The 2004 Arizona Water Settlements Act Proposals

Staff Report

to the

New Mexico Interstate Stream Commission

November 11, 2014

Table of Contents

CHAPTER 1: INTRODUCTION

This report presents the synthesis process of evaluating the 2004 Arizona Water Settlements Act proposals.

The Arizona Water Settlements Act (Pub.L. 108-451)

President George W. Bush signed the Arizona Water Settlements Act ("AWSA") into law in December 2004. The AWSA allocates an annual average of 14,000 acre-feet of additional water from the Gila Basin ("AWSA water"). Of this amount, 4,000 acre-feet per year may be consumed from the San Francisco River. The AWSA water represents a 47% increase over New Mexico's current Gila Basin apportionment in the 1964 US Supreme Court Decree in *Arizona v. California*.

New Mexico was first allocated additional water from the Gila Basin in the 1968 Colorado River Basin Project Act (CRBPA). However, the priority of the 1968 CRBPA water is September 30, 1968, a date junior to nearly all downstream Arizona water rights. The AWSA overcomes the priority issue and ensures that New Mexico can develop the additional Gila River allocation.

In the 2004 AWSA, Congress ratified a separate document, the Consumptive Use and Forbearance Agreement (CUFA), that contains the terms of New Mexico diversions of Gila River water and the related constraints under which New Mexico would be able to divert the AWSA water from the Gila River.

The AWSA allocates to New Mexico up to $128 million in non-reimbursable federal funding. Sixty-six million dollars of the funding can be used to fund a New Mexico Unit to develop the new water and/or to fund water utilization alternatives that will meet water supply demands. The $66 million must be expended in Luna, Grant, Hidalgo, and Catron counties. The remaining $62 million may only be disbursed on a construction cost-schedule basis for construction of a New Mexico Unit.

New Mexico must inform the U.S. Secretary of the Interior by December 31, 2014, if the State intends to construct a project to use the additional water. If New Mexico chooses not

to develop any of the additional water, the additional $62 million in federal funding will be forfeited.

The Planning Process

In September 2004, the ISC formally adopted a policy to guide it when considering uses of the water and funding provided to New Mexico in the AWSA:

> "The Interstate Stream Commission recognizes the unique and valuable ecology of the Gila Basin. In considering any proposal for water utilization under Section 212 of the Arizona Water Settlements Act, the Commission will apply the best available science to fully assess and mitigate the ecological impacts on Southwest New Mexico, the Gila River, its tributaries and associated riparian corridors, while also considering the historic uses of and future demands for water in the Basin and the traditions, cultures and customs affecting those uses."

The three main tenets of the ISC Gila policy are to recognize and mitigate any impacts to the Gila ecology, to use the best available science, and to provide for current and future water uses.

The tenets of the ISC Gila policy have also guided the planning process. Public meetings regarding the AWSA began in 2001. To date, there have been over 200 public meetings on the AWSA, conducted in various venues throughout the region.

In 2005, the Gila San Francisco Coordinating Committee ("GSFCC") formed. The GSFCC was composed of a representative each from the Office of the Governor, the Bureau of Reclamation, the Gila San Francisco Water Commission, the US Fish and Wildlife Service, the Interstate Stream Commission, and the New Mexico Department of Game and Fish. The purpose of the GSFCC was to develop baseline information, especially as to any potential impacts on endangered species that might occur from development of the additional AWSA water. The GSFCC held a number of open public meetings, hosted science forums, and began creating a decision support model to aid in building stakeholder consensus.

The GSFCC chartered a Technical Subcommittee composed of state and federal agencies, local officials, environmental non-governmental organizations (NGOs), and other stakeholders. In late 2005, the Technical Subcommittee crafted a consensus plan of integrated basic scientific studies. The studies focused on baseline environmental data and information and potential impacts to species under the Endangered Species Act (ESA). In 2006, the legislature appropriated full funding for those studies, but the appropriation was vetoed.

In September 2007, the Southwest New Mexico Stakeholders Group (SWNMSG) formed. The charge of the SWNMSG was to craft a small consensus set of proposals to present to the Commission. After several years of work, the SWNMSG was unable to find consensus.

Consequently, in 2011, the ISC invited stakeholders to submit proposals directly to the Commission. Stakeholders submitted forty-one project proposals for use of the water and/or funding. To evaluate proposals, the Commission created, with stakeholder input, a two-tier evaluation process. The ISC established an Evaluation Panel that reviewed and ranked the proposals. The Evaluation Panel consisted of one representative each from the New Mexico Environment Department, New Mexico Department of Game and Fish; the New Mexico Energy, Minerals, and Natural Resources Department; the New Mexico Interstate Stream Commission ("ISC"), and the Office of the State Engineer ("OSE"). The process and evaluation criteria were crafted with input, albeit without unanimous consensus, from regional stakeholders and local governments.

The Evaluation Panel passed 21 proposals from Tier-1. Stakeholders submitted 20 of the 21 passed proposals for Tier-2 consideration. The evaluation process and final rankings by the Evaluation Panel are posted at <http://nmawsa.org/library/isc-memos/february-2012-staff-memo-to-the-nm-interstate-stream-commission/view>.

The Gila-San Francisco Water Commission ("GSFWC") conducted its own evaluations and ranked proposals. New Mexico First[1] also held a "Gila Town Hall," where over one hundred stakeholders, members of the public, and local officials from southwest New Mexico expressed their opinions on various alternatives for use of the funds and water.

[1] New Mexico First is an independent, non-governmental public policy organization that engages people in important issues facing their state or community

On February 29, 2012, after considering ranking by the Evaluation Panel, the GSFWC rankings, the recommendations from the New Mexico First Gila Town Hall, and extensive public testimony, the ISC approved 16 projects for further assessment, integration, and/or refinement. One of the proponents subsequently withdrew its proposal. There are currently 15 projects remaining, and all have undergone further assessment. Locations of the proposals are indicated in Figure 1-1, below.

Each of the fifteen remaining stakeholder proposals has undergone comprehensive assessments of technical feasibility, costs and benefits, cultural impacts, water supply, and environmental impacts, if any.

The ISC has completed over fifty different studies or investigations. In addition, the ISC staff has also considered studies performed by others. All final studies may be found, along with their respective goals, methods, and results in Appendix 1.

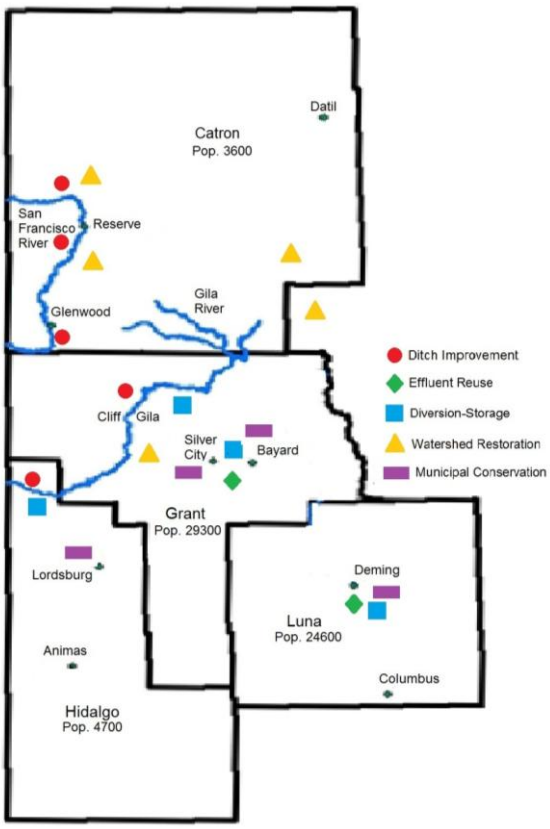


Figure 1-1: Locations of 15 proposed projects

Public Involvement

The ISC staff has held over 200 public meetings regarding the AWSA since 2001 and has continued a comprehensive process of public involvement, including facilitated quarterly public meetings. The ISC has also created a website dedicated to the New Mexico portion of the AWSA (www.nmawsa.org). All scopes of work, reports, and ongoing efforts are posted there.

During the planning process, the Commission and ISC staff have received numerous comments from stakeholders and the general public. These inputs were summarized and

presented to the ISC in August 2014 and can be found at <http://nmawsa.org/meetings/isc-meeting-august-26-2014/isc-staff-presentation-maps-study-summaries/view>.

Finally, the ISC has convened a smaller group composed of fifteen members from local governments and stakeholder interests to provide representative, broad-based input on specific issues. The composition of this "Input Group" includes local governments, agricultural interests, municipalities, and environmental NGOs.

The New Mexico Unit Fund

The New Mexico Unit Fund was created in the state treasury on April 6, 2011, for the purpose of receiving the funds allocated to New Mexico by the AWSA (NMSA 1978, § 72-14-45). Deposits of $9.04 million were received in January for each of calendar years 2012, 2013, and 2014. An identical amount will be deposited in the Fund in January 2015. As of October 3, 2014, the cash balance in the NM Unit Fund is $23,934,967.45.

The Rivers of the Gila Basin

The Gila River originates in the Gila Wilderness in the mountains of southwest New Mexico and flows 90 miles south and west before it crosses the Arizona border. The Gila River has highly variable flows. The median daily flow is 73 cubic feet per second (cfs) as it leaves the wilderness reach. However, its flow exceeds 1,000 cfs at least once during most years and has exceeded 20,000 cfs three times since 2005. While the median flow at the Gila near Gila gage is only 73 cfs, the mean (daily average) flow is just 149 cfs, or 107,825 acre-feet per year.

The first 40 miles of the Gila's path are mostly through Wilderness Areas and National Forest. The river then enters the Cliff-Gila valley, where four separate diversion structures divert water to irrigators and copper mines. The river continues to the Redrock – Virden farming areas where more structures divert water for irrigation before it crosses the Arizona border. These points of diversion deliver water for the exercise of surface water rights that have priority dates from the 1860s to the early 1900s.

The San Francisco River is the other major river in the Gila Basin. It originates in Arizona and flows east into New Mexico near the town of Luna. The San Francisco River continues through New Mexico for 70 miles before re-entering Arizona south of Glenwood. There are 19 community ditches that divert from the San Francisco.

Terms of Diversion

In the 2004 AWSA, New Mexico, Arizona, the U.S. Secretary of the Interior, and senior downstream water users agreed to the terms of diversion in the Consumptive Use and Forbearance Agreement (CUFA). Congress ratified the CUFA in the AWSA. The CUFA gives New Mexico a contractual right to divert and consume the 14,000 acre-feet of additional water from the Gila basin without objection by senior downstream water users.

The AWSA requires the Secretary of the Interior to implement an exchange, through the Central Arizona Project (CAP), of an amount of mainstem Colorado River water equal to the additional Gila Basin water depleted in New Mexico. Figure 1-2 shows a schematic of the AWSA operation in New Mexico and Arizona.

The 1968 Colorado River Basin Project Act (CRBPA) sets the priority of exchange water (Pub. L. 90-537, § 304 (e). The provision states that, in case of a shortage or reduction on the Colorado River, users who have yielded water from other sources in exchange for mainstem Colorado River water shall have the first priority on the CAP. The senior priority of the exchange water is not modified by the 2004 AWSA. If shortages on the Colorado River do occur, the 14,000 acre-feet necessary to effect New Mexico's exchange will have the first priority on the CAP.

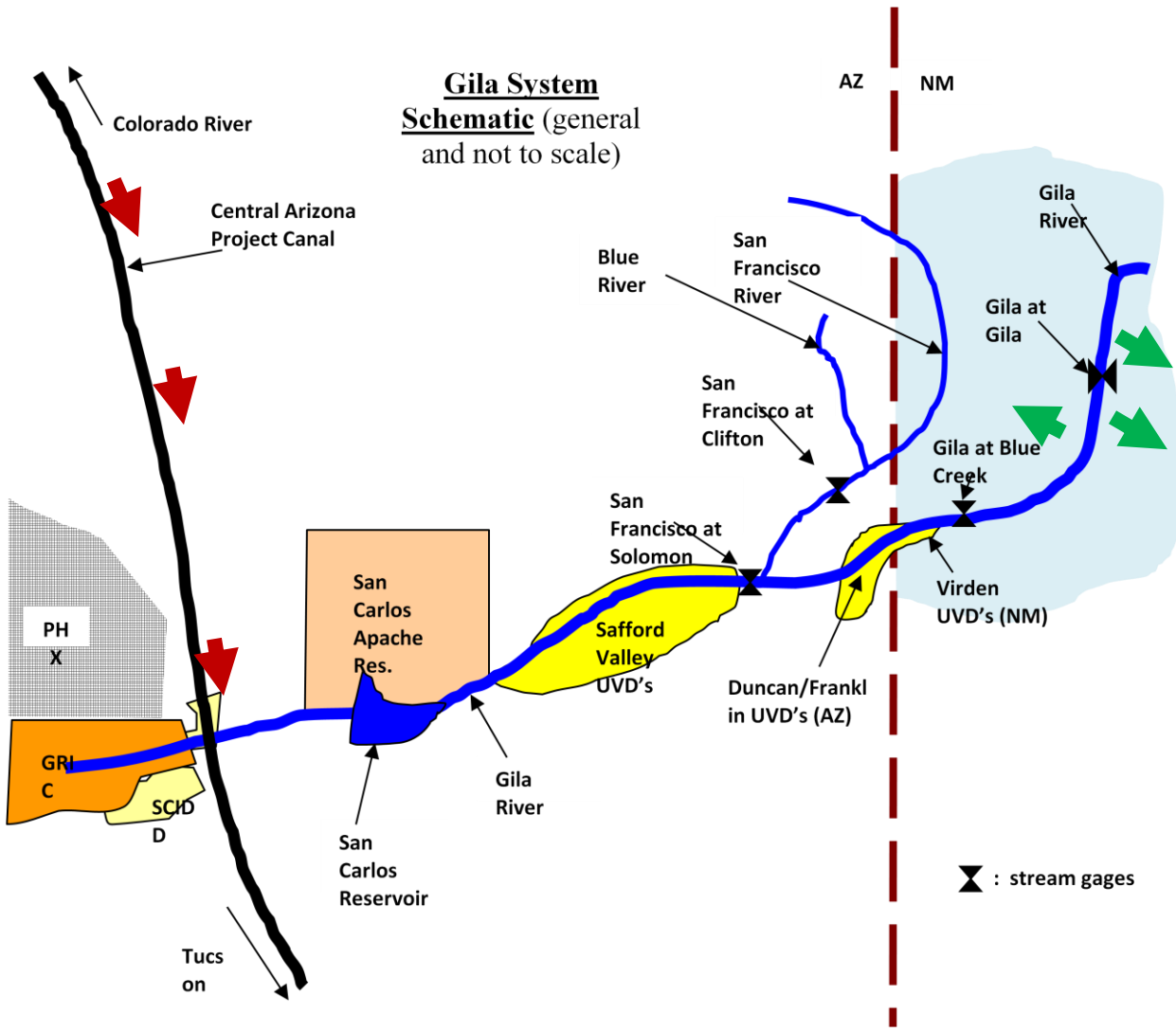


Figure 1-2: Schematic of the AWSA operation

When New Mexico consumes Gila Basin Water in New Mexico (green arrows), the Secretary of the Interior replaces the consumptive use in New Mexico with mainstem Colorado River water (red arrows) delivered to downstream users (GRIC) via the Central Arizona Project.

Chapter 2 discusses the results of evaluations of the 15 stakeholder proposals. Chapter 3 presents scoring and results from a suite of decision matrices. Appendices 1 through 5 contain backup information and data utilized by ISC staff.

CHAPTER 2: FINAL PROPOSALS

2.1 Introduction

In 2011, the ISC created a two-tiered evaluation process and encouraged stakeholders, tribes, federal and state agencies, and local governments to submit project proposals. The ISC accepted 41 project proposals during the period May - June 2011. Twenty proposals met the Tier-1 criteria and passed to the Tier-2 ranking process.

The ISC staff recommended 16 Tier-2 proposals for further assessment, refinement, or combination. On February 29, 2012, the Commission approved the ISC staff recommendations. In 2013, the City of Bayard withdrew its proposal from consideration.

The ISC staff began further evaluations of the following proposals:

1) Catron County (San Francisco Watershed Proposal)
2) City of Deming (Diversion & Storage a.k.a. Southwest Regional Water Supply System)
3) City of Deming (Effluent Reuse)
4) Gila Basin Irrigation Commission (Diversion & Storage)
5) Gila Conservation Coalition (Municipal Conservation Fund)
6) Gila National Forest (Watershed Proposal)
7) Grant County (Effluent Reuse - Reservoir)
8) Grant County Water Commission (Well Field & Pipeline)
9) Grant Soil & Water Conservation District (Watershed Proposal)
10) Hidalgo County (Diversion & Storage)
11) New Mexico Forest Industries Association (Watershed Proposal)
12) New Mexico State University (Watershed Proposal)
13) Pleasanton East-side Ditch Company (Ditch Improvement)
14) Sunset and New Mexico New Model Canals (Ditch Improvement)
15) 1892 Luna Irrigation Ditch (Ditch Improvement)

During the December 2, 2013, ISC meeting, ISC staff requested permission to optimize seven project proposals. The Commission approved the optimizations in Table 2-1.

Table 2-1: Proposal optimizations

PROPOSAL	PROPOSAL ELEMENT MODIFIED	OPTIMIZATION	REASON
Catron County	1. Ditch Improvements	1. Evaluate ditch improvements separately from watershed restoration elements	1. Evaluation of combined ditch and watershed projects cannot be compared with evaluations of discrete ditch projects
City of Deming (Diversion & Storage)	1. Store AWSA water in Mogollon Creek 2. Store AWSA water in Mangas Creek	1. Consider Spar and Winn Canyons 2. Consider other storage locations 3. Consider means to efficiently combine proposal with the GBIC and Hidalgo County proposals	1. Storage in Mogollon Creek poses conflicts with AWSA 2. Mangas Creek contains endangered species populations 3. Cost savings
City of Deming (Effluent Reuse)	1. Install 16-inch diameter PVC trunk line	1. Use 10-inch and 16-inch trunk lines	1. Cost savings
Gila Basin Irrigation Commission	1. Store AWSA water in on-farm ponds	1. Remove on-farm storage option	1. No adequate acreage available
Grant County Water Commission	1. Water storage tanks: 1 @ 825,000 gal.; 1 @ 250,000 gal.; 1 @ 3,000,000 gal. 2. 16-inch HDPE and iron pipe material 3. Four wells 4. 2 booster stations	1. Single water storage tank @ 850,000 gal. 2. 16-inch PVC pipe 3. Two wells 4. 1 booster station	1. Additional tanks not needed 2. Improved water conveyance 3. Two wells suffice for proposed water quantity; only two wells applied for from OSE 4. Single booster station is sufficient
Grant County	1. Fill reservoir with Bayard effluent 2. Refurbish spring boxes on Cameron Creek; refurbish water lines at Ft. Bayard; irrigate Bayard ball fields; build pipeline from Bayard to Santa Clara and Ft. Bayard; discharge water to creek for infiltration	1. Fill reservoir with AWSA water conveyed from the Southwest Regional Water Supply System 2. Remove refurbishment of spring boxes and tanks, irrigation of ball field, pipelines from Bayard to Santa Clara and Ft. Bayard, discharge of water to creek	1. Bayard effluent not available 2. Other components no longer needed
Hidalgo County	1. Storage in Schoolhouse Canyon	1. Consider other storage locations	1. Schoolhouse Canyon has numerous faults (geologic)

After the Commission approved the optimizations, the ISC staff continued to evaluate the proposals under the following descriptors:

1) Catron County (San Francisco Watershed Proposal)
2) Catron County (Ditch Proposal)
3) City of Deming, Hidalgo County and Gila Basin Irrigation Commission (combined Diversion & Storage, a.k.a. Southwest Regional Water Supply Proposal)
4) City of Deming (Effluent Reuse)
5) Gila Basin Irrigation Commission (Irrigation Diversion Structure)
6) Gila Conservation Coalition (Municipal Conservation Fund)
7) Gila National Forest (Watershed Proposal)
8) Grant County (Recreational Reservoir)
9) Grant County Water Commission (Well Field & Pipeline)
10) Grant Soil & Water Conservation District (Watershed Proposal)
11) New Mexico Forest Industries Association (Watershed Proposal)
12) New Mexico State University (Watershed Proposal)
13) Pleasanton East-side Ditch Company (Ditch Improvement)
14) Sunset and New Mexico New Model Canals (Ditch Improvement)
15) 1892 Luna Irrigation Ditch (Ditch Improvement)

In this chapter, the descriptions and assessments of the above proposals are summarized.

2.2 Proposal Descriptions and Assessments

2.2.1 Catron County (Ditch Proposal)

Background

The Catron County San Francisco Watershed Proposal was submitted by the Catron County Commission. The ISC accepted amendments to the proposal after the Whitewater-Baldy Complex Fire burned more than 297,845 acres in the Gila National Forest and effectively negated the original watershed project proposal. Amendments to the proposal include improvements to community and private irrigation ditches that divert water from the San Francisco River and its tributaries. Specifically, Catron County proposes improvements on the ten ditches labeled on the map at right (Figure 2-1).

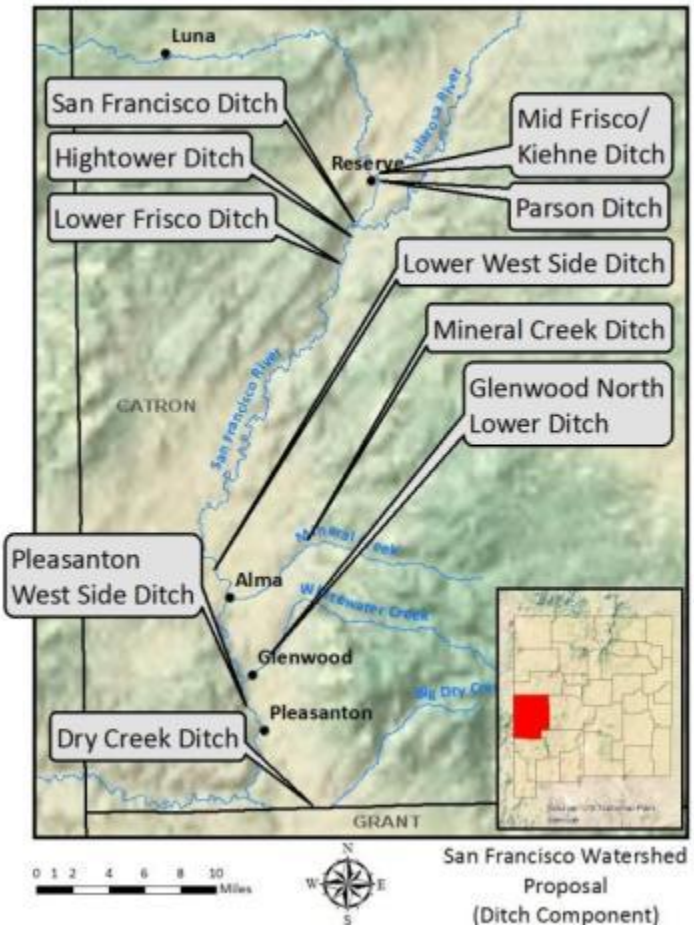


Figure 2-1: Map of Catron County Ditches

The U.S. Supreme Court *Arizona v. California* decree permits 725 irrigated acres in the Reserve area and 1,003 acres in the Glenwood area, including lands on tributary streams. The proposal does not include ditches in the Luna area or the Apache Creek-Aragon area, which are allowed 225 and 316 irrigated acres, respectively. The primary crop is unimproved pasture.

Some ditches are not presently in use, such as the Pleasanton West Side Ditch. The proposal author communicated to ISC staff that the non-use is the result of the repeated washouts of the diversion structure.

Description

Catron County proposes to improve community and private ditches in order to divert water at higher flows, filter sediment, and improve efficiency. The county proposes to accomplish these goals through construction of infiltration galleries in lieu of conventional earthen dams or weirs; on-farm ponds to store water and to provide a faster water

application rate; and replacement of earthen ditches with pipe in order to reduce conveyance losses.

The Catron County Commission proposes to administer the funds. The San Francisco Soil & Water Conservation District would be the fiscal agent for private ditch projects, as such districts have authority to provide assistance to private landowners.

Technical Evaluation
In order to assess the technical feasibility of the proposal, the ISC staff contracted with Portage, Inc., to select two representative ditches and provide conceptual design alternatives and cost estimates.

Mid Frisco/Kiehne Ditch
Portage staff met with representatives of the Mid Frisco/Kiehne Ditches on site. After viewing the existing infrastructure and discussing the needs on the ditch, Portage produced a PEA with two design alternatives and cost estimates that include materials, installation, tax, and a 15 percent contingency. Though the PEA does not contain annual O&M costs, Portage assumes 5 percent at this level of assessment.

The alternatives consists of a infiltration gallery, pipeline, regulating structure for the point where the ditch splits into two, five holding ponds and other infrusture. The size of the dual-wall HDPE pipe is the only difference (30- and 24-inch vs. 24- and. 18-inch pipe) between the two alternatives.. The cost estimate for Alternative 1 is $1,650,014.

The cost estimate for Alternative 2, with the smaller pipe sizes, is $1,321,768.

Glenwood North Lower Ditch
The Glenwood North Lower Ditch diverts water via subsurface water collection pipe (like an infiltration gallery) along Whitewater Creek, a tributary of the San Francisco River. Water is used for pisciculture at the Glenwood Fish Hatchery operated by the New Mexico Department of Game & Fish. Water that exits the hatchery is used for agriculture. Though not verified, it is suspected that the perforated collection pipe has accumulated sediment and has been infiltrated by tree roots.

According to ISC records and reports, the Glenwood North Lower Ditch experiences no physical water supply shortage due to the large quantities of water diverted into the fish ponds.

Portage staff met with representatives of the Glenwood North Lower Ditch. After viewing the existing infrastructure and discussing the needs on the ditch, Portage produced a PEA with four design alternatives and cost estimates that include materials, installation, tax, and a 15 percent contingency. Though the PEA does not contain annual O&M costs, Portage assumes 5 percent of capital costs at this level of assessment.

The differences in the alternatives are accounted for by pipe material and size. The respective costs of the alternatives are: $556,017; $454,393; $571,769; and $447,287.

A potential cost that is not accounted is the special removal and disposal of an existing segment of transite pipe. Transite is a cement-fiber compostite material, and early manufacturers used asbestos as part of the fiber composition.

Environmental Impacts
The ISC staff also hired Portage, Inc., to assess the potential environmental impacts of Catron County's proposal. Portage looked at the "human environment," and impacts to cultural resources and socioeconomics are included in the environmental evaluation.

Portage evaluated nine resource areas under "No Action" and "Proposed Action" scenarios. Those nine resource areas are as follows: land use; geologic environment/soils; water resources; ecological resources; historical and cultural resources; air quality; aesthetics; noise; and socioeconomics. Each resource area had its own evaluation criteria. Impacts were categorized as either "no impact," "less-than-significant impact," or "potentially significant impact."

Portage identified no impact or a less-than-significant impact to all resource areas should the project be constructed.

If the project is not constructed, Portage identified potentially significant impacts to water resources and socioeconomics. Portage states that continued system degradation would be expected to result in continual and increasing impacts to the water users with impacts to hatchery operations and agricultural water supply.

Cultural Impacts
Cultural impacts are addressed in the "Environmental Impacts" section. One additional consideration is that *acequias* and community ditches are themselves regarded as a cultural resource and a part of New Mexico's heritage.

Water Supply
The water supply for community ditches in Catron County is variable. Most experience at least some water shortage due to the timing and variability of flows on the San Francisco River and its tributaries. All have conveyance losses, but these losses will vary by location, as they are a function of such variables as soil permeability and wetted area.

The proposed on-farm ponds may ameliorate the shortages and increase the on-farm efficiency. The ditch linings may increase water deliveries to the farm headgates, especially when diverting at low river flows.

Economics
The total estimated benefit of the Catron County Ditch Proposal amounts to about $11.4 million through 2050. The total cost amounts to about $14.5 million through 2050. Estimated benefits of the Catron County Ditch Proposal are less than the assumed proposal costs, resulting in a net cost of about $3.1 million. The benefit-cost ratio of this proposal is 0.78.

Mid Frisco/ Kiehne PEA URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/preliminary-engineering-assessment-mid-frisco-keihne-ditch/view

Environmental Assessment URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/environmental-assessments/mid-frisco-keihne-ditch-environmental-assessment/view

Glenwood North Lower Ditch PEA URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/preliminary-engineering-assessment-glenwood-north-lower-ditch/view

Environmental Assessment URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/environmental-assessments/glenwood-north-lower-ditch-environmental-assessment/view

2.2.2 City of Deming (Effluent Reuse)

Background

The City of Deming is located in the high plains desert of southern New Mexico. The City currently expends up to 20% of its annual water consumption irrigating parks and recreational facilities. The U.S. Geological Survey (USGS) has eight monitor wells within 4 miles of Deming. Water levels in these wells have decreased at an average rate of 0.74 foot per year (ft/yr) for several decades. The City desires to expand an existing effluent reuse system to irrigate the aforementioned parks and recreational facilities, hence, reducing stress on the aquifer.

All of the parks are owned by the city. The ball fields at the high school are owned by the public school system. Because the city charges one half the price of new water for effluent, this project would reduce the costs to the schools.

Description

The City of Deming proposal would expand an existing effluent reuse system with three miles of piping to irrigate ball fields and parks with treated effluent instead of clean groundwater (Figure 2-2). The existing system provides treated effluent to the golf course and cemetery. Souder Miller Engineers from Las Cruces evaluated the proposal.

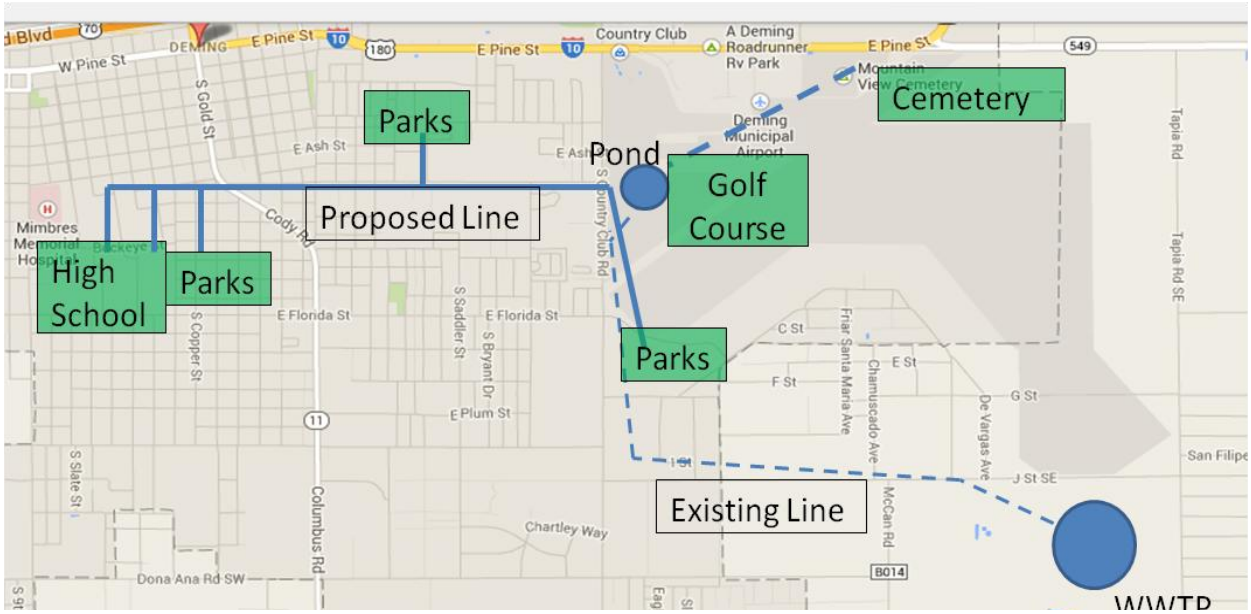


Figure 2-2: Schematic of proposed effluent reuse project. WWTP = Waste Water Treatment Plant

Technical Evaluation
Souder Miller identified the following project elements:

- Higher capacity pumps necessary for the WWTP and golf course
- Effluent treatment at WWTP must be enhanced
- Storage ponds at WWTP are adequate
- Existing pipelines are okay
- Main trunk line - Two miles of 10 – 12-inch PVC pipe
- 1 ½ miles of 6-inch PVC pipes required to service park areas

Environmental Impacts
The project would be entirely on property owned by the City of Deming. No detrimental environmental effects are anticipated, and NEPA is not required.

Cultural Impacts
There is no anticipation of encountering archaeological sites.

Water Supply
The areas proposed for new service by the project use up to 30.37 acre-feet of potable groundwater per month for up to 6 months per year. Areas on the system, but with inadequate infrastructure for delivery, use up to 37 acre-feet of potable groundwater per month for up to 6 months per year. This project would replace the potable groundwater with treated effluent, resulting in a total savings of up to 400 acre-feet per year.

To put this in perspective, the water budget of the Deming Area is:

<u>DEBITS</u>
Agricultural: 24,000 acres irrigated
Pumping @ 3 AF/Y = 72,000 AF/Y
Deming Municipal Use = 2,850 AF/Y to 4,000 AF/Y
<u>CREDITS</u>
15% Traditional Irrigation = 3,600 acres
= 5,400 AF/Y return flow
85% Drip Irrigation = 20,400 acres
= 0 AF/Y return flow
Municipal = 500 AF/Y effluent reuse
Natural recharge = 31,100 AF/Y
BALANCE = -37,850 acre-feet/year

NOTE: Deming owns 6,103 AF/Y of groundwater rights, but use has dropped in the last few years due to conservation efforts and the closure of a major food processing facility. While 400 AF/Y is only 1 percent of the debit, the people of Deming are very concerned about the declining water levels in their wells.

Economics
Depending on the treatment level selected for this project, the cost is between $4 and $4.5 million. Deming has received a grant from the NM Water Trust Board for $800,000, which is being applied specifically to upgrading pumps. Deming provided matching funds of $141,000. This leaves the request for AWSA funds at $3.5 million. The annual O&M costs will be about $75,000.

Total proposal benefits are estimated to be about $36.1 million through 2050. Total costs up to the year 2050, are about $5.9 million, including capital expenditures and annual O&M costs. The benefit-cost ratio of the proposal is 6.09:1, based on Harvey Economics (HE) study. This ratio is 2.82:1 in the Reclamation's economic study.

Link to the PER by Souder Miller: http://nmawsa.org/ongoing-work/final-effluent-resuse-proposal-pers/deming-wastewater-reuse/deming-effluent-reuse-per/view

2.2.3 Gila Basin Irrigation Commission (Irrigation Diversion Structure)

Background

The Gila Basin Irrigation Commission's (GBIC) Diversion and Storage proposal is comprised of Storage component, and Irrigation Diversion component. The storage component was merged into Deming's Southwest Regional Water Supply proposal. This section presents the evaluation of the irrigation diversion structure only.

The U.S. Supreme Court's *Arizona v. California* decree permits the irrigation of 5,314 acres in the Cliff-Gila Valley. The ISC's records indicate 1,743 irrigated acres in 2012.

Three community ditches divert Gila River water: Upper Gila, Fort West, and Gila Farms (Figure 2-3). The primary crop is unimproved pasture, which is used primarily for cattle grazing.

Figure 2-3: Map of the Cliff-Gila Irrigation Points of Diversion

Description

The irrigators construct push-up earthen berms as the points of diversion. These consistently wash out under high flows, and the irrigators may reconstruct them multiple times per year. The irrigators desire permanent diversion structures to withstand high flows, to transport sufficient flow, and to be cost-effective to maintain.

One point of diversion would potentially be located at or just upstream of the current Upper Gila and Fort West Ditch diversions. The second diversion would be sited to provide water to the Gila Farms Ditch. GBIC requests $3.27 million in AWSA funds for engineering and construction.

Technical Evaluation
The ISC staff contracted with BHI to assess the GBIC proposal. BHI staff visited the ditches and points of diversion and produced a PER containing two design alternatives and cost estimates.

The first alternative would replace existing Upper Gila and Ft. West points of diversion with separate permanent grouted boulder weirs. A grouted boulder weir would direct water through a series of gates and an outlet ditch. Grout would make the structure more permanent and would prevent water from "leaking" between the boulders and possibly depriving irrigators of their full water right. The structure could provide adequate head to the intake structures during low-flow conditions.

A new connecting ditch from Ft. West to the Gila Farms ditch would eliminate the need for a Gila Farms point of diversion, which presently lies on a part of the river that is geomorphologically unstable.

The second alternative would consolidate the Upper Gila and Fort West points of diversion into a single grouted boulder weir, thereby reducing construction and maintenance costs. The Gila Farms point of diversion would also be eliminated and a connecting ditch constructed from the Ft. West ditch.

Environmental Impacts
Currently, native vegetation is removed for a reach of several hundred feet when the earthen push-up dams are built, impacting water quality and the riparian zone. The proposed design would eliminate the need for regular disturbance of the floodplain and the riparian zone as well as the negative sediment deposition that takes place during reconstruction or maintenance.

A fish passage could also be built into the design to address native fish movement upstream and downstream.

Cultural Impacts
Periodic floods wash out the existing push-up dams, necessitating reconstruction sometimes multiples times per year. Continuing high flows can prevent reestablishment of the diversions, and irrigators can be without water for many weeks at a time, preventing establishment of more varied crop types and limiting the ability of the farming community primarily to pasture.

The improved diversions, coupled with storage, could also enhance the opportunity to expand irrigated acreage to more fully realize adjudicated rights. This would support the farming communities and cultures.

Water Supply:
The amount of water conserved is not accurately quantified at this appraisal level, but staff estimates annual water savings of 224 acre-feet.

Economics:
Total costs of the Alternative 1, the preferred alternative, include about $1.7 million in capital expenditures and about another $880,000 in O&M costs through 2050 for a total of $2.5 million. Total estimated benefits of the GBIC proposal are about $2.7 million. Net benefits are about $208,000. The benefit-cost ratio is 1.08:1.

Link to PER: http://nmawsa.org/ongoing-work/diversion-and-storage-proposals/bhi-final-preliminary-engineering-report-4-11-2014/preliminary-engineering-report-gila-river-diversion-conveyance-and-storage-alternatives-april-2014/view (Pg. 26-27 & 30-32, Figures 19-24)

2.2.4 Gila Conservation Coalition Municipal Conservation to Reduce Net Depletions to Groundwater

Background

The Gila Conservation Coalition ("GCC") is a partnership of environmental and conservation groups and individuals in southwestern New Mexico with the self-described mission of promoting conservation of the Upper Gila River Basin and surrounding lands.

Figure 2-4: Water conservation methods

Description

GCC proposes to establish a fund to finance municipal water conservation programs in southwestern New Mexico. Under the proposal, the ISC would endow the fund with $7.742 million to $10.4 million of AWSA money. The fund would be administered by the New Mexico Finance Authority ("NMFA") or a state agency. The proponent compares the proposed fund to the Water Project Fund, which has disbursed over $44 million for water conservation, treatment, recycling, or Reuse statewide for the period 2002 to 2012.

GCC proposes specific water conservation programs for each county, as shown in Table2-2 below.

Table 2-2: Proposed Water Conservation Programs

Conservation Method	COUNTY			
	Catron	Grant	Hidalgo	Luna
Toilet rebates	X	X	X	X
Clothes washer rebates	X	X	X	X
Showerhead giveaway	X	X	X	X
Increasing block rate structure			X	X
Outdoor watering ordinances		X		
Leak detection and repair		X	X	

Technical Evaluation
As part of its evaluation of the proposal, the ISC elected to fund two $50,000 water conservation pilot projects – one in Silver City and one in Deming – in February 2012. The grant agreements were signed in spring 2013, and the individual programs began in summer 2013. The agreements required the municipalities to provide a cost share of 30 percent.

Silver City Conservation Pilot Project
For its pilot project, Silver City replaced its irrigation system at the Altamirano Sports Complex with a U.S. EPA WaterSense weather-based smart irrigation system. The Altamirano Sports Complex consists of 11.5 acres of cool-season turfgrass. The Town of Silver City pays for the irrigation of the ball fields, but school district staff operate the system and conduct the maintenance.

Annual irrigation water usage by the Altamirano Sports Complex for the period 2008 to 2012 ranged from 48 to 62 acre-feet. The complex was Silver City's top single water user in 2011 and 2012. In 2012, its use was 61 acre-feet, or 2.4 percent of Silver City's water production.

Post-installation water usage for the period August 2013 through June 2014 totaled 32 acre-feet. Annual usage for the past five years, disregarding July of each year, ranged from 39 to 52 acre-feet by comparison.

Deming Conservation Pilot Project
Whereas Silver City targeted a specific water user, Deming targeted a specific sector. Deming's pilot conservation project focused on the residential sector, which demands 49 percent of Deming's water production. The difference between average January and June residential consumption in Deming is approximately 153 acre-feet as illustrated by Figure 2-5.

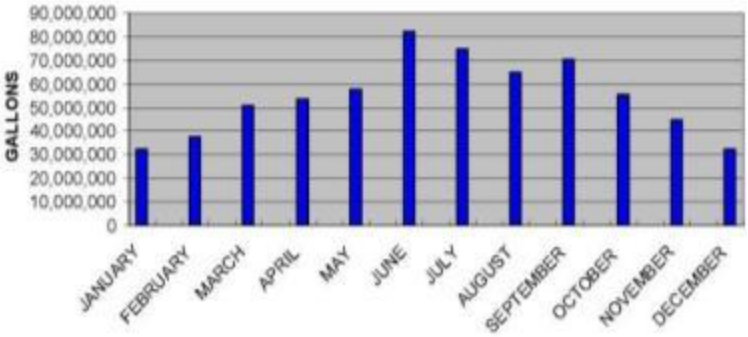


Figure 2-5: City of Deming Average Monthly Water Consumption Residential Sector (2007-2011)

Therefore, Deming specifically targeted residential summer demand by offering rebates for conversion of turfgrass landscaping to xeriscaping and for replacement of evaporative coolers with refrigerated air units.

Deming offered rebates of $1.00 per square foot of turfgrass replaced and $1,000 for refrigerated air units. To inform the public of the program, Deming officials met with local landscape and HVAC contractors, advertised in the local newspaper and government buildings, and partnered with Public Service Company of New Mexico ("PNM") for a radio and newspaper advertisement campaing.

The results included two landscape conversions of 1,210 square feet and eight refrigerated air units. Consequently, Deming expended only 16 percent of the grant funds. (The balance reverted to the New Mexico Unit Fund.)

However, Deming identified lessons for future conservation programs, including tailoring programs to fit the local community and its economy.

Environmental Impacts
The environmental impacts of the proposal were not specifically evaluated.

Cultural Impacts
The cultural impacts of the proposal were not specifically evaluated. However, one may presume that conservation programs will lead to lifestyle change for high-usage customers.

For low-usage customers, programs will have either little effect or be somewhat adverse. For example, a clothes washer rebate program can be anticipated to have no effect on a customer who already has a new, high-efficiency front loading washer. However, if such programs result in a reduction of system revenues that must be offset by rate increases, the rate increases incurred by a customer on water may reduce spending in other areas, such as entertainment.

Water Supply
Water conservation programs are components of water supply management in southwestern New Mexico. GCC's proposal can either be seen as duplicative of the Water Project Fund or as a supplemental funding source for programs in the southwestern counties.

Actual water savings depend on multiple factors, including present usage, income (for the residential sector), and enforcement (of ordinances). Calculation of water savings post-implementation will depend upon long-term data collection and record keeping.

However, Harvey Economics estimates that regional water savings in the first year of project implementation would total about 171 acre-feet. It is expected that more people would take advantage of the programs each year, and, by 2050, the savings would be 1,150 acre-feet.

Economics
Total proposal costs are about $10.4 million through 2050. The total estimated benefit is about $75.7 million through 2050, resulting in an estimated net benefit of about $65.4 million. The benefit-cost ratio of this proposal is 7.32:1, according to the HE economic study. This ratio is 5.92:1 in the Reclamation's economic study.

Harvey Economics notes that this proposal "carries a higher, multifaceted degree of uncertainty than the other proposals, owing in part to conservation program uncertainty, customer response, and costs…"

URL: http://nmawsa.org/ongoing-work/municipal-water-conservation/municipal-conservation-pilot

2.2.5 Grant County Recharge and Reservoir

Background
Grant County desires to construct a reservoir for recreational fishing and swimming in order to enhance the quality of life in the area and stimulate the local economy.

Description
Grant County proposes to construct this recreational reservoir on Twin Sisters Creek, near Fort Bayard. The water to fill this reservoir would be from the Gila River transported through pipelines proposed for the SW Regional Water Supply (Figure 2-6).

Technical Evaluation
The ISC contracted with BHI to evaluate the project to appraisal level (10 percent). This project would consist of a connection to the Southwest Regional Water Supply, a pump station and pipeline to convey water to the reservoir, a dam and outlets works, and, further upstream, a smaller sediment dam to capture storm run-off and to settle sediment. All storm run-off would be released within 96 hours.

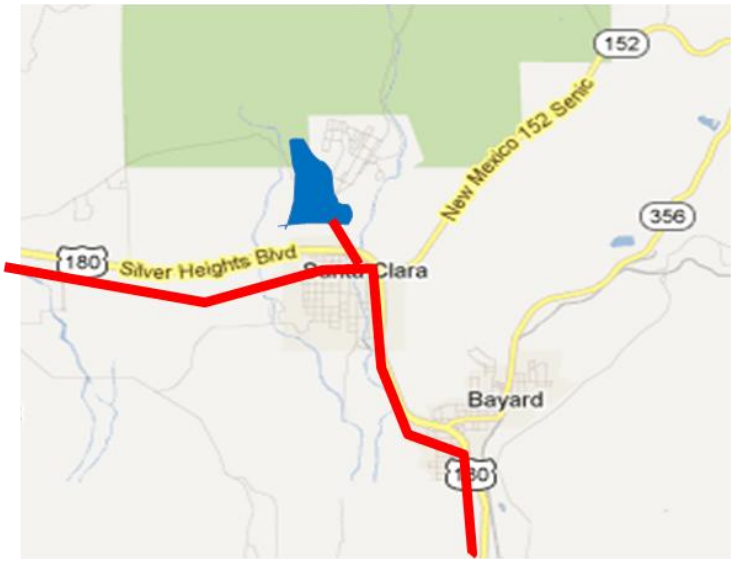


Figure 2-6: Schematic Map of Grant County Reservoir (Not to Scale)

Environmental Impacts
The area that would be inundated, Twin Sisters Creek, is usually dry. No sensitive ecological issues are anticipated.

This project would be built entirely on federal property, whether US Forest Service or Fort Bayard Military Reservation. The Gila National Forest office in Silver City manages the right of way along Highway 180. Hence, NEPA would be required.

Cultural Impacts
There may be archaeological sites may in this area.

While very near the historical Fort Bayard, the recommended reservoir site is separated from it by a hospital.

A recreational facility with ball fields and picnic tables is located nearby. County planners anticipate adding more facilities, such as an archery range, should the reservoir be built.

Water Supply
John Shomaker & Associates, Inc. , a hydrology consulting firm, completed two separate studies to determine effects on downstream wells should either creek under consideration be dammed. They concluded that so long as storm water is bypassed, reservoir seepage would recharge the aquifer by approximately 60 AF/Y.

Economics
BHI offered three different configurations of reservoirs on Twin Sisters Creek ranging from 1,636 AF at $13 million to 14,103 AF at $25 million. BHI recommended the mid-sized alternative of 3,000 AF (125 surface acres) at a cost of $18 million.

Total benefits amount to about $63.5 million and include both the construction stimulus ($19.3 million) and recreational benefits ($44.1 million). Capital and O&M costs from 2025 to 2050 amount to about $16.1 million. The proposal's net benefits amount to about $47.4 million. The Grant County Reservoir proposal has a benefit-cost ratio of 3.95:1, based on the HE economic study. This ratio is 1.18:1 in the Reclamation's economic study.

Link to the PER by BHI: http://nmawsa.org/ongoing-work/final-effluent-resuse-proposal-pers/grant-county-tier-ii-awsa-application/grant-county-proposal-per/view

2.2.6 Grant County Water Commission (Well Field and Pipeline)

Background

The Grant County Water Commission was formed under a Joint Powers Agreement with the State of New Mexico to create a regional water supply. It proposes to provide an additional 950 AF/Y to the Mimbres mining communities and Silver City from a well field near the regional airport (Figure 2-7). It has support from Bayard, Hurley, Santa Clara, Silver City and Grant County.

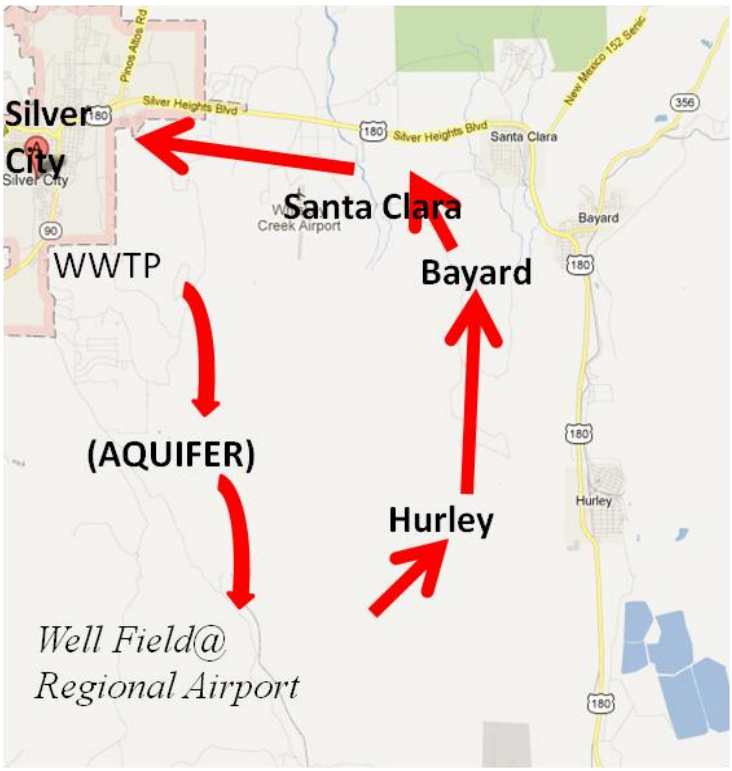


Figure 2-7: Schematic Map of GCWC Pipeline

The communities have already done a considerable amount of work toward this project, including drilling a test well, with grants from the NM Colonias Infrastructure Fund and other monies.

Silver City already owns rights to 193 AF/Y at the Grant County Airport. That water is currently undeveloped. The remainder of the water is contingent upon NM OSE approving the Silver City Application to Increase Diversion of Groundwater by 750 AF/Y that was submitted in April 2013. This application seeks a Groundwater Credit due to decades of discharging effluent to the aquifer. Regardless of the decision by the NM OSE, the 193 AF of well water could serve Hurley that currently owns no water rights.

Silver City has diversion rights for a total of 4,567 acre feet per year. Bayard has rights for 742 acre-feet per year. Santa Clara has rights totaling 515 acre-feet per year. Bayard and Santa Clara experience occasional water shortages. Silver City's wells are located near the continental divide where they can tap into the Gila River basin. The other towns are relying on the Mimbres Basin aquifer which is thinner and less productive in the north than it is near the airport.

Each town has its own infrastructure of treatment facilities, pumps and tanks, most of which is in fair to good condition. During the summer, Silver City uses treated effluent to water the golf course and some parks. Any remaining effluent is sold to a farm. However during the winter, there is no place to use or store the effluent, so it is dumped to an arroyo and allowed to soak into the aquifer.

Description

The Grant County Water Commission proposes to construct a well field and a 15-mile pipeline to provide 950 AF/Y of water to the towns of Hurley, Bayard, Santa Clara and Silver City. The ISC staff contracted with William J. Miller Engineers to perform a 10-percent appraisal level evaluation of the project.

Technical Evaluation

William J. Miller Engineers determined that the following items would achieve the goals of the proposal:

- Two new wells up to 1,500 feet deep
- Two 125-horsepower pumps
- Water treatment system
- 850,000-gallon water storage tank
- Two 100-horsepower and one 25-horsepower booster pumps
- Approximately 16.4 miles of 12" PVC pipe
- Electric power line construction
- Access road construction and site development
- Acquisition of easements and right-of-way.

While the water volume could be achieved with the 12-inch line, the proponent requested 16-inch line to allow for future growth. The original proposal contained many items not required to achieve the desired goal. William J. Miller Engineers eliminated these items during its evaluation.

Environmental Impacts

Endangered Species Act issues are not anticipated, but possible. The pipeline could cross federal property. If so, NEPA would be required.

Cultural Impacts

Archeological artifacts will probably be encountered during the construction of this project.

A breakdown of the population (2010 Census) by water system is shown in Table 2-3:

Table 2-3: breakdown of the population (2010 Census) by water system

Town	Population
Hurley, North Hurley	1,297
Bayard, Hanover	2,328
Santa Clara	1,686
Silver City, Tyrone, Pinos Altos, Arenas Valley and Rosedale	20,310

The total population of 25,624 is anticipated to grow by 35% over the next 40 years.

Water Supply

This project would allow increased access to groundwater, 950 AF/Y, for nearly 26,000 people.

Economics

The cost of the project requested is estimated at $16.4 million. Minus the grants already received, this request is for $15.8 million. Annual O&M would be $505,000.

Total proposal benefits amount to an estimated $38.6 million. Capital expenditures are estimated to be about $15.9 million, while total O&M costs add up to about $13.4 million through 2050. Total proposal costs are $29.3 million. Net benefits are about $9.4 million. The proposal has a benefit-cost ratio of 1.32:1, based on the HE economic study. This ratio is 0.87:1 in the Reclamation's economic study.

Link to the PER by William J. Miller Engineers: http://nmawsa.org/ongoing-work/final-effluent-resuse-proposal-pers/grant-county-water-commission-final-per

2.2.7 Pleasanton East-Side Ditch Company

Background

The Pleasanton East-Side Ditch Company (Pleasanton) diverts water from the San Francisco River in western Catron County (Figure 2-8). The U.S. Supreme Court *Arizona v. California* decree permits 1,003 irrigated acres in the Glenwood area, within which Pleasanton lies. The ISC's records indicate 185.35 acres irrigated from the Pleasanton ditch in 2012. The primary crop is pasture, but there are some truck crops grown.

Figure 2-8: Map showing Pleasanton, NM

Despite being the last New Mexican water user on the San Francisco River, ISC records indicate that Pleasanton does not experience water shortages. This is likely due to the agricultural return flows and tributary discharge above Pleasanton.

However, according to the proposal, infrastructure and maintenance issues on the 20,000-foot Pleasanton ditch affects water supply to users at the end of the ditch. The earthen portions and 50-year-old deteriorating concrete ditch result in unquantified conveyance losses.

Description

Pleasanton requests AWSA funds to re-line the ditch or replace it with pipe.

Technical Evaluation

The ISC staff contracted with Portage, Inc., to assess Pleasanton's proposal. Portage staff visited the ditch with its representatives and produced a preliminary engineering assessment (PEA) containing four design alternatives and cost estimates that include materials, installation, tax, and a 15 percent contingency. Though the PEA does not contain annual O&M costs, Portage assumes 5 percent of capital costs at this level of assessment.

1. Alternative 1 is priced for 17,000 feet of 30-inch HDPE pipe at $2,040,718.
2. Alternative 2 is priced for 17,000 feet of 36-inch HDPE pipe at $2,661,806.
3. Alternative 3 is priced for 17,000 feet of 36-inch corrugated metal pipe at $1,830,656.
4. Alternative 4 is priced for 13,500 feet of 36-inch HDPE pipe and 3,500 feet of concrete liner at $2,536,236. This alternative is preferred by at least some ditch members, as they prefer the aesthetics of a more traditional *acequia* through the residential part of Pleasanton.

Environmental Impacts
The ISC staff also contracted with Portage to assess the potential environmental impacts of Pleasanton's proposal. Portage looked at the "human environment." Thus, impacts to cultural resources and socioeconomics are included in the environmental evaluation.

Portage evaluated nine resource areas under "No Action" and "Proposed Action" scenarios. Those nine resource areas are as follows: land use; geologic environment/soils; water resources; ecological resources; historical and cultural resources; air quality; aesthetics; noise; and socioeconomics. Each resource area had its own evaluation criteria. Impacts were categorized as either "no impact," "less-than-significant impact," or "potentially significant impact."

Portage identified no impact or a less-than-significant impact to all resource areas should the project be constructed.

If the project is not constructed, Portage identified potentially significant impacts to water resources and socioeconomics. Portage states that "…continued decline of the system would be expected to result in continual and increasing impacts to the water users" with a resultant "measurable change of the existing socioeconomic environment."

Cultural Impacts
Cultural impacts are addressed in the "Environmental Impacts" section. One additional consideration is that *acequias* and community ditches are themselves regarded as a cultural resource and a part of New Mexico's heritage.

Water Supply
As previously stated, ISC records indicate that Pleasanton rarely, if ever, experiences water shortage. However, pipe may improve water conveyance to the most downstream water user(s) on the ditch.

Economics
The total estimated benefit of amounts to about $4.2 million through 2050. The total cost of the proposal amounts to about $5.4 million through 2050. There is a net cost of about $1.2 million. The benefit-cost ratio of this proposal is 0.78:1, based on the HE economic study. This ratio is 2.53:1 in the Reclamation's economic study.

PEA URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/preliminary-engineering-assessment-pleasanton-east-side-ditch-co/view

Environmental Assessment URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/environmental-assessments/pleasanton-east-side-ditch-co.-environmental-assessment/view

2.2.8 Southwest Regional Water Supply

Background

The City of Deming, Hidalgo County and Gila Basin Irrigation Commission have (GBIC) submitted proposals to divert and store Gila River water pursuant to the AWSA. As previously shown, the three diversion and storage components have been combined to create one integrated diversion and storage proposal called the "Southwest Regional Water Supply" (SWRWS).

The Cliff-Gila Valley irrigators' diversions at low flows may dry the Gila River for miles, resulting in intermittent reaches of the river downstream. In addition, timing and variability of flows leave farmers with an unreliable source of water and little choice for crop selection.

The river goes dry for even longer stretches above the Virden Valley, forcing the irrigators supplement surface water with groundwater.

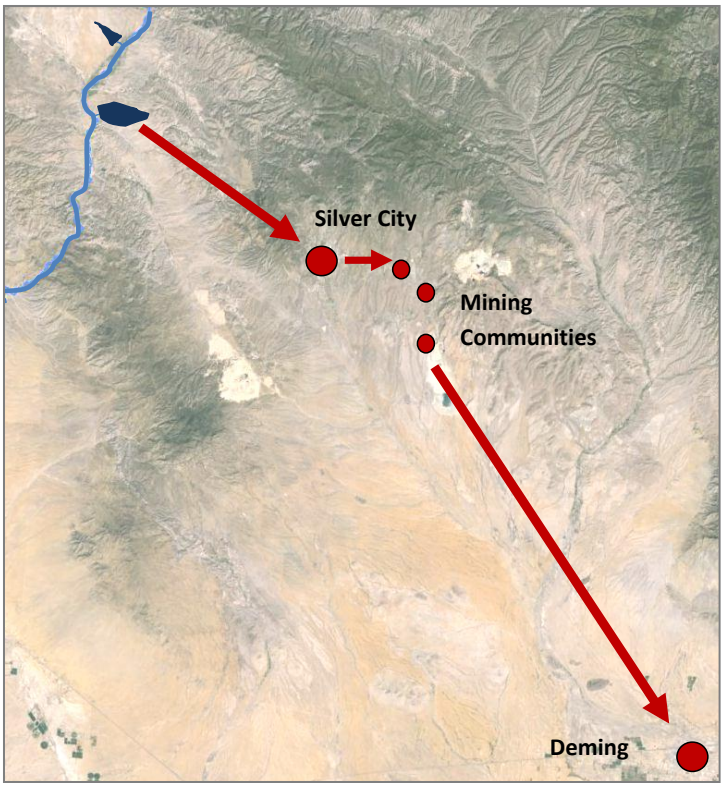


Figure 2-9: Schematic Map showing Reservoirs and SWRWS Pipeline

The Gila Basin is also a source for municipal water supply, as Silver City pumps groundwater from Frank's Well Field.

Municipalities in the Mimbres Basin, such as Deming, also rely on groundwater, though agriculture is the largest water user. Due to the demand for water, the Mimbres Basin suffers from a groundwater deficit, and water levels appear to be declining.

Description

The proposed project would divert water from the Gila River and store it in off-stream reservoirs in the Cliff-Gila and/or the Virden Valleys. The project would release water upon demand and pump it over the continental divide to the Mimbres Basin (Figure 2-9). Potential uses of this water are municipal & industrial, environmental and agricultural purposes.

Technical Evaluation

1. Phase I

The ISC staff contracted with Bohannan-Huston, Inc. (BHI), to identify the best locations for diversion and storage sites, and to design diversion structures, conveyances, and a pipeline at an appraisal (10%) level. BHI reported five diversion and storage alternatives in its Phase I preliminary engineering report (PER). Those alternatives included the following components:

- Diversion:
    - Location: From the Gila river between Turkey Creek & Mogollon Creek (Gila National Forest)
    - Method: Coanda Screens (surface diversion structure)
    - Amount: Maximum 350 cfs
- Storage:
- 6 canyons: Spar, Maldonado, Winn, Pope, Sycamore, Dix
- Conveyance:
    - Tunnel from diversion point to reservoirs by gravity
    - Buried pipes between the reservoirs by gravity
- Pumping/Pipeline:
    - Alignment: US Highway 180 right-of-way
    - 5 pump stations

2. Technical Review of Phase I

The ISC staff subsequently contracted with RJH Consultants, Inc., to conduct an independent review of BHI's Phase I PER in order to identify any significant technical issues and provide recommendations for improvements. RJH indicated that BHI had applied an appropriate level of investigation, data collection, and analyses for the appraisal level. However, RJH also indicated that major issues such as water yield, storage site geology, and sedimentation were inadequately addressed and could create significant challenges. RJH recommended the issues be addressed in a future phase of study.

3. Phase II

The ISC contracted Bohannan-Huston, Inc. (BHI) to perform Phase II Engineering Evaluation of the SWRWS proposal, still at an appraisal (10%) level. The scope of work included:

- ✓ geomorphologic investigation and bathymetric survey of the potential diversion site
- ✓ geophysical and geotechnical samplings of potential reservoir sites
- ✓ evaluation of pumping options
- ✓ evaluation of energy options (solar)
- ✓ engineering analyses and cost estimates
- ✓ evaluation of diversion and storage in Virden Valley (Hidalgo County)

The consultant came up with three new alternatives for diversion and storage in their preliminary engineering report (PER), all of which met the project objectives. Those alternatives included the following components:

- Diversion:
  - Surface diversion:
    - Location: Upstream the confluence of Brock Canyon: BHI identified a new location for a diversion structure, which more stable vertically and laterally, In addition, there is easy access to the site from Turkey Creek Road. This site also avoids existing mitigation areas.
    - Method: Coanda Screens (200 cfs)
  - Subsurface diversion:
    - Location: downstream of Turkey Creek
    - Method: Infiltration Galleries (150 cfs)
- Storage:
  - 4 canyons: Spar, Winn, Pope, Sycamore
  - Method: Earthen dam lined with HDPE liner and clay subgrade layer to control seepage
- Conveyance:
  - Tunnel from diversion location to Spar by gravity, or buried pipes from mouth of Spar to Spar by pumping
  - Buried pipes from Spar to other reservoirs by gravity
- Delivery:
  - Release water for environmental use by gravity (from Spar)
  - Release/Pump back water for agricultural use (from Winn)
  - Pump water over the Divide along Hwy 180 for Municipal and Industrial (M&I) and recreational uses (from Pope)
    - Alignment: Highway 180 right-of-way
    - 5 pump stations with PNM power extension
    - Feeds Grount County Resrvoir
- Power Generation (Contingent upon agreement with PNM):
  - Solar Arrays
    - Interconnected to PNM grid for SWRWS pump stations
    - Winn Pump Station
  - Hydro-Turbines:
    - Recommended for SWRWS pipeline to Deming

As mentioned above, BHI also looked at the option of a diversion and storage project in the Virden Valley, and developed five alternatives. The major finding was that cost per AF for those alternatives was 5 -10 times the cost per AF of the Alternative 1 for Cliff-Gila, due to significant increase in tunnel length, and reduction in project storage volume from 65,000 AF to 6,000 AF.

4. Bureau of Reclamation's Evaluation

The ISC entered into a Memorandum of Understanding (MOU) dated May 7, 2013 with the Bureau of Reclamation (Reclamation) to collaboratively develop technical information to assist in New Mexico's decision-making process for the Arizona Water Settlements Act (AWSA). This work effort included an engineering assessment of the three diversion proposals (GBIC, Hidalgo & Deming), and identification of other potential diversion and storage configuration alternatives, as well as estimating the construction and O&M costs.

The engineering assessment of the three diversion proposals was completed to identify data gaps and provide a more complete and consistent description to evaluate along with other potential diversion and storage configuration options developed by Reclamation for the ISC's consideration. The configurations Reclamation identified consist of 4 diversion sites along the Gila River and 24 canyon storage sites, of which Reclamation analyzed 8 alternatives more in-depth. Alternatives range from over 1,000 to 62,000 AF of storage and $41 to $598 million in construction costs. Operation, maintenance and replacement costs were also calculated for each diversion proposal and alternative.

5. Value Engineering Study

The ISC contracted with RJH Consultants, Inc. (contractor) and Solutions Engineering & Facilitating, Inc. (subcontractor) to conduct a Value Engineering (VE) study for the SWRWS proposal. The objectives were to:

- ✓ Review AWSA water availability
  - Review ISC's AWSA diversion model with drought flow reductions
  - Provide a range for annual firm yield with climate change scenario
- ✓ Review BHI and Reclamation appraisal-level designs
  - Suggest improvements
  - Suggest additional approaches or concepts
  - Recommend any alternative concepts
- ✓ Identify preferred configuration of components
- ✓ Recommend further studies and investigations

The VE Team consisted of eight senior technical specialists plus a senior value engineering specialist/facilitator. The technical specialties included: constructability and costing; hydraulic structures and conveyance; environmental permitting; geomorphology & sediment transport; dams, reservoirs & geotechnical engineering; electrical; tunneling; hydrology, water modeling & yield; and value engineering and life-cycle costing. The VE workshop was held in Denver, CO. A summary of findings of the VE study is presented below.

<u>AWSA Water Availability and Yield: See text under "Water Supply".</u>

<u>Preferred Configuration of Components (diversion, sedimentation, conveyance, storage/reservoirs, and distribution/delivery)</u>

- Use two diversion structures:
  - Coanda screens, expanding across the erosion area within the floodplain
  - Infiltration galleries or passive intake screens
  - Use BHI's recommended diversion point
- Use two reservoirs with capacity at least in the 45,000 AF range:
  - Small Spar Reservoir (as proposed by BHI)
  - Replace Winn, Pope, and Sycamore Reservoirs with:
    - A larger Spar Reservoir with a pump station (46,000 AF), or
    - Greenwood Reservoir with a pipeline to the Upper Gila Valley (47,000 AF)
- Reduce or eliminate the canyon sediment traps
- Conveyance:
  - From diversion point to small Spar Reservoir:
    - Tunnel or
    - Steel buried pipe
- Delivery Over the Continental Divide:
  - Route:
    - Via Tyrone mine (establish a cooperative agreement with Freeport McMoran), or
    - Via Twin Sisters Canyon (Grant County Reservoir) along US Highway 180
  - Reduce the number of pump stations
  - Use hydro-generation as proposed by BHI

Next Steps and Suggested Further Studies

- Develop a definitive and concise purpose and need statement
- Conduct the following investigations:
  - Integrated simulation of water supply and key system operations elements (timing, amount, etc)
  - detailed hydraulic modeling of the diversion structures
  - detailed assessment of climate change
- Refine the major components' configurations and sizing
- Perform additional geotechnical investigations for selected sites
- Revisit the dam design and reservoir seepage design

Final Conclusions

- The VE Team believes the overall concept of diversion and storage is technically feasible.
- The VE Team feels permitting will be prolonged and challenging.
- Reusable return flows and tributary runoffs should be recaptured and/or exchanged.

Environmental Impacts

The AWSA requires that a New Mexico Unit be evaluated in accordance with the National Environmental Policy Act (NEPA). However, for the ISC proposal review and selection process, it was necessary to gain an understanding of potential effects on the environment. Thus, a suite of environmental and ecological studies were ordered by staff.

It should be noted that the ISC staff applied a minimum bypass of 150 cfs (double the median flow) before any diversion would take place.

Based upon the historical flow record, legal constraints, and the aforementioned bypass, the the project would divert on only 10 percent of days, 7 percent of flows, from the highest 17 percent of flows.

- **Hydrology and Geomorphology**

The diversions would result in short-term local decreases in groundwater gains of 1/4 to one foot during stream-losing conditions, according to the groundwater-surface water model developed for AWSA project evaluation.

Diversions through BHI's proposed structure would lower water surface elevations from the structure to approximately 1,600 feet upstream by 0.5 to one foot, depending upon river discharge. The diversion structure would have relatively minor effects on sediment transport within the project reach.

- **Fish Habitat Simulations**

The ISC staff contracted for two fish habitat studies. The first used a 1-D habitat model (PHABSIM) to examine two reaches below existing diversions in the Cliff-Gila Valley, i.e., the reaches both have existing hydrologic alteration. The study concluded that AWSA diversions would result in a range of ±5 percent habitat change for fish species in their variant life stages. The endangered Spikedace and Loach Minnow would experience up to 3 percent increase in habitat.

The study also indicated that upon releasing 10 cfs as an environmental flow augmentation back to the river, there would be up to 11% habitat increase for all fish species.

The second study used a 2-D habitat model (River2D) to examine four reaches: two hydrologically unaltered and two altered. One of the unaltered sites is located in the vicinity of the BHI's proposed diversion structure in Phase II.

For the hydrologically unaltered sites, the study concluded that AWSA diversions would result in native species' habitat changes ranging from 0.5 percent decreases to 4.9 percent increases. For non-native species, the habitat changes ranged from 0.2 percent decreases to 2.5 percent increases.

For the altered sites, i.e., downstream of existing diversions, the AWSA diversion would result in habitat changes for native species from 2 percent decreases to 10 percent increases. The results for non-natives indicate a range of 3.6 percent decrease to 2.3 percent increase, with slight decreases in habitat availability for many species.

The study also found that, in general, augmentation or environmental releases would increase native species' habitat availability while reducing that of non-natives.

- **Benthic Macroinvertebrate Modeling**

The fish habitat simulations do not account for the availability of food. Thus, the ISC staff contracted for benthic macroinvertebrate biomass modeling in order to quantify the effects of existing Gila River water uses on aquatic insects and to evaluate the effects of flow augmentation. Generally, the summer river drying is detrimental to the aqautic insect community, and there is a lag in recovery. Augmentation flows would prevent steep declines in aquatic insect populations.

- **Biological Survey of Potential Reservoir Sites**

The reconnaissance identifed no species or habitats that could not be mitigated. Furthermore, there will be no AWSA diversion or storage either in the Gila Wilderness or the Bird Area.

Cultural Impacts
No "show stoppers" were identified through a desktop archeological survey. Further field archeological surveys and social studies would be required if the project goes forward. Access to public lands would not be impaired.

Water Supply
Based on the ISC's AWSA diversion model and historical discharge, the project's permissible annual average diversions would be approximately 12,000 acre-feet. Under a drought reduction of approximately 10 percent in stream flow by 2050, there will be only 2.6% reduction in AWSA diversions. Using the Nature Conservancy's drought projections of a reduction of 15% in median flows and a 6% reduction in mean flows, the long-term reduction in divertible AWSA flows is 3%.

AWSA water availability and yield was a topic of investigation by the VE team. They concluded that the ISC diversion model provides reasonable estimates of divertible flow for historical conditions. The ISC estimates of divertible flow under a climate change scenario are also reasonable for reconnaissance level planning purposes.

The VE team also indicated that the amount of water that can be delivered from the Project will substantially increase if the reservoir is not operated on a strict "firm yield" basis. About 8,000 to 9,000 acre feet of water can be delivered from a reservoir on an average annual basis, depending upon the capacity of storage that is constructed. The above yield estimates are preliminary, reconnaissance level estimates for VE purposes only, and there could be reductions in yield due to various permitting and operational requirements. The development of an integrated water supply and operations model was recommended to refine the estimates of divertible flow and Project water yield.

Economics
The total cost of the proposal amounts to about $528.9M through 2050, including capital expenditures, annual O&M expenditures, and annual pre-banking costs. Net benefits amount to about $760.9 million. All benefits and costs have been discounted back to 2013 present value dollars. The benefit-cost ratio of the proposal is 1.44:1 in the HE economic study.

Link to Phase I,Technical Review, Phase II, and VE study: http://nmawsa.org/ongoing-work/diversion-and-storage-proposals

Link to Reclamation's report: http://nmawsa.org/ongoing-work/united-states-bureau-of-reclamation/appraisal-level-report-on-the-awsa-tier-2-proposals-and-other-diversion-storage-configurations-july-2014/view

2.2.9 Sunset Canal & New Mexico New Model Canal

Background

The Sunset Canal and the New Mexico New Model Canal divert water from the Gila River near Virden in northwestern Hidalgo County (Figure 2-10). The ditches serve irrigators in Virden before crossing the border to serve water users in Arizona. Water in the canals is administered by the Gila Water Commissioner in Safford, Arizona, in accordance with the U.S. District Court of Arizona *Globe Equity No. 59* decree (1935). The Sunset Canal serves 2,236 acres in New Mexico; New Model serves 315 acres. Corn, cotton, and small grains are the predominate crops.

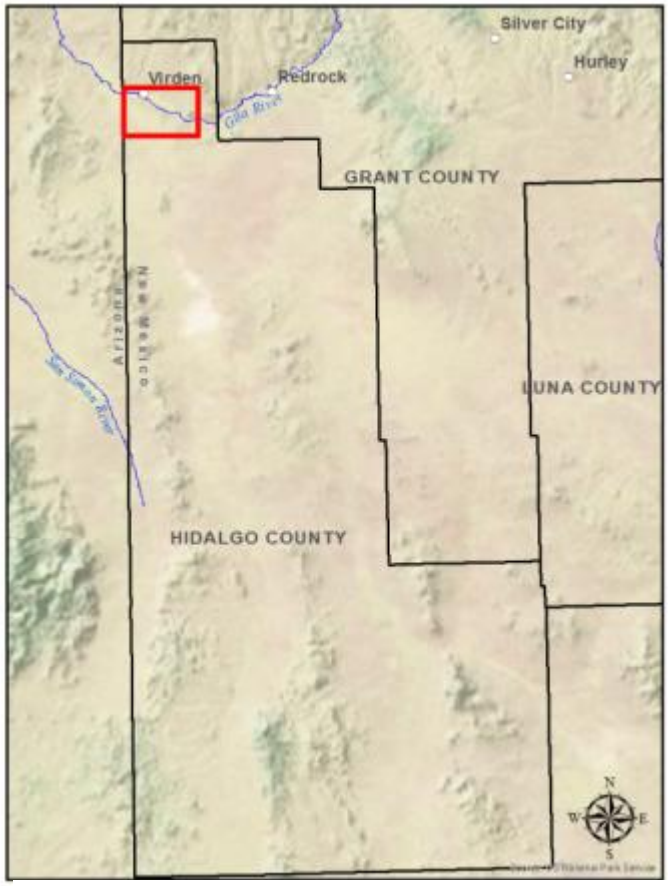


Figure 2-10: Map showing Virden, NM

Description

Sunset and New Model Canals propose to line the canals with pipe, install plug valves on farm turnouts, and meter the farm turnouts. The goals are to reduce conveyance and to better monitor water distribution to users.

Technical Evaluation

The ISC staff contracted with Portage, Inc., to visit the ditches with ditch representatives and produce a preliminary engineering assessment (PEA) with design alternatives and cost estimates. The cost estimates include materials, installation, tax, and a 15 percent contingency. Though the PEA does not estimate annual O&M costs; Portage assumes 5 percent of capital costs at this level of assessment.

- **Sunset Canal**

Portage produced two alternatives for the Sunset Canal. The first alternative consists of a 27,800 feet of 42-inch HDPE pipe above Virden and 22,000 feet of 36-inch HDPE pipe below Virden, as well as other infrastructure. The cost estimate for Alternative 1 is $9,110,125.

The second alternative consists of a 27,800 feet of 48-inch HDPE pipe above town and 22,000 feet of 42-inch HDPE pipe below town, as well as other infrastructure. The cost estimate for Alternative 2 is $11,305,945.

- **New Mexico New Model Canal**

Portage also produced two alternatives for the New Model Canal. The first alternative consists of a 24,000 feet of 36-inch HDPE pipe and other infrastructure. The cost estimate for Alternative 1 is $3,792,518.

The second alternative consists of a 24,000 feet of 42-inch HDPE pipe and other infrastructure. The cost estimate for Alternative 2 is $4,777,488.

Environmental Impacts
Portage, Inc., also assessed the potential environmental impacts of the Sunset and New Model proposal. Since Portage looked at the "human environment," impacts to cultural resources and socioeconomics are included in the environmental evaluation.

Portage evaluated nine resource areas under "No Action" and "Proposed Action" scenarios. Those nine resource areas are land use; geologic environment/soils; water resources; ecological resources; historical and cultural resources; air quality; aesthetics; noise; and socioeconomics. Each resource area had its own evaluation criteria. Impacts were categorized as either "no impact," "less-than-significant impact," or "potentially significant impact."

Portage identified no impact or a less-than-significant impact to all resource areas should the project be constructed.

If the project is not constructed, Portage identified potentially significant impacts to water resources and socioeconomics. Portage states that "…continued decline of the system would be expected to result in increasing impacts to the water users" with a resultant "measurable change of the existing socioeconomic environment."

Cultural Impacts
Cultural impacts are addressed in the "Environmental Impacts" section. One additional consideration is that *acequias* and community ditches are themselves regarded as a cultural resource and a part of New Mexico's heritage.

Water Supply
Irrigators on the two canals typically suffer from surface water shortages during the summer months, when the Gila River can go dry. Under such circumstances, most farmers resort to pumping supplemental wells.

Sunset Canal infrastructure includes approximately 54,000 feet of unlined canal. New Model Canal infrastructure includes approximately 24,000 feet of concrete-lined or unlined canal. Water users' full allocation is six acre-feet per acre.

While the proposed project would increase the overall system efficiency, without a storage component it would not alleviate the summer reliance on supplemental wells.

Economics
The total estimated benefit of the proposal is about $18.9 million through 2050. Between capital expenditures and annual O&M expenditures, the total cost is approximately $28.6 million through 2050, resulting in a net cost of about $9.7 million. The benefit-cost ratio of this proposal is 0.66:1, based on the HE economic study. This ratio is 2.15:1 in the Reclamation's economic study.

Sunset Canal PEA URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/preliminary-engineering-assessment-sunset-canal/view

Environmental Assessment URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/environmental-assessments/sunset-canal-environmental-assessment/view

New Model Canal PEA URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/preliminary-engineering-assessment-nm-new-model-canal-1-10-2014/view

Environmental Assessment URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/environmental-assessments/new-mexico-new-model-canal-environmental-assessment/view

2.2.10 1892 Luna Irrigation Ditch Association

Background

The 1892 Luna Irrigation Ditch Association (Luna or Association) diverts water from the San Francisco River in western Catron County (Figure 2-11). The U.S. Supreme Court *Arizona v. California* decree permits 225 irrigated acres in the Luna area, which includes land on tributary streams. The Association has storage rights in Luna Lake, Arizona, and a water bank established pursuant to NMSA 1978, § 73-2-55.1. The ISC's records indicate 188.5 irrigated acres in the Luna area in 2012. Of that, 26.94 acres were irrigated from the North Side Ditch. The primary crop is unimproved pasture.

Figure 2-11: Map showing Luna, NM

Description

Luna requests $1,363,000 in AWSA funds over five years for construction of permanent diversion structures for four ditches and replacement of earthen ditches with closed pipe. This figure does not include National Environmental Policy Act ("NEPA") costs. (The point of diversion is located on U.S. Forest Service land.) Luna estimates annual operations and maintenance ("O&M") costs of $17,500, which includes $15,000 worth of donated time and equipment from Association members.

Technical Evaluation

The ISC staff contracted with Portage, Inc., to assess Luna's proposal. Portage staff visited the Luna North Side Ditch with a representative of the Association and produced a preliminary engineering assessment (PEA) containing two design alternatives and cost estimates that include materials, installation, tax, and a 15 percent contingency. Though the PEA does not contain annual O&M costs, Portage assumes 5 percent of capital costs at this level of assessment.

The first alternative consists of a weir, headgate structure, cleanout structure, and 24-inch diameter dual-wall high-density polyethylene (HDPE) pipe. Portage provided costs only

for HDPE, as its strength, flexiblity, imperviousness to corrosion, and weight make it a preferred alternative to other pipe material. The cost estimate for Alternative 1 is $1,363,713.

The second alternative consists of a subsurface infiltration gallery and 24-inch diameter HDPE pipe. The cost estimate for Alternative 2 is $1,365,348.

The infiltration gallery may be less prone to flood damage, provided that it is constructed below the river's scour level. The challenge would be to construct it at an elevation adequate to deliver water into the ditch.

Environmental Impacts
Portage also assessed the potential environmental impacts of Luna's proposal. Portage looked at the "human environment," and impacts to cultural resources and socioeconomics are included in the environmental evaluation.

Portage evaluated nine resource areas under "No Action" and "Proposed Action" scenarios. Those nine resource areas are as follows: land use; geologic environment/soils; water resources; ecological resources; historical and cultural resources; air quality; aesthetics; noise; and socioeconomics. Each resource area had its own evaluation criteria. Impacts were categorized as either "no impact," "less-than-significant impact," or "potentially significant impact."

Portage identified no impact or a less-than-significant impact to all resource areas should the project be constructed.

If the project is not constructed, Portage identified potentially significant impacts to water resources and socioeconomics. Portage states that "…continued decline of the system would be expected to result in continual and increasing impacts to the water users" with a resultant "measurable change of the existing socioeconomic environment."

Cultural Impacts
Cultural impacts are addressed in the "Environmental Impacts" section. One additional consideration is that *acequias* and community ditches are themselves regarded as a cultural resource and a part of New Mexico's heritage.

Water Supply
Due to storage, water banking, and low demand from non-resident landowners, physical water supply has not been an issue in Luna.

However, infrastructure and maintenance issues on the Luna ditches affect water supply. First, floods on the San Francisco River destroy the temporary earthen diversion dam, resulting in cut-off of the irrigation supply until the dam can be reconstructed. Secondly, the earthen and concrete-lined ditches fill with sediment after floods, and they are prone to erosion and/or washout. Finally, the ditches suffer unquantified conveyance losses.

Economics
The total estimated benefits equal about $2.4 million through 2050. Between capital expenditures and annual O&M expenditures, the total cost amounts to about $3.2 million, with a resultant net cost of about $0.8 million. The benefit-cost ratio of this proposal is 0.76:1, based on the HE economic study. This ratio is 0.84:1 in the Reclamation's economic study.

PEA URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/preliminary-engineering-assessment-1892-luna-irrigation-ditch/view

Environmental Assessment URL: http://nmawsa.org/ongoing-work/ditch-improvement-assessments/environmental-assessments/1892-luna-irrigation-ditch-environmental-assessment/view

2.2.11 Watershed Restoration Proposals

Background
Stakeholders proposed five separate watershed restoration projects. Three are academic studies and two are utilitarian operations. Figure 2-12 shows the locations of those proposals.

Description
NM State University requested $2.2 million for a 10-year nested watershed study treating 2.3 square miles.

NM Forest Industries Association requested $2.3 million for a 10-year paired watershed study treating two square miles.

Grant County Soil & Water Conservation District requested $1.2 million for a 10-year paired watershed study treating 6.3 square miles.

Catron County requested $7 million for evaluation, planning, designing and implementing mitigation after fire damage over 800 square miles. The mitigation would include rehabilitation and thinning, possibly with monitoring, but no specific plan was submitted.

The US Forest Service (Gila National Forest) requested $8.4 million over 10 years to rehabilitate 50 square miles of post-fire damage and thin another 105 square miles using Forest Service standard fire prevention methods, which do not measure the effects of the treatment.

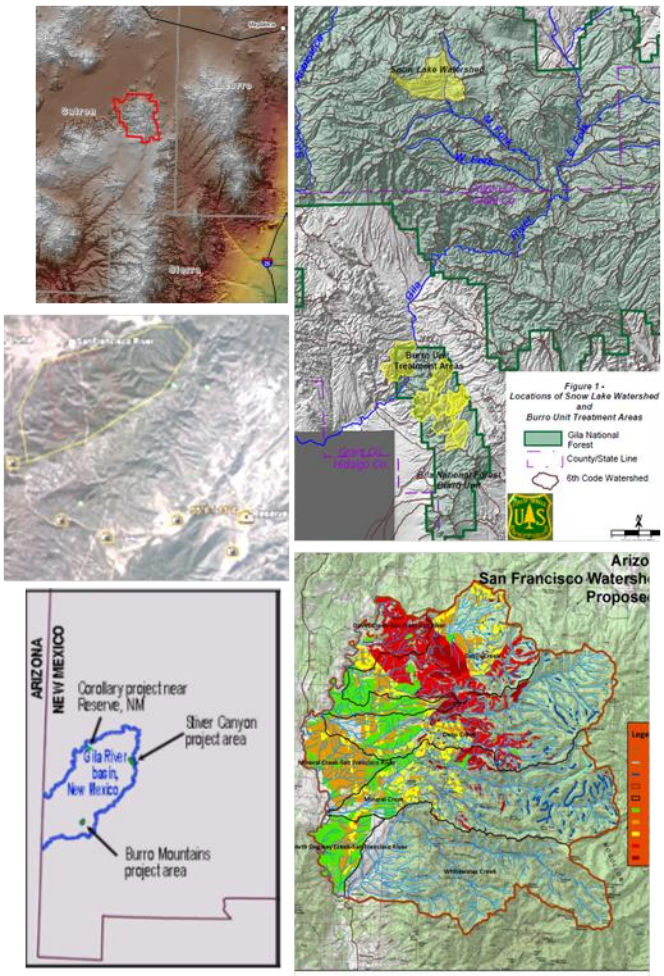


Figure 2

Technical Evaluation
As ISC staff researched the science behind the proposals, considerable disagreement regarding a number of questions surfaced. In an effort to find some foundation for consensus and direction regarding the proposals, staff convened a work group of eight respected watershed scientists and managers. There was no discussion of actual proposals during the meeting. Each participant presented his/her own recent work or study. At the end of the day, there was no consensus regarding whether to thin a forest for water yield,

how to thin a forest, why to thin a forest, whether to extract natural resources from the forest for profit, or how to reliably monitor and estimate the water yield of forest thinning.

The US Forest Service, along with the NM Energy, Minerals and Natural Resources Department, maintains that forest thinning aids with fire prevention, improves wildlife habitat, improves forest health, and generally improves watershed function. They believe that thinning may increase water yield, but that yields are difficult to measure and highly dependent on the elevation and climate of the forest. Other reasons for thinning a forest include acquiring wood for lumber or improving grassland for livestock.

The US Forest Service representative who attended the ISC workgroup cited the "Fool Creek Study" which took place near Denver, Colorado and lasted nearly 60 years. He summarized thus:

- Water yield increases only when forests are thinned at very high elevations when there is a great deal of snowfall.
- The thinning must be maintained.

The methods for measuring the effects of thinning were discussed at length by each presenter. Other scientists discussed ET towers, chlorine mass balance comparisons, soil moisture gauges, remote sensing (satellite imagery), comparing areas of burn scars after large fires and measuring the dry weight of grasses that grow. One presenter mentioned pounding rods into the ground all over his test site to measure the depth to rock so he would have an idea of how much moisture the soil could hold. All of the presenters discussed the damage done to equipment by bears, elk, fire, floods and other natural hazards.

Outside of the work group, there is more commentary on the topic. E.g., the *2003 Jemez y Sangre Water Plan, State of New Mexico*, "Appendix F" addresses the question of whether water yield will increase after forest thinning and concludes:

- Little to no water yield increases can be expected in areas where annual precipitation is less than about 18-20 inches (e.g., piñon–juniper forest).
- Water yield increases would be least in dry years, when they are most needed.
- The smallest potential for increasing water yield is in a ponderosa pine forest.
- Prescribed burns are designed to remove only the brush, not to kill the large overstory trees. Therefore, they are not likely to cause an increase in water yields.
- Thinning a piñon-juniper forest might slow run-off, making it more useable, but not actually increase the water yield.

All discussions of forest thinning as a means to increasing water yield are permeated by the issue of longevity. In order for any increased water yield to last, the treatments must be maintained. Therefore, the cost of maintenance should be included in the initial cost estimates.

Three AWSA watershed proposals "thinning for water yield" are academic in nature, and, thus, they are more costly per acre than simply thinning without study. This raised the

question, "If you are certain that there will be water yield increase, why go to the expense of studying it? Why not use the money to thin a larger area?" This question was posed to EMNRD foresters and AWSA project proponents outside of the work group. The response was that the studies upon which the anticipated yields were based were many miles away, and the results from any approach are highly site specific.

Environmental Impacts
As each proposal is in a different area, the environmental issues and NEPA requirements vary. The Gila National Forest proposal has already completed NEPA.

Cultural Impacts
Each of the proposals would probably encounter archeological sites, and, therefore, a cultural resources survey would be required.

Water Supply
See discussion above.

Economics
Due to the vast uncertainty of project water yield and other aspects of the proposals, benefits cannot be quantified. However, Reclamation evaluated the benefits and costs for two *final* watershed proposals: NMFIA and NMSU proposals. The benefit-cost ratio is 0.3:1 for the NMFIA proposal, and 0.79:1 for NMSU proposal. These ratios were based solely on the proponents' predictions.

Link to the Watershed Workgroup notes: http://nmawsa.org/ongoing-work/watershed-restoration-research/watershed-workgroup-notes-april-4-2014/view

CHAPTER 3 PROPOSAL MATRIX EVALUATIONS

3.1 Introduction

The stakeholder proposals for use of AWSA water and/or funds vary greatly in quantity of water, effort to construct, cost, and number of beneficiaries. In addition, they vary greatly in scope and intent. Because of the great differences in type, costs, complexity, and purpose, the 15 stakeholder proposals accepted by the Commission for further evaluation and assessment present unique challenges in evaluation.

In order to compare such a disparate set of proposals, ISC staff investigated a number of decision matrices. A decision matrix is a chart that allows an analyst to systematically identify, analyze and rate the strengths of relationships between sets of information. Decision matrices are especially useful for looking at large numbers of alternatives, each with a large number of decision factors, and for assessing each factor's relative importance. The goal was to find an objective method of evaluating the proposals.

The evaluation methods used were:

1. Choosing by Advantages ("CBA")
2. Modified CBA method ("CBA as modified by ISC")
3. Multiple Criteria Decision Making method
4. Gila San Francisco Water Commission ranking.

The AWSA requires that the ISC consult with the Southwest New Mexico Water Study Group or its successor in determining expenditures from the New Mexico Unit Fund for a New Mexico Unit or other water utilization alternatives (Pub. L. 108-451 § 212 (i)). The Gila-San Francisco Water Commission is the successor to the Southwest New Mexico Water Study Group.

Stakeholders proposed five separate watershed restoration projects. Three are academic studies and two are utilitarian operations. However, from research in the literature and results of a workshop attended by eight watershed experts (pg. 47-48 above), it is not possible to reliably quantify the water increase, if any exists, from thinning trees. The best estimates for water yield in the Gila from tree thinning are very little gain to some loss. Even if water yield does increase, the delivery of the extra water to an end user is neither defined nor certain. Because the yield and use for the water cannot be quantified, watershed proposals cannot be included in matrices that require that data.

There are many good reasons to thin a forest, e.g., fire prevention, wildlife habitat improvement, biodiversity, and livestock grazing improvement. While they have not been included in the evaluation methods listed above, watershed improvement projects have not been excluded from consideration for funding.

Along with the above methods, there were two benefit-cost analyses performed. The ISC staff also ranked the proposals based on the benefit-cost ratios that resulted from these studies. The discussion and the findings are presented in Section 3.6.

3.2 Choosing By Advantages (CBA)

3.2.1 Background

Choosing By Advantages, or CBA, is a system of determining the best decision by looking at the importance of advantages of each alternative. The CBA method was developed by Jim Suhr when he worked for the U.S. Forest Service, and it has been used by agencies such as the U.S. Forest Service and the U.S. National Parks Service.

3.2.2 Matrix Elements

In order for the proposed projects to be included in the matrix, the ISC Gila staff of the Special Projects Bureau established initial criteria:

- The proposal had to comply with the AWSA and any other applicable law.
- The proposal had to be reasonably expected to yield or conserve water.

The five watershed proposals were not included in the matrix due to the uncertainty of whether or not they yield water.

The first step in constructing the CBA matrix was to select the factors. Factors are the elements or components of a decision, and they contain criteria, attributes, and advantages. The factors selected by the ISC Gila staff are:

- Water Supply
- Interests Served
- People Served
- Environmental Impacts
- Technical Challenges
- Timing of Implementation
- Complements Regional Water Plan Objectives

When determining which factors to include, the ISC staff considered the following criteria:

- ISC Gila Policy
- Applicability of the factor to all AWSA project proposals
- Availability of data

The staff ruled out factors that were:

- Qualitative or not measurable
- Double counted

After selecting factors, the staff assigned attributes. An attribute is a characteristic of one alternative. Attributes were assigned by the ISC staff based upon the descriptions in Table 3-1.

Table 3-1: List of CBA matrix factors and attributes.

FACTOR	ATTRIBUTE	TARGET
Water Supply	Average annual yield of project (acre-feet per year)	Greatest average annual yield
Interests Served	Serves municipal & industrial, agricultural, outdoor recreational, and environmental interests	Greatest number of interests
People Served	Number of people served	Greatest number of people served
Environmental Impacts	Magnitude of effects on the general environment of SW NM (±10); riparian habitat (±10); Gila/San Francisco Rivers (±10); tributaries (±10); and endangered species (±20)	Greatest positive effects
Technical Challenges	Difficulty of design and construction (10-50)	Least challenging to design and construct
Timing of Implementation	Year project online	Least amount of time to implement project
Complements Regional Water Plan Objectives	Priority for implementation as assigned by the Regional Water Plan: (5) Priority alternative with Implementation Priority 1; (4) Priority alternative with Implementation Priority 2; (3) Priority alternative with Implementation Priority 3; (2) Non-priority alternative with Implementation priority 1; (1) Non-priority alternative with Implementation priority of 2 or 3; (0) Not listed. If meeting more than one, numbers are added.	Priority alternative with implementation priority 1. Greatest total score

After populating the attributes, the advantages of each proposal were calculated. An advantage is a favorable difference in quality or quantity of an attribute of one proposal compared to another.

The lowest scoring attribute for each factor, displayed in red font, has no advantage. The attributes of every other proposal are calculated by taking the difference between their scores and the lowest attribute score.

3.2.3 Importance

After calculating the advantages, importance, or intensity of preference, is assigned. The ISC staff compared the greatest advantages in each factor in order to assign the values. It was determined that the Southwest Regional Water Supply System's (SWRWS) advantage in water supply of 7,950 acre-feet was of paramount importance, so this advantage was assigned an importance of 100. All other top advantages were assigned importance values of less than 100.

The other advantages within each factor were then weighed on the same scale of importance as the top advantage. For example, the Sunset/New Model water yield importance was determined as follows:

$$Importance_{\text{Sunset}} = \frac{advantage_{\text{Sunset}}}{advantage_{\text{SWRWS}}} \times 100$$

Or

$$23 = \frac{1803}{7950} \times 100$$

The proposals are shown in order of greatest importance score in Table 3-2.

Table 3-2: Proposals listed in order of importance score.

PROPOSAL	IMPORTANCE
Southwest Regional Water Supply System	336
Gila Conservation Coalition (conservation fund)	221
San Francisco Watershed Restoration (ditches)	144
Grant County Reservoir	138
Deming Effluent-Reuse	90
Gila Basin Irrigation Commission (diversion structure)	84
Grant County Water Commission Well Field & Pipeline	61
Sunset & NM New Model Canals	60
1892 Luna Irrigation Ditch Association	57
Pleasanton East-Side Ditch (Alt. 4)	47

3.2.4 Cost

Once all of the importance scores were calculated, cost was considered. In CBA, cost is a special factor. For this matrix, cost is expressed in dollars per acre-foot ($/af), derived as follows:

$$Cost = \frac{\frac{capital\ cost\ (\$)}{project\ life\ (\text{years})} + O\&M\ cost\ (\$/\text{year})}{project\ yield\ \left(\frac{\text{acre-feet}}{\text{year}}\right)}$$

The proposals were placed in order of increasing cost. The incremental increases in cost were then calculated. Next, while keeping the proposals in cost order, the incremental importance was calculated. These values are shown in Table 3-3.

Table 3-3: Cost-ordered proposals with incremental costs and importance values.

PROPOSAL	COST	IMPORTANCE	INCREMENTAL COST	INCREMENTAL IMPORTANCE
Pleasanton East-Side Ditch (Alt. 4)	225	47	225	47
Gila Basin Irrigation Commission (diversion structure)	351	84	126	37
Deming Effluent-Reuse	413	90	62	6
Sunset & NM New Model Canals	487	60	74	-30
Gila Conservation Coalition (conservation fund)	544	221	57	161
San Francisco Watershed Restoration (ditches)	627	144	82	-78
Grant County Water Commission Well Field & Pipeline	926	61	300	-83
Southwest Regional Water Supply System	1,776	336	849	275
1892 Luna Irrigation Ditch Association	2,013	57	238	-279
Grant County Reservoir	7,776	138	5,763	81

In order to eliminate bias in favor of one size of project or another, the ratio of incremental importance to incremental cost was taken. These values are shown in Table 3-4.

Table 3-4: Proposals ranked by incremental cost: incremental importance ratio.

PROPOSAL	INCREMENTAL COST/INCREMENTAL IMPORTANCE
Gila Conservation Coalition (conservation fund)	2.82
Southwest Regional Water Supply System	0.32
Gila Basin Irrigation Commission (diversion structure)	0.29
Pleasanton East-Side Ditch (Alt. 4)	0.21
Deming Effluent-Reuse	0.09
Grant County Reservoir	0.01
Grant County Water Commission Well Field & Pipeline	-0.28
Sunset & NM New Model Canals	-0.40
San Francisco Watershed Restoration (ditches)	-0.95
1892 Luna Irrigation Ditch Association	-1.17

The complete CBA matrix is shown as Table 3-5 on the following page.

Table 3-5: CBA Matrix

	1-Water Supply			2-Interests Served			3-People Served			4-Environmental Impacts			5-Technical Challenges			6-Timing of Implementation			7 - Complements Regional Water Plan Objectives			
	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	**Importance Score Sum**
PROPOSAL	Average annual yield of project (acre-feet/year)	Target: Greatest average annual yield		Serves municipal & industrial, agricultural, outdoor recreational, and environmental interests	Target: Greatest number of interests served		Number of people served	Target: Greatest number of people served.		Magnitude of effects on the general environment of SW NM (±10); riparian habitat (±10); Gila/San Francisco Rivers (±10); tributaries (±10); and endangered species (±20)	Target: Greatest positive effects		Difficulty of Design and Construction (10-50)	Least challenging to design and contruct		Year project online	Target: Least amount of time to implement project		Priority for implementation as assigned by the Regional Water Plan: (5) Priority alternative with Implementation Priority 1; (4) Priority alternative with Implementation Priority 2; (3) Priority alternative with Implementation Priority 3; (2) Non-priority alternative with Implementation priority 1; (1) Non-priority alternative with Implementation priority of 2 or 3; (0) Not listed. If meeting more than one, numbers are added.	Target: Priority alternative with implementation priority 1/ Greatest total score		
1892 Luna Irrigation Ditch Association	50		0	1		0	158	134	0	3	3	20	40	30	17	2019	15	8	5	2	12	**57**
Grant County Water Commission Well Field & Pipeline	900	850	11	1		0	15,865	15,841	28	0		0	35	25	14	2019	15	8	3		0	**61**
Gila Basin Irrigation Commission (diversion structure)	224	174	2	2	1	25	100	76	0	3	3	20	40	30	17	2019	15	8	5	2	12	**84**
Pleasanton East-Side Ditch (Alt. 4)	844	794	10	1		0	24		0	0		0	42	32	18	2021	13	7	5	2	12	**47**
Deming Effluent-Reuse	400	350	4	2	1	25	14,855	14,831	26	0		0	45	35	20	2018	16	9	4	1	6	**90**
San Francisco Watershed Restoration (ditches)	800	750	9	1		0	194	170	0	15	15	99	38	28	16	2021	13	7	5	2	12	**144**
Gila Conservation Coalition (conservation fund)	952	902	11	1		0	42,880	42,856	75	0		0	50	40	23	2016	18	10	7	4	23	**221**
Sunset & NM New Model Canals	1,853	1,803	23	1		0	152	128	0	0		0	42	32	18	2021	13	7	5	2	12	**60**
Grant County Reservoir	60	10	0	2	1	25	54,609	54,585	95	0	0	0	32	22	13	2034		0	4	1	6	**138**
Southwest Regional Water Supply System	8,000	7,950	100	4	3	74	31,088	31,064	54	12	12	79	10		0	2034		0	8	5	29	**336**

3.3 CBA as Modified by ISC

The CBA method (discussed in Section 3.2.1) requires that the paramount importance be assigned to only one advantage. The Commission's Gila Policy, however, recognizes three critical elements: the Gila ecology, the historic and traditional uses for water, and cultures and traditions related to those uses. The Gila Policy does not mandate that the three elements have equal importance. However, many stakeholders have long considered the ISC Gila Policy requires that the three elements be given equal importance.

To reflect this interpretation of the ISC Policy, the ISC staff modified the CBA method to provide identical maximum importance values for the highest advantage in each of the three policy elements. Staff addressed cultures and traditions with the factors "interests served" and "people served." Staff split the 100 possible importance points 50 each between the two factors.

In response to a long-standing request by some stakeholders, all evaluation methods consider cost per acre foot for each proposal.. In the CBA Modified matrix, cost per acre-foot is explicitly included as a factor. The calculated cost per acre foot for each proposal is presented in Appendix 4.

The CBA as modified by ISC scoring matrix is given in Table 3-6 below. The explanation regarding the attributes of this matrix remains the same as CBA, discussed thoroughly in Appendix 2.

Table 3-6: CBA as Modified by ISC Matrix

	HISTORIC AND FUTURE DEMAND (100 Importance)			TRADITIONS AND CULTURES (100 Importance, 50 each)						GILA ECOLOGY (100 Importance)			OTHERS												
	Water Supply (Average Acre-Feet/Year)			Interests Served (10 pt.s ea for municipal/industrial, agricultural, environmental, outdoor recreational)			People Served (Number of people served)			Ecologic Impacts (-10 pt.s to +10 pt.s for riparian, upland, wildlife, stream flow, ESA species)			Technical Challenges (Difficulty of design, 0 pts for impossible to 50 pt.s not difficult Importance = 25)			Timing of Implementation (Years to operational Importance = 10)			Regional Water Plan (See note 1 below Importance = 20)			Cost per Acre-Foot (Annual capital cost plus annual OM&R per annual acre-feet for project, Importance = 80)			IMPORTANCE TOTALS:
	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	Attributes	Advantages	Importance	
Maximum Importance:	100			50			50			100			25			10			20			80			
Deming Effluent-Reuse	400	350	4	20	10	17	14855	14831	14	0	0	0	45	35	22	2018	16	9	4	1	4	413	1600	72	141
Grant County Water Commission Well Field & Pipeline	900	850	11	10	0	0	15865	15841	15	0	0	0	35	25	16	2019	15	8	3	0	0	926	1087	49	98
GCC Municipal Conservation	952	902	11	10	0	0	42880	42856	39	0	0	0	50	40	25	2016	18	10	7	4	16	544	1469	66	167
Grant County Reservoir	N/A[1]	-	-	30	20	33	54429	54405	50	0	0	0	32	22	14	2034	0	0	4	1	4	N/A[1]	-	-	101
Pleasanton East-Side Ditch (Alt. 4)	844	794	10	10	0	0	24	0	0	0	0	0	42	32	20	2021	13	7	5	2	8	225	1788	80	125
Catron Ditches	800	750	9	10	0	0	194	170	0	15	15	100	38	28	18	2021	13	7	5	2	8	627	1387	62	204
Sunset & NM New Model Canals	1853	1803	23	10	0	0	152	128	0	0	0	0	42	32	20	2021	13	7	5	2	8	487	1526	68	126
1892 Luna Irrigation Ditch Association	50	0	0	20	10	17	158	134	0	3	3	20	40	30	19	2021	13	7	5	2	8	2013	0	0	71
Southwest Regional Water Supply System	8000	7950	100	40	30	50	31088	31064	29	12	12	80	10	0	0	2034	0	0	8	5	20	1776	238	11	289
GBIC Diversion	224	174	2	20	10	17	100	76	0	4	4	27	40	30	19	2019	15	8	5	2	8	313	1701	76	157

1 - Because the Grant Reservoir produces such a low water yield, using that low number would result in all other proposals receiving virtually the same advantage and importance scores. For this reason, the Grant Reservoir was not considered for scoring in this factor.

3.4 MCDM Method

3.4.1 Background

Multi-Criteria Decision Making (MCDM) is a generic term used to encompass a broad range of analytical methods that use matrices as the basis for their conclusions. (Jakubchak, 2009) It has been used for decades as an effective decision-making tool for complex situations. The ISC staff used MCDM as one of the well-known methods to synthesize all the AWSA proposals evaluations and studies.

Each MCDM matrix has four main parts: (a) alternatives, (b) criteria, (c) weight or relative importance of each attribute and (d) scores of alternatives with respect to the criteria. (Vyas et al, 2013). In the AWSA case, alternatives are the AWSA proposals. It was also decided to use equal weights for all proposals, since there is no priority amongst the proposals. The criteria and scoring system will be discussed below.

3.4.2 MCDM Criteria

In order to be consistent with the CBA factors, ISC staff applied the same approach, discussed in Section 3.2.2, to develop criteria for the MCDM method. The criteria used in the MCDM method are listed below:

1. Technical challenges
2. Timing of implementation
3. Environmental impacts
4. Water supply (or project yield)
5. Cultures and traditions:
    a. No. of Interests served
    b. No. of people served
6. Compliance with the regional water plan
7. Economics:
    a. Capital cost per AF (over the life of the project)
    b. O&M cost per AF (over the life of the project)

The ISC staff considered cost differently for the MCDM method. In the following section, the scoring system of each criterion is described.

3.4.3 MCDM Scoring

In order to populate the MCDM matrix with scores, an identical range of 1 to 5 was adopted, with the 5 being the most desired value of an alternative under a criterion, and 1 being the least desired. It should be noted that in some instances, the score of 0 was also assigned, in case there was no value for that alternative under that specific scoring system. Table 3-7 shows the scoring system pertinent to each criterion on the following page.

Table 3-7: MCDM Criteria Scoring

Criterion		Scoring System
Technical Challenges		5: Easy to construct 4: Slightly difficult to construct 3: Moderately difficult to construct 2: Highly difficult to construct 1: Extremely difficult to construct
Timing of Implementation *(When project would come on line)*		5: Immediately 4: Within two years 3: Within five years 2: Within 10 years 1: Greater than 10 years
Environmental Impacts		5: Will benefit ecology; no mitigation required 4: Will benefit to ecology; requires some mitigation 3: Will provide no benefits to ecology; no mitigation required 2: Will provide no environmental benefits; mitigation required 1: Will provide no benefit. No mitigation possible.
Water Supply *(Acre foot per year of additional water developed or conserved)*		5: >4,000 4: 3,000 – 4,000 3: 2,000 – 3,000 2: 1,000 – 2,000 1: <1,000
Cultures & Traditions	No. of Interests served *(farming & ranching, outdoor recreation, environmental, business/industry, municipal)*	5: Will benefit all five 4: Will benefit four 3: Will benefit three 2: Will benefit two 1: Will benefit one
	No. of people served	5: Project will serve more than 12,800 people 4: Project will serve 9,600 to 12,800 people 3: Project will serve 6,400 to fewer than 9,600 people 2: Project will serve 3,200 to fewer than 6,400 people 1: Project will serve fewer than 3,200 people
Economics	Capital cost per AF (over the life of the project)	5: <$301/AF 4: 301 - 600 3: 601 - 900 2: 901 - 1200 1: >$1200/AF
	O&M cost per AF (over the life of the project)	5: <$250/AF 4: 250 - 500 3: 501 - $749 2: 750 – $999 1: $1000/AF or more
Compliance with Regional Water Plan		See Table 3-8 on next page.

Table 3-8: Regional Water Plan Priorities

Alternative [a]	Implementation Priority
Water Resource Infrastructure Development	
Divert New Mexico's Gila River Entitlement for aquifer storage and recovery	5
Store New Mexico's Gila/San Francisco River Entitlement in reservoirs	3
Treat and reuse wastewater	5
Recycle commercial and residential on-site water for nonpotable uses.	5
Desalinate water in southern basins	3
Develop additional surface water	5
Collect rainwater off structure roofs or other impervious surfaces	4
Enhance surface recharge in and along surface water courses	5
Import a large amount of water into the region	3
Water Conservation	
Implement municipal water supply conservation	5
Implement agricultural conservation measures	5
Implement industrial conservation measures	5
Water Quality	
Identify, monitor and protect groundwater and surface water vulnerable to contamination	5
Construct alternative wastewater treatment systems to replace/modify septic systems	4
Water Supply Development	
Manage watersheds to improve yield and reduce the risk of fire	5
Implement cloud seeding or other programs to increase precipitation	3
Remove non-native vegetation and revegetate with native species to reduce riparian evapotranspiration	5
Develop additional groundwater	3
Water Resources Management	
Establish a water bank	5
Establish a regional water management authority	5
Develop a border groundwater management plan	5
Develop local and/or regional groundwater management plans	5
Restrict installation of new domestic wells and/or the amount of pumpage from existing domestic wells in areas outside of the Gila	5
Petition the OSE to declare undeclared groundwater basins in the region	5
Set aside some of the captured New Mexico Gila/San Francisco River Entitlement for instream flow and environmental purposes in the Gila	1
Ensure that future growth optimizes wise use of water resources and protects local social and cultural values	1
Consider making water use in the Gila and Mimbres Basins more equitable with the rest of the region	3

Source: Table 8-20, 2005 Southwest New Mexico Regional Water Plan (Region 4), Pg. 8-174 to 8-177

Note: The priorities were reversed to assign the highest importance to 5, and lowest to 1.

Based on 2010 US census data, the total population of the four-county region was 63,228. For the sake of simplicity, a total regional population of 64,000 was assumed. Then a range of 5% to 20% of that number was assigned to scores 1 to 5, incrementally (less than 5%, 5%-10%, 10%-15%, 15%-20%, more than 20%).

Finally, the formula used to calculate the numbers for the economics criteria are as follow:

$$Capital\ Cost\ per\ AF = \frac{\frac{Capital\ Cost\ (\$)}{Life\ of\ the\ Project\ (yr)}}{Water\ Supply\ (^{AF}/_{yr})}$$

$$Annual\ O\&M\ Cost\ per\ AF = \frac{Annual\ O\&M\ Cost\ (^{\$}/_{yr})}{Water\ Supply\ (^{AF}/_{yr})}$$

The related costs and project life of all proposals are presented in Appendix 4.

Table 3-9 shows the final MCDM matrix on the following page.

Table 3-9: MCDM Matrix

PROPOSAL	Technical Challenges	Timing of Implementation	Environmental Impacts	Water Supply	Cultures & Traditions		Compliance w/ Regional water plan	Economics		Total Score
					No. of Interests Served	No. of People Served		Capital cost per AF	OM&R cost per AF	
Deming Effluent Reuse Project	4	4	3	1	2	5	5	5	5	34
Southwest Regional Water Supply System	1	1	4	5	4	5	5	1	4	30
Gila Conservation Coalition (conservation fund)	5	5	3	1	1	5	5	4	4	33
Grant County Water Commission Well Field & Pipeline	3	3	2	1	1	5	1	4	3	23
Grant County Reservoir	3	1	4	1	2	5	1	1	1	19
Gila Basin Irrigation Commission (diversion structure)	4	3	4	1	2	1	5	5	5	30
Sunset & NM New Model Canals	4	3	3	2	1	1	5	5	4	28
Pleasanton East-Side Ditch (Alt. 4)	4	3	3	1	1	1	5	5	5	28
Catron County Ditches	4	3	4	1	1	1	5	5	4	28
1892 Luna Irrigation Ditch Association	4	3	5	1	2	1	5	4	1	26

3.5 Rankings

The stakeholder proposals for use of AWSA water and/or funds vary greatly in quantity of water, effort to construct, cost, and number of beneficiaries. In addition, they vary greatly in scope and intent.

In order to compare such a disparate set of proposals, staff investigated a number of ranking and scoring methods, as presented in previous sections. The goal was to find an objective method of comparing and ranking the proposals.

The staff chose three methods for constructing decision-making matrices:

- Choosing By Advantages (CBA)
- CBA as modified by ISC
- Multiple-Criteria Decision-Making (MCDM)

Staff found that no method can be entirely objective. Each method biased some proposals over others for subjective or numerical reasons.

While these scores and rankings are informative and are meant for the Commission's consideration, the staff does not intend to base its final recommendation solely on these matrices' results. In addition, the staff will consider all data and information, qualitative and quantitative, that has been gathered from investigations, stakeholder input, and public comments over the past 10 years.

The staff will present its final recommendation to the Commission at the ISC meeting scheduled for November 14, 2014.

Table 3-10 shows the final rankings of the proposals, based on different methods. The rankings provided by the Gila-San Francisco Water Commission are also presented.

Table 3-10: Final Ranking of the AWSA Proposals for Different Methods

	MCDM	CBA (based on importance)	CBA (using cost factor)	CBA as Modified By ISC	GSFWC[1]
Municipal Conservation	2	2	1	3	8
Deming Effluent Reuse	1	5	5	5	9
Grant County Reservoir	10	4	6	8	2
SWRWS (Combined Diversion & Storage)	3	1	2	1	1
GCWC Wellfield and Pipeline	9	7	7	9	7
GBIC (Diversion Improvement Component)	3	6	3	4	-
Catron County (Ditches Component)	5	3	9	2	3
Pleasanton Ditch	5	10	4	7	6
Luna Ditch	8	9	10	10	4
Sunset/New Model Ditch	5	8	8	6	5
NMSU Watershed	Watershed proposals could not be included in the ISC's matrices because no firm estimate of water yield is available. Watershed proposals are not excluded from consideration for funding.				12
Grant SWCD Watershed					11
Gila National Watershed					
Catron County Watershed					10
NMFIA Watershed					

1 - The Gila San Francisco Water Commission ranked proposals by categories. See Appendix 5. The rankings above represent ISC staff's interpretation of overall rankings.

Note: The ranking "1" is the most favorable, while "15" is the least favorable.

3.6 Benefit-Cost Analyses

The ISC entered into a Memorandum of Understanding (MOU) with the Bureau of Reclamation (Reclamation) to develop technical information to assist in New Mexico's decision-making process for the Arizona Water Settlements Act (AWSA). One of the primary purposes of the MOU was to provide an appraisal level economic analysis of the benefits, costs and regional impacts of all the Tier-2 proposals.

The ISC also contracted with Harvey Economics (HE) to conduct an economic evaluation, provide benefit-cost (BC) analyses for all proposals, and forecast the costs and benefits to 2050.

While these benefit-cost studies will appear to the casual reader to be similar in scope and objectives, they are actually quite different. Fundamental differences in input data, assumptions, and methods are very substantial. The major differences are listed and explained below:

1. **Proposals**

Based upon the Commission's approval of optimizing some of the Tier-2 proposals (described in Chapter 2 Introduction), the HE study was narrowly focused on only the economic benefits and costs of the *final optimized* proposals, whereas the Reclamation's study was prepared as part of a broad-based evaluation of the *Tier-2* proposals:

- Reclamation looked at the three diversion and storage proposals individually (as proposed by City of Deming, GBIC, and Hidalgo County), whereas HE looked only at the combined diversion and storage proposal (known as SWRWS).
- Reclamation evaluated the GBIC diversion and storage proposal, whereas HE evaluated only the irrigation diversion component.
- Reclamation evaluated the Catron County proposal, which encompasses watershed and ditch components. HE only evaluated the ditch component.
- Reclamation did not evaluate two of the watershed proposals (GSWCD Forest Restoration & USFS Watershed Restoration) because the quantities of water saved were not provided in the proposals. HE did not evaluate any of the five watershed proposals, since their water yields, benefits, and functions were unknown.

2. **Input Data**

Reclamation performed an appraisal-level study using information from the engineering reports that were complete at the time. These included reports for the Deming Effluent Reuse, Grant County Reservoir, GCWC Wellfield and Pipeline, and the Ditch proposals. Reclamation based their study of Municipal Conservation and three Diversion and Storage proposals solely on the Tier-2 proposals, as written.

However, HE found that information initially supplied by the applicants was insufficient to perform the BC study. For example, HE scrutinized water yield and other project effects and adjusted them to reflect more accurate projections of the likely project outcome. This difference resulted in large discrepancies between HE and Reclamation in the final benefit estimates for certain proposals.

3. Methods

Due to the restrictions of an appraisal level study, Reclamation relied heavily upon a "benefit transfer" approach, basically a compilation and adoption of the assumptions from other studies. This technique is a common and acceptable method for conducting appraisal level studies, but it produces widely varying ranges of assumptions and benefit estimates.

Reclamation did a thorough job of collecting many economic studies and data to perform its analyses. Drawing upon a large number of other studies, however, poses some difficulties. Some studies may be more relevant to the AWSA BC study than others. Another issue is that the range of assumptions and benefit estimates is very broad. Under these circumstances, the selection of the point estimate for the ultimate BC analysis becomes the critical determination.

Reclamation conducted its economic analyses in accordance with the Council on Environmental Quality's Principles and Guidelines (P & G). HE's analyses followed generally accepted economic analytical principles. In fact, the two methods are not substantively different; HE's methods are all recognized in the P & G document.

The difference lies in HE's selection of what it considered to be the most appropriate method for each proposal and each type of benefit, whereas Reclamation applied numerous methods as long as they were sanctioned by the P & G. This produced a wide range of estimates. The best example is found in the agricultural benefit estimates. HE chose a region-specific, net income approach, compared to the Reclamation's application of multiple approaches with varying degrees of regional applicability.

HE included the benefits of project construction as part of the economic effects, whereas Reclamation did not. HE included these benefits because the AWSA monies will be new expenditures to the State of New Mexico, and HE adopted the State and the region of SW New Mexico as the accounting stance for this study. Reclamation considered regional economic impacts and HE did not, since that is distinguished from the BC analysis.

4. Financial Assumptions

Both Reclamation and HE expressed their findings in 2013 dollars, but the financial assumptions used to arrive at 2013 dollars were quite different. Reclamation used the

Consumer Price Index (CPI) to adjust figures. HE used Reclamation's Construction Cost Index since consumer goods are not relevant to this study.

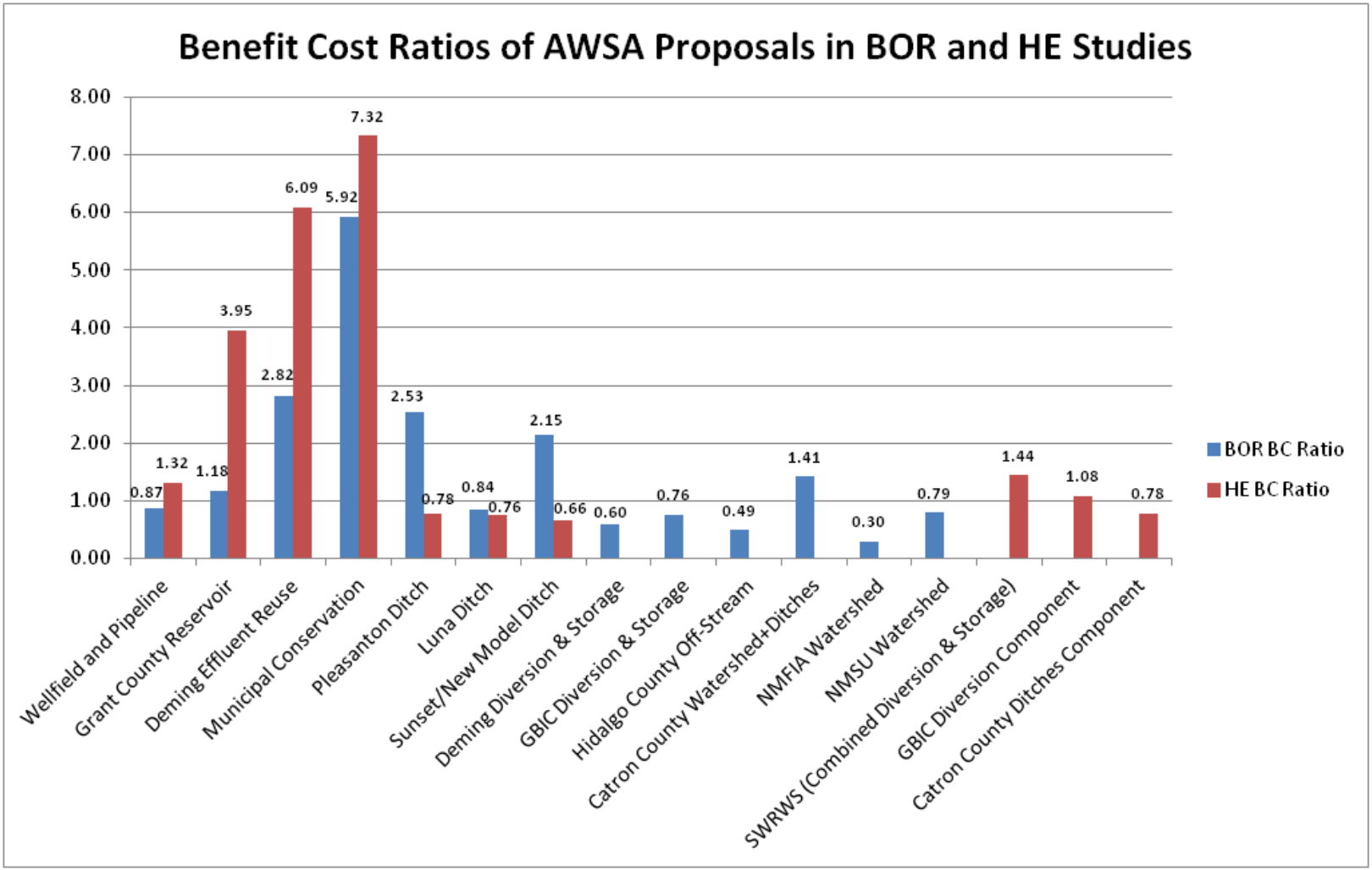
Reclamation and HE also discounted future dollars, both benefits and costs, back to present value. However, Reclamation used a discount rate of 3.5 percent which includes inflation, whereas HE used a figure of 1.09 percent, which excluded inflation. Since the figures are already expressed in 2013 dollars, HE maintains that inflation should not be included in the discount rate.

Other financial assumptions differed as well. Reclamation included Interest during Construction (IDC). HE believed that IDC is a project financing issue which is not specifically related to a BC analysis. Reclamation excluded the NMGRT, but HE included this tax. Together, these differences in the financial assumptions produce substantial differences in the calculated benefits and costs.

Figure 3-1 provides a visual representation of the benefit-cost ratios of each of the AWSA proposals in Reclamation and HE studies. The results indicate that:

- There are only seven proposals that have been evaluated by both Reclamation and HE.
- In both studies, the Municipal Conservation proposal has the highest benefit-cost ratio.
- All three diversion and storage proposals (Deming, GBIC, Hidalgo County) exhibit negative benefit-cost ratios in Reclamation's study. However, the SWRWS proposal (combined diversion and storage) has a positive benefit-cost ratio in the HE study.
- The Deming Effluent Reuse and Grant County Reservoir proposals also have relatively high benefit-cost ratios. The latter proposal is contingent upon the construction of SWRWS proposal.
- The Reclamation's study shows higher benefit-cost ratios for the ditch proposals than the HE study.
- The Luna Ditch proposal has a negative benefit-cost ratio in both studies. However, it is one of the three proposals (GBIC-Irrigation Diversion, Luna, Sunset/New Model) that have qualitative environmental benefits associated with riparian preservation and less habitat disturbance.
- The two final watershed restoration proposals evaluated by Reclamation (NMFIA, NMSU) have negative benefit-cost ratios.

Figure 3-1: Benefit-Cost Ratios of AWSA Proposals



Source: Table V-30 of Reclamation's Report (Pg. 157), Table 6-22 of draft HE report (Pg. 6-24)

Note: The high ends of ranges for total benefits and costs have been used to calculate Reclamation's benefit-cost ratios.

Table 3-11 shows the ranking of the final proposals, based on the two BC studies:

Table 3-11: Ranking of Final Proposals

Final Proposal	Ranking based on HE BC Study	Ranking based on Reclamation's BC Study
Municipal Conservation	1	1
Deming Effluent Reuse	2	2
Grant County Reservoir	3	5
SWRWS (Combined Diversion & Storage)	4	8*
Wellfield and Pipeline	5	6
GBIC (Diversion Improvement Component)	6	-
Catron County (Ditches Component)	7	-
Pleasanton Ditch	8	3
Luna Ditch	9	7
Sunset/New Model Ditch	10	4

* Although Reclamation did not evaluate the combined diversion and storage proposal, the range for the three proposals in the Reclamation's study is the lowest of all proposals (0.49-0.76). Thus, it was interpreted by the ISC staff that the SWRWS proposal would receive the lowest ranking based on the Reclamation's study, which is an 8.

References

Daniel B. Stephens & Associates, Inc., 2005. "Chapter 8. Analysis of Alternatives for Meeting Future Demand" in Southwest New Mexico Regional Water Plan. Retrieved from <http://www.ose.state.nm.us/Planning/RWP/region_04.php>. Accessed October 31, 2014.

Institute for Decision Innovations. About CBA. Available online: <http://www.decisioninnovations.com/>. Accessed November 6, 2014.

Jakubchak, Lindsey N., 2009, The Effectiveness of Multi-Criteria Intelligence Matrices in Intelligence Analysis, Mercyhurst College, Pennsylvania.

Suhr, Jim., 1999. The Choosing by Advantages Decisionmaking System. Westport, CT: Quorum Books.

Vyas Gayatri S. & Misal Chetan S., 2013, Comparative Study of Different Multi-criteria Decision-making Methods, Journal of Institute for Research and Development, India, Volume-2, Issue-4

APPENDIX 1. STUDIES AND INVESTIGATIONS

This Appendix presents a summary of the studies and investigations funded by the New Mexico Interstate Stream Commission ("ISC" or "Commission") in its evaluation of project proposals for use of Arizona Water Settlements Act of 2004 ("AWSA") funds and/or water.

The Commission has commissioned over fifty studies and engineering evaluations since the AWSA planning process began in 2001. Studies and evaluation have addressed technical, hydrologic, ecologic, geomorphic, geotechnical, geologic, engineering issues and concerns, and others. A large part of the work done has addressed environmental/ecologic concerns. Engineering studies and reviews identified technical issues to be addressed, scientific studies raised additional questions, and further studies were commissioned to address these issues.

These studies provide important input for staff evaluations and assessments of proposals and will aid the Commission in making informed and considered decisions.
The following pages summarizes the goals, methods, and results of each study or investigation completed to date. The links to the full reports for each study or investigation are also given.

A1.1: Biological Survey (2013)

Goal

As part of the analysis of nine (9) canyons along the Gila River considered for AWSA water storage, in early 2013 the Interstate Stream Commission contracted with SWCA Environmental Consultants to survey the area for threatened or endangered species and their habitats.

Method

Using data from different federal and state agencies, SWCA first developed a list of 135 special status plant and animal species believed to be in the area. This included data from the US Fish and Wildlife, NM Department of Game and Fish, NM Energy, Minerals & Natural Resources Department, New Mexico Rare Plant Technical Council, Natural Heritage New Mexico. After compiling this list, SWCA analyzed the habitat needs of the species and compared them to the actual soil, vegetation and water conditions in the canyons. In this analysis, SWCA eliminated 62 species from the list because ground conditions would not support them.

SWCA then sent biologists to the canyons for on-site field surveys to confirm the desktop survey. In some canyons, they found conditions to be quite different than what the government agencies had reported. In each canyon, SWCA conducted a systematic search for habitat, or conditions that would support habitat, for any of the 73 species. To provide further documentation of the area in standard format, SWCA used methods developed by the NM Environment Department, the Army Corp of Engineers, and the Natural Resources Conservation Service to evaluate the ecological status and pasture conditions of the area.

Results

The final report of ecological conditions in 9 canyons indicates that, while there are habitats suitable for sensitive species in the area, there are none that cannot be mitigated.

Report can be found at

Link: http://nmawsa.org/ongoing-work/ecological-studies/biological-survey

A1.2: Cultural Resources Survey (2013)

Goal

As part of the analysis of eleven (11)canyons along the Gila River and near Ft. Bayard that were being considered for AWSA water storage, in early 2013 the Interstate Stream Commission contracted with SWCA Environmental Consultants to perform a desktop survey of the area for the presence of archeological artifacts.

Method

The desktop records search included a search of the online New Mexico Cultural Resources Information System (NMCRIS) database and the General Land Office (GLO) land patents database maintained by the Bureau of Land Management (BLM). The NMCRIS database contains information on known archaeological sites, previous cultural resources surveys, and properties listed on the New Mexico State Register of Cultural Properties (SRCP) and the National Register of Historic Places (NRHP). The sensitivity analysis was conducted using a statistical model of cultural resource sensitivity for southwestern New Mexico created by the BLM in 2013.

Results

The results of the desktop records search were inconclusive. Very few cultural resource surveys have been conducted in the potential impoundment areas, and few archaeological sites—and no NRHP or SRCP properties—are located in within any of these areas.

The statistical analysis did indicate areas of probable cultural resource sensitivity throughout the northern Mimbres Basin and the Gila River valley.

Link not available

A1.3: AWSA Diversion Model (2014)

Goal

Beginning in 2001, ISC staff hydrologists developed Excel spreadsheet models for use in AWSA negotiations. After many iterations and refinements, after conclusion of negotiations, a spreadsheet was completed that reflects all of the requirements of the AWSA.

Method

This model applies AWSA constraints to every day of available historical data for the USGS streamflow gauges on the Gila and San Francisco Rivers that are applicable to the CUFA. The model estimates that over the 75 years of historical data, an annual average of slightly more than 12,000 acre-feet could have been diverted from the Gila river while maintaining compliance with the AWSA.

A number of scientists have attempted to estimate the changes in streamflows due to climate change. Although the models used can diverge by large amounts, most scientists have converged on a reduction in upper Gila streamflow of 8%.

Results

Using the same Excel spreadsheet model, but reducing every daily value for streamflow and storage in San Carlos reservoir by 10% to simulate long term drought or climate change, the model estimated there would have been an annual average of ~11,790 acre-feet per year of AWSA water available for diversion, or a decrease of approximately 2.6%.

A decrease of 16% in streamflow and storage results in a decrease in average allowable AWSA diversions to 11,490 acre-feet per year, or a reduction of approximately 5%. The non-linearity of reductions is due to the many overlapping constraints in the AWSA.

A1.4: Reviews of Gila Flow Needs Assessment (2014)

Goal

In 2012, the Interstate Stream Commission wrote a letter to the Bureau of Reclamation in support of The Nature Conservancy (TNC) application for grant monies under the Desert Landscape Conservation Cooperative and WaterSMART Program. The grant was to study the Gila River to determine what flow volume is required to provide adequate water for the various ecological and environmental functions it supports.

While the NM ISC provided data for the study and staff attended the workshop, it did not participate in authoring the 527 page report that was generated in July 2014. Because the report references the ISC and some of our work, the ISC contracted with the following consultants to review different chapters of the report:

- Dr. David Gutzler, UNM: Review of Chapter 3 "Climate and Hydrology of the Upper Gila River Basin"
- SSPA: Review of Chapter 5 "Evaluation of Hydrologic Impacts to the Gila River from the Consumptive Use and Forbearance Act (CUFA) Diversion and Climate Change"
- HDR: Review of Chapter 6 "Hydrodynamic Modeling and Ecohydraulic Relationships"
- SSPA: Review of Chapter 7 "Groundwater and Surface Water Interaction in the Cliff-Gila Valley, NM"
- HDR: Review of Chapter 10 "Effects of Altered Flow Regimes and Habitat Fragmentation on the Gila River Fishes"
- SWCA: Review of Chapter 10 "Effects of Altered Flow Regimes and Habitat Fragmentation on the Gila River Fishes"

Method

Technical review

Results

Please see the following pages for each review.

A1.4.1 Review of the Nature Conservancy's Gila River Flow Needs Assessment Chapter 3 "Climate and Hydrology of the Upper Gila River Basin (Garfin et al)"

Goal:

Chapter 3 characterizes the estimates of the effects of projected climate change on flows on the upper Gila and San Francisco Rivers. A review by Dr. David Gutzler from the Department of Earth and Planetary Sciences, University of New Mexico was conducted to examine and verify the chapter's methods and conclusions.

Method:

Dr. Gutzler applied an independent professional review of the chapter.

Results:

Regarding the methodology used in this chapter, there were strengths and weaknesses identified. The strengths are state of the art models, and high-resolution analysis available for daily output. The weaknesses are known model limitations, and relatively few simulations.

Garfin et al's general conclusion (projection of decreasing future flows) was found to be qualitatively consistent with previous projections by US Bureau of Reclamation, and Dr. Gutzler's analysis of upper Gila flows commissioned by ISC. However, several topics were recommended for future plans and studies to overcome low confidence in some elements of the results.

A1.4.2 Review of the Nature Conservancy's *Gila River Flow Needs Assessment* Chapter 5, "Evaluation of Hydrologic Impacts to the Gila River from the Consumptive Use and Forbearance Act (CUFA) Diversion and Climate Change" (2014)

Goal:

Chapter 5 characterizes hydrologic impacts of four scenarios using the Nature Conservancy's (TNC) Indicators of Hydrologic Alteration (IHA) software to extract statistical comparisons to the unaltered historical hydrograph for the Gila near Gila gage. A review by S.S. Papadopulos & Associates, Inc. (SSPA), was conducted to examine and verify the chapter's input data and conclusions.

Method:

SSPA conducted an independent professional desktop review of the chapter.

Results:

SSPA found the objective results of the chapter useful. However, SSPA noted that the accompanying opinion regarding ecological significance is misplaced. SSPA indicates that TNC's Figure 4 shows the AWSA-impacted hydrograph maintaining seasonal variability; which is consistent with the diversion constraints.

A1.4.3 Review of the Nature Conservancy's Gila River Flow Needs Assessment Chapter 7, "Groundwater and Surface Water Interaction in the Gila-Cliff Valley, NM" (2014)

Goal:

Chapter 7 reviews data collection and compilation efforts, provides statistical characterizations of data, and seeks to characterize and evaluate relationships between surface water, groundwater and vegetation/habitat conditions. A review by S.S. Papadopulos & Associates, Inc. (SSPA), was conducted to examine and verify the chapter's data, methods, and conclusions.

Method:

SSPA conducted an independent professional desktop review of the chapter.

Results:

SSPA found the that the chapter "lacks sufficient quantitative basis for addressing some of the claims" regarding AWSA diversion impacts on groundwater and riparian vegetation. SSPA recommends that conclusions regarding ecological impacts associated with groundwater levels, volumes of recharge, or rates of groundwater recession be based on the ISC's surface water-groundwater model rather than on the methods provided in Chapter 7.

A1.4.4 Review of the Nature Conservancy's Gila River Flow Needs Assessment Chapter 6, "Hydrodynamic Modeling and Ecohydraulic Relationships" (2014)

Goal:

Chapter 6 investigates inundation patterns, incipient sediment transport conditions, and riparian vegetation recruitment processes under four scenarios. HDR Engineering, Inc., reviewed and provided comment on hydrodynamic model development and assumptions.

Method:

HDR conducted an independent professional desktop review of the chapter.

Results:

HDR generally found that details on model development and calibration were lacking. The ISC staff requested the model development report and the model calibration report from both the Nature Conservancy and one of the chapter authors. The reply appeared to indicate that neither existed at the time of the report's publication.

A1.4.5 Review of the Nature Conservancy's Gila River Flow Needs Assessment Chapter 10 "Effects of Altered Flow Regimes and Habitat Fragmentation on Gila River Fishes" (2014)

Goal:

Chapter 10 provides analyses of the relationships between Gila River discharge and fish density with projections of the effects of building a New Mexico Unit. HDR Engineering, Inc., reviewed and provided comment on the statistical analyses and the authors' inferences from the results.

Method:

HDR conducted an independent professional desktop review of the chapter.

Results:

Generally, HDR found that the statistical models have limited predictive value and that TNC overstates the magnitude of expected effects of a river diversion on fish fauna.

A1.4.6 Review of the Nature Conservancy's Gila River Flow Needs Assessment Chapter 10 "Effects of Altered Flow Regimes and Habitat Fragmentation on Gila River Fishes" (2014)

Goal:

Chapter 10 provides analyses of the relationships between Gila River discharge and fish density with projections of the effects of building a New Mexico Unit. SWCA Environmental Consultants reviewed and provided comment on the statistical methods and analyses ,the authors' inferences from the results, and the authors' comments on the effects of river fragmentation.

Method:

SWCA conducted an independent professional desktop review of the chapter.

Results:

SWCA found that the fish sample site hydrology was not analogous to that at the Gila River near Gila stream gage site, which is used in the study. In addition, SWCA found that the authors used small, biased biological samples; used flawed procedures for fish age determinations, and failed to meet the underlying assumptions of their statistical analyses.

Finally, SWCA indicated that the discussion of the effects of river fragmentation on aquatic species is important, but, due to the nature of proposed AWSA projects and diversions, the discussion is not specifically relevant to proposals under evaluation.

A1.5: Hydrological Study of Ft. Bayard (2012)

Goal

As part of the feasibility analysis of the Grant County Tier 2 proposal, the NM ISC hired John Shomaker and Associates, Inc. (JSAI) to evaluate and quantify the potential hydrologic effects associated with the creation of reservoirs on creeks near Ft. Bayard. As any of the proposed reservoirs could be located a short distance upstream of the Bayard well field, both quantity and quality of water could be adversely impacted.

Method

JSAI used a groundwater model to calculate potential reservoir seepage and hydraulic response of the aquifer to seepage from the reservoir. Then they calculated the travel velocity within the groundwater system.

Results

With this information, JSAI determined that the groundwater travel time from the recommended potential reservoir site to the Bayard Well Field is 3 years. An increase in recharge (60 ac-ft/yr) will occur if stormwater runoff is routed around the proposed reservoir. A 60 ac-ft/yr decrease in recharge will occur if stormwater is impounded in the proposed reservoir.

Link: http://nmawsa.org/ongoing-work/final-effluent-resuse-proposal-pers/grant-county-tier-ii-awsa-application/02-08-2013-jsai-bayard-hydrologic-analysis-report/view

A1.6: Remote-Sensing-Based Comparison of Water Consumption by Drip-irrigated Versus Flood-irrigated Fields (2013)

Goal

In 2012, the Interstate Stream Commission contracted with Intera Geosciences Engineering to quantify the differences in water consumption between on farm irrigation methods, specifically comparing drip to flood irrigation in the Deming, NM area.

Method

Intera identified, located with GPS, and photographed fields planted in the same crops, but irrigated by different methods. Intera then used satellite imagery and the METRIC software to quantify and compare the surface temperatures and evapotransiration in the different fields through-out the growing season.

Results

Surface temperatures in drip irrigated fields are lower than in flood irrigated fields, indicating a higher water consumption and transpiration from plants. Using the METRIC software, consumption in drip-irrigated fields ranged 8% to 16% higher than in flood irrigated fields. More biomass is being produced (higher yield) and each plant is using more water. Less water is available for return to the aquifer.

http://nmawsa.org/ongoing-work/agricultural-water-use/comparison-of-water-consumption-by-drip-irrigated-versus-flood-irrigated-fields/view

A1.7: Low Water Use Crop report (Best Use of the Arizona Water Settlement Act Water: Examples of High Value, Low Water Use Crops) (2012)

Goal

In 2011, the Interstate Stream Commission contracted with Competitive Advantage Consulting Ltd. (CACL) to identify crops that might lead to higher economic return and lower water use than those currently grown in the Cliff-Gila farming valley.

Method

Through a series of field interviews, site visits and research, CACL identified the crops currently under cultivation, the profits and the issues with them. CACL also researched other crops that could be grown in the area, their water use, and the profits they could generate.

Results

There are many crops, such as lavender, grapes and onions, that might produce higher economic return and use less water than current crops. However, to transition to them would require new equipment, local and regional infrastructure, and increased labor.

Link: http://nmawsa.org/ongoing-work/agricultural-water-use/examples-of-high-value-low-water-use-crops/view

A1.8: Hydrosphere Hydrological Model (2007)

Goal

In 2007, the Interstate Stream Commission contracted with Hydrosphere Resource Consultants, Inc. of Socorro, NM to evaluate the effect of Silver City pumping on Gila River base flows

Method

Hydrosphere did a review of several models of the area and ran scenarios with the Balleau model.

Results

- Approximately 40% of base flow in the Gila between Mogollon and Redrock derives from the Mangas Trench where Silver City's Frank's well field is located.
- Estimates of total Mimbres basin recharge ranges from approximately 14,000 AF/Y to approximately 31,900 AF/Y.

The report can be found at

http://nmawsa.org/ongoing-work/hydrogeology

A1.9: Geomorphology of the Upper Gila River within the State of New Mexico (2006)

Goal:

The ISC staff contracted Mussetter Engineering, Inc. to evaluate the existing dynamics of the Gila River, and the geomorphologic impacts of the AWSA diversions.

Method:

The consultant conducted field surveying, and hydraulic /sediment transport modeling to achieve the objectives of the study.

Results:

The results showed that maximum diversions under the AWSA are unlikely to have a significant effect on sediment transport, water-surface elevations, or durations of inundation for any of the geomorphologic surfaces. The study was conducted when an additional annual average of 18,000 acre-feet per year of AWSA water was envisioned. The final AWSA limits New Mexico to an additional annual average of only 14,000 acre-feet per year. Impacts would be even less than thought in the study.

Link: http://nmawsa.org/ongoing-work/geomorphology/geomorphology-of-the-upper-gila-river-within-the-state-of-new-mexico/view

A1.10: Mimbres Basin Water Supply, and Silver City Water Demand (2009)

Goal:

The ISC staff contracted Intera to evaluate estimates of the Mimbres Basin water supplies, analyze groundwater availability in Silver City, and develop a water budget for the Silver City area.

Method:

The consultant did data analysis and model research for the purpose of this study.

Results:

The results indicated that it is likely that there is adequate groundwater to supply Silver City over the next 40 to 60 years. However, it may require deepening existing wells or adding new wells.

Link: http://nmawsa.org/library/sw-nm-stakeholders/technical-memorandum-mimbres-basin-water-supplies-6-30-2009/view

A1.11: Stream Flow Projections for the Upper Gila River (2013)

Goal:

The ISC staff contracted Dr. Gutzler from the Department of Earth and Planetary Sciences, University of New Mexico to estimate the effect of projected climate change on average peak-season flow in the upper Gila River.

Method:

He used two methods for his study: Dynamical and statistical modeling. The major assumptions for this study were as follow:

- [For the dynamical model]: The temperature increases over the next few decades to the point at which the long term temperature effect overwhelms the decadal variability of precipitation variability.
- Inter-annual and decadal variability is fixed.
- Flows only associated with snowpack were focused in this report, not summer flows.
- Built-in Uncertainties:
    - Projected increase in atmospheric greenhouse concentration
    - Future greenhouse gas forcing
    - Models (Decadal variability)

Results:

His conclusion was that there could be a reduction of approximately 8% by 2021 - 2050, relative to a baseline period of 1951 - 2012. The study also concluded that the timing of peak stream flow and the shape of the seasonal hydrograph are likely to change considerably over the next several decades.

Link: http://nmawsa.org/ongoing-work/streamflow-projections-for-the-upper-gila-river-considering-climate-change/draft-stream-flow-projections-for-the-upper-gila-river/view

A1.12: Assessment of Potential Impacts on Gila River Fish Species from AWSA Diversions –Habitat Modeling (2014)

Goal:

The ISC staff contracted SWCA Environmental Consultants to quantify habitat change for fish species from the AWSA diversions.

Method:

The consultant applied Physical Habitat Simulation (PHABSIM) for this purpose. PHABSIM is the microhabitat modeling component of the Instream Flow Incremental Methodology (IFIM), and was originally developed and maintained by the U.S. Fish and Wildlife Service Instream Flow Group (now U.S. Geological Survey, Aquatic Systems and Technology Applications Group, Fort Collins Science Center). PHABSIM calculates a habitat index, in part based on simulation of river depths and velocities from 1-D hydraulic models that represent the river by cross-sections. For 1-D applications in this study, the hydraulic and habitat index simulations were derived from the computer program SEFA (System for Environmental Flow Analysis). SEFA is developed by Aquatic Habitat Analysis Inc. that implements the equivalent algorithms of PHABSIM.

Initially, 17 species of interest were mentioned in the scope of work: 11 fish (6 native fish species: Spikedace, Loach Minnow, Gila Chub, Desert Sucker, Sonora Sucker, and Longfin Dace; and 5 non-native species: Green Sunfish, Smallmouth Bass, Channel Catfish, Common Carp, and Red Shiner), 1 native bird (Southwest Willow Flycatcher), 2 native reptiles (Northern Mexican and Narrow-headed Garter Snakes), 2 amphibians (1 native frog: Chiricahua Leopard Frog; and 1 non-native frog: Bullfrog), and 1 non-native crustacean (Crayfish).

However, after doing research, the consultant concluded that the relationships between the species other than fish and flow are too uncertain to include in a PHABSIM-type analyses. Therefore, only fish species were evaluated in this process.

Results:

The results indicated that there was up to 5% positive and negative habitat changes for the fish species in their variant life stages (spawning, larvae/fry, juvenile, adult) under the AWSA diversions. The endangered species Spikedace and Loach Minnow had up to 3% positive habitat change. It also showed that releasing and maintaining 10 cfs in the river at the time when the river goes dry/intermittent below the irrigation diversions in the Cliff-Gila Valley, would result in up to 11% habitat increase for all species.

Link: http://nmawsa.org/ongoing-work/ecological-studies/gila-fisheries-modeling-report/assessment-of-potential-impacts-on-gila-river-fish-species-from-diversions-under-the-terms-of-the-2004-arizona-water-settlements-act/view (Chapters 2, 3, 4)

A1.13: Assessment of Potential Impacts on Gila River Fish Species from AWSA Diversions – Population Analysis (2014)

Goal:

The ISC staff contracted SWCA Environmental Consultants to quantify the probability of extinction for two endangered fish (Spikedace, Loach Minnow) from the AWSA diversions.

Method:

The consultant applied Population Viability Analysis (PVA) method for this purpose, an individual-based model for evaluating extinction risk in small fish populations subject to potentially strong density dependence in juvenile survival. These types of density-dependent responses are likely common in fish species from arid climates with highly fluctuating flow conditions.

The model can be used to run large numbers of stochastic simulations quickly to allow rapid screening of policy options and sensitivity analysis of the results to uncertainties about key population parameters.

Results:

The results indicated that under the drought conditions, the probability of extinction for Spikedace and Loach Minnow is 8.5% and 1.5%, respectively. The probability of extinction under the presence of non-native species would be 100% for both species.

However, upon releasing discharges up to 10 cfs back to the river at the time when the river goes dry/intermittent below the irrigation diversions in the Cliff-Gila Valley, the probability of extinction for both Spikedace and Loach Minnow becomes zero. In other words, a target baseline flow of about 10 cfs would provide beneficial habitat to native fish while not providing extensive habitat for non-native predators such as Smallmouth Bass and Channel Catfish. This flow augmentation scenario must be carefully considered to further reduce the risk of non-native fish colonization and habitat fragmentation in case of drought.

Robust monitoring efforts and surveys on abundance, diet, and prey overlap for the key native and non-native fish species in this reach should be undertaken to track fish community response to any flow augmentations, and to assess predation potential. This type of information, taken over time can help to resolve uncertainties and refine understanding of the relationships between discharge and fish communities.

Link: http://nmawsa.org/ongoing-work/ecological-studies/gila-fisheries-modeling-report/assessment-of-potential-impacts-on-gila-river-fish-species-from-diversions-under-the-terms-of-the-2004-arizona-water-settlements-act/view (Chapter 5)

A1.14: Review of USGS Mimbres Basin Groundwater Levels Report (2013)

Goal:

A 2013 USGS report on groundwater depletion in the United States shows water levels in the Mimbres Basin to be "generally stable" from 2000 to 2008 for the Mimbres Basin. A review study by the ISC staff was conducted to examine and verify the USGS study's input data and conclusion.

Method:

To estimate the trend in groundwater levels in the basin, field measurement data were analyzed from the sixty-seven wells that were spatially distributed throughout the basin, and were sampled regularly, following to USGS protocols, since 1997.

Results:

The review study revealed that the USGS report relied solely on water levels from fifteen Silver City wells, which are located in the northwest corner of the Mimbres Basin and the eastern portion of the Gila Basin. In addition, the results indicated continued water level declines in the Mimbres Basin for the 2000 – 2008 period (0.3 ft/yr on average). There are several other studies that confirm the declining water levels in the Mimbres basin for the same period.

Link: http://nmawsa.org/library/presentations/groundwater-levels-in-the-mimbres-basin-stable-or-declining/view

A1.15: Estimates of Region-Wide and Deming Area Water Supplies (2009)

Goal:

The ISC staff contracted Daniel B. Stephens & Associates, Inc. to evaluate current and historical depletion rates in the Deming area, and estimate current water supplies in that area.

Method:

The consultant did a hydrological budget analysis for the purpose of this study.

Results:

The consultant concluded that the Deming area's groundwater supply is estimated to be at approximately 5 million AF. Secondly, groundwater levels showed to be declining at an average rate of 0.6 ft/yr, while demand is projected to be steady to increasing. Finally, Deming's supply wells were predicted to lose 50 ft of their water columns over the next 90 years.

Link: http://nmawsa.org/library/sw-nm-stakeholders/estimates-of-region-wide-and-deming-area-water-supplies-draft-6-30-2009/view

A1.16: Regional Water Demand Study for Southwest New Mexico (2010)

Goal:

The ISC staff contracted AMEC Earth & Environmental, Inc. to assess the current water demand of key individual sectors in the four-county area such as agriculture, municipal, mining industry, and livestock, and estimate their future water demand by year 2050.

Method:

The consultant conducted a desktop analysis for the purpose of this study.

Results:

The results indicated that irrigated agriculture is the largest water demand across most of the region, historically 87% of total withdrawals and 76% of total depletions for the region in 2005. Conversion from flood to drip/sprinkler irrigation can result in more crop per acre and less water withdrawn per irrigated acre which equals to decreased pumping costs and increased farm profitability. However, it can increase aquifer depletions, as well. Thirdly, much of the study area has been identified by the US Department of Energy as having high potential for Green Energy generation (solar, wind, geothermal). Solar, in particular, can require significant quantities of water. Hence, industrial water demands are expected to increase.

There will be increases in total water demand in the region through 2050. Given the supply shortage in the region, the availability of AWSA water may help relieve that pressure.

Link: http://nmawsa.org/library/sw-nm-stakeholders/regional-water-demand-study-for-southwest-new-mexico-catron-grant-hidalgo-and-luna-counties-10-10-2010/view

A1.17: Gila Wetlands Study (2014)

Goal:

The ISC staff contracted Dr. Mark Stone et al from the University of New Mexico to calculate the hydrologic budgets for two wetlands in the Cliff-Gila Valley, and evaluate groundwater-surface water interactions associated with the wetland systems under different AWSA diversion scenarios. Jeffrey Samson, Dr. Stone's PhD student, worked on this project. The study duration was 23 months.

Two wetland systems in the Cliff-Gila Valley were identified for the purpose of this study: One system with very little anthropogenic impact (between Mogollon Creek and the Upper Gila ditch diversion) and a second that is heavily influenced by human activities (downstream of the Ft. West ditch diversion).

Method:

The study was conducted through field monitoring effort including the installation of riparian monitoring wells and meteorological stations, and monthly field visits for data collection. Those data were used to parameterize and calibrate groundwater models that were developed to evaluate future flow scenarios. They used MODFLOW for their modeling purposes. MODFLOW is a three-dimensional groundwater model developed and supported by the USGS.

Results:

The results showed that the AWSA diversions decrease water levels in the wetlands from 1 to 5 inches, and then return to baseline conditions.

Link: Final report not yet reviewed and posted.

A1.18: Phase II Engineering Evaluation of the Diversion and Storage Proposals (2014)

Goal:

Based on the results of Phase I and RJH's technical review, the ISC staff tasked BHI with Phase II of the engineering evaluation for the combined diversion and storage proposal. The objectives of this study are:

- Refine design and configuration of the Phase I recommended alternatives and cost estimates through:
    - Geomorphologic modeling
    - Geophysical/Geotechnical field work
- Evaluate pumping options (including Solar power)
- Evaluate an alternative to divert the AWSA water to a side canyon near Virden valley (Hidalgo County)

Method:

The consultant is conducting the engineering design analysis through modeling, field surveys, and geotechnical field tests. BHI has hired subcontractors to help achieve the tasks mentioned above.

Results:

Results of this study are discussed in detail in Chapter 2 of this report. Briefly, a different diversion location was specified, along with a different arrangement of storage facilities. Various options for pumping water were evaluated. A storage location at Virden was evaluated. Costs were updated from Phase I.

.

A1.19: Value Engineering Study for the Combined Diversion and Storage Proposal (2014)

Goal:

The ISC staff contracted RJH Consultants, Inc. to conduct a Value Engineering study for the SWRWS proposal to:

- Evaluate the proposed conceptual designs.
- Suggest improvements of current conceptual designs, and/or additional approaches or concepts.
- Recommend further studies and investigations.

Method:

The results of BHI's Phase I and II studies, as well as the US bureau of Reclamation's engineering evaluation were used for a Value Engineering workshop which was facilitated by a Certified Value Engineering Specialist. The participants of this workshop were highly-qualified professionals with expertise in applicable technical areas.

Results:

The Value Engineering (VE) Team selected BHI's Preferred Alternative No. 2 as the base case against which to measure their VE Proposals. This Value Engineering (VE) Study generated thirteen (13) proposals (quantifiable ideas) and seventeen (17) supplemental recommendations (non-quantifiable ideas).

Results of this study are discussed in detail in Chapter 2 of this report. Briefly, the VE Team believes the overall concept of diversion and storage is technically feasible, but permitting will be prolonged and challenging. They made suggestions to use two diversion structures, including a Coanda screen, use BHI's recommended diversion point, and use two reservoirs with capacity at least in the 45,000 AF range (Larger Spar with pump, or Greenwood).

They also recommended conducting a detailed hydraulic modeling of the diversion structures, developing an integrated simulation of water supply and key system operations elements, and revisiting dam safety and reservoirs' seepage control design as the next steps and further studies.

A1.20: Agricultural Economics in Southwest New Mexico (2014)

Goal:

The ISC staff has contracted Dr. Frank Ward et al from the New Mexico State University to estimate the potential economic advantages of providing the AWSA water to three farming areas in SWNM (Cliff-Gila, Deming, Virden).

Method:

The consultant conducted the study through field interviews and optimization modeling.

Results:

Based on preliminary results, existing crop irrigation in the study area produces an annual total farm income in the base year equal to $49.2 million per year. Additional supplies made available by the AWSA water, if combined with adequate water storage would permit growers access to more and better timed water. Access to more water and better timed water would permit growers to shift to higher valued crops, with resulting higher average economic values of water. Total farm income for the base year 2012 over the three county region with the AWSA water and storage is estimated at $50.9 million. Additional farm income for 2012 made available by the AWSA water and storage is estimated at $1.7 million per year.

This study is still on-going.

Link: Final report not yet reviewed and posted.

A1.21: Economic Evaluation of All AWSA Proposals (2014)

Goal:

The ISC staff has contracted Harvey Economics to provide benefit-cost analyses of all tangible and intangible items for all proposals, and forecast the costs and benefits to 2050.

Method:

The consultant is doing a benefit-cost analysis (BC) for the purpose of this study.

Results:

The table below offers the total benefits, total costs and benefit-cost ratios of the AWSA proposals analyzed as part of this study. This is discussed in detail in Chapter 3.

Proposal	*Total Benefits (2014 - 2050)*	*Total Costs (2014 - 2050)*	*Benefit Cost Ratio*
Southwest Regional Water Supply	*$760.9*	*$528.9*	*1.44*
GBIC Irrigation Diversion Structure	*$2.7*	*$2.5*	*1.08*
Deming Effluent Reuse	*$36.1*	*$5.9*	*6.09*
Grant County Wellfield and Pipelines	*$38.6*	*$29.3*	*1.32*
Grant County Reservoir	*$63.5*	*$16.1*	*3.95*
Catron County Ditch Improvements	*$11.4*	*$14.5*	*0.78*
Luna Ditch Improvements	*$2.4*	*$3.2*	*0.76*
Sunset/New Model Ditch Improvements	*$18.9*	*$28.7*	*0.66*
Pleasanton East Side Ditch Improvements	*$4.2*	*$5.4*	*0.78*
Municipal Conservation Programs	*$75.7*	*$10.4*	*7.32*

Note: Benefits and costs are presented in millions of 2013 dollars

A1.22: Review of Gila Conservation Coalition's Mimbres Basin Water Supply Study (2014)

Goal:

A 2014 report by John Ward, prepared for the Gila Conservation Coalition (GCC) indicates that conversion to drip irrigation has resulted in significant water savings in the Mimbres Basin, reduction in water withdrawals has diminished rate of groundwater depletion, and importing AWSA water will have little impact on Mimbres basin water supplies. A review study by the ISC staff was conducted to examine and verify the GCC study's input data and conclusions.

Method:

The staff conducted a desktop review analysis for the purpose of this study.

Results:

The review study revealed that there were questionable approaches, assumptions, and data usage for irrigated acreage, groundwater trends, and agricultural/consumptive water use. However, helpful and practical recommendations for better monitoring of Mimbres wells and further studies of return flows from flood irrigation are proposed in the GCC report.

A1.23: Environmental Baseline Data (2013)

Goal
In calendar year 2012, ICS staff contracted with Tetra Tech to collect and format environmental baseline data and to provide these data on digital media.

Method
This is an initial assembly, organization, quality control, and formatting of data that characterizes the physical, human, and natural environment and, in some cases, the recent historical context in which these elements reside.

Results
The products have been used, where applicable, to support the more specific studies. For example, the 2009 and 2011 National Agriculture Imagery Program ("NAIP") aerial images have been used to examine the summer dry reaches of the Gila River and to identify point of diversion locations. The New Mexico Environment Department's benthic macroinvertebrate ("BMI"), or aquatic insect, sampling data was used for the BMI study conducted for the ISC by HDR Engineering, Inc.

The work also included a study of post-fire hydrology for the Upper Gila Watershed. Tetra Tech developed a model for ungaged reaches of the watershed in order to evaluate pre-fire and post-fire hydrology in those reaches. However, as the work progressed, the ISC staff determined that most of the model domain resided outside of the area of interest, and staff questioned the validity of many of the assumptions. Therefore, additional work on post-fire hydrologic modeling was not pursued.

URL: http://nmawsa.org/ongoing-work/gila-watershed-data

A1.24: Indicators of Hydologic Alteration (2013)

Goal
In 2013, S.S. Papadopulos & Associates, Inc. ("SSPA"), reviewed the *Indicators of Hydrologic Alteration* ("IHA") software as applied to Gila River flows and simulated AWSA diversions.

Method
SSPA compared the IHA results for the Gila's historical record to the historical record minus diversions under the AWSA's legal constraints.

Results
The IHA software was developed, and is distributed, by the Nature Conservancy. The software calculates a set of 33 descriptive statistics derived from stream gage records to express pre- and post-alteration hydrologic conditions. The 33 statistics are organized into five parameter goups: (1) magnitude of monthly water conditions; (2) magnitude and duration of annual extreme water conditions; (3) timing of annual extreme water conditions; (4) frequency and duration of high and low pulses; and (5) rate and frequency of water condition changes.

One way that IHA expresses change in hydrologic condition is deviation factor. More specifically, the deviation factor expresses the difference between metrics for the pre- and post-AWSA flow sequences and is calculated as the ratio of the absolute value of change to the historical value: *(post-impact value - pre-impact value)/ pre-impact value*. A value of zero equals no effect, and a large deviation factor, i.e., close to one, means that the effect is great.

In the parameter group for monthy median Gila flows, only the month of March shows a deviation factor greater than zero. The median flow drops from 188 cubic feet per second ("cfs") to 159 cfs. The deviation factor is 0.16.

In the second parameter group, magnitude and duration of annual extreme water conditions, the seven-day maximum flow showed the greatest deviation factor: 0.24. The historical median seven-day maximum is 759 cfs. Under the AWSA scenario it is 576 cfs.

The third and fourth parameter groups show no deviation factors greater than zero.

The fifth parameter group, rate and frequency of water condition changes, has small deviation factors for change in fall rate and number of reversals.

The IHA software also calculates Environmental Flow Components ("EFCs"). EFCs are an attempt to divide the hydrograph into repeating sets of annual hydrographic patterns that are ecologically relevant. Their differences between pre- and post-alteration EFCs are also expressed as deviation factors.

Large flood (>8,264 cfs) duration saw the highest deviation factor, 0.41, with the duration dropping from 66 day to 39 days. Large flood recurrence is 10 years.

IHA software can be used to highlight the more sensitive elements of flow alteration, e.g., by examining the deviation factor. To this end, IHA results were helpful in identifying scenarios to examine using the three-dimensional Gila-Cliff hydrologic model developed by SSPA.

In applying IHA to the Gila River, however, one should view the results cautiously, as the software relies on means and medians, and the flashy nature of Gila flows can render such statistics unsuitable given the magnitude of the extremes. In addition, the output addresses neither the nature nor degree of ecological impacts.

URL: http://nmawsa.org/ongoing-work/indicators-of-hydrologic-analysis

A1.25: Analysis of Flow and Water Use Alternatives on Hydrologic Conditions in the Riparian Corridor of the Gila-Cliff Basin (2014)

Goal
The ISC contracted with SSPA to model surface water-groundwater interactions along the Gila River in the Cliff-Gila Valley in order to quantify the resultant hydrolgic impacts to the system from diverting AWSA water.

The ISC requested four model runs to simulate a variety of hydrologic conditions.

Method
SSPA constructed the three-dimensional Gila-Cliff Model for the purpose of modeling the near-river surface water-groundwater interactions under existing conditions and under AWSA diversion scenarios. The model domain extends from above the confluence of Mogollon Creek to below the confluences Duck and Bear Creeks **(Figure 1)**.

SSPA calibrated the model using water level data from piezometers and stage gages, three seepage runs on the Gila River, ditch diversion records, and other data.

The ISC staff selected four scenarios for evaluation, based upon SSPA's review of IHA results. A brief description of each scenario follows:

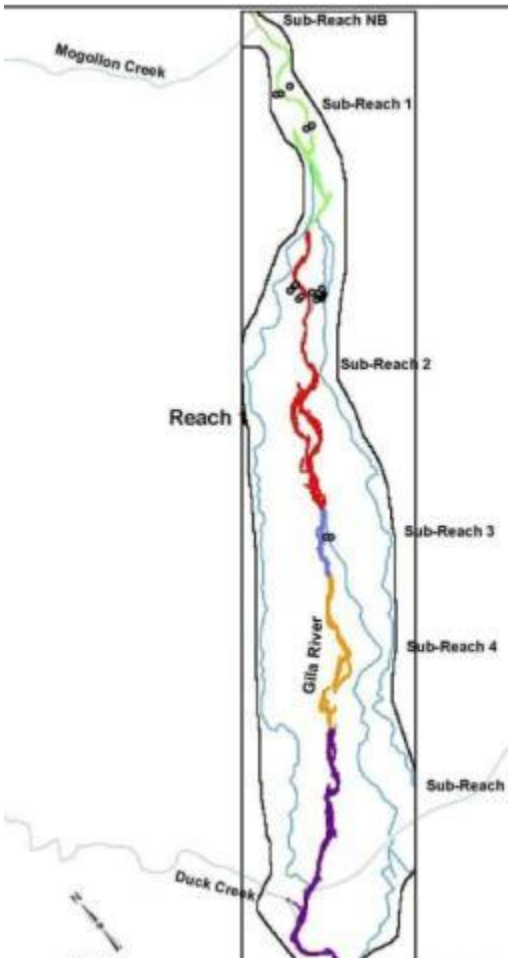


Figure 3: Gila-Cliff Model domain

Scenario 1 shows the impact of small diversions in a lower flow year. Most diversions occur in March. Simulated river flows are patterned after water year 1965.

Scenario 2 shows the impacts of high diversions in a year of average annual flow. AWSA diversions occur in early spring months with additional small diversions in August and September. This simulation represents the impacts of higher AWSA diversions in a higher flow year than simulated in Scenario 1. Simulated river flows are patterned after water year 2007.

Scenario 3 is a two-year scenario, patterned after water years 2010 through 2011, and shows the impacts of diverting during a wet year that is followed by a dry year. This scenario examines whether or not effects of diversions would persist into a

subsequent drought year. Annual Gila flow and AWSA diversions are above long-term median and mean values for the first year. Diversions occur in late winter and early spring of the first year. The second year is a drought year with no diversions.

Scenario 4 is patterned after water years 1999 through 2000 and examines effects of a low-flow year with low AWSA diversions followed by a drought year.

Results

Since the shallow aquifer and the Gila River are hydrologically connected, high river flows result in a losing stream and gaining aquifer. The model results for the four scenarios show that AWSA diversions would result in short-term, localized decreases in groundwater gains. The groundwater level is not drawn down; rather, the increase in water level is not as great as under existing conditions.

The magnitudes of the decreases range from one-quarter foot to one foot, depending upon location and scenario. Starting water levels in spring range from approximately seven to nine feet below land surface. Recovery to non-diversion water levels takes no longer than one to two weeks.

For the multi-year scenarios, the simulations show no long-term effect of diversions on groundwater.

URL: http://nmawsa.org/ongoing-work/groundwater-modeling/analysis-of-flow-and-water-use-alternatives-on-hydrologic-conditions-in-the-riparian-corridor-of-the-gila-cliff-basin-june-2014/view

A1.26: Gila River Flow and Riparian Vegetation Health in the Cliff-Gila Valley (2014)

Goal

The ISC staff hired INTERA to compare riparian vegetation health with Gila River flows in the Cliff-Gila Valley. The staff's hypothesis was that vegetation health increases with stream flow.

The impetus for the study was staff's observation of dead and/or dying Fremont cottonwood trees below the upstream agricultural points of diversion, where the Gila River routinely dries in the summer. If a positive correlation between flow and vegetation health were to exist, there could be environmental benefit to releases of stored water in the summer, as posed by diversion and storage project proponents.

Method

In order to complete the study, INTERA cond ucted field work to identify vegetation communities and examined aerial imagery in order to estimate vegetation extent.

INTERA then examined satellite imagery and created a Normalized Difference Vegetation Index ("NDVI") in order to estimate vegetation health. NDVI is calculated from the the visible and near-infrared light reflected by vegetation **(Figure 2)**. Simply put, NDVI is a measure of plant greenness. Healthier plants result in higher NDVI values.

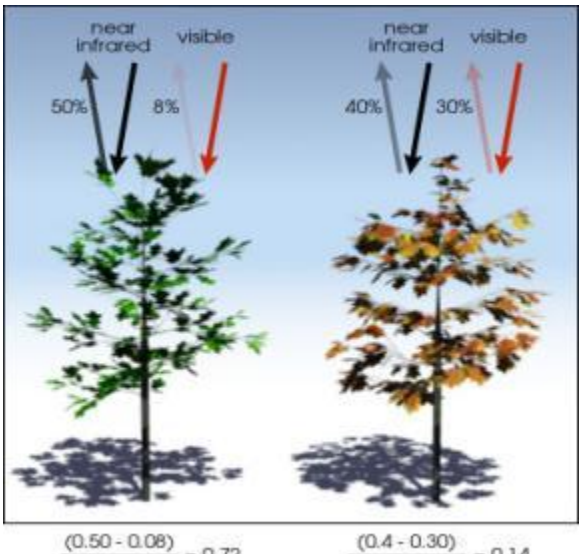


Figure 4: Illustration of how NDVI is calculated: Difference between reflected infrared and visible light divided by the sum of reflected infrared and visible light.

Source: earthobservatory.nasa.gov

INTERA concurrently estimated flow into and out of subreaches in order to compare vegetation health in each of those subreaches with flow. The hydrologist modeled the flow using gaged flow data, contributing watershed area, and ditch diversion records.

The NDVI analysis and the hydrology were used to perform the correlation analysis.

Results

The correlation analysis shows generally that as streamflow increases, riparian health increases, and the response is rapid.

The reach with the majority of the valley's agriculture is more complex.

The NDVI results for that reach show that the vegetation just downstream of the two uppermost diversion structures is less robust than in other areas. SSPA's three-dimensional modeling shows existing, steep groundwater declines in this areas. INTERA's and SSPA's work, taken with the body of literature on cottonwood response to groundwater fluctuations, appear to indicate that the summer low flows coupled with the exercise of water rights have negative effects on cottonwood health.

In contrast, the results of the study show that, just downstream, agricultural return flows are supporting the adjacent riparian vegetation.

URL: http://nmawsa.org/ongoing-work/flow-and-riparian-health-correlation-project-1

A1.27: Modeling Benthic Macroinvertebrate Responses to Proposed AWSA Diversions (2014)

Goal

In order to complement the fish physical habitat simulation, which modeled physical habitat suitability for fish, the ISC staff hired HDR Engineering, Inc., to study the effects of Gila River flow on aquatic insects, which the native spikedace and loach minnow prey upon. This study had three goals:

1. Develop flow-ecology relationships for benthic macroinvertebrates ("BMI"), or aquatic insects;
2. Predict BMI productivity, i.e., biomass production, as a function of flow and wetted area; and
3. Characterize BMI community metric responses to low flow and interrupted flow.

Method

In order to accomplish the goals for the study area, HDR and ISC staff selected specific study sites. HDR staff collected BMI samples, mapped habitat, collected flow data, and used existing data. They developed the study area hydrology and then developed reach-specific two-dimensional hydraulic models.

HDR used the RIVBIO biomass model to predict BMI productivity as a function of flow and wetted area and/or perimeter. Using IHA hydrologic metrics and BMI community metrics, HDR characterized BMI community metric responses to low and interrupted flows.

Results

Modeling shows that during years with high spring flow, BMI productivity below agricultural diversions was reduced, but it quickly recovered. In years with little or no spring flow, productivity below the diversions dropped to zero and did not recover until resumption of continuous flow later in the year.

BMIs dessicate on a five-day decay curve once habitat dries. Short-term inundation has little to no effect on BMI productivity, as the BMIs do not have sufficient time to recolonize the areas.

As to AWSA diversion scenarios, AWSA diversions would result in less than a 0.5 percent reduction in benthic productivity, as the high flow conditions under which diversions would be authorized result in only short-term inundated area. The lag in BMI colonization, coupled with the short duration of inundation, means that the slight reduction in inundated area will not affect BMI productivity.

HDR also examined the effects of releasing water from storage at times when the river channel is dry. HDR modeled environmental flows of 10, 20, 30, and 40 cfs. While BMI productivity increased with each increment of flow, the greatest percentage increase was

from zero to 10 cfs. Such flow would be sufficient to maintain BMI productivity until natural flow resumed in the reach.

URL: http://nmawsa.org/ongoing-work/benthic-macroinvertebrate-study

A1.28: Fish Habitat Simulation (2014)

Goal
The ISC staff contracted with HDR Engineering, Inc., to determine the effects of a diversion project on fish habitat in four reaches: two hydrologically unaltered and two altered. One of the unaltered sites is located in the vicinity of the BHI's proposed diversion structure in Phase II. This habitat modeling covers areas not considered by similar work conducted by SWCA.

Method
HDR began the work by reviewing habitat suitability criteria developed by SWCA and its subcontractors. In addition, HDR staff conducted a bathymetric survey and habitat mapping earlier this summer. HDR staff also conducted additional habitat mapping as well as collect flow measurements and water surface elevations.

The habitat modeling was accomplished using a habitat component for the two-dimensional hydraulic model River-2D. HDR staff then provided a habitat time series for native and non-native fish species under historical flows, AWSA diversions, and environmental flow augmentation scenarios

Results
For the hydrologically unaltered sites, the study concluded that AWSA diversions would result in native species' habitat changes ranging from 0.5 percent decreases to 4.9 percent increases. For non-native species, the habitat changes ranged from 0.2 percent decreases to 2.5 percent increases.

For the altered sites, i.e., downstream of existing diversions, the AWSA diversion would result in habitat changes for native species from 2 percent decreases to 10 percent increases. The results for non-natives indicate a range of 3.6 percent decrease to 2.3 percent increase, with slight decreases in habitat availability for many species.

The study also found that, in general, augmentation or environmental releases would increase native species' habitat availability while reducing that of non-natives.

Link: http://nmawsa.org/ongoing-work/ecological-studies/gila-fisheries-modeling-report/gila-river-fish-habitat-report-october-13-2014/view

A1.29: Digital Hydrogeologic-Framework Model of the San Francisco River Basin, West-Central new mexico and East-Central Arizona (2009)

Goal
The goal of this effort was to create a digital hydrogeologic framework model of the San Francisco River Basin aquifer systems and to provide information on the water-bearing and water-transmitting properties of geologic units.

Method
The model and maps were completed using geologic mapping, literature review, and and general geologic principles.

Results
A geologic report with accompanying map plates were produced as part of this effort. However, since the only Tier 2 project proposals in the San Francisco River Basin are ditch and watershed improvement projects, the knowledge has not been applied.

URL: http://nmawsa.org/library/sw-nm-stakeholders/digital-hydrogeologic-framework-model-of-the-san-francisco-river-basin-west-central-new-mexico-and-east-central-arizona-6-2009/view

APPENDIX 2: CHOOSING BY ADVANTAGES DESCRIPTION OF ATTRIBUTES AND SCORING

A2.1: Catron County (Ditch Proposal)

Water Supply: The estimated average annual amount of water conserved for the Catron County Ditch Proposal is 800 acre-feet.

Interests Served: The proposal receives a "1" for interests served: agricultural.

People Served: The proposal is estimated to serve 194 persons. This is based upon the assumption that the Pleasanton East-Side Ditch is representative of Catron County community ditches, i.e., 24 water users. Then, the number 24 is multiplied by 10 ditches. However, at least one ditch, the Pleasanton West-Side Ditch, is not in use, so 24 are subtracted. At least one ditch is a private ditch, so another 22 are subtracted.

$$(24 \times 10) - 24 - 22 = 194$$

Environmental Impacts: Some diversion structures are anticipated to be replaced with infiltration galleries, which would reduce the frequent in-channel work for earthen structures on the San Francisco River. However, the number of structures to actually be replaced is uncertain; five (+5) are assumed.

In addition, the proposed on-farm storage ponds would provide an ancillary benefit to wildlife; one per ditch is assumed (+10).

Therefore, the proposal receives a "15" for benefit to the San Francisco River and tributaries.

Technical Feasibility (Challenges): The proposal receives a "38" because ditch projects are common in New Mexico. The score is not higher due to the infiltration gallery component.

Timing of Implementation: Assuming that work could concurrently commence on at least some of the 10 ditches, it is estimated that all work would be completed by 2021.

Complements Regional Water Plan Objectives: The proposal receives a "5" for meeting the following:

1. Implement agricultural conservation measures (5)

A2.2: Southwest Regional Water Supply System, integrating proposals from GBIC, Deming, and Hidalgo County

Water Supply: The estimated average annual yield for the City of Deming (Southwest Regional Water Supply System, including GBIC and Hidalgo County) proposal is 8,000 acre-feet, based on the recent Value Engineering Study.

Interests Served: The proposal receives a "4" for interest served: municipal & industrial, agricultural, outdoor recreational, and environmental interests.

People Served: The proposal is estimated to serve 31,088 persons. The number is the sum of the populations of Bayard, Cliff, Deming, Gila, Hurley, Santa Clara, Silver City, and Virden, from the 2010 U.S. Census.

Environmental Impacts: The proposal receives a "+12" for a net environmental benefit on the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species

- Potentially inundate up to four side canyons; minor impacts to scrub vegetation in three canyons; potential impacts to riparian habitat in one canyon: -2 (Winn), -2 (Spar), -2 (Pope,; -6 (Sycamore) = -12
- Potentially provide water to wildlife (primarily mammals and waterfowl) at reservoirs: 2+2+2+2= +8
- Potentially release water with ancillary benefit of preventing die-off of riparian vegetation, BMI, listed species, and birds and amphibians in the Ft. West Ditch reach: +2+2+6+2= +12
- Lower high flows and potentially release water to increase habitat of spikedace and loach minnow: +6
- Minor reduction in secondary channel flows: -2

Technical Feasibility (Challenges): The proposal receives a "10" (low score) because the project would be complex and challenging.

Timing of Implementation: It is projected that the project would come on line by 2034.

Complements Regional Water Plan Objectives: The proposal receives an "8" for meeting the following:

1. Store New Mexico's Gila/San Francisco River Entitlement in reservoirs (1)
2. Develop additional surface water (2)

3. Set aside some of the captured New Mexico Gila/San Francisco River Entitlement for instream flow and environmental purposes in the Gila (5)

A2.3: City of Deming (Effluent Reuse)

Water Supply: The estimated average annual amount water conserved is 400 acre-feet.

Interests Served: The proposal receives a "2" for interests served: municipal and industrial; and outdoor recreational.

People Served: The proposal is estimated to serve 14,855 persons, which is the population reported for Deming in the 2010 U.S. Census.

Environmental Impacts: The proposal receives a "0" because it is not anticipated to affect the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species.

Technical Feasibility (Challenges): The proposal receives a "45" because the project is presents a low degree of difficulty for implementation.

Timing of Implementation: It is assumed that the improvements could be on line in 2018.

Complements Regional Water Plan Objectives: The proposal receives a "4" for meeting the following:

1. Treat and reuse wastewater (2)
2. Ensure that future growth optimizes wise use of water resources and protects local social and cultural values (2)

A2.4: Gila Basin Irrigation Commission (Irrigation Diversion Structure)

Water Supply: The estimated average annual water yield for the proposal is 224 acre-feet, which is primarily water not lost during periods of point of diversion washout.

Interests Served: The proposal receives a "2" for interest served: agricultural and environmental interests.

People Served: The proposal is estimated to serve 100 persons

Environmental Impacts: The proposal receives a "+3" because it would prevent repeated incursions of heavy equipment into the Gila's riparian corridor and sediment production, up to three times per year.

Technical Feasibility (Challenges): The proposal receives a "40" because the project is assumed to offer a relatively low degree of difficulty for implementation.

Timing of Implementation: It is assumed that the first use of conservation funds could be in 2019.

Complements Regional Water Plan Objectives: The proposal receives a "5" for meeting the following:

1. Implement agricultural conservation measures (5)

A2.5: Gila Conservation Coalition (Municipal Conservation Fund)

Water Supply: The estimated average annual amount water conserved for the Gila Conservation Coalition proposal is 952 acre-feet. This is based upon Harvey Economics' assumptions regarding annual increases in project participants and water savings.

Interests Served: The proposal receives a "1" for interest served: municipal and industrial.

People Served: The proposal is estimated to serve 42,880 persons. The number is the sum of the population in the incorporated areas of the Southwestern Planning Region from the 2010 U.S. Census. The number is not the same as number of participants, as it assumes that all users on a water system would benefit from the conservation of others.

Environmental Impacts: The proposal receives a "0" because it is not anticipated to affect the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species.

Technical Feasibility (Challenges): The proposal receives a "50" (highest possible score) because the project is assumed to offer a low degree of difficulty for implementation.

Timing of Implementation: It is assumed that the first use of conservation funds could be in 2016.

Complements Regional Water Plan Objectives: The proposal receives a "7" for meeting the following:

2. Implement municipal water supply conservation (5)
3. Ensure that future growth optimizes wise use of water resources and protects local social and cultural values (2)

A2.6: Grant County (Recreational Reservoir)

Water Supply: The water supply of the Grant County reservoir would be dependent on the Southwest Regional Water Supply System, so it does not receive a score based upon capacity. However, it receives a "60" for aquifer recharge. In the CBA AS MODIFIED BY ISC matrix, the supply is orders of magnitude lower than other proposals, creating numerical inaccuracies in calculating relative advantages and importances (E.g., if used in cost calculations, the low supply translates to virtually identical importances for all other propsoals.). For this reason, the Grant county Reservoir proposal was omitted from water supply and cost factors.

Interests Served: The proposal receives a "2" for interest served: municipal and industrial and outdoor recreational.

People Served: The proposal is estimated to serve 54,609 persons. The number is the sum of the population of Grant and Luna Counties from the 2010 U.S. Census.

Environmental Impacts: The proposal receives a "0" for a net environmental benefit on the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species

- Potentially inundate up one canyon; minor impacts to scrub vegetation: -2
- Potentially provide water to wildlife (primarily mammals and waterfowl) at reservoirs: +2

Technical Feasibility (Challenges): The proposal receives a "32." A dam and pipeline would be constructed, but the design and construction are common.

Timing of Implementation: It is assumed that the project would come on line in 2034.

Complements Regional Water Plan Objectives: The proposal receives a "4" for meeting the following:

1. Store New Mexico's Gila/San Francisco River Entitlement in reservoirs (1)
2. Develop additional surface water (2)
3. Import a large amount of water into the region (1)

A2.7: Grant County Water Commission (Well Field & Pipeline)

Water Supply: The estimated average annual amount of water yield is 900 acre-feet.

This estimate is based on the assumption that the Office of the State Engineer will fully grant Silver City's application for a groundwater credit. It should be noted that the 900 acre-feet does not represent an additional water supply for the region or represents any conservation of water. Instead, the proposal would pump existing groundwater in the Mimbres aquifer and reuse and deplete Silver city's effluent instead of allowing it to recharge the aquifer.

Interests Served: The proposal receives a "1" for interests served: municipal & industrial.

People Served: There are 15865 people served by the water systems of the towns involved in this project.

Environmental Impacts: The proposal receives a "0" because it is not anticipated to affect the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species.

Technical Feasibility (Challenges): The proposal receives a "35" because wells and water systems are typical infrastructure for water systems in New Mexico. However, the system does have to be properly designed.

Timing of Implementation: It is estimated that the project could come on line in 2019.

Complements Regional Water Plan Objectives: The proposal receives a "3" for meeting the following:

1. Develop additional groundwater (3)

A2.8: Pleasanton East-Side Ditch Company

Water Supply: The estimated average annual amount of water conserved for the Pleasanton East-Side Ditch Company proposal is 844 acre-feet. This is based upon taking the average ditch diversion for the period 2008 – 2012 and assuming a 20 percent conveyance loss that could be conserved.

This is likely a high estimate, and, certainly, the entirety of losses could not be conserved, especially with Pleasanton preferring the alternative with one segment of open ditch. In addition, the ISC's records indicate that Pleasanton rarely, if ever, experiences water shortage.

Interests Served: The proposal receives a "1" for interests served: agricultural.

People Served: The proposal indicates that the ditch serves 24 water users.

Environmental Impacts: The proposal receives a "0" because it is not anticipated to affect the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species.

Technical Feasibility (Challenges): The proposal receives a "42" because the ditch projects such as Pleasanton's are common in New Mexico, and it is assumed to offer a low degree of difficulty for implementation, especially since replacement of the point of diversion is not proposed.

Timing of Implementation: The project would likely be constructed in two phases. In addition, a portion of the project would be on U.S. Forest Service land, and thus, would require NEPA compliance. Therefore, it is projected that the project would be completed in 2021.

Complements Regional Water Plan Objectives: The proposal receives a "5" for meeting the following:

2. Implement agricultural conservation measures (5)

A2.9: Sunset and New Mexico New Model Canals

Water Supply: The estimated average annual water supply for the Sunset-New Model proposal is 1,853 acre-feet. This is based upon taking the average diversion for each canal over the period 2005 – 2012. Since both canals serve lands in New Mexico and Arizona, the diversion on each ditch was multiplied by the respective proportion of land served in New Mexico. It was then assumed that there is a 20 percent conveyance loss that could be conserved.

Interests Served: The proposal receives a "1" for interests served: agricultural.

People Served: It is assumed that the project would serve 152 persons, based upon the 2010 U.S. Census population of Virden.

Environmental Impacts: The proposal receives a "0" because it is not anticipated to affect the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species.

Technical Feasibility (Challenges): The proposal receives a "42" because ditch projects are common in New Mexico, and it is assumed to offer a low degree of difficulty for implementation.

Timing of Implementation: It is projected that the project would be completed in 2021.

Complements Regional Water Plan Objectives: The proposal receives a "5" for meeting the following:

1. Implement agricultural conservation measures (5)

A2.10: 1892 Luna Irrigation Ditch

Water Supply: The estimated average annual water supply for the Luna Irrigation Ditch proposal is 50 acre-feet. This is based upon taking the average diversion for each canal over the period 2008 – 2012 and assuming a 20 percent conveyance loss.

Interests Served: The proposal receives a "1" for interests served: agricultural.

People Served: It is assumed that the project would serve 158 persons, based upon the 2010 U.S. Census population of Luna census-designated place.

Environmental Impacts: The proposal receives a "3" because it is anticipated that the installation of a permanent diversion structure will have a positive effect on the San Francisco River.

Technical Feasibility (Challenges): The proposal receives a "40" because ditch projects are common in New Mexico, and it is assumed to offer a low degree of difficulty for implementation.

Timing of Implementation: It is projected that the project would be completed in 2019. NEPA will be required for reason that the point of diversion is located within national forest.

Complements Regional Water Plan Objectives: The proposal receives a "5" for meeting the following:

1. Implement agricultural conservation measures (5)

APPENDIX 3: MULTIPLE CRITERIA DECISION-MAKING DESCRIPTION OF ATTRIBUTES AND SCORING

A3.1: Catron County (Ditch Proposal)

Water Supply: The estimated average annual amount of water conserved for the Catron County Ditch Proposal is 800 acre-feet.

Interests Served: The proposal receives a "1" for interests served: agricultural.

People Served: The proposal is estimated to serve 194 people. This is based upon the assumption that the Pleasanton East-Side Ditch is representative of Catron County community ditches, i.e., 24 water users. Then, the number 24 is multiplied by 10 ditches. However, at least one ditch, the Pleasanton West-Side Ditch, is not in use, so 24 are subtracted. At least one ditch is a private ditch, so another 22 are subtracted. (24 x10) – 24 – 22 = 194

Environmental Impacts: Some diversion structures are anticipated to be replaced with infiltration galleries, which would reduce the frequent in-channel work for earthen structures on the San Francisco River. In addition, the proposed on-farm storage ponds would provide an ancillary benefit to wildlife. There might be a need for mitigation.

Technical Challenges: The proposal receives a "4" on a scale of 0 to 5, with 5 being very easy. The score is not higher due to the infiltration gallery component.

Timing of Implementation: Assuming that work could concurrently commence on at least some of the 10 ditches, it is estimated that all work would be completed by 2021.

2005 SW Regional Water Plan: As this project would implement agricultural conservation, it reflects Alternative WC2 of the Water Plan. This is a priority alternative and has the Implementation Priority of 1.

Design life: Assume this system will last 40 years.

Capital cost: Design, permitting and construction would cost $6.7 million. To estimate the total volume of water the project would provide, the volume of water per year was multiplied by the number of years the facilities might be in service:

$800 \frac{\text{AF}}{\text{yr}}$ x 40 yr = 32,000 AF.

Then, the cost was divided by this volume of water: $ 6684800 ÷ 32000 AF = $209 per AF.

OM&R cost: Unknown. Estimate $330,000 and divide by water yield:

$330,000 ÷ 800 = $413 per AF

Combined Annual Costs: $209 +$413 = $622 per AF.

A3.2: City of Deming Effluent Reuse:

This project would apply treated effluent to recreational facilities that are currently being maintained with potable water pumped from the aquifer.

Water volume: This project replaces 400 AF/yr of water pumped from the aquifer with treated effluent. This effluent is currently wasted to evaporation.

Number of different interests served: By reducing pumping costs and alleviating stress on the aquifer, this project should benefit the entire municipality of Deming. By leaving 400 AF/yr in the aquifer for other uses, this project also serves agriculture. This was counted as 2 interests served, recognizing that municipal could include "industry" and agriculture could be considered as "business." The count was limited to 2 to avoid double-counting.

Number of people served: There are about 14,600 people living in Deming. This is 23% of the 63,000 people living in SW NM.

Environmental: This project is not likely to benefit any ecology or require any mitigation. It will not affect any forest or natural aquatic ecology.

Technical challenges: No complex engineering or construction methods would be required for this project and, as the routes of the pipelines are on previously developed city property, there are few unknowns. The pipelines would reach about 2 miles from the source, gaining 20 feet elevation. Pumps and a control system would also be required. No NEPA, environmental or archaeological surveys would be required for this project. On a scale of 0 to 5, with 5 being very easy, this would rate 4.

Time to implement: Final design and construction could commence immediately after funding as the entire project would take place on city owned property. It could be built and operating in less than 2 years.

2005 SW Regional Water Plan: As this project would treat and reuse wastewater, it reflects Alternative ID3 of the Water Plan. This is not a priority alternative, but does have the Implementation Priority of 1.

Design life: With proper maintenance, the system should last for several decades. Some sections of pipeline may get reconfigured, or new areas might be added, but the 2-mile-long trunk line will be versatile and serve for 50 years.

Capital Cost: Depending on the final selection of treatment level, the construction cost of this project could vary by $300,000. The following is done assuming design, permitting and construction would cost $4.52 million. To estimate the total volume of water the project

would provide, the volume of water per year was multiplied by the number of years the facilities might be in service: $400 \frac{AF}{yr}$ x 50 yr = 20000 AF.

Then, the cost was divided by this volume of water: $4,520,000 ÷ 20000 AF = $226 per AF.

OM&R Costs: The 10% evaluation estimated OM&R to be $75,000 annually.

$75000 ÷ 400 AF = $187 per AF.

Combined Annual Costs: $220 +$187 = $413 per AF.

A3.3: Gila Basin Irrigation Commission (Diversion Structure)

The irrigators in the Cliff-Gila Valley construct push-up earthen berms as the diversion points for Upper Gila, Fort West, and Gila Farms community ditches. There is a need to enhance and improve the existing diversion points to withstand high flows and to transport sufficient flow, as well as cost-effective to maintain. The GBIC proposal requests more permanent diversion structures that would be built in the same general location where their earthen diversions exist today.

Water supply volume: Based on the ISC staff's estimate, the water yield could be up to 10% of the irrigators' water rights (approximately 224 AF/yr).

Number of different interests served: The GBIC proposal would support agriculture and the environment.

Number of people served: It is estimated that this project could serve about 100 people in the Cliff-Gila Valley that are less than 5% of the regional population.

Environmental impacts: This proposal would eliminate the need for regular disturbance of the floodplain and the riparian zone and the negative sediment deposition that now takes place every time the push-up diversion dams require rebuilding or maintenance. Therefore, it benefits the ecology. The conservative assumption is that it might require some mitigation.

Technical Challenges: There would be minimal technical challenges to construct the structure for this proposal.

Time to implement: Following permitting and design, the project construction would begin in 2018 and take place over a period of 2 years. Therefore, the project could potentially come on line in 2020.

Design life: The ISC staff assumed a project life of 50 years for this proposal.

2005 SW Regional Water Plan: As this project would implement agricultural conservation, it reflects Alternative WC2 of the Water Plan. This is a priority alternative and has the Implementation Priority of 1.

Capital cost of the project is estimated to be $1.766 million in 2013 dollars. Hence, capital cost per acre foot over the life of the project is: $1,728,000 ÷ 224 ÷ 50= $154/AF

Annual O&M costs are estimated to be $35,477 in 2013 dollars. Hence, O&M cost per acre foot over the life of the project is: $35,477 ÷ 224 = $158/AF

A3.4: Gila Conservation Coalition (Municipal Conservation Fund)

Water Supply: The estimated average annual amount water conserved for the Gila Conservation Coalition proposal is 952 acre-feet. This is based upon Harvey Economics' assumptions regarding annual increases in project participants and water savings.

Interests Served: The proposal receives a "1" for interest served: municipal and industrial.

People Served: The proposal is estimated to serve 42,880 people. The number is the sum of the population in the incorporated areas of the Southwestern Planning Region from the 2010 U.S. Census. The number is not the same as number of participants, as it assumes that all users on a water system would benefit from the conservation of others.

Environmental Impacts: The proposal is not anticipated to affect the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species. This project is not likely to benefit any ecology or require any mitigation. It will not affect any forest or natural aquatic ecology.

Technical Challenges: The proposal receives a "5" (highest possible score) because the project is assumed to offer a low degree of difficulty for implementation.

Timing of Implementation: It is assumed that the first use of conservation funds could be in 2016.

2005 SW Regional Water Plan: As this project would provide assistance for domestic conservation, it reflects Alternative WC1 of the Water Plan. This is a priority alternative and has the Implementation Priority of 1.

Design Life: Assumed to be 20 years

Capital Cost: The goal of this proposal is to establish a $10 million fund which can be used to assist with conservation projects. In 2013 dollars, this is estimated to be $9.2 million. Hence, capital cost per acre foot over the life of the project is: $9,227,000 ÷ 952 ÷20= $485/AF

Annual O&M costs are estimated to be $35,477 in 2013 dollars. Hence, O&M cost per acre foot over the life of the project is: $57,000 ÷ 952 = $60/AF

A3.5: Grant County Reservoir

This project would create a recreational reservoir, for fishing and swimming, in a canyon near Fort Bayard. This reservoir would be filled with water from the Gila River accessed from the SW Regional Water Project proposed by other entities.

Water supply: This project poses many facets regarding water supply. First, it would make 3000 AF of Gila River water available for use in the Fort Bayard area. If this were to be compared to the Grant County Water Commission proposal, the score could be based on 3000. ISC staff was concerned that this would "double count" water from another proposal. Second, it would add about 60 AF/yr to the local groundwater table through seepage. Third, it would lose up to 550 AF/yr to evaporation. Considering this reservoir strictly as a recreational unit, excluding any of the subsequent suggestions that it might serve other purposes as a water storage facility, it could be rated at negative 490 AF/yr . For purposes here, it is assumed to be 60 AF/yr.

Interests served: This project would serve outdoor recreation and environmental interests.

People served: The reservoir resulting from this proposal could serve anyone who chooses to use it, whether they are local or tourist. To estimate this number, the entire populations of the area serviced by the Silver City, Bayard, Santa Clara and Hurley water systems was added to the population of Deming, totaling approximately 44,000 people. This is 70% of the people living in SW NM.

Environmental: This reservoir is planned for a canyon that seldom has water in it. Still, there is a possibility that mitigation would be required. There is equal possibility that providing a reliable source of water would benefit a riparian habitat.

Technical challenges: This project would require designing and constructing a dam that accommodates the geography and geology of the canyon and the demands on the reservoir. A pipeline with connection into the regional pipeline would have to be designed and installed, as would access roads, a pump station and power lines. It will impact federal land, so NEPA would be required. On a scale of 0 to 5, with 5 being very easy, this would rate 3.

Time to implement: Assuming that final design and construction commencing about the same time as the regional pipeline, around the year 2030, this project would be completed about 2035. Actual time for design and construction is about 4 ½ years.

Design life: With proper maintenance, the system should last for many decades. For purposes here, design life is assumed to be 50 years.

2005 SW Regional Water Plan: As this project would store New Mexico's Gila/San Francisco River Entitlement in a small, non-mainstem reservoir, it reflects Alternative ID2. This is not a priority alternative, but does have the Implementation Priority of 3.

Capital cost: Design, permitting and construction of this project would cost $18 million. Based on 60 AF/yr yield and a 50 year lifetime, to estimate the total volume of water the project would provide, the volume of water per year was multiplied by the number of years the facilities might be in service: $60\frac{AF}{yr}$ x 50 yr = 3000 AF. Then, the cost was divided by this volume of water:

$18,000,000 ÷ 3000 AF = $6000 per AF.

OM&R costs: Estimated to be $105,300 annually. $105,300 ÷ 60 AF = $1,755 per AF.

Combined Annual Costs: $6000 +$1755 = $7755 per AF.

A3.6: Grant County Water Commission Well field & Pipeline

This project would pump up to 943 AF/yr from the Mimbres Basin aquifer and distribute it to Hurley, Bayard, Santa Clara, Silver City and other small communities.

Water supply: This project would make up to 943 AF/yr of water available for municipal use in Grant County. As it would extract water from the aquifer, it would have a negative effect on the long-term water supply. The proposed plan is for the project to be built in phases, pumping only 193 AF/yr at the beginning and ramping up to 943 AF/yr after several years.

Interests served: Municipal only.

People served: There are 15865 people served by the water systems of the towns involved in this project. This is 25% of the people living in SW NM.

Environmental: In the process of determining locations for pipelines, power lines, and roads, environmental surveys would be required. Threatened or endangered species habitat might be encountered. This project would not likely benefit any ecology, but may require some mitigation. It would not affect any forest or natural aquatic ecology.

Technical challenges: This project would require design and construction of a system that could pump from water from 1000 feet below ground, then uphill 600 feet across 15 miles. Pipes would have to connect to existing systems. One large storage tank, access roads and power would have to be installed.. Given the distance this pipeline must go, there would be considerable field work done to determine the most appropriate path. Depending on the routing of the pipeline, NEPA may be required. On a scale of 0 to 5, with 5 being very easy, this would rate 3.

Time to implement: The scoring assumes that final design and construction would begin immediately after funding is approved. Estimated time to complete permitting, design and construction is 3 ½ years.

Design life: With proper maintenance, the system should last for many decades. Wells in the Deming area, 35 miles to the south, have experienced declining water levels for several decades. It is not known whether this well field would experience the same after continued use. For purposes here, design life is assumed to be 50 years.

2005 SW Regional Water Plan: As this project would develop additional groundwater, it reflects Alternative WM1 of the Water Plan. This is a priority alternative, and has the Implementation Priority of 3 (indicating to begin implementing in 11 to 40 years).

Capital cost: Design, permitting and construction of this project would cost $16.4 million. Given the range of pumping mentioned above, this calculation was based on 900 AF/yr yield and a 50 year lifetime. To estimate the total volume of water the project would provide, the volume of water per year was multiplied by the number of years the facilities might be in service:

$900 \frac{AF}{yr}$ x $50\ yr$ = 45000 AF.

Then, the cost was divided by this volume of water: $16,400,000 ÷ 45000 AF = $365 per AF.

OM&R costs: Estimated to be $505,300 annually. $505,300 ÷ 900 AF = $561 per AF

Combined Annual Costs: $365 +$561 = $926 per AF.

A3.7: Pleasanton East-Side Ditch Company

Water Supply: The estimated average annual amount of water conserved for the Pleasanton East-Side Ditch Company proposal is 844 acre-feet. This is based upon taking the average ditch diversion for the period 2008 – 2012 and assuming a 20 percent conveyance loss that could be conserved.

This is likely a high estimate, and, certainly, the entirety of losses could not be conserved, especially with Pleasanton preferring the alternative with one segment of open ditch. In addition, the ISC's records indicate that Pleasanton rarely, if ever, experiences water shortage.

Interests Served: The proposal would serve agriculture.

People Served: The proposal indicates that the ditch serves 24 water users.

Environmental Impacts: The proposal is not anticipated to affect the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species. This project is not likely to benefit any ecology or require any mitigation. It will not affect any forest or natural aquatic ecology.

Technical Challenges: The proposal receives a "4" on a scale of 0 to 5, with 5 being very easy. It is assumed to offer a low degree of difficulty for implementation, especially since replacement of the point of diversion is not proposed.

Timing of Implementation: The project would likely be constructed in two phases. In addition, a portion of the project would be on U.S. Forest Service land, and thus, would require NEPA compliance. Therefore, it is projected that the project would be completed in 2021.

2005 SW Regional Water Plan: As this project would implement agricultural conservation, it reflects Alternative WC2 of the Water Plan. This is a priority alternative and has the Implementation Priority of 1.

Design Life: Assumed to be 40 years.

Capital cost of the project is estimated to be $2.5 million in 2013 dollars. Hence, capital cost per acre foot over the life of the project is: $ 2,536,000 ÷ 844 ÷ 40= $75/AF

Annual O&M costs are estimated to be $ 126800 in 2013 dollars. Hence, O&M cost per acre foot over the life of the project is: $126800 ÷ 844 = $150/AF

A3.8: Southwest Regional Water Supply (SWRWS)

This combined proposal would divert AWSA water from the Gila River, store it in off-stream storages in the Cliff-Gila Valley, release it for environmental and agricultural needs during low flows, and pump the water over the continental divide to communities in the Mimbres Basin. The SWRWS pipeline is proposed to be constructed along the right-of-way for US Highway 180.

Technical challenges: Based on the VE study, the overall concept of diversion and storage is technically feasible. However, it requires the most challenging engineering and construction of all AWSA proposals.

In terms of time to implement, the project construction would begin in 2024 and take place over a period of 10 years, following permitting and design. Therefore, the project could potentially come on line in 2034.

Environmental impacts: There will be no AWSA diversion or storage either in the Gila Wilderness or the Birds Area. Riparian health/flow correlation study (Intera, 2013), benthic macroinvertebrate study (HDR, 2014), fish habitat simulations (SWCA, 2014 / HDR, 2014), and population viability analyses (SWCA, 2014) indicate that maintaining and/or releasing at least 10 cfs in the river at the time when the river goes dry/intermittent in the Cliff-Gila Valley below the irrigation diversions, would result in riparian vegetation robustness, increased benthic macroinvertebrate productivity (which are food sources for native fish), zero probability of extinction for Spikedace and Loach Minnow, and up to 11% habitat increase for all fish species. This low flow augmentation scenario could potentially be considered to further reduce the risk of non-native fish colonization and habitat fragmentation in case of drought. Based on these studies commissioned by the ISC, this proposal could benefit the ecology through environmental releases. No species or habitats were identified that could not be mitigated (SWCA, 2013). Therefore, it is concluded that the SWRWS proposal would benefit to ecology, but requires some mitigation.

The ISC staff assumed a project life of 50 years for this project; i.e. with proper maintenance, this project could last for at least 50 years.

Water supply volume: Based on the ISC's AWSA diversion model, an annual average AWSA diversion of up to about 12,000 AF/Y would be available based on historical data since 1937. The water availability and safe yield were of topics of investigation by an independent Value Engineering Team. Based upon the VE Team's initial review, the ISC spreadsheet provides reasonable estimates of divertible flow for historical conditions for reconnaissance level planning purposes. The preliminary results also showed that about

8,000 to 9,000 acre feet of water can be delivered from reservoir on an average annual basis, depending upon the capacity of storage. ISC staff assumed the availability of 8,000 AF/yr for the purpose of the decision matrix.

Capital cost of the project is estimated to be $5.48 million in 2013 dollars, based on the ISC staff's interpretation of the VE draft report. Hence, capital cost per acre foot over the life of the project is:

$548,000,000 ÷ 8,000 ÷ 50= $1,370/AF

Annual O&M costs are estimated by reducing BHI's estimate for Alternative 2B in Phase I study by 10%, based on the ISC staff's interpretation of the VE draft report:

$2,264,000 × 0.9 = $2,037,600

Hence, O&M cost per acre foot over the life of the project is:

$2,037,600 ÷ 8,000 = $255 per acre foot.

Number of different interests served: The SWRWS project could meet agricultural, recreational, environmental, and municipal and industrial needs.

Number of people served: It is estimated that this project could serve more than 30,000 people in Grant, Luna, and Hidalgo Counties that are more than 20% of the regional population.

2005 SW Regional Water Plan: This project reflects the highest priority of the 2005 State Water Plan for the region.

Based on the preliminary results of the economic study, the SWRWS proposal has the benefit-to-cost ratio of 1.44, given the aforementioned assumptions.

A3.9: Sunset and New Mexico New Model Canals

Water Supply: The estimated average annual water supply for the Sunset-New Model proposal is 1,853 acre-feet. This is based upon taking the average diversion for each canal over the period 2005 – 2012. Since both canals serve lands in New Mexico and Arizona, the diversion on each ditch was multiplied by the respective proportion of land served in New Mexico. It was then assumed that there is a 20 percent conveyance loss that could be conserved.

Interests Served: The proposal would serve agriculture.

People Served: It is assumed that the project would serve 152 people, based upon the 2010 U.S. Census population of Virden.

Environmental Impacts: The proposal is not anticipated to affect the general environment of southwestern New Mexico, riparian habitat, the Gila and San Francisco Rivers, tributaries, or endangered species. This project is not likely to benefit any ecology or require any mitigation. It will not affect any forest or natural aquatic ecology.

Technical Challenges: The proposal receives a "4" on a scale of 0 to 5, with 5 being very easy.

Timing of Implementation: It is projected that the project would be completed in 2021.

2005 SW Regional Water Plan: As this project would implement agricultural conservation, it reflects Alternative WC2 of the Water Plan. This is a priority alternative and has the Implementation Priority of 1.

Design Life: Assumed to be 50 years.

Capital cost of the project is estimated to be $12.9 million. Hence, capital cost per acre foot over the life of the project is: $12,903,000÷ 1,853 ÷ 50= $139/AF

Annual O&M costs are estimated to be $ 645100. Hence, O&M cost per acre foot is:

$645100÷ 1,853 = $348/AF.

A3.10: 1892 Luna Irrigation Ditch

Water Supply: The estimated average annual water supply for the Luna Irrigation Ditch proposal is 50 acre-feet. This is based upon taking the average diversion for each canal over the period 2008 – 2012 and assuming a 20 percent conveyance loss.

Interests Served: The proposal would serve agriculture.

People Served: It is assumed that the project would serve 158 people, based upon the 2010 U.S. Census population of Luna.

Environmental Impacts: The proposal is anticipated to benefit the ecology of the San Francisco River. This project is not likely require any mitigation. It will not affect any forest ecology.

Technical Challenges: The proposal receives a "4" on a scale of 0 to 5, with 5 being very easy.

Timing of Implementation: It is projected that the project would be completed in 2019. NEPA will be required for reason that the point of diversion is located within national forest.

2005 SW Regional Water Plan: As this project would implement agricultural conservation, it reflects Alternative WC2 of the Water Plan. This is a priority alternative and has the Implementation Priority of 1.

Design Life: Assumed to be 50 years.

Capital cost of the project is estimated to be $1.4 million in 2013 dollars. Hence, capital cost per acre foot over the life of the project is: $ 1438700÷ 50 ÷ 50= $575/AF

Annual O&M costs are estimated to be $ 71,900. Hence, O&M cost per acre is:
$71,900 ÷ 50 = $1438/AF.

APPENDIX 4: COST SHEET

2013 $$	SWRWSP	GBIC	DEMING EFF	GCWC WELL & Pipeline	GC RES	CATRON DITCH	LUNA	SUNSET/NEW MODEL	PLEASANTON	GCC
Capital	548,062,731	1,728,355	4,520,000	16,423,700	18,063,500	6,684,800	1,438,700	12,903,000	2,536,000	9,227,000
Design Life	50	50	50	50	50	40	50	50	40	20
Capital/yr	10,961,255	34,567	90,400	328,474	361,270	167,120	28,774	258,060	63,400	461,350
O&M	2,264,364	35,477	74,800	505,300	105,300	334,200	71,900	645,100	126,800	57,000
Pre-bank	978,683									
TOTAL	14,204,302	70,044	165,200	833,774	466,570	501,320	100,674	903,160	190,200	518,350
AF/YR	8,000	224	400	900	60	800	50	1,853	844	952
$/AF	1,776	313	413	926	7,776	627	2,013	487	225	544

Watershed proposals

	SFW (CATRON)	NMFIA	NMSU	GNF	GSWCD
Capital	7,440,358	2,350,914	2,247,581	3,378,274	1,253,648
Design Life					
Capital/yr	744,036	235,091	224,758	482,611	125,365
O&M					
Pre-bank					
TOTAL	744,036	235,091	224,758	482,611	125,365
AF/YR					
$/AF	14,881	4,702	4,495	9,652	2,507

APPENDIX 5: GILA SAN FRANCISCO WATER COMMISSION'S RESOLUTION

RESOLUTION #R-14-10-31-1

A RESOLUTION PRIORITIZING THE PROJECTS RELATED TO THE ARIZONA WATER SETTLEMENT ACT

WHEREAS, The 2004 Arizona Water Settlements Act Section 212(i) has specific language to include the "Southwest New Mexico Water Planning Group" or its successor as a consulting agency to the New Mexico Interstate Stream Commission in the selection of projects for funding through the AWSA: and ,

WHEREAS, The Gila/San Francisco Water Commission is the direct successor to the Southwest New Mexico Water Planning Group and is representative of the four southwest counties of New Mexico, a majority of the municipalities, soil and water conservation districts, ditch associations and irrigation commissions; and,

WHEREAS, The Gila/San Francisco Water Commission is dedicated to the interests of these same entities concerning municipal water supply, agricultural water supply, infrastructure improvements, and conservation practices while maintaining a healthy ecosystem for both the San Francisco River and the Gila River alike; and,

WHEREAS, the communities, water users, and stakeholders in the Southwest New Mexico Water Planning Region including Catron, Grant, Hidalgo, and Luna Counties, wish to work cooperatively to protect and conserve the water resources of the planning region and to ensure that the water supplies assured to New Mexico under the AWSA are utilized for the benefit of the planning region.

WHEREAS, it is the interest of the Gila/San Francisco Water Commission and the residents of Southwest New Mexico to represent the needs of the area through the process approved by the Interstate Stream Commission for prioritization and selection of projects being considered for funding.

NOW, THEREFORE BE IT RESOLVED by the Gila/San Francisco Water Commission that through a meeting held on October 21, 2014 a list of priorities was approved by unanimous vote utilizing a classification system of projects with priorities as follows:

1. Diversion
2. Water Delivery
3. Conservation
4. Watershed Restoration

NOW, THEREFORE BE IT FURTHER RESOLVED by the Gila/San Francisco Water Commission that with the exception of the number 1 priority all other projects will be prioritized by utilizing the listing provided by Resolution #R-12-02-21-1 within their respective category and that these priorities be recommended to the Interstate Stream Commission for consideration.

Diversion

1. Southwest Regional Water Supply Project (Deming Diversion)
2. Gila Basin Irrigation Commission Diversion
3. Hidalgo County Off-stream Storage
4. Grant County Reservoir
5. San Francisco Watershed Rehab (Irrigation portion)

Water Delivery

6. Luna Ditch Association
7. Sunset and New Model Ditches
8. Pleasanton Eastside Ditch
9. Grant County Water Commission Regional Supply
10. Coalition Diversion

Conservation

11. Gila Conservation Fund
12. Deming Conservation Fund
13. Deming Water Reuse

Watershed restoration

14. San Francisco Watershed Rehab
15. Grant Soil and Water Conservation Watershed Rehab
16. NMSU Watershed restoration and Monitoring

Passed, Approved and Adopted by the Gila/San Francisco Water Commission this 31st day of October, 2014.

Anthony Gutierrez – Chairman GSFWC