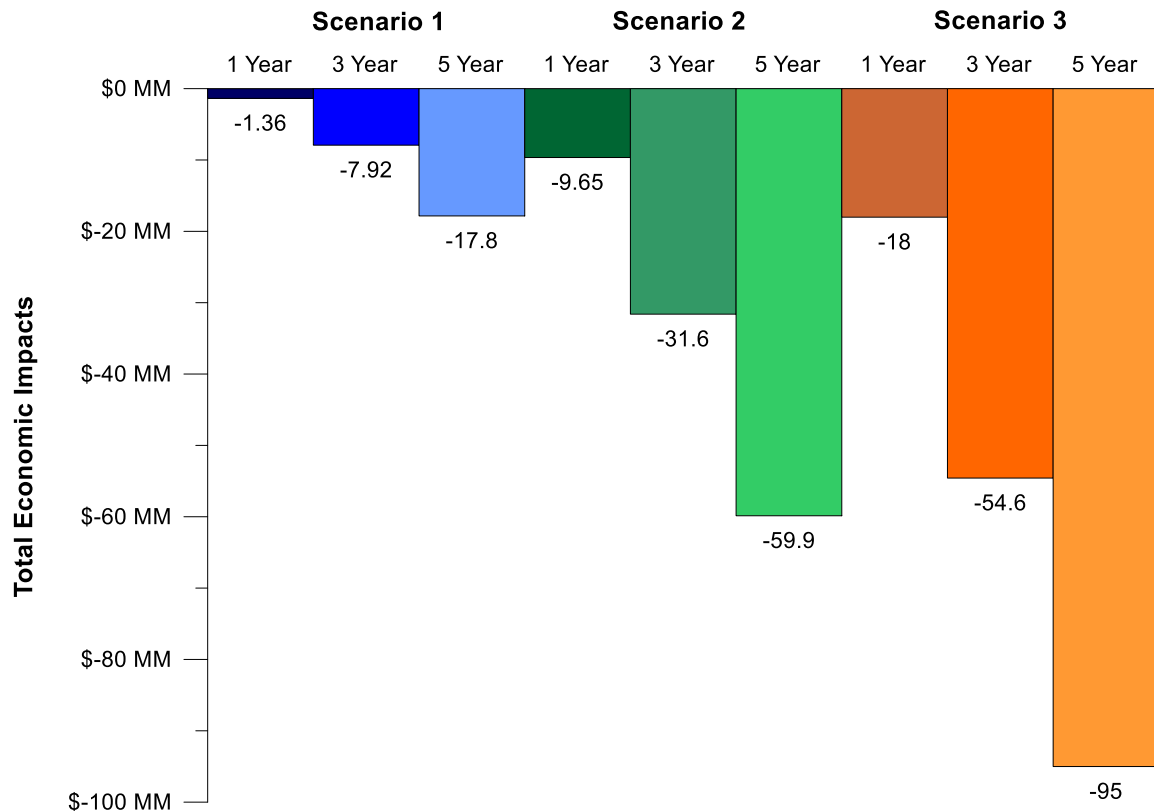
	Direct Effects	Secondary Effects	Total Economic Impacts
<b>One-Year Program</b>			
Gross Output (M)	-\$8.5	-\$9.5	-\$18.0
Employment	-96	-140	-236
Personal Income (M)	-\$1.9	-\$5.3	-\$7.2
<b>Three-Year Program (Cumulative)</b>			
Gross Output (M)	-\$25.3	-\$29.3	-\$54.6
Employment	-101	-139	-240
Personal Income (M)	-\$6.0	-\$15.8	-\$21.8
<b>Five-Year Program (Cumulative)</b>			
Gross Output (M)	-\$44.4	-\$50.6	-\$95.0
Employment	-116	-156	-273
Personal Income (M)	-\$10.7	-\$27.4	-\$38.0

With a 100 percent reduction in Post-Compact irrigation water, regional economic losses would be \$18.0 million, \$54.6 million and \$95.0 million for one-, three- and five-year curtailments, respectively.

Exhibit 5-1 illustrates the magnitude of total Gunnison County economic impacts from involuntary irrigation curtailments under various durations.

**Exhibit 5-1.**

**Losses in Total Economic Output for Gunnison County under Three Involuntary Curtailment Scenarios**



A comparison with measures of economic activity for all of Gunnison County can place these economic impacts in context, as shown in Table 5-4.

**Table 5-4.**  
**Percentage Impacts (Losses) to Gunnison County Economy from**  
**Involuntary Irrigation Water Curtailment Scenarios**

Gunnison County 2018	Scenario 1			Scenario 2			Scenario 3		
	One Year	Three Years	Five Years	One Year	Three Years	Five Years	One Year	Three Years	Five Years
Gross Retail Sales \$783,506,000	-0.2%	-1.0%	-2.3%	-1.2%	-4.0%	-7.6%	-2.3%	-7.0%	-12.1%
Wage and Salary Employment 9,398	-0.2%	-0.5%	-0.7%	-1.3%	-1.6%	-2.1%	-2.5%	-2.6%	-2.9%
Wage and Salary Income \$365,911,000	-0.1%	-0.9%	-2.0%	-1.1%	-3.5%	-6.5%	-2.0%	-6.0%	-10.4%

In 2018, Gunnison County total gross sales amounted to about \$800 million dollars, total wage and salary employment was about 9,400 persons, and total personal income was about \$350 million. Although significant to ranchers, Scenario 1 impacts would create a modest County-wide impact. Scenario 2 would cause a loss to gross retail sales of about 4 to 8 percent for the full County economy if curtailment lasted three or five years, respectively. Scenario 3 impacts would cause a decline of 6 to 10 percent in wages and salaries during three- or five-year curtailments, respectively.

**Total agricultural impacts under a voluntary curtailment program.** To the extent that a voluntary curtailment program fully compensates Basin ranchers for their direct and residual economic losses, economic losses to the ranchers would be avoided. The secondary losses would occur because agricultural supply businesses would be impacted, but other consumer businesses might benefit. This pattern is projected to hold for Scenario 1 curtailments and for one-year programs. With longer programs and greater water curtailments, the secondary impacts are likely to occur similar to the involuntary program, although the direct effects will be offset by program payments. For example, with Scenario 2, five-year curtailments, and estimated \$35 million of the \$60 million in total Gunnison County impacts will still occur under a voluntary, fully compensated program.

**Other economic impacts.** It is important to look beyond the aggregate economic statistics to fully understand the economic implications of irrigation water curtailment in the Upper Gunnison Basin. Ranching is one of few basic economic activities in this region, meaning that cattle sales brings new money to the area to support the economy. Damage to agriculture in this region would also result in a less diverse economy, meaning the region would have to rely on the other major basic sectors, recreation and tourism.

One gauge of the impact of irrigation water curtailment to the Upper Gunnison Basin agriculture is the effect it will have on ranch revenues. Under Scenario 2, annual average impact will range from a 38 percent reduction to a 52 percent reduction, depending on the length of the program. Clearly, this level of curtailment will be a major impact to the agricultural sector.



A substantial economic effect on the Basin ranching sector can also lead to broader sociological impacts. Agriculture and the ranching families have made up the fabric of the area for a long time. Irrigation water curtailments along with aging demographics and the temptation to sell out for cash might speed up the retirement of working ranches in the area.

Less irrigation will also have impacts on the groundwater table and those who rely on that resource. This would include domestic wells, but also the City of Gunnison with its businesses and residents. Diminished groundwater resources would, at best mean the City and County residents and businesses might need to spend monies on new wells, in addition to re-considering their water supply strategies. Those impacts are not captured in the economic impact analysis.

Finally, the increased “browning” of the Upper Gunnison Basin, both in geographic extent and duration, will have an additional negative impact on the region. Knowing this phenomenon is likely to occur, its actual effects are difficult to assess.

All these effects will be accentuated by the longer-term curtailment programs, voluntary or involuntary. Uncertainties will grow as the programs extend.

## **Recreation and Tourism Secondary and Total Impacts**

Tourism and recreation is a second basic economic sector important to this area. In Section 4, we described how direct effects on recreation and tourism would occur because of changes in stream flows. Boating will be largely unaffected. Fishing will be positively affected, especially in dry years. Impacts will be less for the short duration programs because improved conditions will be unpredictable. Overall, recreational impacts are likely to be positive but moderate and substantially positive in dry years. Given their temporary nature, measurable secondary effects are unlikely.

## **Mitigation Program Elements**

This study has focused on the impacts of curtailment. The design of a voluntary curtailment program is beyond the scope. Even so, the results of this study point to program characteristics which might be favorable:

- 1) Shorter curtailment is preferred.
- 2) The amount of water curtailment matters.
- 3) Compensation beyond revenue loss will be necessary.
- 4) A curtailment program will work better for some Upper Gunnison sub-basins.
- 5) One size does not fit all.
- 6) Flexibility will be key.

This suggests that the design of a voluntary program will be complex to be effective.

# APPENDIX

**Table A-1.**  
**Percent Changes in Ranch Operations with 30 Percent Curtailment of Post-Compact Water, by Sub-Basin.**

Percentage Changes	Tomichi Sub-Basin			Ohio Sub-Basin			East Sub-Basin			Gunnison Mainstem			Other Sub-Basins		
	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years
Irrigation Acres <sup>2</sup>	Neg	-3.5	-6.5	-8.3	-12.5	-33.3	-4.5	-48.4	-66.1	-3.2	-6.9	-16.8	-1.4	-12.8	-19.9
Hay Yield per Acre	Neg	-4.0	-6.6	-5.0	-8.3	-33.2	-20.2	-47.2	-67.4	-1.7	-5.5	-15.8	-5.7	-15.8	-24.1
Cattle Inventory	Neg	-5.9	-11.9	-13.2	-17.6	-17.6	Neg	-30.4	-60.8	-10.0	-14.8	-16.2	-2.1	-12.2	-21.5
Cattle Sales	Neg	-6.4	-12.7	-5.8	-23.1	-23.1	Neg	-32.4	-63.2	-4.2	-18.5	-20.2	-0.8	-13.7	-23.9
Total Revenue	Neg	-4.1	-10.1	-4.3	-16.7	-16.7	Neg	-29.4	-61.2	-3.2	-13.4	-15.0	-0.6	-10.7	-20.6
Operating Expenses	Neg	Neg	Neg	2.9	-3.2	-5.8	12.7	-25.6	-45.3	2.1	-2.4	-4.3	2.7	-5.0	-8.9
Workers on Ranch	Neg	Neg	-1.5	Neg	-40.0	-40.0	Neg	-42.0	-70.0	Neg	-19.3	-20.1	Neg	-12.1	-19.1

Notes: Neg = Negligible change

"Other" includes Cebolla, Cochetopa, Lake Fork and Taylor Sub-Basins

**Table A-2.**  
**Percent Changes in Ranch Operations with 50 Percent Curtailment of Post-Compact Water, by Sub-Basin.**

Percentage Changes	Tomichi Sub-Basin			Ohio Sub-Basin			East Sub-Basin			Gunnison Mainstem			Other Sub-Basins		
	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years
Irrigation Acres <sup>2</sup>	-2.2	-8.7	-17.4	-50.0	-58.3	-66.6	-11.3	-94.5	-100	-20.4	-27.6	-36.2	-7.2	-28.7	-36.8
Hay Yield per Acre	-8.0	-42.7	-49.3	-58.3	-66.6	-75.0	-33.7	-83.2	-100	-25.3	-50.9	-58.2	-17.0	-54.6	-64.0
Cattle Inventory	-14.9	-23.8	-35.7	-58.8	-58.8	-58.8	-36.6	-100	-100	-48.3	-50.4	-53.3	-25.7	-42.9	-50.8
Cattle Sales	-15.9	-29.1	-41.8	-38.5	-38.5	-38.5	-39.9	-100	-100	-32.3	-35.9	-39.4	-23.7	-44.0	-52.4
Total Revenue	-12.2	-30.1	-42.3	-54.9	-56.2	-56.2	-25.9	-83.7	-100	-43.6	-49.3	-52.5	-21.0	-44.0	-55.1
Operating Expenses	Neg	5.2	-9.0	-25.0	-37.1	-44.3	5.9	-74.4	-100	-18.7	-26.5	-35.4	-2.9	-15.4	-30.6
Workers on Ranch	Neg	Neg	-7.4	-50.0	-70.0	-70.0	Neg	-65.0	-100	-24.1	-33.8	-37.6	-4.1	-19.5	-32.1

Note: "Other" includes Cebolla, Cochetopa, Lake Fork and Taylor Sub-Basins

**Table A-3.**  
**Percent Changes in Ranch Operations with 100 Percent Curtailment of Post-Compact Water, by Sub-Basin.**

Percentage Changes	Tomichi Sub-Basin			Ohio Sub-Basin			East Sub-Basin			Gunnison Mainstem			Other Sub-Basins		
	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years	1 Year	3 Years	5 Years
Irrigation Acres <sup>2</sup>	-25.2	-41.3	-75.0	-83.3	-87.5	-91.7	-100	-100	-100	-47.4	-58.9	-81.4	-43.6	-55.8	-81.0
Hay Yield per Acre	-54.7	-61.3	-66.6	-83.3	-83.3	-83.3	-100	-100	-100	-64.6	-68.9	-72.4	-68.1	-72.7	-76.3
Cattle Inventory	-20.8	-31.8	-54.7	-67.0	-67.0	-67.0	-100	-100	-100	-56.0	-58.6	-64.1	-42.3	-49.5	-64.8
Cattle Sales	-28.8	-44.5	-67.7	-23.1	-61.5	-100	-100	-100	-100	-24.6	-56.9	-91.2	-41.6	-57.6	-78.5
Total Revenue	-45.0	-57.0	-79.1	-82.5	-82.5	-82.5	-100	-100	-100	-72.6	-75.7	-81.6	-60.8	-68.8	-83.5
Operating Expenses	-17.1	-17.1	-17.1	-22.8	-36.4	-40.0	-100	-100	-100	-21.4	-31.6	-34.3	-32.6	-34.7	-35.3
Workers on Ranch	-48.2	-48.2	-63.0	-60.0	-70.0	-80.0	-100	-100	-100	-53.9	-58.7	-71.2	-60.1	-60.9	-72.2

Note: "Other" includes Cebolla, Cochetopa, Lake Fork and Taylor Sub-Basins

It is important to note that under a voluntary program, the ranchers' operating revenues might decrease but these could be partially or completely offset by program monies.