Executive SUMMARY

ES.1 Introduction

The Alamosa River Watershed Restoration Master Plan and Environmental Assessment (Master Plan) summarizes current environmental conditions and develops solutions for identified problems in the Alamosa River basin that will lead to a healthier watershed. The incentive for the Master Plan was provided by a legal settlement over potential injuries caused by the Summitville Mine. That settlement also provided funding for implementation of some of the restoration projects described in the Master Plan. The scope of the Master Plan includes the entire watershed, with the exception of the Summitville Mine site itself, which is addressed through the Superfund Program. The Master Plan covers a broad array of natural resources and watershed functions and values. The result is a multi-disciplinary approach to watershed assessment that has produced a prioritized plan for watershed restoration and enhancement. Specific projects are identified, along with potential financing sources, including the Natural Resource Damage (NRD) funds from the Summitville legal settlement.

The State of Colorado and the United States recovered $5,000,000 in NRD funds to use to restore, replace, or acquire the equivalent of the natural resources potentially injured by the hazardous substances released from the Summitville Mine. There are two federal natural resource trustees and three state natural resource trustees (Trustees) who guided the Master Plan process and will also guide implementation:

- United States Department of the Interior represented by Fish and Wildlife Service and Bureau of Land Management
- United States Department of Agriculture's Forest Service
- Colorado Attorney General
- Executive Director of the Colorado Department of Public Health and the Environment
- Director of the Colorado Department of Natural Resources.

The Alamosa River Foundation, a non-profit organization of local citizens, represented local interests and was heavily involved in development of the Master Plan.

The Master Plan was developed by MWH Americas, Inc., in association with Agro Engineering, Lidstone & Associates and SWCA, under contract to the Colorado Water Conservation Board..

ES.2 Environmental Impacts

The Alamosa River watershed comprises 148 square miles in the San Luis Valley of south-central Colorado. The mainstem of the Alamosa River is 51 miles long, extending from near the Continental Divide to east of the City of La Jara. Elevations vary from over 13,000 feet to about 7,600 feet. Key features in the watershed include:

- Summitville Mine, a gold mine that operated from 1986 to 1992 using open pit and cyanide leach methods but which is now a Superfund site;
- Terrace Reservoir, a storage impoundment for irrigation water;
- Extensive irrigated agriculture in the lower watershed;
- Extensive forested areas and hydrothermally altered zones in the upper watershed.

Figure ES-1 is an overview map of the watershed.

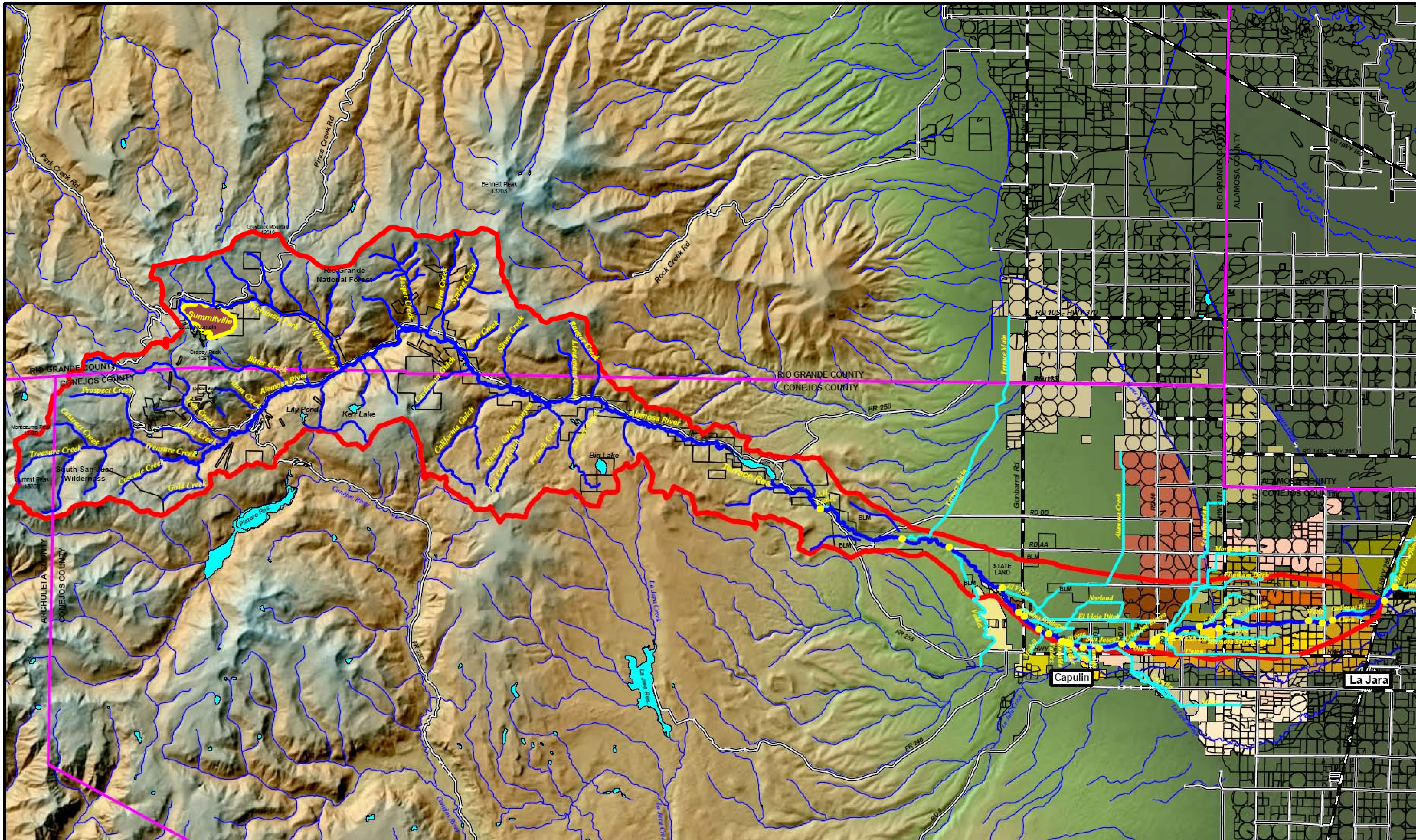
The Alamosa River watershed has been significantly impacted by human activity. In addition, several natural conditions also affect watershed resources. This report describes the affected environment of the Alamosa River Watershed according to resource categories. The key issues identified per resource category are described below.

Channel of the Alamosa River and major tributaries

- The upper watershed produces naturally high sediment loads.
- Terrace Reservoir, irrigation diversions, and channel straightening impact the river's geomorphology
- Structures located within Alamosa River floodplain are a flood hazard, especially in Capulin

Surface water quantity

- Highly altered hydrologic regime does not support natural functions and values.



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Alamosa River Watershed Restoration Master Plan

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Figure ES-1. Alamosa River Watershed Overview

Note: Different colored center pivots represent service areas of canals

- Historical streamflow has been significantly altered by water use for agriculture and other purposes, particularly by operation of Terrace Reservoir. The river is dry downstream of Terrace Reservoir during late fall, winter, and early spring (see Figure ES-2).
- The Alamosa River is a highly over-appropriated stream.
- There are no unappropriated surface flows for environmental purposes.
- There may be limitations on future new storage, due to the Rio Grande Compact. Figure ES-3 shows the Rio Grande River Basin in Colorado.

Surface water quality

- Hydrothermally altered areas naturally create water quality conditions with low pH and high metal concentrations in some areas of the Alamosa River watershed (see Figure ES-4).
- Historic mining created additional sources of contamination.
- Water quality in the Alamosa River downstream of Wightman Fork has improved significantly in recent years due to remediation efforts at Summitville. However, water quality below Wightman Fork continues to exceed pH, copper, zinc, and aluminum water quality standards. Iron concentrations are also high in comparison to toxicological reference values.
- The risk of untreated releases from the Summitville site remains high due to lack of storage and treatment plant capacity. Untreated releases have the potential to kill fish populations restored to the Alamosa River and impact downstream water users.
- The water of the Alamosa River is often observed to be turbid. Levels of suspended sediments rise exponentially during spring snow melt and precipitation events.

Groundwater

- Agricultural land use, irrigation, and drought have caused groundwater levels to decline.
- Naturally high metal content and mining activity in the upper watershed may have negatively impacted groundwater quality.
- Due to the limited amount of existing water quality data regarding groundwater basins affected by the Alamosa River, additional monitoring is necessary to accurately assess existing groundwater conditions.

Figure ES-2. Alamosa River at County Road 8
Photo courtesy of Alan Miller

Terrace Reservoir

- The spillway is insufficient to pass the Probable Maximum Flood design inflow. The State Engineer has imposed a filling restriction that limits the water level in the reservoir.
- The dam was never constructed to the originally planned height. The dam could be raised, but a stability and liquefaction analysis would be required to assure the safety of the structure.
- The outlet structure has been a chronic source of problems and has required dewatering of the reservoir and subsequent flushing of sediment downstream.
- When the reservoir is emptied in the future, there must be a more effective method of preventing large quantities of sediment from being washed downstream.
- Deposition of metals and sediments in the reservoir has tended to improve downstream water quality. However, hypolimnetic water with the lowest pH and highest metal loads is often passed downstream to irrigators because the reservoir outlet is at the bottom.
- Resuspension of bottom sediments appears to lower pH and increase metals concentrations.

Sediments

- There is naturally high sediment load from upper watershed.
- Terrace Reservoir captures upper watershed sediment.

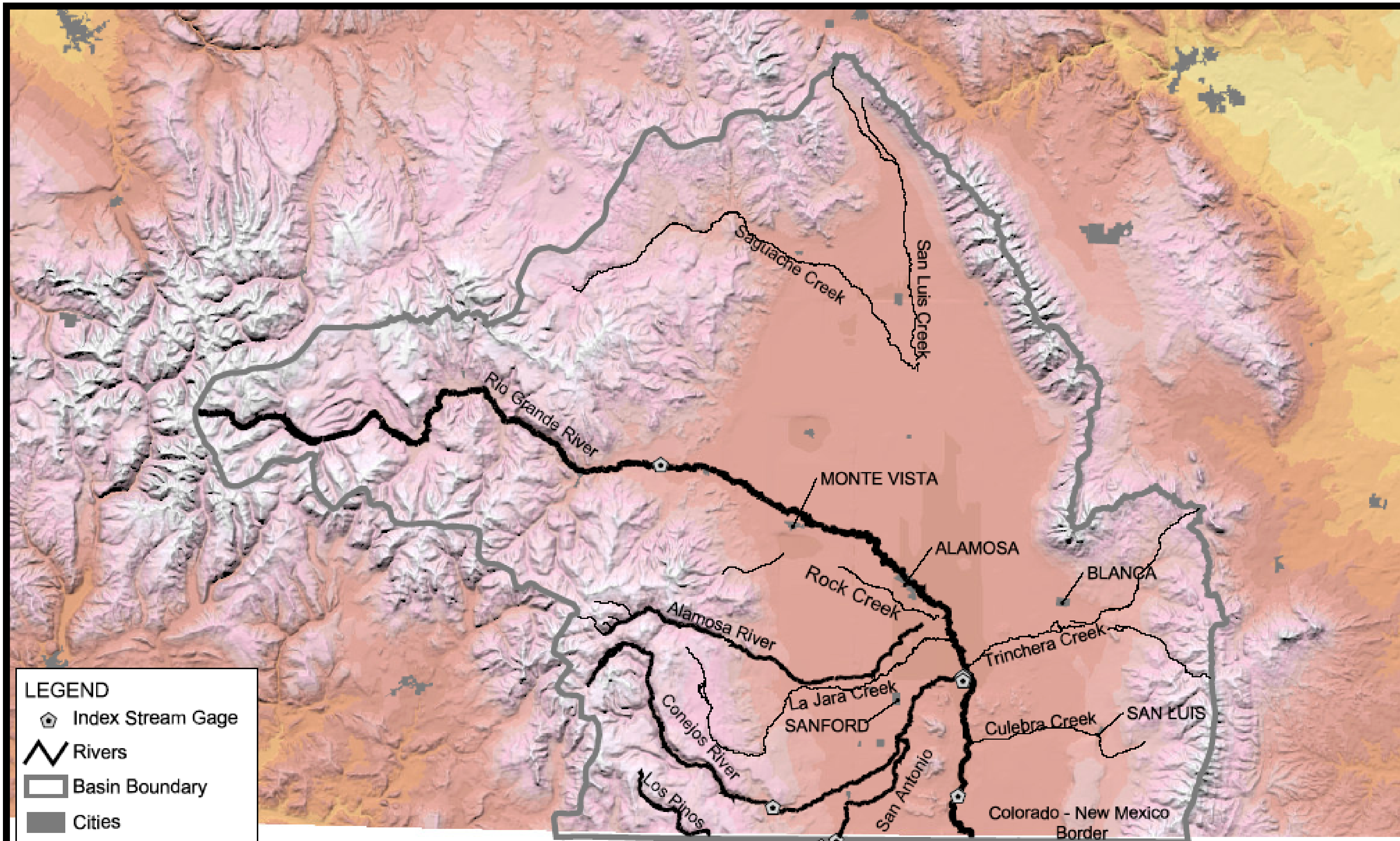

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Figure ES-3.
Rio Grande Basin in Colorado

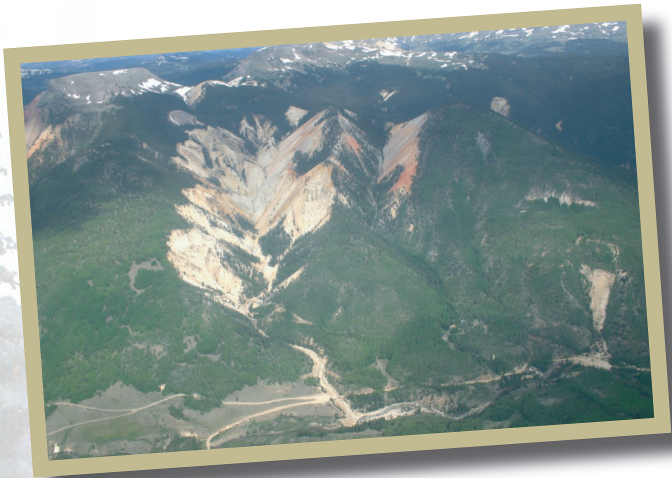

Figure ES-4. Alum Creek Drains Highly Erosive Terrain with Low pH Runoff

- Irrigation diversions reduce the sediment transport capacity of the river.
- Channel straightening has changed the river's sediment transport capacity.
- Sediment quality studies indicate elevated levels of total metals within the watershed.

Riparian habitat (vegetative communities)

- Noxious and non-native vegetation have become established in the lower Alamosa River.
- Overgrazing of the riparian corridor has degraded habitat in the lower Alamosa River.
- Placer mining has impacted the riparian corridor of the upper Alamosa River.
- Reduced groundwater levels, low flows, water quality, and sedimentation in the Alamosa River impact the quality of riparian vegetation.

Biological resources (wildlife resources)

- Impaired water quality in the Alamosa River adversely effects biological communities.
- Fish populations cannot be maintained in the lower Alamosa River due to lack of flow.
- Lack of oxbows and floodplain in the Alamosa River limit habitat values.
- Cottonwood health has been degraded by low groundwater levels and lack of overbank flows in the lower watershed.
- Introduced fish species, such as carp, displace native fishes.

Agricultural uses

- High rates of channel erosion and deposition impact headgates and water diversion.
- Operation of Terrace Reservoir and senior ditches creates a dry channel for much of the year.
- A dry channel impacts the stability of diversion structures and the delivery of water due to lowered local groundwater levels and reduced riparian vegetation.
- Release of sediments during the draining of Terrace Reservoir impacts diversions and agricultural lands and places a burden on downstream water users.
- Degraded water quality impacted irrigation infrastructure, agricultural soils, crops, and livestock.

Recreational uses

- Impaired fisheries limit recreational use of the Alamosa River and tributaries.
- Sedimentation in Terrace Reservoir may limit fishery productivity and recreational opportunities.
- Public perception of the Alamosa River Watershed health deters recreational utilization.

The watershed was broken into 17 segments and subwatersheds for the affected environment analysis. Figure ES-5 shows the segments and subwatersheds in the Alamosa River Watershed that are most impacted by human activities.

Table ES-1 shows the segment and subwatershed ratings that were assigned for each resource category according to the affected environment analysis.

ES.3 Master Plan Objectives and Watershed Vision

The Master Plan uses a multi-objective approach to make recommendations for watershed improvements. General Master Plan objectives as identified by local, state and federal stakeholders prior to the development of the Master Plan are:

- River and watershed health
- Protection of resources
- Restoration of impacted natural resources
- Bio-diversity
- Resource services to the public

The overall restoration strategy is to identify and pursue the opportunities for recovering lost natural values and enhancing those existing features that have the highest

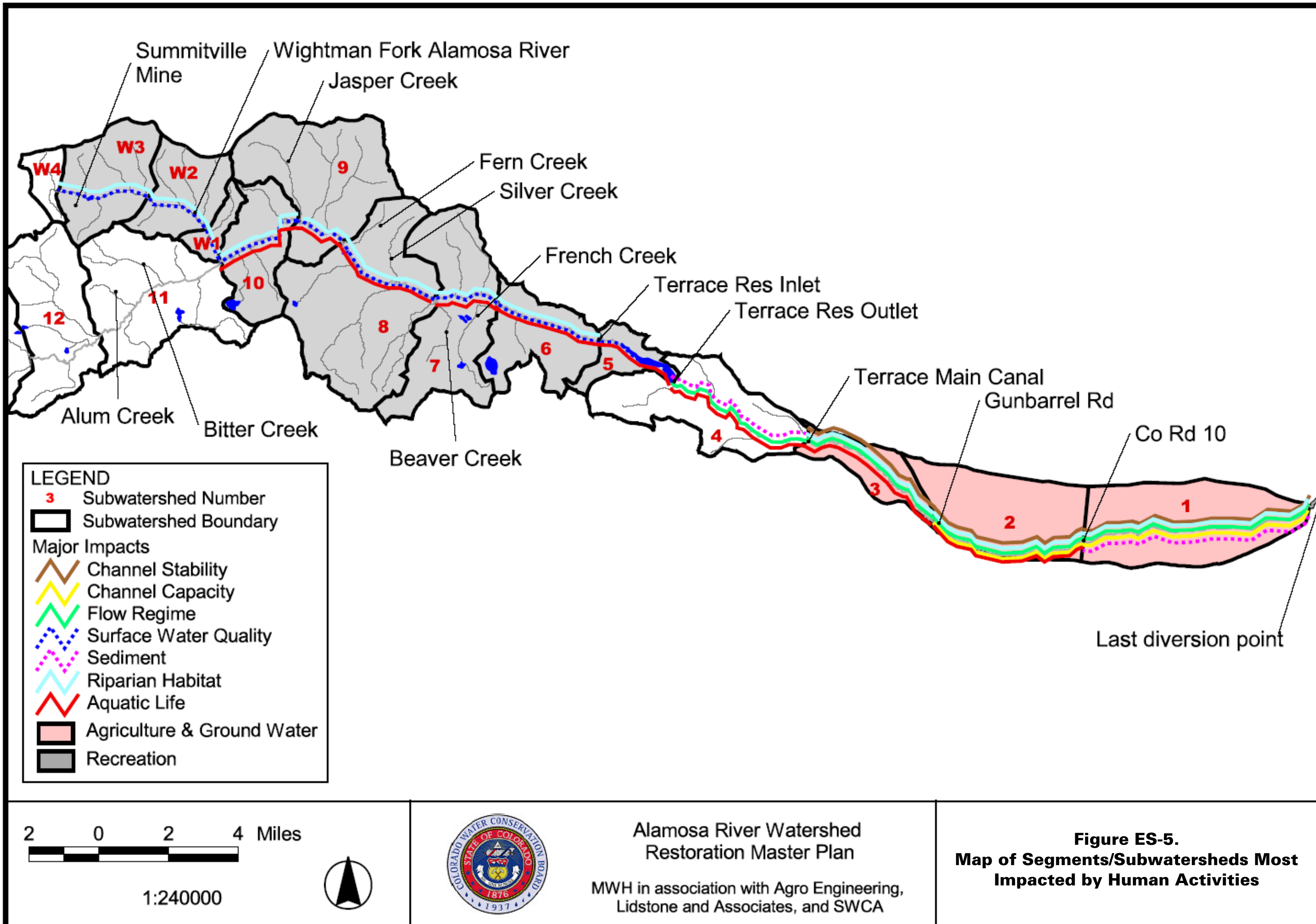

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Figure ES-5.
Map of Segments/Subwatersheds Most Impacted by Human Activities

Table ES-1. Stream Segment and Subwatershed Rating

Category – Criterion	Stream Segment/Subwatershed														
	1	2	3	4	5	6	7	8	9	10	11	12	T1	W1–3	W4
Channels – Channel Stability	Poor	Poor	Poor	Fair	N/A	Fair	Good	Good	Good	Good	Good	Good	Good	Good	Good
Channels – Channel Capacity	Poor	Poor	Fair	Good	N/A	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good
Surface Water Quantity – Natural Flow Regime	Poor	Poor	Poor	Poor	N/A	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good
Surface Water Quality – Beneficial Uses	Fair	Fair	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Poor	Fair	Fair	Good	Poor	Good
Surface Water Quality – Watershed Runoff Quality	Fair	Fair	Fair	Good	N/A	Good	Good	Good	Good	Good	Poor	Poor	Good	Poor	Fair
Ground Water – Beneficial Uses	Fair	Fair	Fair	Fair	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Terrace Reservoir – Design and Operation	N/A	N/A	N/A	N/A	Poor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sediments – Channel Sediment Balance	Poor	Fair	Fair	Poor	N/A	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good
Sediments – Watershed Sediment Production	Good	Good	Good	Good	N/A	Good	Good	Good	Good	Fair	Poor	Poor	Fair	Fair	Fair
Riparian Habitat – Health and Diversity	Poor	Poor	Poor	Fair	N/A	Poor	Poor	Poor	Poor	Poor	Fair	Fair	Good	Poor	Good
Biological Resources – Health and Diversity	Poor	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Good	Good	Good	Poor	Good
Agricultural Resources – Agricultural Benefits	Poor	Poor	Poor	Good	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Recreational Uses– Recreational Values	Poor	Poor	Poor	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Poor	Good
N/A – not applicable	Co Rd 10 to Point of last diversion	Gunbarrel Rd to Co Rd 10	Terrace Main Canal to Gunbarrel	Terrace Main Canal to Terrace Outlet	Terrace Reservoir	French Creek to Terrace Reservoir Inlet	Beaver Creek to French Creek	Fern Creek to Beaver Creek	Jasper Creek to Fern Creek	Wightman Fork to Jasper Creek	Iron Creek to Wightman Fork	Treasure Creek to Iron Creek	Treasure Creek	Wightman Fork below Summitville	Wightman Fork above Summitville

potential for success and that have the most favorable ratio of likely benefits to likely costs. Based on this strategy of balancing an idealistic view with pragmatic analysis, a "watershed restoration vision" was developed as a picture of what the watershed could look like after the Master Plan is implemented.

- We envision a naturally functioning channel system
- We envision a balance between competing human and environmental uses of water
- We envision water quality that supports beneficial uses in the watershed
- We envision Terrace Reservoir utilized reliably to its fullest capacity
- We envision a sustainable fishery on the Alamosa River and quality terrestrial and avian habitat
- We envision restoration of riparian habitat in the watershed
- We envision an efficient use of agricultural water from the Alamosa River
- We envision recreational opportunities in the watershed that benefit the public

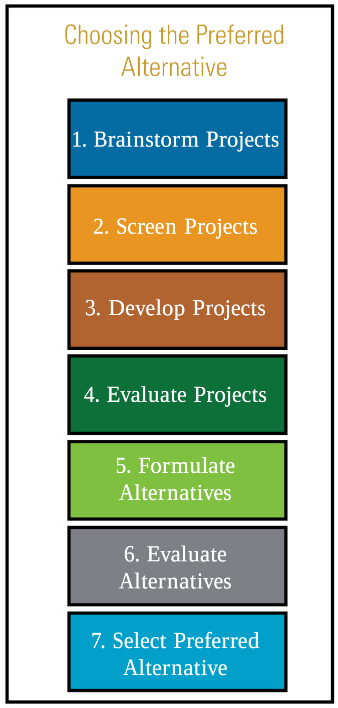
ES.4 Master Plan Process

The watershed restoration strategy is to implement the best combination of projects to obtain the watershed restoration vision described above. The best combination of projects is referred to as the preferred alternative. The following process was used to choose the preferred alternative:

- **Brainstorming -** Assemble a broad list of individual projects including all ideas submitted by the project team and local and agency stakeholders. All potential projects are included ignoring constraints.
- **Screening -** Eliminate projects with fatal flaws in the areas of technical feasibility, permitting, cost, legal issues, and public acceptance.
- **Project Development -** Further develop project details for the projects that passed the screening process.
- **Project Evaluation -** Evaluate projects according to their performance in several multi-disciplinary criteria. Each project is given a score and the best projects are identified.
- **Alternatives -** Assemble the best projects into watershed-wide alternatives that are different combinations of individual projects, each geared toward obtaining the watershed vision.

- **Alternative Impact Evaluation -** Evaluate both positive and negative impacts of the alternatives.
- **Choose Preferred Alternative -** Choose a preferred alternative based on impact evaluation and public comment.

The public has been involved in the Master Plan process since the beginning. Public meetings were held in the San Luis Valley to kickoff the project, discuss potential restoration projects, and formulate alternatives. The Alamosa River Foundation helped to locally publicize events and gather public input outside of meetings. Newsletters were produced and distributed to the entire Summitville interested parties mailing list to provide project status and solicit comment.



ES.5 Project Evaluation

The project team developed 73 potential structural and non-structural projects to improve the Alamosa River watershed. A fatal-flaw screening evaluation was used to eliminate 23 projects. The remaining 50 projects were further analyzed and prioritized. A project ranking and scoring methodology using 14 criteria was developed with both Trustee and stakeholder input. Each project was given a score between 1 and 5 for each criterion. The criteria were assigned different weights according to importance as determined by the stakeholders and Trustees. Each project was given a total score that is the sum of all of the weighted criteria scores (see Table ES-2). Actual scores for each criterion were suggested by the consultant team and then circulated to the public and Trustees for review and comment. The Board of the Alamosa River Foundation determined the scores in the three public categories: public acceptance, addresses issues critical to the public, and public benefits.

Due to the limited number of locations between Summitville and Terrace Reservoir to improve water quality, the consultant team also considered projects upstream of Wightman Fork that treat natural sources of water quality impairment. Improving water quality at locations receiving mostly natural contamination was suggested as a replacement for improving water quality at locations impacted by Summitville. Improving water quality, even if from natural sources, will help restore the environment that was potentially injured by hazardous releases from Summitville.

ES.6 Alternatives Development

An alternative is a comprehensive package of projects that addresses multiple watershed issues. Three alternatives were developed using different approaches. These alternatives are described below and shown in Table ES-3. The three watershed alternatives were each organized into three alternative funding levels: $5 million, $10 million, and $15 million. The first funding level is what is already available through the Summitville settlement. The other two funding levels are discussed because the Alamosa River Foundation and Trustees plan to seek additional funding sources to leverage the funds that are already available.

The table shows that the alternatives are similar in terms of content. The major difference is the order that projects are listed.

Preliminary Alternative 1 - Project Rank

The Project Rank Alternative is composed of the projects with the highest scores as shown in Table ES-2. The order of projects was slightly modified to include prerequisites and synergistic projects that would increase the effectiveness of the alternative.

Preliminary Alternative 2 - Watershed Objectives

The Watershed Objectives Alternative was assembled by the consultant team. This alternative is focused on the technical ability of projects to meet watershed objectives and the vision statements. At least one project was included to address each of the watershed problem categories identified at the outset of the restoration planning effort. This alternative is characterized by a large number of water quality projects because it is necessary to improve water quality in order to attain the vision statements.

Preliminary Alternative 3 - Trustee Preferences

The Trustee Preferences Alternative was developed by the Trustees based on their natural resource restoration goals for the Alamosa River watershed. Their alternative is similar to the other two alternatives. The Trustees included Project 32, acquisition of equivalent resource in the San Luis Valley for high quality habitat and recreation. This project would compensate for Summitville injuries

Table ES-2. Weighted Project Scores

#		Likelihood of success if implemented	Technically feasible to implement	Protection of implemented project	Public Acceptance	Addresses Issues Critical to Public	Public Benefits	Public health and safety	Adverse impacts	Environmental Permitting / Water Rights	Benefits in multiple resource categories	Time to provide at least 50% of expected benefits	Duration of benefits	Benefit/Cost	Addresses Water Quality, Riparian and Aquatic Habitat Issues	Total	Rank	Page Number of complete description	Estimated Project Life Cycle Cost (50 years)
Weight		2	1	1	3	3	3	1	1	1	2	1	1	1	2				
RIVER CHANNEL/CORRIDOR PROJECTS																			
1	Stream restoration Terrace Reservoir to Wightman Fork	4	5	4	3.4	3.4	3.4	3	4	3	4	4	4	4	3	**84**	4	3-12	$1.2M
2	Stream restoration Gomez Bridge to Gunbarrel Road	4	5	3	3.6	3.6	3.6	3	4	3	3	4	4	3	3	**81**	7	3-12	$800k
3	Funding to complete project between Gunbarrel Road and County Road 10	4	5	3	4.2	4.2	4	3	4	4	3	5	4	4	3	**89**	1	3-13	$120k
4	Stream restoration County Rd 10 to County Rd 13	3	3	3	4.2	3.8	4	3	4	3	3	4	2	2	3	**78**	10	3-13	$400k
5	Dead Tree Management Upstream of Terrace Res.	4	5	4	3	2.8	2.6	5	4	4	2	5	3	4	2	**75**	14	3-14	$50k
6	Dead Tree Management Downstream of Terrace Res.	4	5	3	3.6	2.4	2.6	5	4	4	2	5	3	4	2	**75**	15	3-14	$50k
7	Modify land use regulations for flood control	2	5	5	1.8	2	2	4	5	5	1	5	5	5	1	**64**	32	3-15	$10k
8	Setback levees at Capulin for flood control	3	4	4	1.4	1.4	1.6	5	2	2	1	4	5	3	1	**52**	42	3-15	$1M
WATER QUANTITY PROJECTS																			
9	Purchase appropriate water rights for instream flow	3	4	5	3.2	3.4	3.4	3	4	3	5	4	5	4	5	**88**	2	3-17	$1–4M
10	Controlled Releases from Terrace Reservoir with Supplemental Water Source	2	2	4	2.2	2.2	2.8	3	5	3	5	4	5	3	5	**75**	16	3-19	$200k
11	Aquifer storage for instream flow	2	2	4	2.2	2.2	2.4	3	3	3	5	3	5	2	5	**69**	23	3-23	$2M
12	Trade of direct flow diversion right for reservoir storage (no new water source)	4	4	4	2.6	2.6	2.8	3	4	3	5	4	5	5	5	**84**	3	3-19	$100k
13	New reservoir to store instream flow	5	4	5	2.2	1.8	2	3	1	1	5	2	5	1	5	**70**	22	3-21	$10M
14	New reservoir to store existing agriculture water rights	5	4	5	2.2	2	2.2	3	1	1	5	2	5	1	2	**65**	29	3-21	$10M
TERRACE RESERVOIR PROJECTS																			
15	Increase spillway capacity	4	5	4	3.4	3.6	3.6	4	4	3	3	3	5	4	2	**82**	6	3-26	$1.5M
16	Raise crest of dam	4	3	4	2.6	2.6	2.8	4	4	3	3	3	5	3	2	**71**	20	3-29	$3M
17	Sediment removal to increase capacity	3	4	3	1.6	2.2	2.2	3	2	2	3	4	3	2	2	**57**	35	3-30	$2M
18	Improve outlet works (tower)	4	4	4	2.6	2.6	2.6	3	4	3	3	4	5	2	3	**72**	19	3-31	$3M
19	Power generation at Terrace Reservoir	2	4	3	2.2	1.8	2	3	3	2	1	3	5	3	1	**52**	43	3-32	$7M
SEDIMENT MANAGEMENT PROJECTS																			
20	Lower watershed sediment deposition locations	4	4	3	2.2	2.6	2.4	3	4	3	3	4	2	4	3	**69**	26	3-33	$200k
21	Road management in upper watershed	2	3	3	1.6	1.6	2	3	4	4	3	4	3	2	2	**56**	38	3-33	$50k
22	Sediment traps at tributary confluences	2	4	3	3.2	3.6	3.4	4	4	3	5	4	2	3	3	**78**	12	3-34	$2M
WATER QUALITY PROJECTS																			
23	Reclamation of abandoned mines	4	4	3	1.8	2.2	2.2	5	4	3	4	4	5	2	4	**73**	18	3-39	$325k – $1.5M
24	Mainstem lake or reservoir below Wightman Fork	3	4	5	2	2	2	5	2	1	4	2	5	3	5	**69**	24	3-46	$3–15M
25	Sulfate reducing wetland on Wightman Fork or other tributaries	3	3	4	1.6	2	2.2	5	2	3	4	3	3	3	4	**65**	28	3-43	$2M
26	Active water quality improvement on tributaries upstream of Wightman Fork	3	3	5	1.8	2	2	5	4	3	4	3	3	3	4	**68**	27	3-45	$1–4M