FINAL REPORT
VALUE ENGINEERING STUDY

Southwest Regional
Water Supply (SWRWS)
Project

Prepared for:

New Mexico Interstate Stream Commission

Prepared by:

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SECTION 1 – EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report contains the results of the Value Engineering Study of the Southwest Regional Water Supply (SWRWS) Project, proposed to the Interstate Stream Commission as part of the planning process under the 2004 Arizona Water Settlements Act (AWSA). The report is organized in a drill down format, that is, all items are presented first in summary format with increasing levels of detail as one delves (drills down) further into the report. This will allow the reader to easily obtain only the information he or she desires.

The goals for this VE Study were to: review the AWSA water availability including the AWSA diversion model, review the BHI and the BOR appraisal-level designs including the preferred configuration of components, and recommend further studies and/or investigations. Areas not included in this VE Study were: " quality control checks of the current appraisal level designs, review of the legal implication of the project, or independent cost estimate review of the current appraisal level designs.

Technical data provided the VE Team included data from the BHI Phase II Draft Final Report dated September 12, 2014, Bureau of Reclamation Appraisal Level Report on the Arizona Water Settlements Act Tier-2 Proposals and other Diversion and Storage Configurations dated July 2014, plus multiple other reports and data.

The VE Team consisted of eight very senior technical specialists plus an equally senior value engineering facilitator. The technical specialties included: constructability and costing; hydraulic structures and conveyance; environmental permitting; geomorphology and sediment transport; dams, reservoirs and geotechnical; electrical; tunneling; hydrology, water modeling and yield; and value engineering and life-cycle costing.

The Value Engineering (VE) Team selected BHI's Preferred Alternative No. 2 as the base case against which to measure their VE Proposals. Therefore, all of the proposals and supplemental recommendations are measured against this design concept. This Value Engineering (VE) Study generated thirteen (13) proposals and seventeen (17) supplemental recommendations. These proposals and supplemental recommendations are categorized by following technical areas: Diversion, Sedimentation, Conveyance, Storage/Reservoirs, Distribution and Diversion Model Review.

For the purpose of this report, the Value Engineering Proposals are ideas that have the potential to save life-cycle costs, and Supplemental Recommendations are ideas that would improve the project, but don't easily fit into either of the previous category. The first section of the report contains an executive summary of all the value engineering proposals, their estimated savings, and their ultimate disposition. To obtain the backup information about the VE Proposal, or the Review Board (ISC staff) Decision reasoning regarding the VE Proposal, the hyperlinks shown in the summary table can be used. The second section of the report contains a brief project background, the VE Study Team Members, and a brief description of the methodology used. The third section contains detailed information about each VE Proposal. These individual proposal analyses are also organized in a drill down manner. Section Four contains a summary of all the supplemental recommendations, and their ultimate disposition. As mentioned above, these are ideas that the Team thought would add value to the project but do not necessarily reduce life-cycle costs. This section is further subdivided into four sections: AWSA Water Availability, Recommendations for Added Value, Recommendations for Further ISC Study, and Notes to Designer. To obtain the backup information about the VE Supplemental Recommendations, or the Review Board Decision reasoning regarding the VE Supplemental Recommendations, the hyperlinks shown in the summary table can be used. Section Five contains ideas analyzed by the Team, but either failed because they were thought to not be technically viable and/or did not save life-cycle costs. Section Six contains functions analyzed by the VE Team. Section Seven contains all of the brainstorming ideas ideated by the Team both prior to and during the workshop. Section Eight documents the ultimate disposition of the Team's Proposals and Supplemental Recommendations as made by the Review Board.

A summary of findings of the VE Team are as follows:

<u>AWSA Water Availability and Yield</u>

- The ISC diversion model provides reasonable estimates of divertible flow for historical conditions. The average annual amount of t divertible water is about 12,000 AF/yr. The ISC estimates of divertible flow under a climate change scenario are also reasonable for reconnaissance level planning purposes. *It is the VE Team's opinion there will be future reductions in yield due to various permitting and operational requirements.*
- 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 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. Pursuant to this supplemental recommendation, the development of an integrated water supply and operations model is recommended to refine the estimates of divertible flow and Project water yield.*

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

- Use two diversion structures:
  - Coanda screens, expanding across the erosion area within the flood plain
  - Infiltration galleries or passive intake screens
  - Use BHI's recommended diversion point
- Use two reservoirs with total capacity at least in the 45,000 AF range:
  - Small Spar (as proposed by BHI) (1642 AF)
  - 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:
    - Tunnel or
    - Steel buried pipe
- Delivery Over the Continental Divide:
  - Route:
    - Via Tyrone mine (Establish a cooperative agreement with FMI), 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 reservoir 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.

VE PROPOSAL SUMMARY TABLE

Note: To obtain the backup information about the VE Proposal or the Review Board Decision reasoning regarding the VE Proposal, the hyperlinks shown in the summary table can be used.

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD DECISIONS	PAGE NO.
P01-003	Collect, use, and account for surface flows from Gila River tributaries that flow into the system's water storage reservoirs. *Initial Est. Savings: ($20,000)* *Future Est. Savings: $1,580,000* *Total Est. Savings: $1,560,000*	**TABLE** Attractive idea and could be very helpful, but the legal issues are still undecided. The details would have to be worked out in accordance with Sub-term 1.10 of Exhibit 2.47 of Consumptive Use and Forbearance Agreement (CUFA). There are also other laws to which NM must adhere. The NM Office of the State Engineer (OSE) requires that dams release flood runoff within 96 hours.	3-1
P01-009	Use steel pipe to convey diverted water from the Coanda intake screens only at the BHI diversion structure through buried and elevated alignment along the Gila River for discharges into the Spar Reservoir. *Initial Est. Savings: $5,200,000* *Future Est. Savings: $0,000* *Total Est. Savings: $5,200,000*	**DECLINE** Due to environmental concerns and the higher risk of environmental disturbance. In addition, it is not aesthetically desired. It also requires maintenance access road. Construction access would be challenging.	3-6
P01-011	Include water conservation measures as a component of the project. *Initial Est. Savings: $0,000* *Future Est. Savings: $2,864,430* *Total Est. Savings: $2,864,430*	**ACCEPT** Water conservation measures will be included as required by OSE. Those measures are already being considered separately. It would be helpful to know whether or not the savings calculation takes into account the loss of return flows from the fields.	3-10
P01-013	Consolidate Pope and Sycamore reservoirs into one larger reservoir in Greenwood canyon. *Initial Est. Savings: $70,000,000* *Future Est. Savings: $0,000* *Total Est. Savings: $70,000,000*	**ACCEPT** Consolidate Pope and Sycamore reservoirs into one larger reservoir in Greenwood canyon.	3-13
P01-014	Eliminate Winn Reservoir and add a second reservoir in Spar Canyon. *Initial Est. Savings: $17,000,000* *Future Est. Savings: $0,000* *Total Est. Savings: $17,000,000*	**ACCEPT**	3-16
P01-015	Optimize the required number and size of pumping stations for Deming delivery flow (SWRWS) requirements. *Initial Est. Savings: $1,650,000* *Future Est. Savings: $0,000* *Total Est. Savings: $1,650,000*	**ACCEPT**	3-19

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD DECISIONS	PAGE NO.
P01-031	Use passive intake screens to replace the infiltration galleries in combination with Coanda screens at the BHI Gila River diversion point intake structure. *Initial Est. Savings: $13,600,000* *Future Est. Savings: $100,000* *Total Est. Savings: $13,700,000*	**TABLE** This proposal appears to have a greater probability of long-term success than the infiltration gallery. In addition, the projected savings are large. However, USGS data indicates that when the flow is less than 50 cfs, the depth of the water at the gage is less than 5" above 4654'. Looking at the Tetratech bathymetric sketches, these might not be covered during low flows. Finally, security issues need to be addressed.	3-20
P01-048	Construct channels to allow tributary sediment to bypass the storage reservoirs. *Initial Est. Savings: $6,000,000* *Future Est. Savings: ($1,700,000)* *Total Est. Savings: $4,300,000*	**DECLINE** Although this seems preferable to BHI's stormwater detention facilities, sediment removal dams have been in place and to good effect for decades. 12 of the tributaries along the Gila have sediment/flood control dams. Winn Canyon is the largest, and Sycamore has a check dam. But there are no such dams on either Spar or Greenwood.	3-27
P01-055	Modify the feature of the dam discharge to allow greater temperature control of releases. *Initial Est. Savings: $0,000* *Future Est. Savings: $0,000* *Total Est. Savings: $0,000*	**ACCEPT** This will likely be required in order to protect aquatic species.	3-32
P01-060	Use existing electrical infrastructure to feed the low horsepower pumps for Winn Reservoir. *Initial Est. Savings: Not quantified* *Future Est. Savings: Not quantified* *Total Est. Savings: Not quantified*	**ACCEPT WITH MODIFICATIONS** Although the costs/savings are unknown, it seems that the existing electrical infrastructure could be used, especially if there is a pump station for Larger Spar (P01-014), or Greenwood (P01-013). This could also be combined with SR01-030 to use FMI's power infrastructure.	3-35
P01-061	Use 12.47kV or 13.8kV rather than 4.16kV for the large pump motors. *Initial Est. Savings: $2,000,000* *Future Est. Savings: $0,000* *Total Est. Savings: $2,000,000*	**ACCEPT** Due to savings.	3-37
P01-062	Connect into PNM's 115kV source rather than the 69kV source voltage. *Initial Est. Savings: Not Calculated* *Future Est. Savings: Not Calculated* *Total Est. Savings: Not Calculated*	**TABLE** Costs/savings are unknown. Perhaps this could be studied further and some cost estimates generated.	3-39

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD DECISIONS	PAGE NO.
P05-004	Eliminate or move the original concept sedimentation basins from upstream of the off-channel reservoirs into the reservoir innundation area. *Initial Est. Savings: $15,000,000* *Future Est. Savings: $0,000* *Total Est. Savings: $15,000,000*	**ACCEPT** The maintenance issues should be addressed.	3-41

At the time of the VE Study the opinion of probable un-escalated construction bid including design contingency was $641,356,000[1].

Caveats:

- The cost savings shown for each proposal are measured against the raw cost estimates from the consulting firms at the current stage of design which was at 10% appraisal level. Therefore, for consistency's sake the VE Team did not add escalation.
- All savings have been rounded to reflect the level of accuracy of the VE Proposals.
- Cost estimates made by the VE Team are intended to reflect relative values between alternatives. The estimated savings identified within each proposal are based upon comparison of the proposal to the preliminary design basis. Therefore, as is true with all cost estimates, the savings indicated are only an opinion of probable construction cost.
- Only potential savings are shown. As the proposals are implemented, additional costs or savings may result from redesign or modification.
- Some VE Proposals are mutually exclusive; a few are synergistic and could result in greater cost savings if implemented together. Therefore, the potential savings are not the simple sum of all the VE Proposals presented.
- The VE Team did not evaluate the economic viability of the project

The simple sum of the estimate of savings from the accepted VE Proposals is $106,514,430 (after making adjustments for overlapping savings) with an additional $15,260,000 in tabled (pending) savings

[1] Bohannan-Huston, Inc. (BHI) Draft Final Preliminary Engineering Report, Alternative No. 2, Option 1

SECTION 2 – INTRODUCTION

INTRODUCTION

Value Engineering (VE) analysis identifies the high cost areas of a project during the early design stages. The VE Study then determines less expensive alternative designs that can still be incorporated into the next phase of design drawings and specifications without incurring large costs for redesign or major project delay. These VE proposals are substantiated with technical and economic analyses.

This *Final Report* includes:

- A summary of cost savings as a result of the study.
- A summary of accepted proposals.
- Documentation of the Review Board's reasoning
- A summary of the rejected proposals will also be included in the Final Report and will include the reason(s) for their rejection. The reasons may include cost-effectiveness, reliability concerns, unusual operation and maintenance problems, or project delays.

PROJECT DESCRIPTION

1. Study Goals

Study Goals

- Review AWSA water availability and yield
  - Review ISC's AWSA diversion model with drought flow reductions
  - Provide a range for annual firm yield with climate change scenario
- Review current Bohannan Huston, Inc. (BHI) and Bureau of Reclamation (BOR) appraisal-level designs, considering the project components and focus areas
  - Suggest improvements of current conceptual designs
  - Suggest additional approaches or concepts
  - Recommendations for current concepts or alternative concepts that could address project components and focus areas
- Identify preferred configuration of components
- Recommend further studies and investigations

2. Focus Areas

- Potential technical challenges
  - Sediment
  - Seepage
  - Diversion structure design
  - Water availability and yield
  - Conveyance structural concepts and design
  - Storage structure design
  - Power requirements
- Drought impacts (ISC, The Nature Conservancy (TNC),and BOR flow reduction predictions)
- Minimize energy costs and carbon footprint
- Environmental impacts
  - Minimize negative impacts to endangered species and the environment
  - Must be possible to mitigate all negative impacts
  - Maximize positive impacts to endangered species and the environment
- Seek synergies (e.g., releases from storage, solar sales when not pumping, etc.) that can simultaneously meet water user and environmental needs

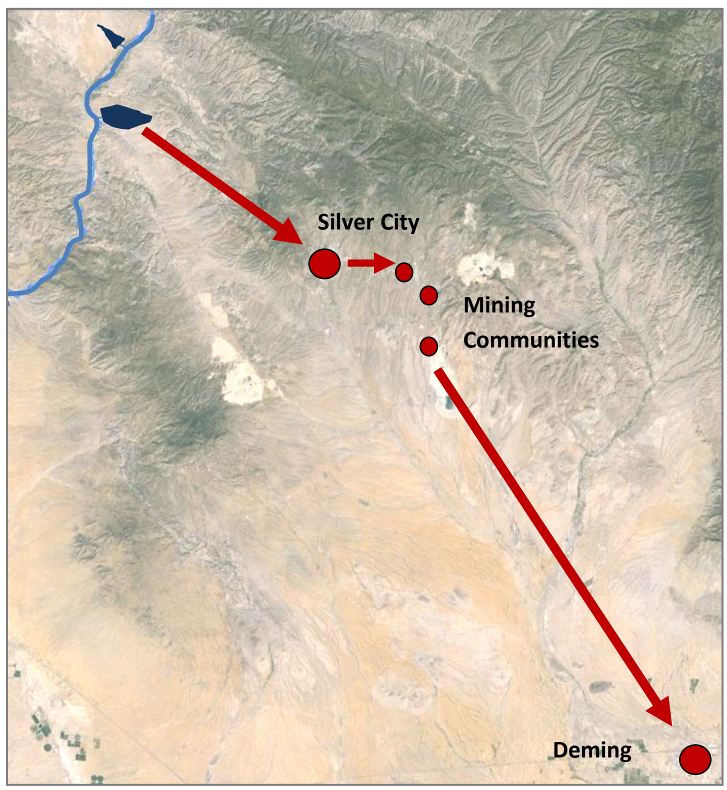
3. Unchangeable Items
    - Maximum average annual diversion from verified model with and without drought
    - Maximum diversion 350 cfs
    - Water in storage for release when needed
    - Compliance with all AWSA constraints
    - Compliance with Endangered Species Act (ESA)

4. Other Items of Note
    - This value engineering workshop was not a quality control check. However, the VE Team did find some areas of note during their analysis. These items are listed in Section 4 of this report under the heading "NOTES TO DESIGNER".
    - The VE Team did not review the legal implications of this project.
    - The VE Team did not review the cost estimates of the current designs.
    - The VE Team did not evaluate the economic viability of the project.
    - All VE studies need a base case against which to evaluate the alternatives. In this report the VE Team's ideas are labeled Proposals and Supplement Recommendations. Alternative 2 from the BHI Draft Final PER was chosen as the base case.

Southwest Regional Water Supply (Diversion and Storage)

Background:

The City of Deming, Hidalgo County and Gila Basin Irrigation Commission (GBIC) have proposed proposals to divert and store the Gila River water available under the 2004 Arizona Water Settlements Act (AWSA). GBIC's proposal is comprised of storage and irrigation diversion components. The Commission approved the staff's recommendation to efficiently optimize the proposals at its December 2013 meeting. The storage component of this proposal has been combined with the other two proposals from Hidalgo County and the City of Deming to create one integrated diversion and storage proposal called the "Southwest Regional Water Supply" (SWRWS).



Description:
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. Potential uses of this water are municipal & industrial, environmental and agricultural interests. The SWRWS pipeline is proposed to be constructed along the right-of-way for Highway 180.

Technical Evaluation:

Phase I

The ISC contracted Bohannan-Huston, Inc. (BHI) to identify best locations for diversions and storage sites in the Cliff-Gila Valley, and design diversion structures, conveyances, and pipeline to Mimbres Basin at an appraisal (10%) level. Using field investigations and desktop analyses, the consultant came up with two alternatives for diversion and storage in their preliminary engineering report (PER).

The ISC staff also contracted RJH Consultants, Inc. to conduct an independent technical review of BHI's Phase I study, identify any significant technical issues, and provide recommendations for improvements. RJH's review showed that BHI had applied an appropriate level of investigation, data collection, and analyses for the 10% level, although there were some major issues such as AWSA water yield, storage sites geology, and sedimentation that were inadequately addressed in the draft final PER (September 12, 2014), and could potentially create significant technical challenges.

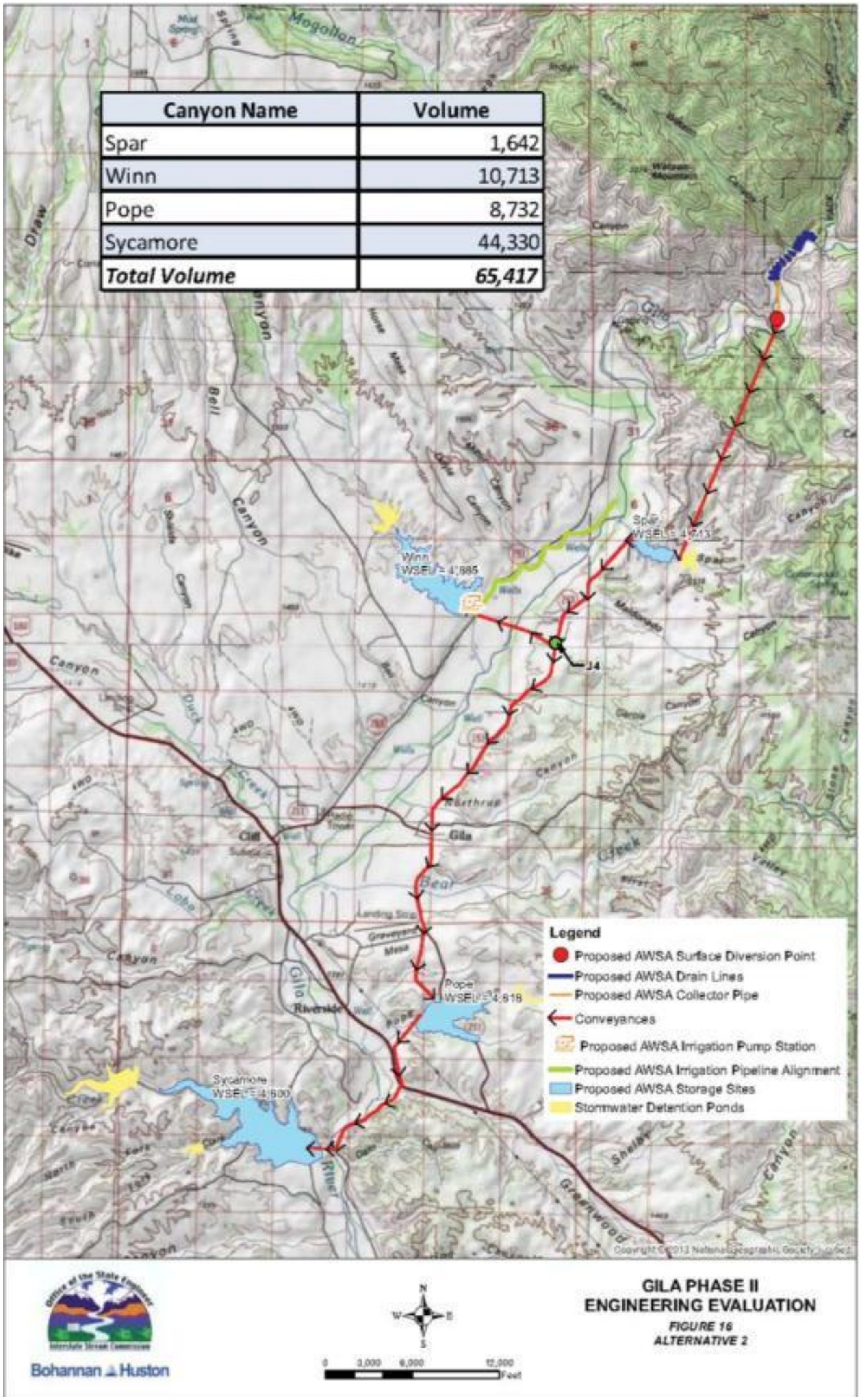
Phase II

After the completion of Phase I, the ISC contracted Bohannan-Huston, Inc. (BHI) to perform Phase II Engineering Evaluation of the SWRWS proposal, still at an appraisal (10%) level. Using additional field investigations including geomorphologic bathymetric surveys and geophysical/geotechnical samplings, and desktop modelings and analyses, the consultant came up with three new alternatives for diversion and storage in their preliminary engineering report (PER), all of which met the project goals (draft final PER, September 12, 2014) As mentioned earlier, The Value Engineering (VE) Team selected BHI's Alternative No. 2 as the base case against which to measure their VE Proposals. Below is the summary of the configuration of that alternative, plus a map and corresponding cost estimates.

- **Alternative 2:**
  - Diversion with the maximum rate of 350 cfs:
    - 200 cfs:
      - Location: From Gila river (upstream the confluence of Brock Canyon)
      - Method: Coanda Screens (gravity surface diversion)
    - 150 cfs:
      - Location: From Gila river (downstream of Turkey Creek)
      - Method: Infiltration Galleries (gravity subsurface diversion)
  - Storage:
    - 4 canyons: Spar, Winn, Pope, Sycamore (Max. Storage Capacity: 65,417 AF)
      - Spar: Lined with an 18'' thick soil-cement grade-control slab
      - Winn, Pope, Sycamore: lined with 60 mil, HDPE liner
  - Conveyance:
    - 108'' buried pipe for 0.2 miles from diversion to tunnel by gravity
    - 3.3-mile tunnel with the diameter of 108'' to Spar by gravity
    - 78'' buried pressured pipe from Spar to J4 by gravity
    - 48''buried pressured pipe from J4 to Winn by gravity
    - 72" buried pressured pipe from J4 to Pope by gravity
    - 60'' buried pressured pipe from Pope to Sycamore (inverted siphon)
  - Pumping from Winn reservoir to the Upstream Irrigation Ditches:
    - Rate (two options):
      - 10 cfs
        - 24'' buried pipe for 3 miles
        - One 4,500 gpm pump, 50 hp motor
      - 50 cfs
        - 42'' buried pipe for 3 miles
        - One 22,500 gpm pump, 300 hp motor

- One cast in place concrete clearwell
- One 30'× 30'× 15' metal building
- VFD pump control
- SCADA system

- Release from Spar reservoir to the river:
    - Wire-enclosed riprap at the orifice inlets
    - 72'' pipe to convey 90 cfs to the river
    - 30'' pipe connecting the orifice inlets to the outlet pipe to the river
    - A ported riser for the 350 cfs outlet
- Pumping to the Mimbres Basin:
    - Alignment: Highway 180 right-of-way
    - 36'' pipeline from Pope reservoir to Silver City
    - 24'' pipeline from Silver City to Deming
    - 5 booster stations, with the following items for each station:
        - two horizontal split-case 3,100 gpm pumps, 500 hp motors
        - 50'× 30'× 20' metal building
        - Pump control and SCADA system
        - PNM power extension
        - One equalization tank with 375,000 gallon capacity
    - 3 hydro-turbines, each capable of passing 3,000 gpm continuously (total of about 4 MWH per year)
        - Two stations to operate at 195 psi and provide 187.5 kW
        - One station to operate at 78 psi and provide 72 kW


Canyon Name | Volume
Spar | 1,642
Winn | 10,713
Pope | 8,732
Sycamore | 44,330
Total Volume | 65,417
Spar WSEL = 4,713
Winn WSEL = 4,885
J4
Pope WSEL = 4,618
Sycamore WSEL = 4,600
Legend
Proposed AWSA Surface Diversion Point
Proposed AWSA Drain Lines
Proposed AWSA Collector Pipe
Conveyances
Proposed AWSA Irrigation Pump Station
Proposed AWSA Irrigation Pipeline Alignment
Proposed AWSA Storage Sites
Stormwater Detention Ponds
Bohannan Huston
GILA PHASE II
ENGINEERING EVALUATION
FIGURE 16
ALTERNATIVE 2

Item	Description	Quantity	Unit	Unit Price	Amount
CONSTRUCTION					
1	Mobilization / Demobilization	5%	%	-	$20,163,000
2	Construction Surveying and Staking	2%	%	-	$7,556,000
3	Materials Testing	2%	%	-	$7,556,000
Diversion					
4	Subsurface Diversion Structure	1	LS	$14,792,000	$14,792,000
5	Surface Diversion Structure	1	LS	$2,172,000	$2,172,000
6	Tunnel	17,080	LF	$3,500	$59,780,000
7	108" Pipeline, including excavation, backfill, compaction, and pipeline appurtenances (Diversion to Tunnel)	1,030	LF	$798	$822,000
8	120" Jack and Bore under river, including Steel Casing	1,030	LF	$1,200	$1,236,000
9	Improve Turkey Creek Road	10	MI	$65,000	$650,000
Conveyances					
10	48" Pipeline, including excavation, backfill, compaction, and pipeline appurtenances (J4 to Winn)	6,840	LF	$304	$2,079,000
11	60" Pipeline, including excavation, backfill, compaction, and pipeline appurtenances (Pope to Sycamore)	14,270	LF	$379	$5,408,000
12	72" Pipeline, including excavation, backfill, compaction, and pipeline appurtenances (J4 to Pope)	28,760	LF	$420	$12,079,000
13	78" Pipeline, including excavation, backfill, compaction, and pipeline appurtenances (Spar to J4)	12,200	LF	$473	$5,771,000
14	66" Jack and Bore under river, including Steel Casing	400	LF	$900	$360,000
Reservoirs					
15	Spar Reservoir	1	LS	$28,222,000	$28,222,000
16	Winn Reservoir with 10 cfs Irrigation Pump Station	1	LS	$46,283,000	$46,283,000
17	Pope Reservoir	1	LS	$34,801,000	$34,801,000
18	Sycamore Reservoir	1	LS	$79,578,000	$79,578,000
Southwest Regional Pipeline					
19	Southwest Regional Water Supply	1	LS	$75,308,000	$75,308,000
	Subtotal all construction items				$404,616,000
	Contingency	30%	%		$121,385,000
	CONSTRUCTION SUBTOTAL				**$526,001,000**
Non-Construction					
20	Design	4.5%	%	$28,108,000	$28,108,000
21	Topographic Survey & Mapping (Reservoir Sites)	1,145	AC	$250	$286,000
22	Right-of-Way Topographic Survey	96	MI	$5,000	$479,000
23	Site Survey (Booster Stations)	6	EA	$5,000	$30,000
24	Right-of-Way Easement Development (Pipeline)	258	EA	$750	$194,000
25	Right-of-Way Easement Development (Rural)	163	EA	$1,500	$245,000
26	Permitting, Environmental Documentation	1	LS	$432,000	$432,000
27	Land Acquisition Services (Reservoirs + Pipeline + Booster Stations)	30	EA	$2,500	$75,000
28	Land Acquisition (Reservoirs + Pipeline + Booster Stations)	1,164	AC	$5,000	$5,822,000
29	Easement Acquisition (Pipeline)	232	AC	$1,000	$232,000
30	Construction Observation and Management	8%	%	$42,080,000	$42,080,000
	NON-CONSTRUCTION SUBTOTAL				**$77,983,000**
	Total all Items				**$603,984,000**
	NMGRT	6.1875%	%		$37,372,000
	GRAND TOTAL				**$641,356,000**

Item #	Item Description	Quantity	Unit	Unit Price	Amount
1	Parts and Repairs (0.1% of Construction Costs)	$ 525,416,000	%	0.10%	$ 525,000
2	Equipment (10% of Parts and Repairs)	$ 525,000	%	10%	$ 53,000
3	Irrigation Replacement Pump (Once every 15 years)	1	EA	$ 35,000	$ 2,000
4	SWRS Replacement Pumps (Once every 10 years)	10	EA	$ 55,000	$ 55,000
5	Annual Pump Maintenance	11	EA	$ 22,900	$ 251,900
6	Labor (Full Time Operator) Diversion, Storage, Conveyance System	4	EA	$ 55,000	$ 220,000
7	Labor (Full Time Operator) Winn Pump Station	1	EA	$ 70,000	$ 70,000
8	Miscellaneous training, insurance, etc. (per operator)	60	month	$ 1,000	$ 60,000
9	Sediment Ponds Maintenance (once every 10 years)	945,000	CY	$ 2	$ 189,000
10	Electricity	1	LS	$ 1,611,000	$ 1,611,000
11	Road Maintenance (once every 5 years)	176,000	SY	$ 2.25	$ 79,000
				Total Annual O&M Cost	**$ 3,115,900**
				Present Value of O&M Cost* (A)	**$ 40,532,000**
				Estimated Total Capital Cost (B)**	**$ 603,984,000**
				Total Capital and O&M Costs (A+B)	**$ 644,516,000**

Notes: *Assumes 3% annual inflation and 1.5 % annual interest rates over 20 years
**Including construction and engineering

ORGANIZATION

A. STUDY TEAM

The VE Team consisted of eight very senior technical specialists plus an equally senior value engineering facilitator. The specialties were selected based on the broad technical needs and focus areas of the project. The technical specialties are listed below:

No.	TEAM SPECIALITIES
1	Constructability & Costing
2	Hydraulic Structures & Conveyance
3	Environmental Permitting
4	Geomorphology & Sediment Transport
5	Dams, Reservoirs & Geotechnical Engineering
6	Electrical Engineering
7	Tunneling
8	Hydrology, Water Modeling & Yield
9	Value Engineering Facilitation, Engineering & Life-Cycle Costing

The reviewers decide upon the status of the VE proposals in one of four ways:

1. Accept the proposed alternative as it stands. This will require the design team to implement the accepted proposed alternative. Those individuals comprising the Review Board are expected to have this authority for their respective organization.

2. Accept the proposed alternative with modifications. This disposition is similar to item 1 but with some changes imposed by the Review Board.

3. Decline the proposed alternative altogether. This disposition is obvious, but proper reasoning must be given for the *Final Report.*

4. Table (defer) the proposed alternative for further study or information gathering. If a proposed alternative is tabled, it is wise to assign responsibilities to resolve the issue(s), assign a schedule for resolution, and design a decision tree.

METHOD OF THE VE STUDY

ANALYTICAL PROCESS

1. Information Phase

Each VE Team Member was given the reports and cost estimate information for the project prior to the workshop. They were given instructions to familiarize themselves with the project. The facilitator asked that the design team start with a very broad overview of the project (the exact phrase used was “satellite view”) of the project with concentration on purpose and need for the project. The facilitator then asked the design team to start to gradually cover the project in increasing detail (the phrase used was “airplane view” down to “feet on the ground” view). Emphasis was made as to how the project fit into scheme of things and especially the interface points at the project ends. The facilitator encouraged the other VE Team members to ask very open ended questions.

2. Function Analysis Phase

The next activity done by the VE Team was to prepare a Function Analysis Technique (FAST) Diagram. This tool forces an analytical team to look at a project with a fresh outlook. For example, if a technical group was given the assignment to improve a heating/ventilating/air conditioning system (HVAC) system for an office building they could ideate the numerous common systems, e.g., dual duct, variable air volume, multi-zone, etc. However, the phraseology of the problem has already limited the group’s thinking to a mechanical system.

By using function analysis to analyze the HVAC system the VE Team would brainstorm the function “control temperature”. This forces the team to broaden the number of possible solutions thus increasing the odds of achieving an improved solution. For example, by brainstorming the function “control temperature” the study team can look at insulation levels, fenestration schemes, thermal storage, reflective roofing, building axis orientation, landscaping, etc. By using the FAST Diagram the study team has been forced to abandon the paradigm of solely using a mechanical system to control temperature.

This VE Team then selected six functions that it felt covered 80% of the project cost.

3. Creative Phase

The VE Team selected the functions for brainstorming per Pareto’s Law, i.e., the 20% of the functions that drive 80% of the project. The formal brainstorming session generated as many alternative methods as possible for achieving the selected functions. These were then segregated by two categories, Value Engineering Proposals (ideas that have the potential to save life-cycle costs), and Supplemental Recommendations (ideas that would improve the project, but don’t easily fit into either of the previous category).

4. Analysis Phase

A rough analysis was performed by first passing or failing the brainstormed ideas, then combining or grouping similar ideas. The VE Team as a whole then discussed and recorded the relative advantages of the original concept (in the base case) versus the advantages of the alternative plus the risks of implementing the alternative concept (as proposed by the VE Team). The ideas surviving these discussions were selected as candidates for further development by individual team members.

5. Development Phase

A cursory technical examination followed the analysis phase. The purpose of this examination was to see it the alternative was indeed technically viable and to better explain the alternative to the design team. An order of magnitude economic analysis of technically feasible alternatives was also made. The economic analysis was done on a life-cycle basis where appropriate. The VE Team tried to use the same base cost data as that used by the design team so that proper comparison could be made with the original concept(s). Ideas that passed these technical and economic analyses and, in the opinion of the VE Team should be incorporated into the design, were prepared as formal proposals.

The VE Team also prepared Supplemental Recommendations. These recommendations are ideas that the VE Team thought would add worth to the project but would not necessarily save capital or future costs. The Supplemental Recommendations were not necessarily priced.

6. Presentation & Report

All proposals, supplemental recommendations, and ideas analyzed but not proposed were recorded during the VE Study and were compiled to in a *Preliminary Report* to be presented to the Review Board for their consideration. Once the Review Board has decided on the proposals' and supplemental recommendations' dispositions the *Final Report* will be prepared.

SECTION 3 – PROPOSALS

VALUE ENGINEERING PROPOSAL NO. 01-003

SUMMARY PROPOSAL DESCRIPTION:

Collect, use, and account for surface flows from Gila River tributaries that flow into the system's water storage reservoirs.

Estimated potential savings:

Initial:	$ (20,000)
Future:	$ 1,580,000
Total:	$ 1,560,000

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

P01-048 - Construct channels to allow tributary sediment to bypass the storage reservoirs.

EVALUATION
Idea Number: 01-003 Idea Description: Collect, use, and account for surface flows from Gila River tributaries that flow into the systems water storage reservoirs.
Advantages of alternative concept: 1. Optimizes the project for all possible inflows including tributaries already captured in the proposed plan. 2. Potentially provides source of water previously unaccounted for. 3. Provide increased opportunity to preserve environmental bypass flows.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

Calculations and/or Discussion:

River flow in the main stem of the Gila River is not the only source of surface water runoff available to the project. Other sources include the following:

- Tributaries that flow into proposed reservoirs at Spar, Winn, Pope, and Sycamore Canyons.[1]
- Tributaries that cross proposed conveyance systems between river diversion points, storage reservoirs, and water delivery points (e.g., Mogollon Creek).

At this time, it is not clear whether tributary flows are part of the AWSA water. If a legal opinion is formulated that capture of tributary inflows does not count against the diverted volume from the Gila, then the tributary inflows are an additional source of water supply for the State of New Mexico. Regardless of whether this runoff may (or may not) already be appropriated and accounted for in AWSA/CUFA water volumes, the tributaries inflows should be accounted for in the overall water distribution plan in the following ways:

- Tributary inflows may be included in the system operations. For example, if a storm occurs on one of the tributaries, and flows directly into a storage reservoir, that storm volume could be credited to the system and accounted for as a separate source of water.
- If the tributary inflows are legally considered to be part of the Gila River adjudicated flow, the credited tributary flow could be used to help maintain the environmental bypass flow by reducing the amount of diverted flow.
- Alternatively, the stored tributary flows could be stored and released to provide environmental bypass flows in times of low water in the main stem of the Gila River.

Estimate of Available Tributary Flow to Reservoirs. Absent systematic stream gauge data on the tributaries to Spar, Winn, Pope, and Sycamore Canyons, the average annual runoff volume was estimated using the Renard equation[2] as shown in Table 1.

Table 1. Tributary Water Yield			
	DA	Average Annual Runoff	
Basin	(mi2)	(in)	(AF)
Spar	4.1	0.367	80
Winn	13.8	0.308	226
Pope	2.0	0.406	44
Sycamore	62.9	0.247	828

The project water volumes in Table 1 are not trivial, and total more than 1,000 acre feet per year. These water volumes, of course, will be variable on a year-to-year basis depending on storm frequency on the tributaries.

Collection into Reservoirs. Four reservoirs are currently proposed as part of the BHI project. As currently designed, runoff flows directly into the four reservoirs along the tributary stream channels. No modification of the proposed design is required to capture these flows.

Collection into Canals. If the conveyance system between the Gila River diversions, the storage reservoirs, and the water distribution points consist of open channels, then it may be possible to capture some portion of the surface runoff from the tributaries where they are crossed by the conveyance system. However, the collection method would need to avoid capture of the sediment load conveyed by the tributary streams, and would also need to capture only the portion of the flow for which there would be available capacity in the conveyance system. Therefore, it is likely that only a small fraction of the tributary flows could practically be captured. Given that new structures would need to be constructed and maintained, and would have potentially adverse impacts on otherwise non-impacted segments of the tributaries downstream of the crossings, this element of this proposal was not evaluated further.

Cost. While no new structures would be required to capture the reservoir inflows, some capital and maintain costs would be required to identify and account for the water volumes delivered by the tributaries to the reservoirs. The tributary discharges would be monitored using ALERT stream gauges installed on the tributary upstream of the reservoirs. Construction of such a gauge costs approximately $5000 (each). Annual maintenance of the gauge and the rating curve, and management of the data cost approximately $3000/year. The stream flow gauges would be used in conjunction with water level sensors in the reservoirs to help verify and calibrate tributary inflow rating curves.

Assuming that 1,000 acre feet of water can be captured annually, this water has a value of $150 per acre-foot,[3] for a benefit of $150,000 per year.

Related Proposals

1. P01-048. If P01-048 is implemented, it will negate any gains from P01-003 because the tributary inflows will bypass the reservoirs.

Footnotes

[1] The same reasoning would apply to any other proposed on-line reservoir location on a free-flowing canyon tributary to the Gila River.

[2] Renard & Stone, 1982, Estimating Sediment Yield from Small Rangeland Watersheds. Equation developed at the USDA-Walnut Gulch Experimental Watershed in southeast Arizona. Qm = 0.4501 A^(-0.1449). Qm = average annual water yield (inches); A = drainage area (mi2).

[3] At the time of the VE study, no economic study has been completed on the economic value (existing or future) of AWSA water captured by the project. Therefore, a value of $150/AF was used for the purposes of evaluating this proposal, based on engineering judgment and group consensus.

LIFE CYCLE COST ANALYSIS				
PROJECT LIFE (IN YEARS):	20	INTEREST:	6.00%	
	ORIGINAL COSTS	ALTERNATIVE "A" COSTS	ALTERNATIVE "B" COSTS	ALTERNATIVE "C" COSTS
INITIAL COSTS:				
BASE COST:				
OTHER INITIAL COSTS:				
Construction cost for gauges	$20,000.00			
SUBTOTAL INITIAL COSTS:	$20,000.00			
SINGLE EVENT FUTURE COSTS				
YEAR (from base year):				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
SALVAGE VALUE:				
PRESENT WORTH OF REPLACEMENT COSTS:				
ANNUAL COSTS				
MAINTENANCE COSTS:	$12,000.00			
OPERATIONS COSTS:				
ENERGY COSTS:				
OTHER ANNUAL COSTS:				
Water savings (new water)	($150,000.00)			
SUBTOTAL ANNUAL COSTS:	($138,000)			
PRESENT WORTH OF ANNUAL COSTS:	($1,582,849)			
NET PRESENT VALUE	($1,562,849)			
CAPITAL SAVINGS				
FUTURE SAVINGS				
TOTAL SAVINGS (original - alternative)				

NOTE: Items in italics are calculated

VALUE ENGINEERING PROPOSAL NO. 01-009

SUMMARY PROPOSAL DESCRIPTION:

Use steel pipe to convey diverted water from the Coanda intake screens only at the BHI diversion structure through buried and elevated alignment along the Gila River for discharges into the Spar Reservoir.

Estimated potential savings:

Initial:	$ 5,200,000
Future:	$ 0,000
Total:	$ 5,200,000

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR04-002 - Do not provide a separate pipe or cast-in-place concrete lining for the tunnel.

This Supplemental Recommendation may impact the estimated tunnel construction costs by possibly lowering tunnel costs, which will directly impact the savings for this Proposal.

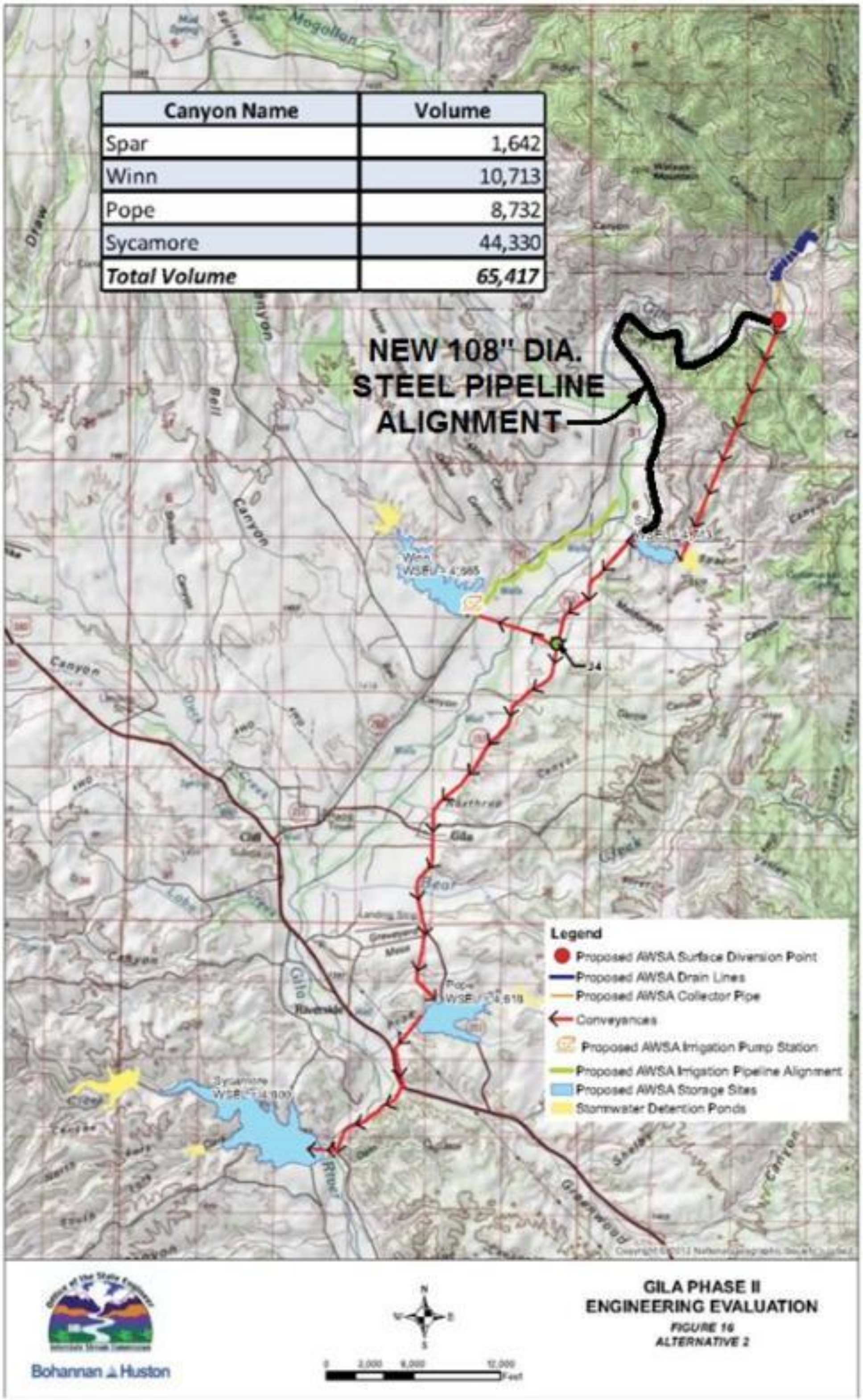
EVALUATION
Idea Number: 01-009 Idea Description: Use steel pipe to convey diverted water from the Coanda intake screens only at the BHI diversion structure through buried and elevated alignment along the Gila River for discharges into the Spar Reservoir.
Advantages of alternative concept: 1. Lower construction costs than tunnel (about 8% less) 2. Allows ease of maintenance and repair access over pipeline
Advantages of original concept: 1. Shorter tunnel alignment length with about 18,000 feet required 2. Straight tunnel alignment minimizes sediment erosion issues 3. Does not involve or require construction access along Gila River in canyon 4. Easier permitting in National Forest land areas
Risks of implementing alternative concept: 1. Pipe installation at uniform downhill slope may not be practical 2. Pipe installation within steep cliff areas may require elevated bracket supports 3. Elevated alignment along Gila River canyon would be difficult to permit 4. Higher levels of Gila River scouring and erosion damage during high river flows 5. Higher levels of environmental disturbances and possible permitting issues

Calculations and/or Discussion:

The steel pipeline would be connected to the structural outlet of the Coanda intake screen structure within the Gila River at the BHI diversion point to convey diverted water by gravity along the downstream Gila River to the Spar Reservoir (see map below). The available water surface elevations are about El. 4736 at the diversion and WS El. 4713 at Spar Reservoir maximum water level. The 108-inch diameter steel pipe would be buried or supported on benches or bracing within the canyon and properly protected from river flows with a nearly uniform slope of about 0.03% to maintain any sediment transport and diverted water flows of up to 350 cfs and 5.5 fps flow velocities by gravity into Spar Reservoir. The approximate pipeline length of 35,000 feet was estimated from the USGS topographic maps to provide the required uniform pipe slope along the Gila River, where burial and benched trenches are preferred. About 80% of the pipeline alignment is located on National Forest land compared to about 100% of the tunnel and pipe option was on the National Forest land (SR04-002). A maintenance access way or road would be placed over the elevated pipeline top or buried backfill protection, where feasible, to allow pipe maintenance during Gila River low flows.

The use of canals and/or flumes as proposed by the Bureau of Reclamation was considered to be impractical and very costly, since the elevated canal or flume areas would require larger bench areas or very significant elevated bracing supports located within the Gila River canyon area as compared to the supported pipeline option.

The total construction cost unit rate for the steel pipeline would be about $800 per foot of 108-inch diameter pipe plus 50% additional pipeline protection and elevated installation costs for about $1,200 per foot of pipeline length with 35,000 feet of required total pipe length. The total pipeline construction costs would be estimated to be about $42,000,000 plus 30% cost contingencies at about $12,600,000 (conservative) for estimated total costs of about $54,600,000. The estimated tunnel construction costs are $59,780,000 (April 2014 PER without 30% contingencies) for a conservative construction cost savings of about $5,180,000, which can be rounded up to $5,200,000.


Canyon Name
Volume
Spar
1,642
Winn
10,713
Pope
8,732
Sycamore
44,330
Total Volume
65,417
NEW 108" DIA.
STEEL PIPELINE
ALIGNMENT
Legend
Proposed AWSA Surface Diversion Point
Proposed AWSA Drain Lines
Proposed AWSA Collector Pipe
Conveyances
Proposed AWSA Irrigation Pump Station
Proposed AWSA Irrigation Pipeline Alignment
Proposed AWSA Storage Sites
Stormwater Detention Ponds
Bohannan Huston
GILA PHASE II
ENGINEERING EVALUATION
FIGURE 16
ALTERNATIVE 2

VALUE ENGINEERING PROPOSAL NO. 01-011

SUMMARY PROPOSAL DESCRIPTION:

Include water conservation measures as a component of the project.

Estimated potential savings:

Initial:	$ 0,000
Future:	$ 2,864,430
Total:	$ 2,864,430

Additional Description:

The NEPA and Section 404 compliance processes will likely require that any diversion-storage alternative demonstrate how conservation measures were considered in developing the need for the water supply provided by the project. Conservation could be considered as yield and/or reduction in demand.

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-011 Idea Description: Include water conservation measures as a component of the project.
Advantages of alternative concept: 1. Aligns with what will likely be required for the NEPA and Section 404 permitting processes.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. Depending on how conservation savings are viewed, the savings may reduce the amount of water needed from the project (demand reduction) or may increase project yields if savings are included as a component of project yield (increase in supply).

Calculations and/or Discussion:

Conservation could include irrigation efficiency improvements or changes to more water efficient crops for agricultural users and water saving measures for M&I users (e.g., low-flow fixtures, metering, block rate structures, water reuse, and outdoor watering conservation programs). Saved water from conservation could also potentially be used in part to help meet environmental flow augmentation targets.

Calculations show an example of an assumed savings of 10% of irrigation water assuming about 4,300 acres of irrigated agriculture in the Cliff-Gila and Virden valleys and a value of $150/acre-feet (AF) of irrigation water. It is assumed that the savings are applied to an average of 3 AF of consumptive use (CU) per acre of irrigated land.

4,300 acres x 3 AF of CU = 12,900 AF of CU

12,900 AF of CU x 0.10 (savings) = 1,290 AF of saved water

1,290 AF of saved water x $150/AF (estimated value) = $193,500

LIFE CYCLE COST ANALYSIS				
PROJECT LIFE (IN YEARS):	20	INTEREST:	6.00%	
	ORIGINAL COSTS	ALTERNATIVE "A" COSTS	ALTERNATIVE "B" COSTS	ALTERNATIVE "C" COSTS
INITIAL COSTS:				
BASE COST:				
OTHER INITIAL COSTS:				
Irrigation water, 3' CU/ac for 4,300 ac x $150/AF	$645,000.00			
SUBTOTAL INITIAL COSTS:	$645,000.00			
SINGLE EVENT FUTURE COSTS				
YEAR (from base year):				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
SALVAGE VALUE:				
PRESENT WORTH OF REPLACEMENT COSTS:				
ANNUAL COSTS				
MAINTENANCE COSTS:				
OPERATIONS COSTS:				
ENERGY COSTS:				
OTHER ANNUAL COSTS:				
Conserved water (assumed 10%)	$193,500.00			
SUBTOTAL ANNUAL COSTS:	$193,500			
PRESENT WORTH OF ANNUAL COSTS:	$2,219,430			
NET PRESENT VALUE	$2,864,430			
CAPITAL SAVINGS				
FUTURE SAVINGS	$2,864,430			
TOTAL SAVINGS (original - alternative)				

NOTE: Items in italics are calculated

VALUE ENGINEERING PROPOSAL NO. 01-013

SUMMARY PROPOSAL DESCRIPTION:

Consolidate Pope and Sycamore reservoirs into one larger reservoir in Greenwood canyon.

Estimated potential savings:

Initial:	$ 70,000,000
Future:	$ 0,000
Total:	$ 70,000,000

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-013 Idea Description: Consolidate Pope and Sycamore reservoirs into one larger reservoir in Greenwood canyon.
Advantages of alternative concept: 1. Only impacts one valley/canyon, which should make permitting easier. 2. Reduces ancillary infrastructure for the dams (outlets, spillways, etc.) 3. Reduces evaporation because the total surface is less 4. Reduces the pumping head to get over the divide because the elevation of the water surface will be higher 5. Eliminates some conveyance pipeline to fill Sycamore. Costs to reduce conveyance not included. 6. Eliminates some construction areas and the need to construction access roads, mobilization and impacts to the existing conditions. 7. Based on brief site visit reservoir geology at dam site may be slightly favorable to other sites.
Advantages of original concept: 1. Two reservoir system provides redundancy and more flexibility for operations and delivery 2. Relocation of highway 180 not required
Risks of implementing alternative concept: 1. Less information available on the geology, but based on site visit has a potential to be more favorable. 2. Relocation of highway 180 may be difficult.

Calculations and/or Discussion:

The current storage:

- Pope = 7,900 AF
- Sycamore = 36,900 AF
- Total is about 44,800 AF

Based on the Reclamation study, the storage in Greenwood can be up to 47,000 ac-ft. The surface areas at normal pool are:

- Pope: 220 ac
- Sycamore: 580 ac
- Greenwood: Based on Reclamation's work the surface area at 47,000 AF is 819 ac.

The net reduction in surface area would be about 800 – 580 = 220 acres. Based on an evaporation of 5 feet per year and assuming a reservoir that is full all year (which is not reality, but good for comparisons). The savings in evaporation could be up to 1,100 AF/year.

The costs for these dams are from the Reclamation Report. Note Reclamation was used in order to have a consistent comparison basis because BHI did not have cost for Greenwood.

- Pope: $137M or $17,341/AF
- Sycamore: $281M or 7615/AF
- Greenwood: $270.4M (see below)

Reclamation developed a cost for a 26,000 ac-ft reservoir with a reservoir area of 481 acres. Elements of this design concept are:

- Dam height 176
- Embankment volume 3.1 MCY
- Cost is $118,000 million for the dam, this is $4538/AF
- Cost is $56.6 million of the relocation of the road.
- Extrapolation of the costs for 47,000 AF = 270M
    - 4,538/ac-ft x 47,000 AF = $213.8 Million
    - Cost for road = $56.6M
- It is likely that the unit cost would be slightly reduced for a larger dam because of the efficiency of going higher (needs less liner/per storage volume, less height on the dam), would use the same spillway, would require the same mobilization, staging, access roads, would modify, but not replace the outlet tower, etc.

Total costs for Pope and Sycamore =	$418M
Cost for Greenwood =	270M
Potential saving:	$148M

The costs from Reclamation are much higher than BHI so look at ratio and then prorate to BHI costs. The combined reservoir is 65% of the cost of the two separate reservoirs from the Reclamation data. Therefore, using BHI costs for Pope = $60.1M and Sycamore = $138M; total cost is $198M. The cost savings to build one reservoir would be $198 x .65 = $128.7M, so the savings would be $70M

Consider Normal Water Surface (NWS) elevation for delivery:

- Pope: 4,616 ft
- Sycamore: 4,600 ft
- Greenwood: 4,660 ft

Elevation of the Normal Water Surface is higher but there is adequate head difference from the diversion to deliver the water by gravity.

VALUE ENGINEERING PROPOSAL NO. 01-014

SUMMARY PROPOSAL DESCRIPTION:

Eliminate Winn Reservoir and add a second reservoir in Spar Canyon.

Estimated potential savings:

Initial:	$ 17,000,000
Future:	$ 0,000
Total:	$ 17,000,000

Additional Description:

This concept would use the smaller Spar Reservoir that is part of Alternative 2 and the tunnel/gravity conveyance to this reservoir. A larger Spar reservoir would be constructed above in Spar Canyon with a capacity of 10,700 AF. The lower Spar would be used as a forebay and a 50 cfs pump station would be built to pump into the upstream Spar Reservoir. This would eliminate Winn Reservoir, the pump station at Winn and the pipeline conveyance to Winn.

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-014 Idea Description: Eliminate Winn Reservoir and add a second reservoir in Spar Canyon.
Advantages of alternative concept: 1. Provides both reservoirs in one canyon. This should reduce environmental impacts and overall sediment load from the drainages into the system. 2. Provides a forebay for pumping and more operational flexibility 3. Enables releases by gravity to conveyance system instead of pumping 4. Eliminates about 5,000 ft of conveyance pipeline 5. Eliminates crossing the Gila River with the conveyance pipeline
Advantages of original concept: 1. Redundant storage facilities 2. No pumping required to fill the upper reservoir
Risks of implementing alternative concept: 1. Would increase area of reservoir on National Forest lands

Calculations and/or Discussion:

This concept would use the smaller Spar Reservoir defined as the Lower Spar for this discussion) and the tunnel/gravity conveyance to Lower Spar. Lower Spar would be used to trap sediment and as a forebay to the pump station. The pump station would be used to pump the water to the Upper Spar Reservoir, which would be upstream in the same canyon. In theory, this would enable a smaller pump station to be used.

If the maximum diversion of 350 cfs is considered then about 700 AF per day would be diverted. The volume of Lower Spar is 1642 AF. Considering the storage volume of 1642 AF and an inflow of 700 AF/day, then the Lower Spar could store the equivalent of 2.3 days of diverted flow (1642/700 = 2.3 days). Evaluate the possible reduction in the pump station capacity for various flow rates for a 350 diversion rate.

Inflow (cfs)	Outflow (cfs)	Number of Days of Diversion
350	50	2.8
350	100	3.3
350	200	5.5
350	250	8.5
350	300	16

The table above is based on an assumption that all water would be pumped to the Upper Spar Reservoir, but some could be diverted through the reservoir and sent downstream by gravity through the conveyance pipeline currently included in the base alternative to either Pope or Sycamore. For purposes of this study, assume that the pump station capacity is 50 cfs.

Look at elimination of Winn Reservoir:

- Storage Volume is 10,700 AF
- Cost of Winn Reservoir and pump station= $82.3M
- Cost of conveyance pipeline total is about $330/ft x 15,640 ft=$5.2M

The Upper Spar Reservoir needs to be built to provide a capacity of 10,700 AF to replace the storage lost by elimination of Winn Reservoir. This results in a Normal Maximum Water Surface at El. 4797. This is a dam height of about 100 feet. BHI developed costs for a 255-foot high dam in Spar Canyon as part of Alternative 3. The costs develop for Spar Reservoir by BHI are:

- Total $280.6 M
- Storage Volume is 46,000 AF
- Unit Cost = $6,100/AF

Required size is 10,700 AF. Using Unit cost of $6100/AF the cost would be $65.3M. The cost for the 1,643 AF Spar is $48.5M or $29,500/AF. Consider the cost range using these ranges.

- At 6,100/AF the total is $65.3 M. This is likely the lowest unit cost and the actual unit cost would likely be higher.
- At 29,500/AF the total is $315.6M. This is not reasonable.

Estimate the pump station cost:

- Capacity 50 cfs
- Pumping Elevation Head = 92 feet
- Based on experience and other projects cost range is $4M to $7M

The water that is currently being pumped from Winn reservoir is being released back into the Gila River at about the same point as the release from Lower Spar Reservoir. With this alternative, releases could be made through the Lower Spar, or a new conveyance from the Upper Spar would need to be built to the Gila River. This was not considered in the costs. Also the cost to eliminate the irrigation pipeline from Winn Reservoir is not included in this assessment. Generally, it is expected that these costs would cancel each other or elimination of the irrigation pipeline would increase the cost savings for this alternative.

Summary:

Cost to eliminate Winn Reservoir, pumping and conveyance is $82M + 5.2M = $87.2M. Cost of pump station is in the range of $4 - $7M. Therefore, the cost available for a larger reservoir is $80M to $83M. The lowest probable costs would be $65.4M. This could result in a savings of up to $17 M.

VALUE ENGINEERING PROPOSAL NO. 01-015

SUMMARY PROPOSAL DESCRIPTION:

Optimize the required number and size of pumping stations for Deming delivery flow (SWRWS) requirements.

Estimated potential savings:

Initial:	$ 1,650,000
Future:	$ 0,000
Total:	$ 1,650,000

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-015 Idea Description: Optimize the required number and size of pumping stations for Deming delivery flow (SWRWS) requirements.
Advantages of alternative concept: 1. Lower construction and O&M costs 2. Simplified O&M with three pump stations instead of five total with upper two pump stations in new locations
Advantages of original concept: 1. Most of right-of-way (ROW) requirements located within highway ROW and near highway for ease of access
Risks of implementing alternative concept: 1. Upper two new pump station locations may be difficult

Calculations and/or Discussion:

The BHI Alternative 2 Base Case indicates that the SWRWS delivery flows to Deming require five (5) pump stations, where each has two 500 HP pumps (rated at 3,100 gpm flow and 400 feet TDH (Total Dynamic Head) for a total overall TDH of 2,000 feet. The estimated construction costs for each pump station (shown in BHI report Table J-22) include about $275,000 (for pump equipment) plus $378,000 (electrical equipment) for about $653,000 total pump equipment costs. The total pump station construction cost was about $1,267,000 each (without 30% contingency as shown in BHI Table J-22). If we assume that the existing 36-inch (138,000 feet in length) and 24-inch (272,000 feet in length) pipe diameters are maintained, which also could be optimized, then the total flows and required pumping heads should remain similar.

The maximum flow velocity in the 36-inch diameter pipe is about 2 fps maximum, which produces a total pipe friction of about 120 feet over the five pump lifts. The total TDH required would be the elevation change from about HGL El. 4600 in Pope Reservoir to the high point about HGL El. 6300 combined with the pipe and pump manifold frictional losses. The total TDH equals about 1,700 feet plus 120 feet pipe and 150 feet (30 feet each) manifold losses yields about 2,000 feet TDH for the five pump stations.

Using optimization techniques, if only three (3) pump stations, instead of the five total, were utilized, then the total TDH should be about 1,940 feet with two deleted @ 30 feet pump manifold losses for each deleted pump station. This would require the pump TDH of about 650 feet (about a 63% increase in TDH) for each new pump station requiring 300 psi working pressures for all pumping equipment. This increased TDH and pressures would also require about 25% of the initial pump reaches of 36-inch pipe working pressures to be increased from 250 psi minimum to 300 psi for about 28,000 feet of pipe with increased working pressures.

The total cost savings would include the differential savings in pump station costs for using three pump stations instead of five total and would be reduced by the additional pipe costs due to increased pressures. The increase in pipe costs would be about 10% greater for using 300 psi rather than 250 psi pressure pipe for about 28,000 feet of 36-inch diameter pipe. The estimated unit price for 36-inch pipe was about $174 per foot (shown in BHI Table J-21). This produces a pipe cost increase of about $487,200 (equals 10% of $174 per foot for 28,000 feet of pipe). The three new 650-foot TDH pump stations would have increased pump equipment costs of about 20% greater than the original 400-foot TDH pump and electrical equipment, which would be about $130,600 cost increase (20% of $653,000) for each new pump station. The total cost increases for using the three new 650-foot TDH pump stations would be about $879,000 (3 at $130,600 for pumps plus $487,200 for pipe costs).

However, the deletion of two of the pump stations produces a savings of about 2 at $1,267,000 or about $2,534,000. This savings amount must be reduced by the $879,000 cost increases for about $1,655,000 total savings, which can be rounded down to $1,650,000.

Total pump energy usage costs between using three to five pump stations will be similar since the total pumping heads are almost the same, so there should be no cost savings for energy usage. However, the O&M service work will be simplified and reduced with only three pump stations compared to five pump station locations.

VALUE ENGINEERING PROPOSAL NO. 01-031

SUMMARY PROPOSAL DESCRIPTION:

Use passive intake screens to replace the infiltration galleries in combination with Coanda screens at the BHI Gila River diversion point intake structure.

Estimated potential savings:

Initial:	$ 13,600,000
Future:	$ 100,000
Total:	$ 13,700,000

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-019 - Add additional erosion protection at the proposed diversion structures to prevent flanking of the structures by riverine erosion during large floods.

SR02-004 - Construct a low head dam at the BHI diversion point on the Gila River comprised of concrete fixed weir wall, piling cutoff walls, and sediment bypass sluiceway to provide sufficient water depth, clean water, and adequate supplies of water diversions into the intake screen area for conveyance to Spar Reservoir.

EVALUATION
Idea Number: 01-031 Idea Description: Use passive intake screens to replace the infiltration galleries in combination with Coanda screens at the BHI Gila River diversion point intake structure.
Advantages of alternative concept: 1. Lower construction and O&M costs 2. Better ease of construction in smaller river impact area
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. River sediment and debris may occasionally cause some intake screen blockages 2. Without using automatic airburst cleaning, expect regular manual screen cleaning

Calculations and/or Discussion:

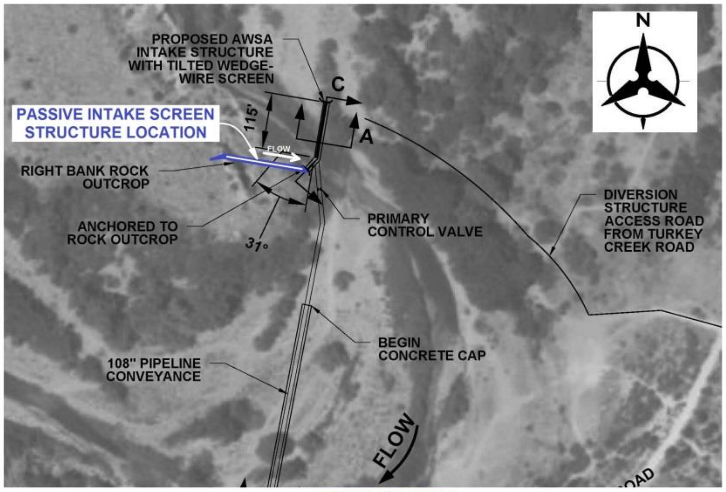
The use of submerged passive intake screens, which are similar to horizontal well screens supported by sloping concrete wall located in the river flow along the right abutment within the Gila River main flow area, would be accessible for maintenance from the right river bank. The passive intake screens would allow the 150 cfs minimum diversion flows to be diverted into the 108-inch diameter steel intake pipe regardless of Gila River water depth, even if the river was not flowing over the Coanda screen area. The passive intake screens would be designed to divert 150 cfs to replace the infiltration galleries and used in combination with the Coanda screens, which would divert up to 200 cfs, for a total maximum diversion flow of 350 cfs at the BHI diversion point.

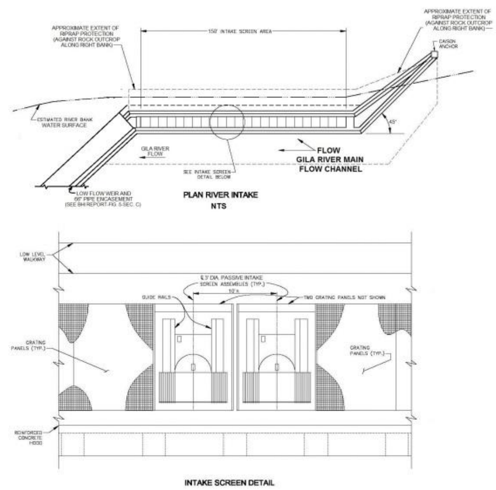
The 150-foot long sloping reinforced concrete wall located along the right bank would support fourteen (14) 36-inch diameter passive intake screens (see photo below) to divert 150 cfs diversion flows from the Gila River. Each passive intake screen would be held in position by guide rails along the sloping concrete wall, which would allow screen removal for maintenance without entering or diverting the river flow. An additional airburst backwash can be used for automatic screen cleaning, but requires an air tank and compressor, which also requires electricity. The additional airburst system is not required, since the river flow around the screens will bypass most sediment, fish, and debris past the screen area.

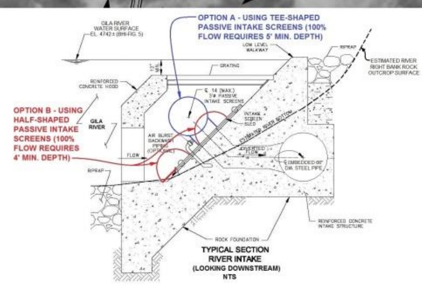
The estimated construction and O&M costs for the reinforced concrete sloping wall and passive intake screens are substantially less than for the infiltration galleries. The estimated volume of reinforced concrete for the sloping abutment wall would be about 200 cy with a unit price of about $1,000 per cubic yard for an estimated total concrete construction cost of about $200,000. The stainless steel 36-inch diameter passive intake screens constructed and removable on the sloping concrete wall are about $50,000 each for a total passive screen cost at about $700,000. The total constructed concrete wall and passive intake screen costs are estimated at about $900,000 plus 30% contingency costs for an estimated $1,170,000 total construction costs.

The estimated construction costs for the BHI infiltration galleries were estimated at $14,792,000 (shown in BHI Alternative 2 cost estimate). The total savings from using passive intake screens instead of the infiltration galleries are about $14,792,000 (for subsurface diversions without any contingency costs) minus $1,170,000 would be about $13,622,000 total savings (use $13,600,000) in initial construction costs.

The following life cycle cost analysis table (shown below) compares the original BHI Alternative 2 (Original costs), the Bureau of Reclamation (Alternative A costs), and the VE team (Alternative B costs) for diversion and intake structure costs and O&M costs for comparisons. The total net present value costs for the intake and diversion structures are shown in the table, as follows: BHI (Original) = $17,537,500; Bureau of Reclamation (Alternative A) = $20,606,800 (most expensive); and VE team (Alternative B) = $3,800,800 (lowest costs). The total present value of reduced O&M costs using the VE Team option would be about $114,700 ($573,496 minus $458,797), rounded down to $100,000 total future savings, as shown on the front page.







P01-031
GILA RIVER
DIVERSION AREA FROM BHI FIGURE 5
PASSIVE INTAKE SCREEN
DETAILS

LIFE CYCLE COST ANALYSIS				
PROJECT LIFE (IN YEARS):	20	INTEREST:	6.00%	
	ORIGINAL COSTS	ALTERNATIVE "A" COSTS	ALTERNATIVE "B" COSTS	ALTERNATIVE "C" COSTS
INITIAL COSTS:				
BASE COST:	$14,792,000.00	$5,376,000.00	$1,170,000.00	
OTHER INITIAL COSTS:	$2,172,000.00	$14,600,000.00	$2,172,000.00	
SUBTOTAL INITIAL COSTS:	$16,964,000.00	$19,976,000.00	$3,342,000.00	
SINGLE EVENT FUTURE COSTS				
YEAR (from base year):				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
SALVAGE VALUE:				
PRESENT WORTH OF REPLACEMENT COSTS:				
ANNUAL COSTS				
MAINTENANCE COSTS:	$50,000.00	$40,000.00	$40,000.00	
OPERATIONS COSTS:		$10,000.00		
ENERGY COSTS:		$5,000.00		
OTHER ANNUAL COSTS:				
SUBTOTAL ANNUAL COSTS:	$50,000	$55,000.00	$40,000.00	
PRESENT WORTH OF ANNUAL COSTS:	$573,496	$630,845.67	$458,796.85	
NET PRESENT VALUE	$17,537,496	$20,606,846	$3,800,797	
CAPITAL SAVINGS		($3,012,000)	$13,622,000	
FUTURE SAVINGS		($57,350)	$114,699	
TOTAL SAVINGS (original - alternative)		($3,069,350)	$13,736,699	
NOTE: Items in italics are calculated				

VALUE ENGINEERING PROPOSAL NO. 01-048

SUMMARY PROPOSAL DESCRIPTION:

Construct channels to allow tributary sediment to bypass the storage reservoirs.

Estimated potential savings:

Initial:	$ 6,000,000
Future:	$ (1,700,000)
Total:	$ 4,300,000

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

P01-003 - Collect, use, and account for surface flows from Gila River tributaries that flow into the systems water storage reservoirs.

P05-004 - Eliminate or move the original concept sedimentation basins from upstream of the off-channel reservoirs into the reservoir innundation area.

EVALUATION
Idea Number: 01-048 Idea Description: Construct channels to allow tributary sediment to bypass the storage reservoirs.
Advantages of alternative concept: 1. Eliminates the high construction cost of the sediment basins. 2. Eliminates the adverse impact of cutting off flow from stream segments downstream of reservoirs, making environmental permitting of the reservoirs easier. 3. Diverts most of the tributary sediment yield past the reservoir, preserving water quality of water stored in the reservoirs. 4. Minimizes the need for sediment maintenance and reservoir dredging. 5. Minimizes the need for sediment maintenance and life cycle costs for sediment basins.
Advantages of original concept: 1. Allows surface water inflows to reservoirs as potential additional water source.
Risks of implementing alternative concept: 1. Some risk of clogging culvert inlets and spilling water and sediment into reservoirs. This could be avoided with appropriate anti-clogging design measures at the inlets.

Calculations and/or Discussion:

This proposal eliminates the sediment storage basins upstream of the reservoirs, and replaces the basins with bypass channels that carry tributary inflows and sediment past the reservoir. The bypass channels were assumed to be culverts under or through the reservoir. The bypass channels would be sized for the 10-year event, which is likely equivalent to (or greater than) the effective discharge[1] for the tributaries. This channel would allow most of the bedload (coarse sediment) to bypass the reservoir during all flood events, and all of the sediment load during floods smaller than the 10-year event. Note that this proposal results in the loss of tributary water inflows to the project, except during rare events that exceed the 10-year flood.

The benefits of implementing this proposal include the following:

- Eliminates the high construction cost of the sediment basins
- Eliminates the adverse impact of cutting off flow from stream segments downstream of reservoirs, making environmental permitting of the reservoirs easier
- Bypasses most of the tributary sediment yield past the reservoir, preserving water quality of water stored in the reservoirs
- Minimizes the need for sediment maintenance and reservoir dredging
- Minimizes the need for sediment maintenance and life cycle costs for sediment basins

The disadvantages of implementing this proposal include:

- Cost of bypass channels
- Loss of tributary inflows as an additional water source to the reservoirs (See P01-003)
- Required maintenance of culvert inlets (likely much less than required maintenance of sediment basins)
- Potential for damaging abrasion of culverts by coarse sediment transport

Potential Cost Savings

- Construction cost of sediment basins.
- Life-cycle cost of sediment maintenance.

Conceptual Design

- Design discharges (100-year) were obtained from the BHI Draft Final Gila PER Appendix F – Hydrology as listed below. 10-year discharges were estimated as 0.3 x Q100.

	Q100	Q10
Spar:	2,903 cfs	870 cfs
Winn:	3,532 cfs	1,060 cfs
Pope:	1,172 cfs	352 cfs
Sycamore:	15,929 cfs	4,779 cfs

- Culvert costs were estimated assuming low grade RCP culverts with 4-ft diameters at $125/linear foot (installed). The number of pipes required was estimated assuming ~10 cfs/ft 2 conveyance capacity. In some cases, where the number of culverts was higher than practical, it was assumed that the costs of using larger, but fewer, RCBC's were equivalent.
- The culvert costs will include headwalls and outlet energy dissipaters, although those costs were not explicitly estimated.
- Sediment transport capacity of culverts. The culverts will be required to convey all of the sediment delivered by the upstream stream segments. However, given that the culverts will have substantially lower hydraulic roughness (Manning's N) than the natural channels, and the slopes will approximately match the pre-reservoir channels, there is minimal risk that sediment will accumulate in the culverts. More likely is the risk of abrasion of the culverts by transport of the gravel and cobble fraction of the incoming sediment load.

Cost of Proposed Stormwater Detention Facilities in BHI Design (Source: Draft Final Gila PER Appendix J)[2] versus cost of Bypass Channels

	BHI Design	Bypass Channel	Cost Difference
Spar:	$3.4 million	$1.5 million	$1.9 million
Winn:	$6.4 million	$5.0 million	$1.4 million
Pope:	$1.6 million	$1.9 million	$(0.3 million)
Sycamore:	$7.4 million	$4.4 million	$3.0 million

Footnotes:

[1] Effective discharge is the frequency integrated event that carries the most sediment.
[2] The BHI costs for the sediment basins are rather high. It is highly likely that more cost effective options are available for the sediment basins, but insufficient details were provided with the Draft Final PER report to allow a detailed value engineering proposal regarding design of the basins.

LIFE CYCLE COST ANALYSIS

PROJECT LIFE (IN YEARS):	20	INTEREST:	6.00%	
	ORIGINAL COSTS	ALTERNATIVE "A" COSTS	ALTERNATIVE "B" COSTS	ALTERNATIVE "C" COSTS
INITIAL COSTS:				
BASE COST:				
OTHER INITIAL COSTS:	$3,400,000.00	$1,500,000.00		
	$6,400,000.00	$5,000,000.00		
	$1,600,000.00	$1,900,000.00		
	$7,400,000.00	$4,400,000.00		
SUBTOTAL INITIAL COSTS:	$18,800,000.00	$12,800,000.00		
SINGLE EVENT FUTURE COSTS				
YEAR (from base year):				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
YEAR:				
COST:				
SALVAGE VALUE:				
PRESENT WORTH OF REPLACEMENT COSTS:				
ANNUAL COSTS				
MAINTENANCE COSTS:				
OPERATIONS COSTS:				
ENERGY COSTS:				
OTHER ANNUAL COSTS:				
Loss of tributary water		$150,000.00		
SUBTOTAL ANNUAL COSTS:		$150,000.00		
PRESENT WORTH OF ANNUAL COSTS:		$1,720,488.18		
NET PRESENT VALUE	$18,800,000	$14,520,488		
CAPITAL SAVINGS		$6,000,000		
FUTURE SAVINGS		($1,720,488)		
TOTAL SAVINGS (original - alternative)		$4,279,512		

NOTE: Items in italics are calculated

VALUE ENGINEERING PROPOSAL NO. 01-055

SUMMARY PROPOSAL DESCRIPTION:

Modify the feature of the dam discharge to allow greater temperature control of releases.

Estimated potential savings:

Initial:	$ 0,000
Future:	$ 0,000
Total:	$ 0,000

Additional Description:

The temperature control defined in the base case could be installed at the same cost with greater functionality.

Related Value Engineering Proposals and/or Supplemental Recommendations:

P01-013 - Consolidate Pope and Sycamore reservoirs into one larger reservoir in Greenwood canyon.

EVALUATION
Idea Number: 01-015 Idea Description: Modify the feature of the dam discharge to allow greater temperature control of releases.
Advantages of alternative concept: 1. Allows economic removal of water from the reservoir at many different elevations
Advantages of original concept: 1. The temperature control in the outlet works may not allow enough locations to discharge water at different elevations
Risks of implementing alternative concept: 1. May be harder to permit than the original design

Calculations and/or Discussion:

Alternative 2 includes dams with heights ranging from 51 ft (Spar and Pope), through 77 ft (Winn), to 153 ft (Sycamore) with an average height of 83 ft. For the purposes of this proposal presume that the average case is repeated four times.

The need to use water at various temperatures would arise if water was required for environmental issues where warmer water may be preferable to colder water.

The temperature control device will contain: a vertical pipe supported in the lower section of the reservoir with several valved openings (to allow water to enter the pipe at several levels); an elbow at the bottom of the pipe; a near horizontal pipe through the core of the dam; and a control system to open and close valves, as required.

Since the levels in the reservoirs will vary greatly over time, and the top 3 to 5 ft of the water heats up at a greater rate than the water at lower elevations, there will be a need for many valved openings. This proposal presumes an opening every 10 ft.

The standard system will contain: 85 ft of 48" vertical standpipe (and support structure); 7 each 36" valved (slide-gate) openings; 1 each 48" 90 short degree elbow; 130 ft of 48" near horzontal pipe; one 48" outlet; and the control system. The costs for the the individual pieces are as follows:

- $350/ft for 48" mortar lined steel pipe (215 ft for $75,250)
- $250/ft for vertical pipe support (85 ft for $21,250)
- $2,500/each for short 90 degree 48" elbow
- $2,500/each for slide-gates and controls (7 each for $17,500)
- $1,500 for an outlet; $7,500 for a PLC control system
- $15,000 for a power system
- and 3 days of a crew of 5 at $6,500/day ($19,500) to install and startup.

The total cost per unit is then $160,000 per unit or $640,000 for the project.

The original cost was approximately $640,000 (for 1,500 lf of temperature control works) and allowed water to be drawn from only locations per structure. This proposal has the same cost but allows water to be drawn from three more locations per structure, giving the system a greater functionality.

The life cost of this evaluation was not considered since it is relatively small and inconsequential without any design parameters.

VALUE ENGINEERING PROPOSAL NO. 01-060

SUMMARY PROPOSAL DESCRIPTION:

Use existing electrical infrastructure to feed the low horsepower pumps for Winn Reservoir.

Estimated potential savings:

Initial:	$ Not quantified
Future:	$ Not quantified
Total:	$ Not quantified

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-060 Idea Description: Use existing electrical infrastructure to feed the low horsepower pumps for Winn Reservoir.
Advantages of alternative concept: 1. There are existing electrical lines in the Gila and Cliff communities. It may be possible to power some of the small electrical pumping loads by extending these lines. 2. Studies will be required to evaluate the capability of existing lines to be able to feed any additional loads.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. Existing infrastructure may not have sufficient capacity to serve pumps.

Calculations and/or Discussion:

It may be advantageous to try to utilize existing infrastructure if there is sufficient capacity to serve the smaller pumping loads. Building all new feeders out of a centralized substation to feed the smaller pump loads will be more expensive than shorter line extensions if capacity is available.

VALUE ENGINEERING PROPOSAL NO. 01-061

SUMMARY PROPOSAL DESCRIPTION:

Use 12.47kV or 13.8kV rather than 4.16kV for the large pump motors.

Estimated potential savings:

Initial:	$ 2,000,000
Future:	$ 0,000
Total:	$ 2,000,000

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-061 Idea Description: Use 12.47kV or 13.8kV rather than 4.16kV for the large pump motors.
Advantages of alternative concept: 1. This would eliminate one transformation and one substation size transformer. 2. The individual pump motors would cost somewhat more, but overall cost would be lower. 3. Eliminating one transformer would simplify the design of the substation and reduce cost significantly.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

Calculations and/or Discussion:

The original design would install a 69/12.47kV substation transformer and then require the project to install essentially the same size 12.47/4.16kV substation to step the voltage down to the utilization voltage. By going directly from 69kV to 4.16kV, one transformer could be eliminated, which would cut the cost of the substation in approximately half.

VALUE ENGINEERING PROPOSAL NO. 01-062

SUMMARY PROPOSAL DESCRIPTION:

Connect into PNM's 115kV source rather than the 69kV source voltage.

Estimated potential savings:

Initial:	$ Not Calculated
Future:	$ Not Calculated
Total:	$ Not Calculated

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-062 Idea Description: Connect into PNM's 115kV source rather than the 69kV source voltage.
Advantages of alternative concept: 1. This will give a stronger source to the project making it easier to start motors. 2. Adding 25-30MVA of load to PNM's 69kV system may require a larger 115/69kV transformer. 3. The upgrading of the PNM 69kV system would likely be a cost that the project would have to pay for. 4. The difference in construction costs between 69kV and 115kV high line construction is minor.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

Calculations and/or Discussion:

Using 115kV instead of 69kV would cost maybe 15% more to build, but having to pay to upgrade the PNM transformation from 115kV to 69kV would likely cost approximately $2,000,000 additional. The total project requirements and PNM system electrical system upgrades need to be studied to determine best realistic configuration and costs.

VALUE ENGINEERING PROPOSAL NO. 05-004

SUMMARY PROPOSAL DESCRIPTION:

Eliminate or move the original concept sedimentation basins from upstream of the off-channel reservoirs into the reservoir innundation area.

Estimated potential savings:

Initial:	$ 15,000,000
Future:	$ 0,000
Total:	$ 15,000,000

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

P01-048 - Construct channels to allow tributary sediment to bypass the storage reservoirs.

EVALUATION
Idea Number: 05-004 Idea Description: Eliminate or move the original concept sedimentation basins from upstream of the off-channel reservoirs into the reservoir innundation area.
Advantages of alternative concept: 1. The location would lessen or eliminate the need for the dam safety requirements to be applicable to the sedimentation basin embankment. 2. The location may eliminate the need for an outlet works and for a service/emergency spillway on the sediment basin. 3. The proposed concept could be reduced to provide more simply, topography that encourages a delta forming near the upper end, more favorable for sediment removal. 4. The proposed concept could be further reduced to eliminating the basins wholly, relying on periodic excavation of sediment in times of very lean storage. 5. Considerable fine grained sediment is likely to transport to the main reservoir during low-frequency high volume flows anyway, lessening the effectiveness of the upper sediment basins.
Advantages of original concept: 1. Positive attempt to capture and store sedimentation away from the reservoirs.
Risks of implementing alternative concept: 1. Accumulated reservoir sediment may be harder to remove in periods of recurring favorable annual storage.

Calculations and/or Discussion:

Approximately 950 AF of sediment basins have been contemplated in the four dams in the original concept, totaling approximately $15M of direct costs before applying cost adjustment factors and annual maintenance costs.

Unless overlooked, the documents do not show a detailed breakdown of the cost per AF of constructing each sediment basin. On that basis, and assuming a spillway and outlet works would be eliminated, assume 30% of the cost for each sediment basin would be required for the proposed concept. In the proposed concept, the sediment basin would be eliminated or earthwork topography near the upper end of each reservoir would be constructed to slow flows and encourage extended delta formation where removal would be easiest. Further, assume that in the cost of each reservoir's grading plan (totaling about $16M), sufficient money is included to make the grading plans compatible with efficient, low-storage-year sediment removal from the main impoundment. This evaluates to approximately $15M savings after applying contingency and other factors.

This proposal should be considered with awareness of P01-048 which discusses routing off-channel sediments through the main dams. Along this line, consideration could be given to excavating – essentially spillway channels, to route flows into the adjacent drainages before they enter the main dam impoundments.

SECTION 4 - SUPPLEMENTAL RECOMMENDATIONS

The following ideas were generated by the VE Team and thought to have considerable merit. These ideas are thought to offer improvements, but either the economics were not calculable or the idea could not be developed because of insufficient information.

The VE Team suggests that these recommendations be carefully reviewed and given as much thought and effort as the formal VE Proposals.

SUPPLEMENTAL RECOMMENDATIONS SUMMARY TABLE

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD COMMENTS	PAGE NO.
AWSA Water Availability			
SR01-064	Review and evaluate divertible water supply and project yield.	**ACCEPT** It is necessary.	4-5
Recommendations for Added Value			
SR01-012	Implement a staged project development plan that provides an initial Gila diversion and an initial or base level of storage, selected and designed to facilitate staged design and construction that is based on optimized supply potential versus current and projected demand.	**ACCEPT** Given the time involved and the financial resources, this appears to be a necessity.	4-12
SR01-026	Develop project objectives and operational criteria for diversion-storage alternatives.	**ACCEPT**	4-14
SR01-006	Divert Gila River return flow by exchange or recapture.	**TABLE** This is probably challenging due to CUFA constraints and/or non-point return flows. In addition, returns are needed by downstream users. If NM can demonstrate return flow, it could probably just negotiate a credit and divert water under CUFA terms. There are also questions regarding how this affects water rights and enforcement, and how it takes into account the excess water diverted to provide adequate pressure head.	4-16
SR01-019	Add additional erosion protection at the proposed diversion structures to prevent flanking of the structures by riverine erosion during large floods.	**ACCEPT** This would apparently be necessary for the project to continually accomplish its purpose.	4-19
SR01-020	Add an ALERT/SCADA system to enable opitimized system operation and accounting of water flows into and out of the project.	**ACCEPT** NM may be able to partially fund this through (vii)(D)(2)Section 107 of the AWSA.	4-23
SR01-027	Align the technical (engineering), NEPA, and Section 404 alternatives development and evaluation processes.	**ACCEPT** This would appear to save a great deal of time and effort.	4-27
SR01-037	Develop purpose and need (P&N) statement as foundation for alternatives development and evaluation.	**ACCEPT** This will be formulated as part of NEPA, if NM chooses to develop the AWSA water.	4-30

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD COMMENTS	PAGE NO.
SR01-030	Develop and/or expand and use the existing Freeport-McMoRan (FMI) Tyrone (Bill Evans Lake) facilities for water storage, pumping, and pipeline conveyance for Mimbres basin water requirements.	**TABLE** FMI's facilities are designed for the uses at the mine and for diversion of lower flows than those of AWSA. In addition, Bill Evans Lake likely does not have much additional capacity. Bill Evans Lake accepts only crystal clear, sediment free water. This might be solely to protect their pump impellers. They divert at low flows, whereas under the SWRWS project, sediment-laden water needs to be diverted at high flows. However, FMI's existing power infrastructure could be used to serve pump stations for the reservoirs (e.g. Greenwood). In addition, the route along Mangas Creek through Tyrone Mine could be used for SWRWS pipeline to Deming.	4-32
SR02-004	Construct a low head dam at the BHI diversion point on the Gila River comprised of concrete fixed weir wall, piling cutoff walls, and sediment bypass sluiceway to provide sufficient water depth, clean water, and adequate supplies of water diversions into the intake screen area for conveyance to Spar Reservoir.	**DECLINE** This seems more "invasive" of the channel than the Coanda screen, and the aesthetic appeal of the area might be lost. It is accepted, however, that something needs to be done to prevent flanking across the floodplain (SR01-019).	4-35
SR04-002	Do not provide a separate pipe or cast-in-place concrete lining for the tunnel.	**TABLE** There needs to be additional geological/geotechnical information and research.	4-37
Recommendations for Further Study by the ISC			
SR01-005	Establish a target delivery amount and location(s) for environmental flow augmentation.	**TABLE** This would have to be done at some point. However, it would likely be done when consulting with the US Fish and Wildlife Service and during the NEPA process, if NM chooses to pursue this project.	4-40
SR01-052	Develop an integrated ground water/surface water model to help define operational parameters, to monitor the effectiveness of environmental bypass flows, and to account for non-point discharges of return flows into the Gila River that could be recaptured and reused.	**ACCEPT** This could likely be built upon the model developed by SSPA.	4-42

PROPOSAL NO.	VE PROPOSAL DESCRIPTION	REVIEW BOARD COMMENTS	PAGE NO.
SR01-007	Considering a) BHI's single-liner lined reservoir, homogenous dam over and an unimproved alluvial foundation, and b) Reclamation's zoned earthfill over a cutoff foundation without reservoir seepage control, additional alternative designs should be considered that robustly address dam safety and seepage management.	**ACCEPT** Safety and seepage would need additional attention in next design phase.	4-44
SR01-050	Perform additional detailed hydraulic modeling of the proposed diversion structure to assess its performance under a wider range of likely flow rate and sedimentation conditions.	**ACCEPT** This is necessary in the next design phase. Perhaps even a 3D scale model could be constructed in a laboratory.	4-47
SR01-021	Perform a Monte Carlo simulation of key system operations elements relating to the capture and delivery of AWSA waters to further demonstrate project feasility, identify project vulnerabilities, and identify potential improvements in system performance.	**ACCEPT** This could be done In lieu of modifying the ISC CUFA model for additional climate variability (SR01-049).	4-49
SR01-049	Make the climate change impact analysis in the ISC water availability model more robust by including likely changes in seasonal flow rates due to climate change.	**TABLE** The seasonal flow rates have already been considered in the ISC model. This could be more expanded later.	4-52
SR01-035	Pump water from San Carlos Reservoir back to southwest New Mexico.	**DECLINE** With the AWSA, NM already has terms negotiated and ratified. Legal and physical aspects of this proposal are really challenging.	4-55

AWSA WATER AVAILABILITY

SUPPLEMENTAL RECOMMENDATION NO. 01-064

SUMMARY RECOMMENDATION DESCRIPTION:

Review and evaluate divertible water supply and project yield.

Additional Description:

Complete a review and evaluation of the magnitude and timing of water available for diversion by the Project. Complete a review and evaluation of the yield of the project which considers the proposed structural improvements, the anticipated water demands, and the estimates of the amount of water availale for diversion.

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-020 - Add an ALERT/SCADA system to enable opitimized system operation and accounting of water flows into and out of the project.
SR01-049 - Make the climate change impact analysis in the ISC water availability model more robust by including likely changes in seasonal flow rates due to climate change.
SR01-050 - Perform additional detailed hydraulic modeling of the proposed diversion structure to assess its performance under a wider range of likely flow rate and sedimentation conditions.
SR01-052 - Develop an integrated ground water/surface water model to help define operational parameters, to monitor the effectiveness of environmental bypass flows, and to account for non-point discharges of return flows into the Gila River that could be recaptured and reused.

EVALUATION
Idea Number: 01-064 Idea Description: Review and evaluate divertible water supply and project yield.
Advantages of alternative concept: 1. Will provide refined estimates of Project yield 2. Will facilitate an understanding of how water is diverted, conveyed, stored and used 3. Will facilitate optimization and sizing of reservoir and conveyance facilities
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

DISCUSSION AND/OR CALCULATIONS:

It is important to review and refine the estimates of divertible flow and Project water yield. If the Project proceeds to further planning stages, the development of an integrated water supply and operations model is recommended to assist with this evaluation.

A reconnaissance level review of the water supply estimates was completed by the VE team in association with development of this supplemental recommendation. A summary of the observations from this reconnaissance level review are provided below. It should be noted that this reconnaissance level was not intended to be a substitute for the water supply assessment recommended above, but instead was completed to help understand water availability and to facilitate development of recommendations associated with the VE study.

Pertinent Materials Reviewed (partial list):

- USBR Appraisal Level Report, July 2014
- Summary of CUFA operational constraints provided by ISC
- ISC “Divertible Flow” Spreadsheet
- Gila River Flow Needs Assessment, The Nature Conservancy, July 2014

Estimates of Divertible Flow

Divertible flow is the amount of water that can diverted by the Project from the Gila River. Divertible flow is not the same as project yield, as project yield is also dependent upon other variables such as capacity of reservoir storage. However, estimates of divertible flow are required in order to complete a yield assessment for the Project.

Estimates of daily divertible flow have been developed by both the ISC and The Nature Conservancy (TNC). Flow estimates are available for the period of Gila River stream gauge records which extend from the 1937 water year to the present. We performed a limited review of the ISC spreadsheet model. The TNC model was not available for review.

The ISC spreadsheet model provides reasonable estimates of divertible flow on a daily basis that are adequate for water supply planning purposes. This spreadsheet appropriately applies the CUFA limitations as we understand them. The historical stream flow records for the Gila River at the proposed diversion site provide reliable estimates of historical physical water availability. We made several minor updates to the ISC spreadsheet model. These updates did not markedly alter the estimates of divertible flow.

The two independent analyses (ISC and TNC) appear to model San Carlos Reservoir limitations somewhat differently. However, as noted by TNC (Appendix 2), the difference in the modeling approaches is not a sensitive factor and does not markedly affect estimates of divertible flow.

Mean annual divertible flow estimates derived from the VE updated spreadsheet, and the divertible flow estimates provided by TNC, are summarized below for *historical conditions*. These estimates are similar and comparable, and include a 150 cfs winter bypass.

- ISC Spreadsheet (VE update) = 12,225 AF/yr (1937 to 2013)
- TNC = 12,038 AF/yr (1937 to 2001)

Water is available for diversion in most years. However, it should be noted that water availability is highly variable, and little or no water is available for diversion during low flow conditions that can extend for several years. This variability creates the need for a substantial amount of water storage in order to provide a reliable supply of water from the project.

Observation: Based upon our initial review, we believe that the ISC spreadsheet provides reasonable estimates of divertible flow for historical conditions, and that for the historical period of 1937 to the present, the average annual amount of divertible for the project was about 12,000 AF/yr.

Climate Change

The ISC developed divertible flow estimates for one climate change scenario. Under this scenario, Gila River historical gaged flows less than 400 cfs were reduced by 15%, flows above 800 cfs were increased by 10 %, and historical flows between 400 cfs and 800 cfs were not adjusted. The VE updated ISC spreadsheet estimates a mean annual divertible flow of about 11,920 AF/yr with these adjustments, which is a slight decline from the ISC's historical estimate of 12,225 AF/yr.

TNC evaluated several climate change scenarios. The results of these climate models are not consistent. One of the models indicated a decline in divertible flow in the future, while one model indicated an increase in future divertible flow (Table 3, page 114). These disparate projections are consistent with recent climate change modeling for the southwest United States. The USBR considered 112 different climate model scenarios in its recent evaluation of the Colorado River basin, and while many models simulated a decline in water availability, some models predicted an increase.

For comparative purposes, we evaluated a 10% “across the board, year-round” decline in stream flow for a climate change scenario. From our experience, the 10% reduction in flow is a commonly applied factor for planning at a reconnaissance level. Using the updated ISC model, the 10% reduction in stream flow results in an annual divertible yield of 11,900 AF/yr, which is essentially equal to the ISC climate change scenario.

Observation: The ISC estimates of divertible flow under a climate change scenario are reasonable for reconnaissance level planning purposes. If the Project proceeds to further planning stages, a more detailed assessment of climate change should be considered.

Project Yield

The amount of divertible flow from the Gila River is highly variable. The actual yield of the Project will vary in relation to many variables including but not limited to:

- Reservoir(s) capacity
- Delivery system losses
- Evaporation
- Reservoir seepage
- Timing and magnitude of water demands
- Environmental requirements

A robust operational model of the project should be developed (see SR01-026). The model should consider the above variables, and should also evaluate pre-project and post-project stream flow at key downstream locations.

We understand that operational models for portions of the project may have been developed, however, these models were not available at the time of our evaluation. To facilitate the development of VE proposals, we developed a simple “single bucket” reservoir operation model for the SWRWS project. This model was used to review the potential yield of the project and to better understand reservoir capacity requirements.

The model operates on a daily time step and considers the following variables and information:

- Divertible flow (output from ISC spreadsheet)
- Reservoir Capacity (total, active and dead pool)
- Evaporation (based on representative area-capacity data for Sycamore Reservoir)

- Reservoir Seepage
- Water Supply Demands (M&I, irrigation and environmental)

An illustration of the setup page for this simplistic model is attached.

In order to evaluate yield of a project, it is important to understand the timing, frequency and amount of water demands. For example, environmental reservoir releases may be desired to supplement certain stream flow conditions that may primarily occur during dry periods only, while municipal and industrial demands (M&I) may be relatively constant. Without understanding the desired amount and timing of withdrawals from reservoir storage, it is difficult to evaluate the yield of a project.

We recommend that additional information related to water demands (timing, amount, purpose, etc.) be developed in association with the implementation of this supplemental recommendation.

For purposes of the VE assessment only, we have completed a simple “firm yield” assessment with the “single bucket” model that was developed. For purposes of this analysis, “firm yield” is the amount of water that can be delivered from reservoir storage at a constant year-round rate for every year of the study period. Please note that actual reservoir releases will likely occur at variable rates, and the definition of “firm yield” used in this reconnaissance level evaluation may not be appropriate. The assessment was conducted for the “climate change” hydrology scenario.

Results of the assessment are summarized in the table below.

ESTIMATED FIRM YIELD OF SWRWS (For VE Purposes Only)
CLIMATE CHANGE SCENARIO (ISC Method)
(Acre Feet per Year)

Active Reservoir Capacity (AF)	Reservoir Seepage (% of Water in Storage per Year)		
	1%	3%	5%
15,000	2,250	2,100	1,950
20,000	3,075	2,875	2,675
25,000	3,925	3,700	3,450
30,000	4,575	4,225	3,900
35,000	5,100	4,725	4,350
40,000	5,675	5,225	4,825
45,000	6,200	5,725	5,250
50,000	6,425	5,925	5,425
55,000	6,625	6,075	5,525
60,000	6,800	6,200	5,625
65,000	7,025	6,375	5,750
70,000	7,250	6,550	5,900
75,000	7,475	6,725	6,025

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. If it is acceptable to reduce or eliminate water deliveries during infrequent dry cycles, and concurrently increase reservoir releases (perhaps for irrigation) during other time periods, the amount of water that can be delivered from storage will increase. For example, it may be possible to rely on ground water sources for municipal use during drought cycles, in lieu of water from reservoir storage. This method of operation would allow storage be drawn down on a regular basis, which would concurrently increase releases from storage in many years.

We have applied the "single bucket" model to estimate the average annual yield from the Project that may occur under an alternative reservoir operation such as that described above. We calculated that about 8,000 to 9,000 acre feet of water can be delivered from storage 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. Pursuant to this supplemental recommendation, the development of an integrated water supply and operations model is recommended to refine the estimates of divertible flow and Project water yield.

RECOMMENDATIONS FOR ADDED VALUE

SUPPLEMENTAL RECOMMENDATION NO. 01-012

SUMMARY RECOMMENDATION DESCRIPTION:

Implement a staged project development plan that provides an initial Gila diversion and an initial or base level of storage, selected and designed to facilitate staged design and construction that is based on optimized supply potential versus current and projected demand.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-026 - Develop project objectives and operational criteria for diversion-storage alternatives.

EVALUATION
Idea Number: 01-012 Idea Description: Implement a staged project development plan that provides an initial Gila diversion and an initial or base level of storage, selected and designed to facilitate staged design and construction that is based on optimized supply potential versus current and projected demand.
Advantages of alternative concept: 1. Defers significant initial capital cost. 2. Provides lessons learned from partial system and operation evaluation prior to completion of the full system. 3. May provide for earlier diversions than under full project development plan 4. May provide opportunity to develop minimal and early upper Gila irrigator diversions and defer higher cost components more applicable to Mimbres needs. In this scenario, recapturing and utilizing all Gila releases to extinction becomes more important. 5. May provide basis for tangible, early utilization of initial guaranteed funds.
Advantages of original concept: 1. Allows initial full project utilization. 2. Allows maximum initial storage. 3. Spreads costs for environmental compliance into all components and does not burden initial project users. 4. Provides better assurance that project construction and implementation occurs within the time frames established by the environmental permits. 5. Contains project development to current adversity and current regulatory requirements.
Risks of implementing alternative concept: 1. Initial system operation does not fully utilize AWSA diversion flows. 2. Early system operation reveals new reasons for opposition that threaten development of the later stage(s). 3. Future construction or development cost increases outpace projected escalation. 4. Environmental compliance and permitting will likely be required for the entire (all stages) project up front.

DISCUSSION AND/OR CALCULATIONS:

Proposal 01-026, and its related ideas, addresses evaluating and modeling the system supply and demand. When more is understood about the quantity, type and timing of demand, and more is understood about likely dependability of diverted supply, a better assessment of storage components and delivery components can be made. A staged development plan should reflect this supply and demand understanding.

SUPPLEMENTAL RECOMMENDATION NO. 01-026

SUMMARY RECOMMENDATION DESCRIPTION:

Develop project objectives and operational criteria for diversion-storage alternatives.

Additional Description:

Project objectives and operational criteria are needed to inform alternatives development and screening, sizing of project facilities, and estimates of project yield.

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-027 - Align the technical (engineering), NEPA, and Section 404 alternatives development and evaluation processes.
SR01-037 - Develop purpose and need (P&N) statement as foundation for alternatives development and evaluation.
SR01-021 - Perform a Monte Carlo simulation of key system operations elements relating to the capture and delivery of AWSA waters to further demonstrate project feasility, identify project vulnerabilities, and identify potential improvements in system performance.

EVALUATION
Idea Number: 01-026 Idea Description: Develop project objectives and operational criteria for diversion-storage alternatives.
Advantages of alternative concept: 1. Project objectives and operational criteria will provide the basis for describing how the alternative would be operated; assessing the potential effects of project operations; determining the size and locations of the facilities that are needed; the amount, reliability, timing and location of water to be delivered; and the priorities for delivery of water (environmental flows, M&I and ag.). 2. Can provide for a more efficient project.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

DISCUSSION AND/OR CALCULATIONS:

Project objectives and operations are needed for a variety of processes including alternatives development and screening, design, NEPA, ESA compliance, Section 404 permitting, and describing the project to agencies, interested stakeholders and the public.

For permitting and design purposes, an operations model of the project will be required. The model should simulate daily operations of the project and should provide the following types of information, preferably on a daily time step:

- Project diversions from the Gila River
- Location, amount, timing and type of water demands
- Amount of water diverted to each reservoir, canal and pipeline
- Amount of water released, pumped or otherwise delivered for each Project use, through each project component
- Transit or delivery losses associated with project releases
- Operation of each storage facility including storage content, evaporation, amount stored and seepage estimates
- Irrigation and other return flows
- Pre- and post-project streamflow at the Gila River diversion site
- Pre- and post-project streamflow at all downstream locations of environmental significance

The model should also provide a unified platform for the assessment of alternatives to the original concept. As noted above, an alternatives evaluation will be required for permitting and other planning considerations.

The model may provide a platform for managing real-time operation of the Project.

SUPPLEMENTAL RECOMMENDATION NO. 01-006

SUMMARY RECOMMENDATION DESCRIPTION:

Divert Gila River return flow by exchange or recapture.

Additional Description:

Pursuant to the AWSA, irrigation and other return flows to the Gila River Basin can be used to extinction. The proposal would quantify the amount, location and timing of return flows. It is anticipated that a comprehensive ground water modeling and monitoring program would be implemented for the quantification.

When streamflow conditions allow, the quantified return flows would be diverted from the Gila River into reservoir storage. These diversions may occur by exchange or a similar process.

As an alternative, the reusable return flows could be physically recaptured at one or more small downstream diversion structures on the Gila River. These recaptured return flows to the Gila River could be pumped back to local irrigated fields which may reduce the amount of reservoir releases and increase the yield of the project.

This proposal will not save costs for the initial proposal, but it will add value by increasing project water supplies.

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-052 - Develop an integrated ground water/surface water model to help define operational parameters, to monitor the effectiveness of environmental bypass flows, and to account for non-point discharges of return flows into the Gila River that could be recaptured and reused.

EVALUATION
Idea Number: 01-006 Idea Description: Divert Gila River return flow by exchange or recapture.
Advantages of alternative concept: 1. Increase yield of Project 2. Fully utilize water available pursuant to the AWSA 3. Provide cost effective supplemental irrigation supplies
Advantages of original concept: 1. This proposal is supplemental to the original concept and would rely upon facilities associated with the original concept
Risks of implementing alternative concept: 1. The return flows may, at times, provide important environmental benefits to the Gila River, and the recapture of the return flows may reduce any such benefit 2. Without proper administration, this concept could injure or reduce water available to local irrigators 3. The return flows may not accrue to the river at a location where the water can be easily recaptured or where it is in proximity to irrigated lands 4. Construction of additional Gila River diversion dams to recapture return flows may have undesirable environmental effects and may require substantial permitting activities

DISCUSSION AND/OR CALCULATIONS:

Pursuant to the AWSA, irrigation and other return flows to the Gila River Basin can be used to extinction. The proposal would quantify the amount, location and timing of return flows. It is anticipated that a comprehensive ground water modeling and monitoring program would be implemented for the quantification.

When streamflow conditions allow, the quantified return flows would be diverted from the Gila River into reservoir storage. These diversions may occur by exchange or a similar process.

As an alternative, the reusable return flows could be physically recaptured at one or more small downstream diversion structures on the Gila River. These recaptured return flows to the Gila River could be pumped back to local irrigated fields which may reduce the amount of reservoir releases and increase the yield of the project.

This proposal will not save costs for the initial proposal, but it will add value by increasing project water supplies.

Approximately 4,300 acres of land are irrigated in the Cliff-Gila and Virden valleys. Most of the land is flood irrigated, particularly in the Cliff-Gila area. Return flow from flood irrigated areas can commonly exceed 50% of the application. A conservative and reasonable planning level assumption is that 30% to 40% of water applied to irrigation will return to the stream system. If 5,000 AF of AWSA water is applied to irrigation, irrigation return flows of Project water may range from 1,500 to 2,000 AF per year.

The implementation of a return flow modeling and accounting system may cost from $250,000 to $500,000. In this scenario, the upfront capital cost to develop an acre foot of additional yield could be as low as $250 per acre foot based on the following assumptions:

- 2,000 acre feet of return flows
- Divert 50% of return flows at Gila River intake into existing storage (1,000 AF)
- $250,000 for return flow quantification program
- No new intakes on Gila River required to recapture return flow

Annual accounting of return flows will be required to implement the program during each year of operation. Assuming annual accounting costs of about $50,000, the overall annual cost of developing irrigation water could be less than $100/AF/year.

To the extent that additional downstream collection and diversions facilities are required on the Gila River, the cost of developing this water will increase. Earthen low head irrigation structures similar to those in use in the Cliff/Gila area may cost about $50,000 to $100,000 each. If more permanent low-head diversion structures are required, the cost per structure could be about $250,000 to $500,000. These structures could need a small earthen dam across the channel and a small headgate. These facilities would need to be rebuilt following high flow events. With the addition of diversion facilities to recapture the return flow, the one-time capital cost to develop an acre foot of water will likely be less than $1,000/AF and the total annual cost of developing irrigation water may be about $150/AF/yr.

SUPPLEMENTAL RECOMMENDATION NO. 01-019

SUMMARY RECOMMENDATION DESCRIPTION:

Add additional erosion protection at the proposed diversion structures to prevent flanking of the structures by riverine erosion during large floods.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-050 - Perform additional detailed hydraulic modeling of the proposed diversion structure to assess its performance under a wider range of likely flow rate and sedimentation conditions.

EVALUATION
Idea Number: 01-019 Idea Description: Add additional erosion protection at the proposed diversion structures to prevent flanking of the structures by riverine erosion during large floods.
Advantages of alternative concept: 1. Prevent interruption of diversions due to structure failure by erosion. 2. Minimize the need for costly emergency repairs 3. Lower long-term system costs 4. Protects availability of AWSA water to the project
Advantages of original concept: 1. Lower initial construction cost
Risks of implementing alternative concept: 1. None apparent; the alternative concept lowers the project risk.

DISCUSSION AND/OR CALCULATIONS:

The structures designed to divert river flow from the Gila River are one of the most critical pieces of the proposed system. Without a functioning diversion system, AWSA water in the Gila River that is available for use by the State of New Mexico flows downstream to Arizona.

As currently proposed, the BHI design of the diversion structure does not span the entire floodplain (Figure 1)[1]. As can be seen in Figure 1, although the diversion structure is up to 130 feet in length, it does not appear to cover the active portion of the floodplain[2]. Hydraulic modeling prepared by the Bureau of Reclamation (BOR) and Mussetter Engineering, Inc. (MEI) indicate that floodplain velocities may exceed 5 ft/sec, which is above the threshold for erosion of some of the sandy floodplain soils. The historical channel movement analysis prepared by the BOR indicates that channel movement has occurred in the historic past within the active floodplain. Because flows within the active portion of the floodplain are capable of transporting sediment, scouring new channels, and relocating the channel by lateral erosion and/or avulsive channel processes during floods, the area should be considered to be subject to erosion risk. Also, overtopping of the active floodplain surface appears to be occurring on a less than 2-year frequency according to the BOR modeling. If overtopping during a 2-year or greater flood were to result in significant erosion, the diversion structure could be flanked and rendered ineffective until it was repaired.

Repair of a flanked diversion structure could be delayed by availability of funds, environmental permitting requirements for in-channel work, and the time required to assess, design, and mobilize the repairs. This could result in periods from weeks to years to perform the repairs and re-start the diversions.

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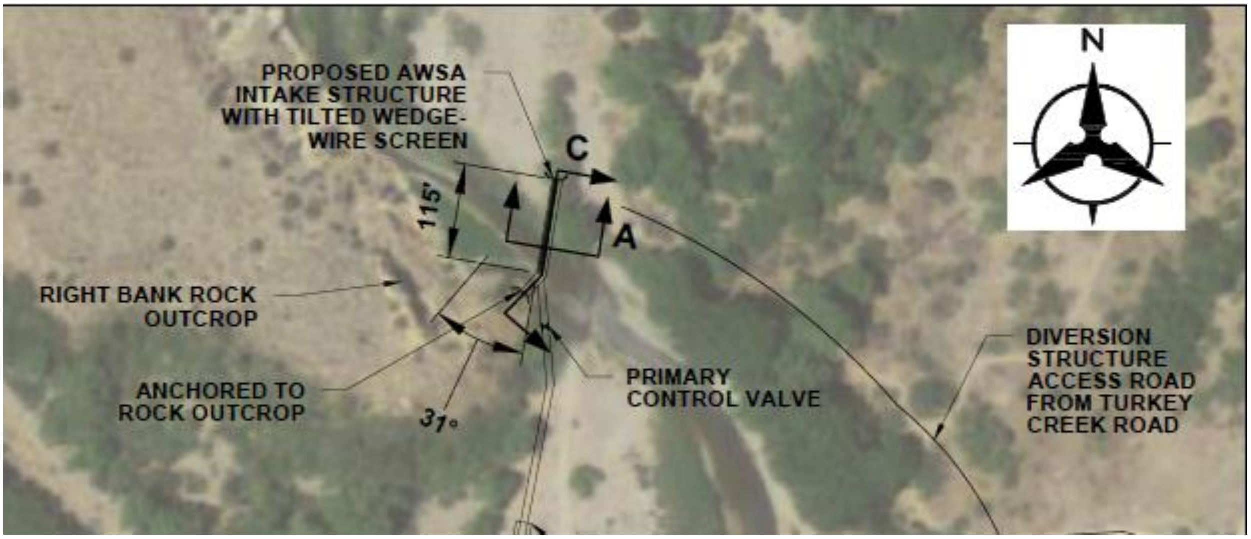

Figure 1. BHI diversion structure design location within the Gila River floodplain. (Source: Draft Final Gila PER, page 97/700).

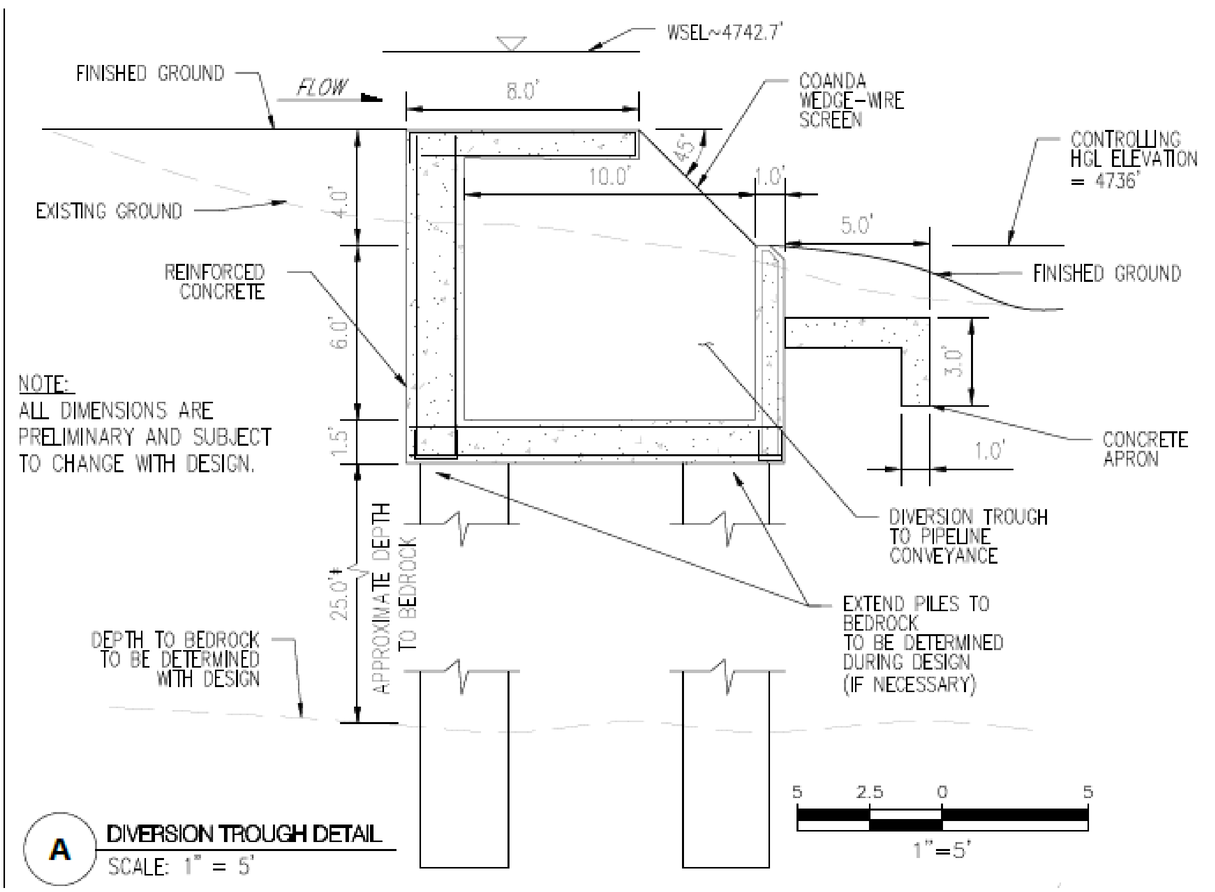

Figure 2. Design sketch for the tilted Coanda screen diversion structure. (Source: Draft Final Gila PER, page 97/700).

Therefore, it is recommended that diversion structures, at minimum, span the active portion of the floodplain and tie into stable surface at low risk of erosion that would result in flanking of the diversion structure. For the purposes of this proposal, the conceptual diversion design proposed by the BOR and shown in Figure 3 is recommended for comparison purposes with the BHI design.

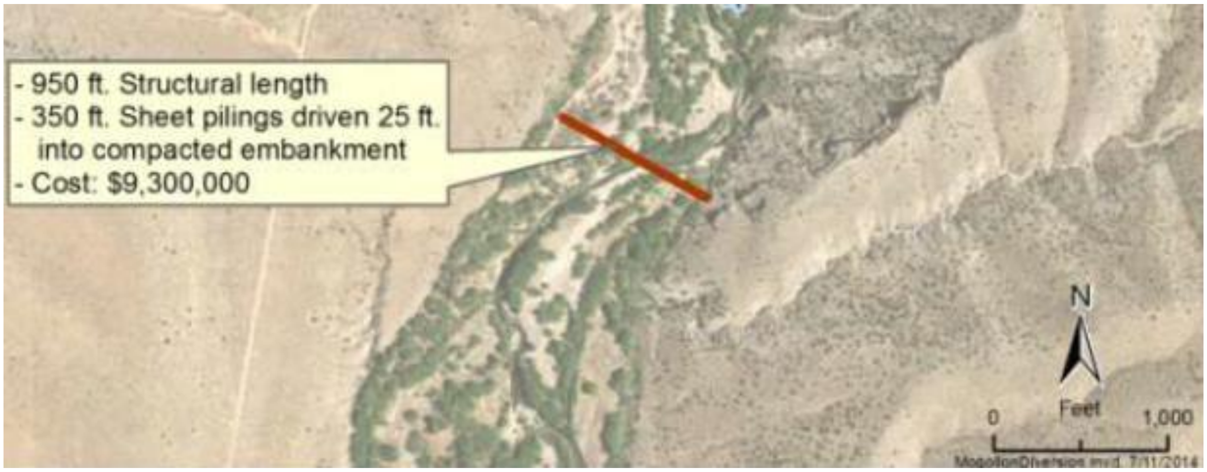

Figure 3. Sketch of BOR diversion structure extent. (Source: Reclamation Presentation Appraisal Engineering 20140721.pdf).

While the cost differential between the BHI design ($2.2 million) and the BOR design ($9.3 million) is significant, the risk of shutting down the project (costs difficult to estimate) and repair ($2 million each event until active floodplain is protected), outweighs the difference.

Footnotes:

[1] Note that the BOR diversion structure design does span the floodplain.

[2] Evidence that the structure does not span the active floodplain includes the large open portion of the floodplain visible in the aerial photograph, and BOR HEC-RAS modeling indicates that flow widths for a 2-year flood exceeds 130 feet.

SUPPLEMENTAL RECOMMENDATION NO. 01-020

SUMMARY RECOMMENDATION DESCRIPTION:

Add an ALERT/SCADA system to enable opitimized system operation and accounting of water flows into and out of the project.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-020 Idea Description: Add an ALERT/SCADA system to enable opitimized system operation and accounting of water flows into and out of the project.
Advantages of alternative concept: 1. More effective capture and retention of AWSA water due to availability of real-time instantaneous flow data. 2. Improved prediction of near-term river flows and flow capture opportunities. 3. Accurate accounting of captured, conveyed and delivered flow. 4. Provide data for effective system operation.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

DISCUSSION AND/OR CALCULATIONS:

Effective operation of the proposed project requires the following:

- Real-time streamflow data. These data are needed to operate the diversion structures at the times when AWSA water is available for diversion.
- Flow forecasting. Flood forecasting data based on state-of-the-art flood forecasting is needed to anticipate imminent and near-term future runoff rates.
- System operation rules. Automated operating rules are required that integrate the legal constraints that define water availability (e.g., environmental bypass requirements, 10-year running diversion volume, downstream flow requirements, etc.), the existing storage availability, the current (and future) water demand, and real-time and expected future flow rates.

The reality of the surface flows in the Gila River is that instantaneous flows can vary significantly from mean daily flows, and certainly from mean annual or mean monthly flows. Therefore, the availability of AWSA water may vary from minute to minute, particularly during summer monsoon flows which may rise and fall rapidly, occasionally multiple times during a single day. To effectively operate diversion structures and maximum capture of AWSA water when it is available, real-time stream and system data are required.

Furthermore, the complex water accounting required to document compliance with AWSA, the Globe Equity Decree, and other water allocations on the Gila River, accurate knowledge of system inflows, conveyance, storage, and releases is required.

An ALERT/SCADA system can provide much of the data needed to operate and manage the proposed project. An ALERT/SCADA system consists of remote sensing and operating tools that detect system inputs (e.g., rainfall, runoff, water levels, etc.), control system elements (gates, releases, conveyance, etc.), and report on system status (e.g., functioning and non-functioning structures, delivery rates, storage volumes, etc.). Potential elements of an ALERT/SCADA system for the project may include the following:

- Precipitation gauges. These gauges can integrate, supplement or slave onto existing NOAA, USFS, USGS, and local precipitation gauges in the watershed.
- Snowpack measurement. SNOTEL gauges operated by the NRCS or other agencies can be sourced to provide estimates of total water content during freezing weather periods.
- Stream flow gauges. These gauges can integrate, supplement or slave onto existing USFS, USGS, BOR, and local stream gauges in the watershed and should include:
    - Gila River main stem – upstream of all project diversion locations a sufficient distance to provide lead time for diversion operations.
    - Tributaries above water storage reservoirs (See P01-003) – these gauges are needed to quantify non-Gila River surface inflows into the project.
    - Project conveyance systems – gauges on system conveyance and release systems (discharge from reservoirs, releases back to the Gila River) are needed to track transfer of water into and out of the system and between system elements.
- Radar. Use of NWS-NOAA radar is useful for prediction of short-term rainfall/runoff.
- Rainfall-runoff model. A system-integrated watershed model using HEC-WMS or equivalent software is needed to convert real-time precipitation measurements, snowpack to snowmelt projection, and generate near-term runoff projections.
- Monitoring well water levels. Knowledge of ground water levels is necessary to estimate effectiveness of environmental bypass flows, identify, predict, and prevent likely river dry up reaches.
- Agricultural return flows. Monitoring agricultural return flows may be important for tracking water that may be recaptured upstream of the Arizona border without being accounted for as AWSA diversions.

It is likely that some synergies may be achieved by working with the Colorado River Forecast Center for long-range river flow forecasts (currently includes the Gila River). Pending water rights concerns and potential conflicts of interest, it may also be worth considering cooperation with SRP flow forecasting operations center.

Some of the ancillary benefits of including an ALERT/SCADA system include the following:

- Accurate accounting for system inflows
- Accounting and credit for system releases
- Documentation of actual diversions, releases, use
- Tributary gauges would trigger need for inspection and/or sediment maintenance if large floods occur

Costs:

$50,000 to $500,000 depending on elements selected just for the elements described above, assuming that existing elements of the currently designed SCADA system are expanded, rather than replaced with an entirely new system.

SUPPLEMENTAL RECOMMENDATION NO. 01-027

SUMMARY RECOMMENDATION DESCRIPTION:

Align the technical (engineering), NEPA, and Section 404 alternatives development and evaluation processes.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-037 - Develop purpose and need (P&N) statement as foundation for alternatives development and evaluation.

EVALUATION
Idea Number: 01-027 Idea Description: Align the technical (engineering), NEPA, and Section 404 alternatives development and evaluation processes.
Advantages of alternative concept: 1. Aligning alternatives screening upfront with these different processes can ultimately save time and produce alternatives that are defensible throughout the lengthy process of engineering and environmental compliance. 2. Minimize the unwelcome surprise of having an alternative considered the preferred alternative based on the technical analysis ultimately being rejected in the NEPA and/or Section 404 processes.
Advantages of original concept: 1. Not aligning the processes would in the short-term be a more simple alternatives development and screening process.
Risks of implementing alternative concept: 1. A non-preferred project alternative could rise to the top with the aligned processes.

DISCUSSION AND/OR CALCULATIONS:

Alignment of these 3 processes would, in addition to engineering and cost considerations, consider environmental effects, conservation, logistics, technical feasibility, energy consumption, and non-structural, as well as structural, ways to accomplish the project purpose and need or combining non-structural and structural components to reduce adverse environmental effects. The evaluation of diversion-storage alternatives will occur as part the technical (engineering) analysis and the NEPA and Section 404 compliance processes. Each of these alternative evaluation processes have a different focus: 1) technical (feasibility, yield and cost); 2) NEPA (evaluation of reasonable range of alternatives); and 3) Section 404 (least environmentally damaging practicable alternative to the aquatic environment). The development and evaluation of alternatives can occur as three distinct separate processes, or to the degree feasible, occur upfront as an intergrated process.

These 3 processes can be integrated by first developing a purpose and need statement (see SR01-037). Alternatives are then developed that potentially meet the purpose and need statement. The suite of alternatives should include a range of concepts that include consideration of non-structural and structural alternatives, water conservation, and variations on project size, facilities and location. Criteria for screening the alternatives are then developed. The screening criteria are derived from the the P&N statement, NEPA guidelines and the Section 404(b)(1) Guidelines. Example criteria could include:

- Yield [P&N]
- Geographic area serviced [P&N]
- Who water is delivered to and for what purposes, including environmental flows [P&N]

- ISC Gila Policy Statement [P&N]
- Feasibile/practicable (logistics, existing technology, cost) [404]
- Impacts to wetlands and waters [404]
- Impacts to federally listed species and designated critical habitat [NEPA]
- Impacts to species of concern [NEPA]
- Impacts to federally owned/managed lands [NEPA]
- Impacts to designated wilderness areas, wildlife refuges, parks or other protected lands [NEPA]
- Impacts to cultural resources [NEPA]

Alternatives surviving the screening using criteria from the P&N, NEPA and Section 404 processes could then be evaluated further as needed for engineering and environmental issues and a proposed preferred altenative or alternatives identified. The alternatives surviving the screening process would also be used in the NEPA and 404 processes which require development and evaluation of alternatives, so much of the alternatives development and screening work needed for these processes would have been done up front.

SUPPLEMENTAL RECOMMENDATION NO. 01-037

SUMMARY RECOMMENDATION DESCRIPTION:

Develop purpose and need (P&N) statement as foundation for alternatives development and evaluation.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-027 - Align the technical (engineering), NEPA, and Section 404 alternatives development and evaluation processes.

EVALUATION
Idea Number: 01-037 Idea Description: Develop purpose and need (P&N) statement as foundation for alternatives development and evaluation.
Advantages of alternative concept: 1. The P&N can serve as a description of the proposed project that allows the ISC to speak consistently in a variety of forums about the project. Until a defined and defensible P&N it is developed, it is open to debate as to what the purpose of the project is, why it is needed, if it is needed, who it serves, and what it would accomplish.
Advantages of original concept: 1. None apparent.
Risks of implementing alternative concept: 1. None apparent.

DISCUSSION AND/OR CALCULATIONS:

Any diversion-storage alternative will require an EIS and likely a Section 404 permit with their associated requirements for an alternatives analysis. The P&N for the project will be required for the EIS and Section 404 permit processes because it forms the foundation for the formulation and screening of alternatives. The P&N can inform decisions on the sizing of project facilities and potentially the design and location of facilities. For a water supply project, the P&N statement articulates the need for the project and typically includes the amount of water needed and frequency of demand to meet a specified need, over a specified period of time, in a defined geographic area for specified users.

SUPPLEMENTAL RECOMMENDATION NO. 01-030

SUMMARY RECOMMENDATION DESCRIPTION:

Develop and/or expand and use the existing Freeport-McMoRan (FMI) Tyrone (Bill Evans Lake) facilities for water storage, pumping, and pipeline conveyance for Mimbres basin water requirements.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-030 Idea Description: Develop and/or expand and use the existing Freeport-McMoRan (FMI) Tyrone (Bill Evans Lake) facilities for water storage, pumping, and pipeline conveyance for Mimbres basin water requirements.
Advantages of alternative concept: 1. Potentially takes advantage of existing facilities, conveyance routes, and power infrastrucure. 2. May provide a more favorable continental divide crossing, depending upon mine property availability and topography 3. If FMI were amenable to or otherwise motived to support the region's water supply needs, there may be intangible benefits to the project. 4. Potentially mine property sites could be found that had much more favorable geology; supporting alternative dam types, with potentially better foundation and seepage characteristics.
Advantages of original concept: 1. The original concept does not rely or depend upon developing a relationship or agreement with FMI, nor include private ownership of primary facilities. 2. The original concept does not involve mine property or any of the inherent environmental issues specific to mine, mine-water, or mine reclamation. 3. The original concept does not rely on existing facilities that may not have additional capacity, or economical means of expansion.
Risks of implementing alternative concept: 1. FMI may not be able, amenable, or motivated to partner in developing regional water supply and delivery needs. 2. Stakeholders may be required to surrender a degree of control over developed facilities and system operation.

DISCUSSION AND/OR CALCULATIONS:

The VE Team did not evaluate specific sites or schemes but understands that Freeport-McMoRan has not been engaged to weigh in on issues related to the AWSA. If this understanding is correct, and considering typical resources and resourcefulness of the mining industry, this engagement may be fruitful. Typical mine property challenges include developing and distributing water supply; managing significant groundwater; meeting intense power supply and distribution demands; containing and treating natural and process mine-water; and managing changing topography and complicated storm and surface water drainage. If FMI needs or benevolence complimented the SWRWS project needs, considering Tyrone’s proximity, engaging FMI might prove very valuable. The map insert below shows the Tyrone facility in relation to a few project reference points.

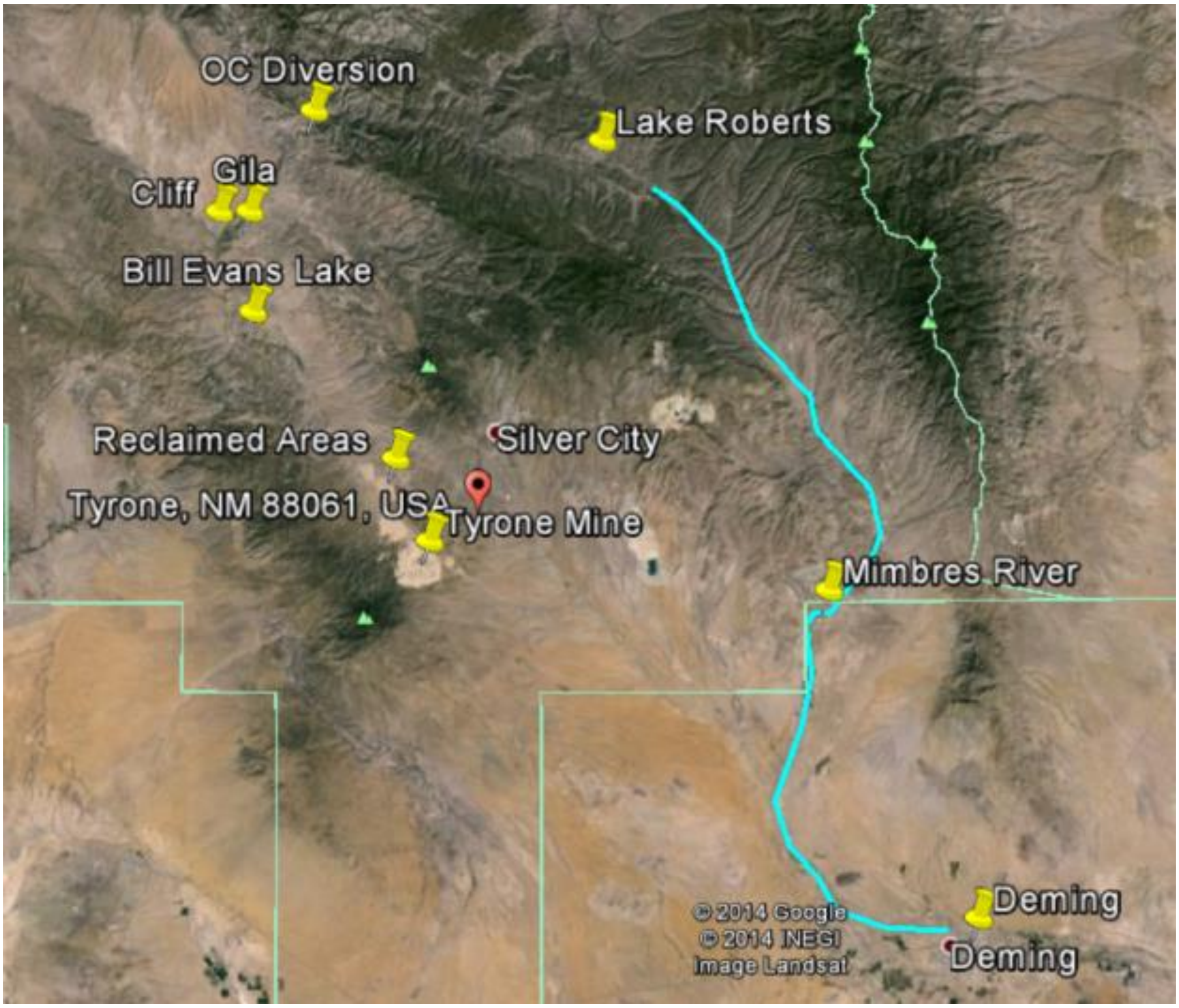
OC Diversion
Lake Roberts
Gila
Cliff
Bill Evans Lake
Reclaimed Areas
Silver City
Tyrone, NM 88061, USA
Tyrone Mine
Mimbres River
Deming
Deming
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Image Landsat

SUPPLEMENTAL RECOMMENDATION NO. 02-004

SUMMARY RECOMMENDATION DESCRIPTION:

Construct a low head dam at the BHI diversion point on the Gila River comprised of concrete fixed weir wall, piling cutoff walls, and sediment bypass sluiceway to provide sufficient water depth, clean water, and adequate supplies of water diversions into the intake screen area for conveyance to Spar Reservoir.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 02-004 Idea Description: Construct a low head dam at the BHI diversion point on the Gila River comprised of concrete fixed weir wall, piling cutoff walls, and sediment bypass sluiceway to provide sufficient water depth, clean water, and adequate supplies of water diversions into the intake screen area for conveyance to Spar Reservoir.
Advantages of alternative concept: 1. Provides adequate water depth for proper intake flows 2. Provides small amount of increased water storage and buffer
Advantages of original concept: 1. Lower construction costs
Risks of implementing alternative concept: 1. River sediment may accumulate and make storage ineffective

DISCUSSION AND/OR CALCULATIONS:

The Bureau of Reclamation used a similar low head dam option for the diversion intake structures for several of system alternatives. This type of diversion structure using a low head fixed-weir structure with sluicing gates merits additional studies as a viable diversion structure option on the Gila River diversion point. The dam would be about 1,000 feet total in length with about 2/3 of the length using reinforced concrete as a fixed weir about 7 feet in height with steel sheet piling as cutoff walls and flow control features. Sheet piles and other types of seepage control need to be carefully evaluated because of the granular nature of the river bed and the possible deep depth of the alluvium. The remaining 1/3 of the dam length should be used as gated control and sluicing operations to pass sediment and debris downstream. The gated sluicing operation is very important to provide adequate clearing of the stored sediment and debris on a continual or occasional basis to ensure clean water and sufficient water depth for proper Gila River intake operations.

Further studies and option refinements are recommended for this low head diversion dam alternative.

SUPPLEMENTAL RECOMMENDATION NO. 04-002

SUMMARY RECOMMENDATION DESCRIPTION:

Do not provide a separate pipe or cast-in-place concrete lining for the tunnel.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 04-002 Idea Description: Do not provide a separate pipe or cast-in-place concrete lining for the tunnel.
Advantages of alternative concept: 1. A large reduction in project cost while retaining the functionality
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. The rock present in the tunneled section is not as structurally strong as presumed during the design process

DISCUSSION AND/OR CALCULATIONS:

Tunnels may be required to convey water for this project. While the general geology is known, the site specific geology is unknown and needs to be investigated while the project design is in-process. If the geologic investigation indicates that the concept is viable, the savings in cost could be substantial.

Tunnels built to pass water may be lined with a pipe or cast-in-place concrete lining or, in some conditions, left unlined. If a tunnel is constructed in competent, self-supporting rock, but has sections of suspect ground, the tunnel may be partially lined only through the poor ground in the subject sections.

In the event that the geologic investigation indicates that the rock is generally competent and only requires support immediately after excavation, as well as a relatively thin covering to prevent slaking, these tunnel(s) may be left unlined, or partially lined only where required. Both geology and hydrology need to be considered when the lining versus non-lining alternate is considered. The risk of water loss, as well as water infiltration and water rights also need to be considered.

The current all-in cost for tunnels for this project is $ 3,500/ft which includes costs for: mobilization, equipment assembly, portal construction, tunnel excavation, tunnel support, tunnel lining, equipment disassembly, and demobilization.

Similar projects, of roughly equal length and diameter, and constructed in similar conditions in the past several years indicate that the cost of the tunnel lining may range from 41% to 61% of the total tunnel construction cost. Since additional initial rock protection support will be required to insure that the rock is protected for the life of the project, those percentages should be reduced by a factor of approximately 40% yielding a new reduction of 25% to 37% of the total tunnel cost, or $875/lf to $1,295/lf. The total reduction for the 17,080 lf of tunnel included w/ Alternative 2 would then be on the order of $14,945,000 to $22,118,600.

RECOMMENDATION FOR FURTHER STUDY BY THE ISC

SUPPLEMENTAL RECOMMENDATION NO. 01-005

SUMMARY RECOMMENDATION DESCRIPTION:

Establish a target delivery amount and location(s) for environmental flow augmentation.

Additional Description:

An ISC objective for a diversion-storage project is to provide environmental augmentation flows to reaches of the Gila River that are currently seasonally dry. An environmental flow augmentation program typically has several variables that need to be determined that in turn affect the design of project facilities (e.g., storage and conveyance) and operations.

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-026 - Develop project objectives and operational criteria for diversion-storage alternatives.

EVALUATION
Idea Number: 01-005 Idea Description: Establish a target delivery amount and location(s) for environmental flow augmentation.
Advantages of alternative concept: 1. Provides the information needed to operate environmental flow augmentation program. Provides greater certainty that the environmental flows will be delivered to the locations needed, in the amounts required, when the flows are needed and project facilities will be designed to meet the requirements of the environmental flow augmentation program.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

DISCUSSION AND/OR CALCULATIONS:

Parameters for operation of the flow augmentation program will need to be developed for NEPA, ESA compliance, and Section 404 permitting processes, as well as addressing the concerns of environmental interests. For example, what will trigger release of the flows? Are the environmental flows trying to maintain a minimum of 10 cfs at all times in the Gila River between Cliff-Gila and Virden-state line? If not, what are the target locations and amounts? Are there certain conditions when the environmental stream flow criteria would not be met (e.g., extreme drought, no water remaining in environmental account/pool, no water in reservoirs, or competing interests for the water). Who would be in charge of implementing the environmental stream flow augmentation program? Will there be a dedicated environmental pool in the reservoir(s)? If so, will the environmental pool have carry over storage if the environmental pool is not entirely needed during a wet year?

SUPPLEMENTAL RECOMMENDATION NO. 01-052

SUMMARY RECOMMENDATION DESCRIPTION:

Develop an integrated ground water/surface water model to help define operational parameters, to monitor the effectiveness of environmental bypass flows, and to account for non-point discharges of return flows into the Gila River that could be recaptured and reused.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-020 - Add an ALERT/SCADA system to enable opitimized system operation and accounting of water flows into and out of the project.
SR01-021 - Perform a Monte Carlo simulation of key system operations elements relating to the capture and delivery of AWSA waters to further demonstrate project feasility, identify project vulnerabilities, and identify potential improvements in system performance.

EVALUATION
Idea Number: 01-052 Idea Description: Develop an integrated ground water/surface water model to help define operational parameters, to monitor the effectiveness of environmental bypass flows, and to account for non-point discharges of return flows into the Gila River that could be recaptured and reused.
Advantages of alternative concept: 1. Define operational parameters to govern system operation 2. Monitor the effectiveness of environmental bypass flows 3. Account for non-point discharges of return flows into the Gila River 4. Allow recapture and reuse of return flows.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

DISCUSSION AND/OR CALCULATIONS:

An integrated ground water/surface water model of the three Gila River valley segments (Cliff, Gila, and Virden Valleys) in New Mexico should be created. The model could be used to achieve the following project goals:

- Establish and quantify the need for, and most effective discharge points for the environmental bypass flows. These data could be used to optimize the rate and best location(s) for the proposed environmental bypass flows, which potentially could vary by reach within the project limits.
- Establish a baseline of gaining and losing reaches, water table elevations, and surface flow rates from which future changes can be measured and evaluated.
- Quantify the amount of return flows back into the Gila River system so that they can be credited (or not) as AWSA water and potentially recaptured and used prior to surface flows reaching the Arizona border.

This model could be included in Monte Carlo simulations (SR01-021) and operating system modeling (SR01-026) to more effectively manage use of the full AWSA allotment by New Mexico.

Development of a useful ground water/surface water model will require calibration data including the following:

- Stream gauges at head and toe of each alluvial valley segment within the project limits
- Ground water monitoring wells spaced within alluvial valleys

SUPPLEMENTAL RECOMMENDATION NO. 01-007

SUMMARY RECOMMENDATION DESCRIPTION:

Considering a) BHI's single-liner lined reservoir, homogenous dam over and an unimproved alluvial foundation, and b) Reclamation's zoned earthfill over a cutoff foundation without reservoir seepage control, additional alternative designs should be considered that robustly address dam safety and seepage management.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-007 Idea Description: Considering a) BHI's single-liner lined reservoir, homogenous dam over and an unimproved alluvial foundation, and b) Reclamation's zoned earthfill over a cutoff foundation without reservoir seepage control, additional alternative designs should be considered that robustly address dam safety and seepage management.
Advantages of alternative concept: 1. A double or redundant liner system provides necessary assurance that a dam failure risk caused by internal erosion would be acceptably low. 2. A double or redundant liner system lessens the need for a zoned earthfill and foundation cutoff rather than the original concept homogenous design 3. A double liner system reduces the risk for high reservoir seepage losses. 4. An asphalt liner could provide much greater erosion resistance than the available soils, or unprotected liner as considered in the original concept. 5. Available soils appear to be reasonably well suited for an asphalt mix. 6. Riprap or sufficiently course erosion protection appears to require extensive processing of site soils or import. 7. Asphalt generally would provide a more flexible and less permeable matrix than soil cement. 8. An asphalt core may reduce the need for more extensive filter and drain zone materials that may be necessary for the zoned embankment. This type of embankment might need to replace the single-lined, homogenous embankment. 9. The original concept includes a spillway over the dam contributing to significant dam safety concerns. Constructing an emergency spillway through one of the abutments or reservoir banks and potentially incorporating a service spillway into the outlet system would make the dam design more favorable for dam safety risk reduction and permitting. 10. A free-standing rather than upstream face mounted outlet works may reduce risk related to differential settlement or foundation deformation.
Advantages of original concept: 1. To the degree the original concept provides acceptable dam safety risk, the construction is simpler and more economical. 2. To the degree the reservoir grading plan and exposed HDPE liner provided acceptable reservoir slope stability and liner durability, the single, uncovered lining system is simpler and more economical.
Risks of implementing alternative concept: 1. Little information exists to evaluate groundwater, groundwater variability during operation and the related uplift pressures and potential damage to any membrane liner system. 2. Establishing stable liner cover on the side slopes. 3. Acceptably overcoming settlement and potentially differential settlement stresses on liner system. 4. Exposed, or uncovered lining systems would be subject to maintenance and life-cycle deterioration.

DISCUSSION AND/OR CALCULATIONS:

A double liner system potentially utilizing asphalt is highlighted in this supplemental recommendation, but other dam and reservoir seepage control designs could be developed.

The proposed concept seeks to provide more robust preliminary design basis to ensure dam safety, ease dam safety permitting, and higher confidence that long-term reservoir seepage will be low. The original concept is understood to include: 1) homogenous embankment over existing foundation alluvium and in places, the Gila conglomerate; 2) no foundation cutoff; 3) a single, exposed HDPE membrane liner over a prepared graded zone; 4) uncontrolled concrete channel spillway routed over the dam embankment, and 5) outlet works intake system constructed on the embankment face.

The proposed design suggests a double lining system to provide redundancy and greater confidence that a homogenous embankment, founded on alluvial soils over permeable bedrock, could be designed to meet necessary dam safety requirements. Similarly a spillway through the abutment or reservoir bank is also proposed to achieve greater confidence reliably and safely. Finally, a free-standing and multi-level outlet works intake structure founded on piles may be needed to address anticipated settlement and need for multi-level withdrawal capability.

Two potential dual lining approaches:

1) Geo-composite Liner GCL) and HDPE	**2) HDPE or GCL with asphalt liner**
Grade reservoir to favor membrane liner installation	
Process (dry-screen) existing, well-graded granular soils to 1.5” minus for a 6” to 12” liner bedding	
Install a GCL	Install GCL or HDPE
Install a 60mil HDPE liner over the GCL	Install 6”-8” site-processed base gravel
Place a minimum 2’ thick, 3” minus soil cover over the HDPE liner	Construct a 4”-6” well-graded asphalt surface

<u>Cost Considerations</u>:

Quantities have not been developed for this supplemental recommendation. By considering this recommendations, savings should be gained by avoiding cost increases related to developing more robust designs during the design process or placing under-designed components into service.

SUPPLEMENTAL RECOMMENDATION NO. 01-050

SUMMARY RECOMMENDATION DESCRIPTION:

Perform additional detailed hydraulic modeling of the proposed diversion structure to assess its performance under a wider range of likely flow rate and sedimentation conditions.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: 01-050 Idea Description: Perform additional detailed hydraulic modeling of the proposed diversion structure to assess its performance under a wider range of likely flow rate and sedimentation conditions.
Advantages of alternative concept: 1. Better document performance of the diversion structure under expected range of conditions. 2. Assure ability of the diversion structure to effectively capture all targeted AWSA water under adverse field conditions.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

DISCUSSION AND/OR CALCULATIONS:

This proposal echoes the recommendation of the Tetratech's Sediment Transport Analysis (2014) to perform more detailed modeling of the diversion structure. The objectives of this additional modeling are to better document and assess the ability of the proposed diversion structure to capture AWSA water under the wide range of field conditions expected during the project life. This model will help assure effective capture of all of the targeted AWSA water.

The additional modeling recommended includes the following:

- Performance of the tilted screen intake structure over the full range of expected discharges. The Gila River flows can vary significantly over short time spans (unsteady flow) rather than the steady, constant flow rates assumed for the hydraulic ratings performed for the concept design study.
- Two-dimensional modeling of the stream reach surrounding the diversion structure. Two-dimensional modeling is recommended to better account for the skewed angle of the diversion structure relative to the river corridor, as well as the non-uniform water surface elevation likely to occur over the main channel and bypass opening relative to the overbanks, floodplains, and the intake portion of the structure itself.
- Additional sediment transport to predict likely changes in bed and floodplain elevations in the vicinity of the diversion structure and any potential impact on diversion efficiency.
- Consideration of the impacts of debris and sediment accumulation in the vicinity of the diversion structure and any potential effects on flow distribution over the structure intake screens.
- Justification of the 1.5 safety factor used to size the tilted screen intakes, given the high expected debris and sediment loads in the vicinity of the diversion structure.

SUPPLEMENTAL RECOMMENDATION NO. 01-021

SUMMARY RECOMMENDATION DESCRIPTION:

Perform a Monte Carlo simulation of key system operations elements relating to the capture and delivery of AWSA waters to further demonstrate project feasility, identify project vulnerabilities, and identify potential improvements in system performance.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-026 - Develop project objectives and operational criteria for diversion-storage alternatives.
SR01-049 - Make the climate change impact analysis in the ISC water availability model more robust by including likely changes in seasonal flow rates due to climate change.

EVALUATION
Idea Number: 01-021 Idea Description: Perform a Monte Carlo simulation of key system operations elements relating to the capture and delivery of AWSA waters to further demonstrate project feasility, identify project vulnerabilities, and identify potential improvements in system performance.
Advantages of alternative concept: 1. Demonstrate project feasibility. 2. Identify vulnerabilities in water diversion and delivery system.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

DISCUSSION AND/OR CALCULATIONS:

While the level of analysis performed by study contractors to date is appropriate for a feasibility assessment and conceptual project design, a number of questions remain regarding how effectively AWSA water can be captured and delivered given the real-time seasonal and instantaneous fluctuation of Gila River surface flows, as well as uncertainties in future water supply. The Interstate Stream Commission has developed a spreadsheet-based model to estimate the water available for AWSA diversions. This spreadsheet could serve as the basis of the type of decision making and programming needed for a Monte Carlo analysis[1] of the assumed operational parameters of the project. The Monte Carlo analysis could also serve as a demonstration and quantification of the project feasibility under the expected range of input parameters. The model would need to be expanded to simulate the interconnectedness of various system elements (diversion capacity, conveyance capacity, storage capacity, return flows) to likely inputs (diversion rate, sediment load, water demand, evaporation, tributary inflow, etc.) and deliveries (agricultural, environmental bypass, municipal, etc.).

Key elements to include in the Monte Carlo analysis:

- Assess the sensitivity of the existing AWSA water availability modeling by using instantaneous flows rather than mean daily flows in the water availability model.
- Assess system vulnerabilities by using Monte Carlo generated flow distributions and seasonal flow variations, rather than historical stream gauge based flow predictions.
- Assess the possible effects of seasonal changes in flow distribution due to future climate change on the availability of AWSA water. For example, some climate change models predict decreased winter flows (i.e., less snow melt), or increased summer precipitation, or no change in annual precipitation but with fewer, more extreme events. The effects of such changes under a variety of potential climate change scenarios could be evaluated and quantified using Monte Carlo simulations.

- Assess impacts of possible river sedimentation on diversion structure efficiency to identify potential weakness in diversion capacities.
- Assess the effect of variations in system operation (fluctuating demand, storage, system breakdowns, etc.) on system performance.
- Assess the effects of diverting AWSA water with high sediment loads (summer flows) versus low sediment loads (spring-winter flows).

The result of the Monte Carlo analysis would be a statement regarding the probability of success of the project under more widely varying input conditions than could be generated using historical data alone. This statement would be valuable for answering potential problematic what-if scenarios.

Footnotes

[1] Monte Carlo methods (or Monte Carlo experiments) are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results; typically one runs simulations many times over in order to obtain the distribution of an unknown probabilistic entity. The name comes from the resemblance of the technique to the act of playing and recording results in a real gambling casino. They are often used in physical and mathematical problems and are most useful when it is difficult or impossible to obtain a closed-form expression, or unfeasible to apply a deterministic algorithm. Monte Carlo methods are mainly used in three distinct problem classes: optimization, numerical integration and generation of draws from a probability distribution. (From Wikipedia)

SUPPLEMENTAL RECOMMENDATION NO. 01-049

SUMMARY RECOMMENDATION DESCRIPTION:

Make the climate change impact analysis in the ISC water availability model more robust by including likely changes in seasonal flow rates due to climate change.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

SR01-021 - Perform a Monte Carlo simulation of key system operations elements relating to the capture and delivery of AWSA waters to further demonstrate project feasility, identify project vulnerabilities, and identify potential improvements in system performance.

EVALUATION
Idea Number: 01-049 Idea Description: Make the climate change impact analysis in the ISC water availability model more robust by including likely changes in seasonal flow rates due to climate change.
Advantages of alternative concept: 1. Assess vulnerability of project and availability of AWSA water under a broader range of climate change scenarios. 2. Provide technical data to refute doomsday climate change scenarios advanced by project opponents.
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent

DISCUSSION AND/OR CALCULATIONS:

Climate change forecasts for the Southwest currently have a wide variety of predictions relating to changes in precipitation. These predictions include decreased annual precipitation (the majority of models), to the increased annual precipitation (a minority of models), as well as changes in seasonal distributions of precipitation. Some of the more commonly predicted changes include various combinations of the following scenarios:

- Increased summer precipitation
- Decreased winter precipitation
- No change in annual precipitation
- Increased frequency of extreme precipitation events, with decreased “normal” precipitation (fewer measurable precipitation events).

These scenarios should be included in the current ISC spreadsheet-based models to better assess the potential future availability of AWSA water to the project.

Season changes in precipitation could impact potential diversion of AWSA water in the following ways:

- Summer storms tend to be flashier, with fast rise times and low runoff volumes. Capturing such events would require a highly responsive operating system.
- Summer storms tend to have higher sediment concentrations and debris loads. Diversion of more sediment laden water may be less efficient due to clogging, and may decrease reservoir storage more rapidly, and may have a greater adverse impact and wear on pumping and conveyance structures.
- Decreased winter precipitation reduced in lower snow pack and spring runoff rates, depletion of storage in San Carlos Reservoir, and higher irrigation demands.

- Increased temperature may increase water demand, particularly for agricultural users.
- Increased number of extreme events with fewer “normal” events may deplete base flows and lower water tables and increase the water volume required to maintain “wet” conditions in the Gila River.

Inclusion of such changes will make the climate change impact analysis more robust by including a broader range of likely changes in seasonal flow rates and the ability to add flexibility to the design to better accommodate future changes.

SUPPLEMENTAL RECOMMENDATION NO. 01-035

SUMMARY RECOMMENDATION DESCRIPTION:

Pump water from San Carlos Reservoir back to southwest New Mexico.

Additional Description:

Related Value Engineering Proposals and/or Supplemental Recommendations:

EVALUATION
Idea Number: SR01-035 Idea Description: Pump water from San Carlos Reservoir back to southwest New Mexico.
Advantages of alternative concept: 1. Avoids or minimizes need to construct additional storage 2. During high flow periods, additional Gila River water will remain in river down to San Carlos Reservoir, which may be preferrable for some environmental attributes 3. Reduces potential environmental affects associated with reservoir construction and development (i.e. loss of habitat, etc.) 4. May be easier to obtain required environmental permits 5. May provide a more reliable dry year supply because of large capacity of San Carlos Reservoir (900,000 acre feet) 6. Potential increase in water supply as a result of reduced seepage losses that would be associated with new upper Gila Basin reservoir(s) 7. Would potentially provide more flow in the Gila River in Arizona
Advantages of original concept: 1. Less pumping, less electrical use, markedly less O&M 2. May provide more local benefit to streamflow and environmental resources in upper Gila River watershed 3. Water quality may be better
Risks of implementing alternative concept: 1. Will require multi-state agreements and consent to use San Carlos Reservoir 2. Operational costs may be unacceptable 3. Will require a greater amount of electricity (may be less green) 4. Enlargement of San Carlos Reservoir may be needed to accommodate the additional diversions 5. Pipeline to Gila may impact sensitive environmental areas 6. Water quality issues may be associated with San Carlos Reservoir 7. Coolidge Dam may be an unsafe dam Reclamation may be sensitive to increasing storage or there may be costs to the project to mitigate dam safety issues. 8. Right-of-way and acquisition costs have not been considered 9. Accounting of available AWSA water may be complex and transit losses in the Gila River upstream of San Carlos Reservoir may need to be considered

DISCUSSION AND/OR CALCULATIONS:

This concept would pump and convey water from San Carlos Reservoir in Arizona to the upper Gila River watershed, and to Deming area. Initially, a single pipeline would extend east from San Carlos Reservoir a distance of about 95 miles. Two separate pipelines would orginate at the terminus of this pipeline; one would extend about 92 miles to Deming, and the other would extend about 56 miles to the Cliff-Gila area. The pipelines would be located along highway and interstate roadways where possible. Elevation of the crest of San Carlos Reservoir is about 2,535', the elevation of Deming is about 4,335' and the elevation of Gila is about 4,560'. Total lift would exceed 2000' for portions of the project. About 25 pumping stations may be required.

Reservoir development in the upper Gila River area would be eliminated, or limited to small facilities for local regulatory purposes.

Pipeline from San Carlos Reservoir to Bifurcation Point: 35 cfs, 30" diameter, 95 miles, $6.30/in diameter/ft	$95M	
Pipeline from Bifurcation to Gila 20 cfs, 24" diameter, 56 miles, $6.30/in diameter/ft	$45M	
Pipeline from Bifurcation to Demming 15 cfs, 18" diameter, 92 mile, $6.30/in diameter/ft	$55M	
Total Pipeline Costs =	$195M	Say $200M
25 Pump Stations @ 2M each =		$50M
Miscellaneous crossings, siphons, etc. =		$50M
Total Conveyance Cost =		$300M

Original Concept: Comparable Conveyance & Storage Costs = $500M (approx.)

Potential Reduction in Conveyance Costs = $200M ($500M minus $300M)

NOTES TO DESIGNER

1. The VE Team' review has focused on the Cliff-Gila reach of the Gila River. It is not clear how environmental flows and agricultural water will be delivered to the Virden-state line area. Can flows of 10 cfs be protected between Cliff-Gila and Virden-state line? Will it take more than a 10 cfs release of water from the Cliff-Gila area to reach the Virden-state line area with 10 cfs (transit losses)?

2. Item 26, Permitting, Environmental Documentation (Alt. 2) on the BHI cost sheet is substantially underestimated. As noted by ISC and Reclamation, the diversion-storage alternatives will require an EIS. Based on Colorado Front Range water supply EISs, the estimated costs for permitting and environmental documentation are more likely to be about \$500,000 - \$1,000,000/year. The EIS and permitting process is likely to take 5-10 years at a cost of \$2,500,000 - \$10,000,000. These estimated costs do not include the costs of environmental mitigation which could be substantial given the environmental and cultural resources in the Gila basin.

3. Reclamation indicated that there are areas throughout the basin that have been designated as mitigation properties for previous projects developed in the basin. It is not known if any of the alternatives will adversely affect these mitigation properties. Impacting these mitigation properties could complicate overall environmental mitigation for the project, increase mitigation costs, and be a factor in alternative screening.

4. PER Phase II Evaluation of AWSA Diversion and Storage Proposals, Table V-13 PNM Power Extension Costs; total costs of \$36,200,000 are about twice what they should be. Table V-14 PNM Redundant Utility Costs (total of \$59,900,000); there is no need for a redundant system.

5. Sediment basins upstream of the reservoirs are way too expensive.

6. Diversion structures should span the floodplain or erosion area.

7. Estimated costs on the BHI cost sheet for Southwest Regional Pipeline, Southwest Regional Water Supply should be \$84,658,000 (NOT \$75,308,000) for Alternatives 1, 2 and 3.

8. Safe and effective storage is a critical component of this project. Geology and hydrology are the primary conditions that drive the technical design of the dams. Additional data is needed to advance the design concepts of the dams to provide appropriate dam safety and manage seepage to acceptable levels. There are several items in the current design concept that based on the limited data may not provide the appropriate dam safety and may be difficult to gain regulatory approval. These include an exposed single HDPE liner for seepage control over coarse alluvial materials, a homogenous dam, and spillway over the top of an earthen dam that is founded on alluvial foundations, and an inlet structure that is supported on an earthen dam.

9. Item 13 on pages 10 and 12 of Appendix J in the Draft Final Gila PER shows 38,600 and 318,000 tons of cement, respectively. These quantities appear to be overstated by a factor of 10 in the cost estimates. For example, 38,600 tons of cement applied to 30,400 cy of soil cement equals over 2,500 # of cement per cy of soil cement. This would normally be 250 to 300 #/cy.

SECTION 5 – IDEAS ANALYZED BUT NOT PROPOSED

EVALUATION
Idea Number: 01-001 Idea Description: Construct a tunnel, or tunnels, from Spar to Pope Reservoirs.
Advantages of alternative concept: 4. None apparent
Advantages of original concept: 2. The method of conveyance is appropriate for the project
Risks of implementing alternative concept: 2. None apparent
Conclusion: Do not propose this idea because it does not reduce cost nor provide an enhanced solution

Calculations and/or Discussion:

The conveyance between the outlet of Spar and the inlet on Pope is currently designed as a series of pipelines. The elevation of the reservoirs and the ground surface along the current pipeline is shown in the drawing entitled “Conveyance Profile and HGL Alternative Diversion Site 6 (350 cfs)” of Appendix G (page 622 of 700) of the Draft Final PER, indicate only one section 3,000 lf long may be applicable to the use of a tunnel. For the alignment shown, an increase in cost from $471/lf for the pipeline to a minimum of $3,500/lf for the tunnel does not make economic sense. Any other alignment for the pipeline to tunnel is equally uneconomic.

EVALUATION
Idea Number: 01-002 Idea Description: Move diversion further upstream to increase the available hydraulic head.
Advantages of alternative concept: 1. Provides the ability to increase the WSEL in Spar Reservoir, from El. 4713 to 4760 2. Enables more storage by gravity in Spar Reservoir, from 1642 ac-ft to 5290 ac-ft 3. Reduces the pumping head if a pump station is placed at Spar Reservoir4.
Advantages of original concept: 1. Shorter conveyance pipeline/tunnel between diversion and Spar
Risks of implementing alternative concept: 1. Longer pipeline alignment. Could impact permitting and operations.
Conclusion: Do not propose this idea because it only increased the head by 54 feet and would add costs over $7,000,000

Calculations and/or Discussion:

This would move the diversion point about 8500 river feet upstream. The approximate elevation of the diversion would be about 4790 feet. The current diversion is at about El. 4736. This increases the head by about 54 feet. This would add about 6000 feet of conveyance.

Assuming a similar proportional head loss as the current tunnel 23/18, 000 = 0.00128 ft/ft the maximum water level could be at El. 4760. The current maximum water elevation is at El. 4713, so this is a 47-foot increase. The corresponding storage volume at El. 4760 is 5,290 ac-ft. The increase in storage volume is 3648 ac-ft. This assumes that the dam is moved up to the location used for BHI alternative 2.

Using the current total project cost (includes contingency and non-construction costs) of about $1300/ft this would add 6000 ft x $1300 = $7,800,000.

The unit cost to build a 1,650 ac-ft Spar reservoir is about $17,235/ac-ft and to build a 44,000 ac-ft Spar is about $3,560/ac-ft. Adding the storage to Spar would cost about would cost about $13 to $60M.

Conclusion is that this provides minimal additional head to service by gravity (54 feet) and cost over $7.8M. No benefit. Fail concept.

EVALUATION
Idea Number: 01-010 Idea Description: Use Groundwater aquifer where Frank's Wellfield is located to reduce the need to convey (pipe) water over the divide.
Advantages of alternative concept: 1. None apparent
Advantages of original concept: 1. Provides reliable method (pipe conveyance) to deliver water to Mimbres Basin
Risks of implementing alternative concept: 1. None apparent
Conclusion: Do not propose this idea because water would need to be injected at the top of the divide at El. 5650 to have the water flow to the east. The groundwater elevation is highest at the top of the divide and flows both west and east from this point.

Calculations and/or Discussion:

The concept is to inject water in the Gila basin side of the aquifer, use the aquifer to convey water and then add additional wells in the vicinity of Frank's Wellfield to extract the water and use it in the Mimbres Basin. Issues related to water quality were ignored and this focused on the gradient and ability to convey the water. The elevation of the groundwater near the Gila River is in the range of El 4500 feet. Moving to the east the groundwater near the continental divide near Frank's well field is about El. 5600 feet. If water is injected on the west side (Gila basin) of the divide the gradient is towards the Gila River, so the water injected would return to the same point it was removed from. You would need to convey the water to at least El 5650 to have any water flow to the east. Even if water was injected at El. 5650 some of the water would flow back to the Gila River, just defeating the transfer of water to Mimbres basin. The elevation of groundwater at the divide is only about 600 feet below the ground surface at the divide (El 6250.). Conclude that this is not a technically feasible alternative.

EVALUATION
Idea Number: 01-029 Idea Description: Coordinate the timing of diversions with water demands.
Advantages of alternative concept: 1. None apparent
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent
Conclusion: Do not propose this idea because it is not feasible.

Calculations and/or Discussion:

Water is available for diversion under the AWSA only at times when streamflow of the Gila River is relatively high, and when local water users do not have a demand for additional supplies for irrigation or other purposes. The demand for AWSA water occurs at low flow periods when it will not be possible to divert ASWA water. Accordingly, it is not possible to time diversions to coincide with the timing of demands for AWSA water.

EVALUATION
Idea Number: 01-036 Idea Description: Use confined ground water storage in lieu of surface water storage.
Advantages of alternative concept: 1. None apparent
Advantages of original concept: 1. Makes no most economic sense for the project
Risks of implementing alternative concept: 1. None apparent
Conclusion: Do not propose this idea because it does not reduce the cost nor provide an enhanced solution.

Calculations and/or Discussion:

This evaluation deals w/ replacing one, or more of the surface reservoirs with a confined underground reservoir built by placing an impervious wall around a portion of an underground aquifer.

For this evaluation, the cost of a reservoir on the west bank of the river will be compared to the cost of enclosing an aquifer with the same volume. For alternative 2, the Winn reservoir has a storage volume of 10,713 acre-feet and that volume will be used to create a single confined aquifer on the west bank of the Gila River.

The applicable comparative cost for the Winn reservoir, from the cost sheets in the Appendix for the Draft Final PER, is $43,296,000.

The presumptions for this proposal are: there is an area that can be identified to build a single confined aquifer; the aquifer is large enough to contain the entire volume required; the geologic conditions of the location will be similar to the characteristics of the hole designated Winn 2 (drilled on the centerline of the downstream side of the proposed Winn dam); the elevation of the water is currently unknown but is presumed to be roughly 1/2 of the total storable depth; there is a 30% void ratio in the ground; the water will never be higher than 5 ft bgs; the the confining mechanism will be a soil-cement wall w/ a typical width of 5'0"; and the method to remove the water from the aquifer is wells.

The hole designated Winn 2 indicates that there is 30' of sand with gravel and silt with blowcounts from 25 to 63 and a median of 41 underlain by at least 10' of the Gila Conglomerate. The useable depth of the profile is (30 ft/2 for the water already in the aquifer less 5 ft bgs =) 10 ft. The volume of the contained area to store 10,713 acre-feet with a 30% void ratio for the callculated depth, is 3,571 acres. If the acerage were square, the perimeter would be approximately 50,680 lf (2.4 miles x 2.4 miles or some variation with a similar perimeter).

The confining wall will then encompass a volume of (50,688 lf x 30 VF x 3 ft/27 cf/cy) 168,960 cy. The unit cost for soil cement (in general although it is also used for the bottom of the reservoir) is $76/cy making the value of the soil cement wall $12,840,960. A similar calculation for a soil-bentonite wall yields a similar cost.

The removal of the water via a well point system will require wells at approximatly 150' on center to provide a reasonable cone of depression within the aquifer. Under this scenario, we will require 7,225 wells, each with a cost of approximately $5,000 generating a cost for pumping of $36,125,000.

The total cost for building and allowing a method of depleating a confined aquifer similar in size to the Winn reservoir is then $48,965,000 which is $5,669.960 (or 13.1%) more than the initial cost for the reservoir.

The on-going time related cost for filling each concept will be similar while the cost for depleating the confined aquifer storage will be much more than the reservoir.

The reason for failure is the increase in cost with no porportionate increase in functionality.

EVALUATION
Idea Number: 01-056 Idea Description: Put a mainline diversion dam on the Gila downstream of the present location to eliminate pumping at Winn.
Advantages of alternative concept: 1. None apparent
Advantages of original concept: 1. None apparent
Risks of implementing alternative concept: 1. None apparent
Conclusion: Do not propose this idea because permitting a new dam on the main-line river will be very difficult

Calculations and/or Discussion:

The original "Shotgun" suggestion was made to use a small dam on the Gila River at the narrow valley upstream of the confluence of Mogollon Creek to: store water; provide a source for the controlled diversion to the Spar Reservoir; and provide a ditch serving the upper west Gila-Cliff River valley. The measurement of the proposed cost was to be balanced against the need to provide a long term pumping solution for that same section of the upper northwest Gila-Cliff valley. This idea is similar to the Bureau of Reclamation idea presented in their document entitled "Reclamation Appraisal Level Report for AWSA Tier-2 Diversion and Storage Report" July, 2014 (pages 52 and 53 of 404).

The cost for the 50 cfs pump station was on the order of $6,032,000 and the cost for a small ditch/pipeline to convey the water was on the order of $249/ft. Disregarding the cost for maintenance of both the pumps and ditch over time, it would take approximately 24,224 lf of ditch to equal the cost of the pumping station. The length of the valley from Winn Reservoir to the mouth of the valley that would be served by the pump station would be approximately 20,000 lf and the length of the conveyance from the potential dam location to the top of the canyon is approximately 4,000 lf for a total of 24,000 lf. The cost of the pump station and the cost of the conveyance are approximately the same, and there is no project savings in the area for which the question was posed.

Knowing that the time for diversions is relative short and sporadic, it may be advantageous to have some sort of "mainline" storage to "even-out" the highs and lows of the diversion system. A small dam placed at the mouth of the canyon at roughly elevation 4640 will allow a backup in the canyon of approximately 3.66 miles to a average maximum depth of 20 VF (and an average depth of 10 ft) for the proposed intake at elevation 4,660. The average width of the top of the canyon is 370 ft and the average width of the bottom of the canyon is approximately 70 ft making the potential backup 975 acre-feet.

The volume of the dam would be on the order of 13,500 cy with a fixed concrete spillway at elevation 4660 ft. The cost to build the dam would be on the order of $1,000,000 to $1,500,000 including: mobilization; construction surveying; materials testing; contingency; design; construction observation; and management.

A major disadvantage may be the difficulty of permitting a new dam on the main channel of the Gila River.

EVALUATION
Idea Number: 03-006 Idea Description: Build a series of small dams along the river instead of the large dams proposed in the canyons.
Advantages of alternative concept: 1. None apparent
Advantages of original concept: 1. Appears to be the best solution
Risks of implementing alternative concept: 1. None apparent
Conclusion: Do not propose this idea because it does not reduce cost nor provide an enhanced solution.

Calculations and/or Discussion:

The original idea was to replace the 4 large reservoirs with several small dams and reservoirs (near the river) through the length of the project. The idea originally had a pass designation and that was changed to a supplemental designation after: 1) a discussion and better understanding that the allowable diversions over time are dependant on the size of the storage areas; as well as 2) confirmation through a second discussion that it is not cost effective to replace a dam in a natural canyon with a dam that has been partially excavated, with the materials used as side berms, to increase volume.

An advantage was the presumed reduction in evaporation. A disadvantage was the problem of sealing the bottom of a dam with a soil-cement process where the bottom of the dam also sees the effects of water beneath (i.e. the top of the water table). As the water table rises beyond the bottom of the soil-cement barrier it will crack the barrier and allow seepage.

The total storage volume required for the project is 65,417 acre-feet and would require an area of 25 square miles for an average depth of 4 ft (the presumed average depth from the top of the river bank to the top of the water table near the river). It would appear that length of the irrigable Gila-Cliff valley is approximately 12 miles and its width is approximately 3 miles generating a total area of approximately 36 square miles. In addition, the potential areas near the river are generally being used as crop lands.

If the depth of a typical reservoir could be more like 8 VF, the total area required would be more like 12.5 square miles which is still 50% of the apparent irrigable area for crops.

In order to limit the area required for crops to no more than 15% of the useable area (or 5 acres), the depth of the average dam would be increased to approximately 20 VF which appears to be much deeper than the average water table.

Another case could be made to place small dams in more canyons on the east side of the river and decrease the size of each while maintaining the size of the Winn reservoir on the west side of the river.

Needing a total of 10,713 acre-feet on the west side for Winn leaves a requirement for 54,704 acre-feet on the east side. Keeping the conveyance at a relatively low decline (and slowly decreasing from EL 4800 at Spar to EL 4600 at Sycamore), Moldanado, Garcia, Northrup, Bear, Pope, and Greenwood canyons appear to be feasible candidates for small dams. Moldanado, Bear, and Greenwood canyons have already been excluded for other reasons leaving only Garcia and Northrup canyons.

Based on the costs included with the current alternate, the cost per acre-foot rises dramatically as the relative capacity of the dam decreases. Making more, and smaller, dams would then increase the cost for the project.

In addition, to incorporate more dams into the system, the declination of the conveyance would decrease and the length of the conveyances would necessarily increase and the cost to the project would increase.

The cost of building a series of small dams in any location is not economic for this project.

EVALUATION
Idea Number: 03-007 Idea Description: Consider using Lake Roberts north of Silver City on Sapillo Creek just west of the continental divide for upper Gila storage as well as gravity conveyance via the Mimbres River.
Advantages of alternative concept: 1. Provides storage in the upper Gila basin 2. Provides storage very near the continental divide 3. Provides storage very near the Mimbres headwaters 4. There is an existing dam at Lake Roberts
Advantages of original concept: 1. Provides needed facilities without close proximity to the Aldo Leopold and Gila Wilderness Areas. 2. Provides necessary storage and conveyance.
Risks of implementing alternative concept: 1. Unable to develop an environmentally acceptable approach.
Conclusion: Do not propose this idea because of the proximity of wilderness areas; unlikely to get more that a few thousand AF; and difficulty with supply pipeline route.

Calculations and/or Discussion:

Lake Roberts is on the Sapillo Creek, just west of the continental divide along NM route 35 about 15-20 miles north of Silver City and Santa Clara. The lake discharges on the western slope into Sapillo Creek, a Gila tributary that is near the Aldo Leopold Wilderness Area and enters the Gila Wilderness Area just west of NM route 15. Sapillo Creek enters the Gila River several miles upstream of the original concept diversion. The area is contained by the national forest and is in rough terrain making a pipeline route that does not pass thru the Wilderness area very difficult. It would appear that a 20’ raise would add less than 2,500 AF and may interfere with the existing highway.

EVALUATION
Idea Number: 03-008 Idea Description: Construct a main-line diversion and storage dam on Mogollon Creek.
Advantages of alternative concept: 1. Provides storage in the upper Gila valley area and may provide enough flow to not require additional diversion.
Advantages of original concept: 1. Does not include a main-line dam on the Gila or a perennial tributary.
Risks of implementing alternative concept: 1. None apparent
Conclusion: Do not propose this idea because the dam would be technically as challenging as other locations and would bear very similar environmental challenges to constructing a dam on the main-line Gila.

Calculations and/or Discussion:

EVALUATION
Idea Number: 04-001 Idea Description: Add a short tunnel section over the divide.
Advantages of alternative concept: 1. None apparent
Advantages of original concept: 1. The original concept appears reasonable
Risks of implementing alternative concept: 1. None apparent
Conclusion: Do not propose this idea because there is no viable stretch of the pipeline alignment over the continental divide where a tunnel should be considered in place of a pipeline.

Calculations and/or Discussion:

Where there are dramatic elevation differences along facility alignments, it is sometimes cost effective to place the facilities in a tunnel instead of on the surface or in a trench. A review of the pipeline alignment does not indicate any such opportunities for this work item. The spikes in the ground elevation along the alignment length shown in the drawing entitled “HGL of Proposed 36” and 24” Pipeline from Pope Reservoir to Deming” in Appendix G (page 625 of 700) of the Draft Final PER show elevation differences of approximately 90 and 130 ft at length stations 120,000 and 130,000 ft over distances of approximately 2,000 and 6,000 ft respectively.

The combination of relative elevation difference over relative long lengths is too low to make tunneling feasible.

The following ideas were dismissed during the initial idea cull. They were not analyzed to the point of listing individual advantages and disadvantages. Reasons for failing an idea included such things as: not being technically viable, not being within a reasonable reach of the project budget, or just plain facetious (usually set out by the facilitator to encourage more far ranging thinking).

INITIALLY FAILED IDEAS TABLE

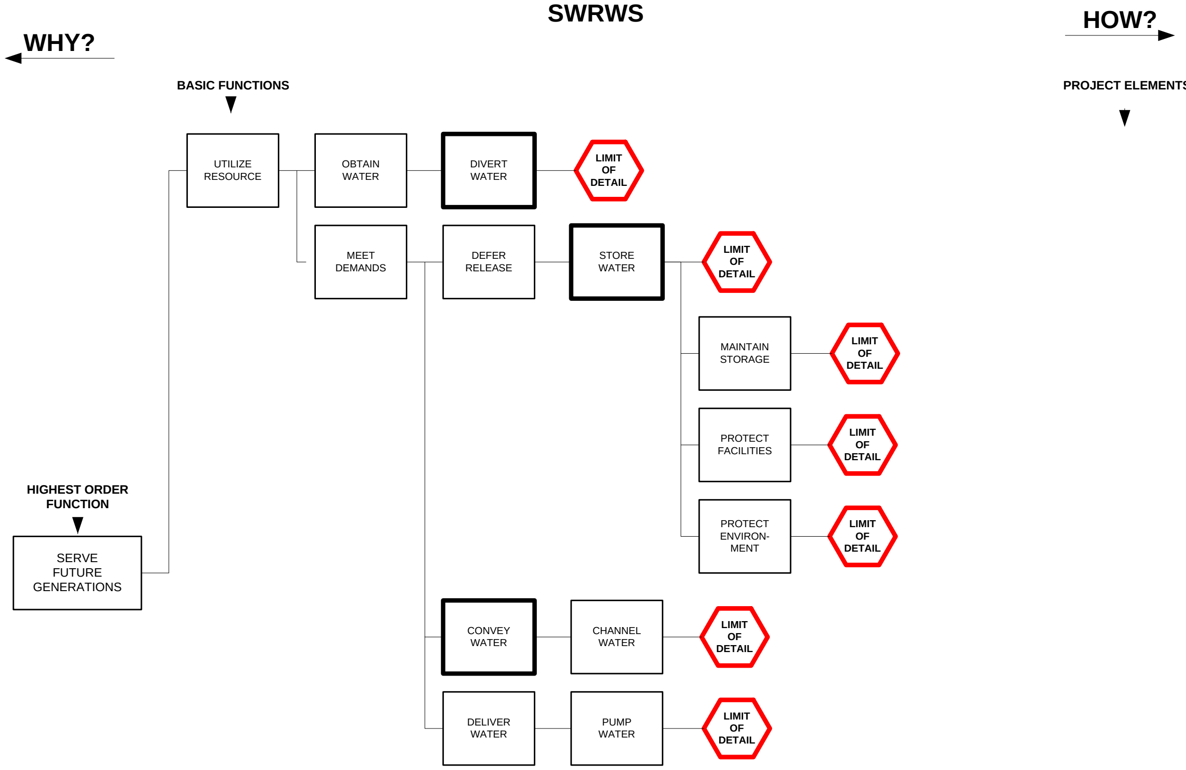
Idea No.	Idea Description	Reason for Failing Idea
01-004	Construct one big on-line dam	Environmental issues make permitting highly unlikely. May have to be considered in the permitting alternative analysis.
01-022	Further excavate the reservoirs rather than raising the dams	Ground water could create uplift problems. Disposal of the spoil is expensive. Previous analyses have shown that diffing down is always more expensive.
01-023	Buy out the farmland water rights &/or buy the farms to get the water	Does not meet the ISC's policy
01-028	Divert more flow and generate power coming from the Spar Reservoir	Water volume (determined by CUFA constraints) and low head won't generate enough electrical power to offset the life-cycle cost.
01-041	Minimize the number of dams to increase the potential for power generation	Not enough water volume and elevation to make it work
01-054	Add the Bear Creek Reservoir and delete Winn and Pope Reservoirs	Bear Creek is a critical habitat[2]
01-063	Investigate the presence of other alternative power sources in the area	Team knowledge indicates there are no such existing facilities
02-002	Wells	Not practical for this volume
02-003	Ranney wells	Previously analyzed and failed by the BoR because of sizing impracticality
02-005	Pumps	Can't pump the needed volume with the river morphology
02-007	Diversion structures	This is a goal, not an alternative
02-008	Flexible geometry	Not robust enough for the environment. Control would be difficult in this location
02-009	Siphon	Insufficient water depth
03-003	Tanks	Impractical for this volume
05-001	Install a sedimentation basin at the diversion point	Volumes make this impractical
05-002	Settling pond near the river	Requires too much area
05-003	Use a mechanical grit chamber	Volumes make this impractical

[2] BHI Figure 1. Proposed impoundment canyons in the Cliff-Gila valley. U.S. Fish and Wildlife Service designated critical habitat for 3 special status species also shown. *and*

SWCA Environmental Consultants. 2014. Arizona Water Settlements Act Proposed Water Impoundment Canyon Survey Report. Prepared for the New Mexico Interstate Stream Commission.

SECTION 6 – FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM

PARTIAL FAST DIAGRAM FOR THE SWRWS



NOTE:
BOLDED BOXES INDICATE FUNCTIONS SELECTED FOR BRAINSTORMING BASED ON COST & POTENTIAL FOR IMPROVEMENT

SECTION 7 – BRAINSTORMING IDEAS

The following table lists all of the ideas generated by the VE Team. They are arranged by the function from which they were generated. Shotgun list ideas are alternatives the VE Team members initially brought to the workshop as a result of their pre-study assignment.

Each idea can be traced to its ultimate disposition by crosschecking the disposition column of this table with Sections 3, 4, and 5 of this report.

Some of the ideas whose disposition is listed as "As Designed" were also assumed to be "as will be designed."

PLEASE NOTE: One of the rules for creativity exercises in a formal VE Study requires the team members to "stretch" their imaginations by generating sometimes facetious and seeming nonsensical ideas in order to ideate a possible conceptual blockbuster. These ideas, too, are recorded in this table.

Brainstorming List

Idea No.	Idea Description	Disposition	With
	Shotgun List		
01-001	Use a tunnel from Spar Reservoir to Pope Reservoir.	Pass	-
01-002	Move the diversion structure further upstream	Pass	-
01-003	Divert some tributary inflows to the reservoir	Pass	-
01-004	Construct one big on-line dam	Fail	-
01-005	Establish a target delivery point for environmental flow augmentation	Supplemental Recommendation	-
01-006	Recapture flow augmentation for other uses	Pass	-
01-007	Use alternative dam designs, e.g., asphalt core dams	Pass	-
01-008	Increase control of the seepage	Combine	01-007
01-009	Pipe the water from the diversion to Spar Reservoir	Pass	-
01-010	Use ground water pumping from Frank's Wells to reduce and/or eliminate SWRWS pumping	Pass	-
01-011	Implement irrigation efficiency improvements and downsize the system accordingly	Pass	-
01-012	Develop an implementation staging plan	Pass	-
01-013	Reduce the number of reservoirs, e.g., Greenwood Reservoir	Pass	-
01-014	Put a pumping plant at the end of the tunnel, make the Spar Reservoir bigger, and eliminate the Winn Reservoir	Pass	-
01-015	Optimize the number of pumping stations	Pass	-
01-016	Diversify the pumping loads	Combine	01-015
01-017	Use soil cement liners for the base of some or all reservoirs	Combine	01-007
01-018	Use a single reservoir between Spar and Pope	Combine	01-013
01-019	Add flanking protection at the diversion locations	Pass	-
01-020	Install a SCADA system on the main branch of the Gila River and its tributaries	Supplemental Recommendation	-

Idea No.	Idea Description	Disposition	With
01-021	Do a Monte Carlo analysis of the operational model	Supplemental Recommendation	-
01-022	Further excavate the reservoirs rather than raising the dams	Fail	-
01-023	Buy out the farmland water rights &/or buy the farms to get the water	Fail	-
01-024	Recapture the irrigation return flow	Combine	01-006
01-025	Capture the tributary flows where canals cross them	Combine	01-003
01-026	Develop operational criteria for environmental augmentation flow	Pass	-
01-027	Align the technical , NEPA and the 404 evaluation processes	Supplemental Recommendation	-
01-028	Divert more flow and generate power coming from the Spar Reservoir	Fail	-
01-029	Coordinate the timing of diversion versus use	Pass	-
01-030	Expand and use the Tyrone (Bill Evans Lake) facility	Pass	-
01-031	Use passive intake screens at the diversion	Pass	-
01-032	Enlarge Winn Reservoir and eliminate the Pope Reservoir	Combine	01-013
01-033	Conjunctive use with groundwater aquifer	Combine	01-010
01-034	Make the Spar Reservoir as big as possible (for pumped storage) and the Pope Reservoir as small as possible	Combine	01-013
01-035	Enlarge the San Carlos Reservoir and pump back to the SWRWS system	Pass	-
01-036	Use contained ground water storage in lieu of surface water storage	Pass	-
01-037	Validate (optimize) the amount of storage needed and input to the project purpose and need	Supplemental Recommendation	-
01-038	Clarify and/or substantiate the purpose and need	Combine	01-037
01-039	Optimize the SWRWS portion of the system to reduce the number of pumps	Combine	01-015
01-040	Install low head hydro generators where possible	As Designed	-
01-041	Minimize the number of dams to increase the potential for power generation	Fail	-
01-042	Reduce the project size so that it becomes viable by implementing some sort of reduced demand, e.g., conservation	Combine	01-011
01-043	Execute an agreement with the irrigators to accommodate environmental augmentation	Combine	01-011
01-044	Water savings form improved irrigation efficiency to be used for environmental augmentation	Combine	01-011
01-045	Have multiple recapture points to recover augmentation water	Combine	01-006
01-046	Develop staged construction for Mangas and Spar Reservoirs	Combine	01-012

Idea No.	Idea Description	Disposition	With
01-047	Build a dam at Greenwood and expand the well field at Franks and add an upper diversion at Mogollon	Combine	01-010
01-048	Let the tributaries bypass the reservoirs to keep the sediment out	Pass	-
01-049	Include seasonal variations in the climatology calculations, include summertime sedimentation allowances	Supplemental Recommendation	-
01-050	Design and model the yield for large diurnal flow variations	Supplemental Recommendation	-
01-051	Design a mechanism for measuring return flows	Combine	01-011
01-052	Establish a groundwater/surface water model for the valley	Supplemental Recommendation	-
01-053	Use Coanda screens only at diversion and use canals from diversion to Spar Reservoir	Combine	01-009
01-054	Add the Bear Creek Reservoir and delete Winn and Pope Reservoirs	Fail	01-013
01-055	Add a feature to the dam discharges to allow temperature control	Pass	-
01-056	Put a mainline diversion dam on the Gila downstream of the present location to eliminate pumping at Winn	Pass	-
01-057	Tie the diversion quantity to the tributary contributions	Combine	01-003
01-058	Develop instantaneous operating criteria versus the mean daily flow	Combine	01-020
01-059	Eliminate the reservoirs and use underground storage	Duplicate	01-036
01-060	Power the low horsepower pumps off the existing infrastructure	Pass	-
01-061	Make the service voltage 4160V	Pass	-
01-062	Have PNM distribute at 115kV	Pass	-
01-063	Investigate the presence of other alternative power sources in the area	Fail	-
01-064	Review and evaluate divertible water supply and project yield	Pass	
	Divert Water		
02-001	Infiltration galleries	As Designed	-
02-002	Wells	Fail	-
02-003	Rainey wells	Fail	-
02-004	Low head dam	Pass	-
02-005	Pumps	Fail	-
02-006	Fixed weirs	Combine	02-004
02-007	Diversion structures	Fail	-
02-008	Flexible geometry	Fail	-
02-009	Siphon	Fail	-
	Store Water		
03-001	Dams and reservoirs	As Designed	-
03-002	Store on existing mine property	Combine	01-030
03-003	Tanks	Fail	-
03-004	Confined aquifers	Combine	01-036
03-005	Store in the river	Combine	01-056

Idea No.	Idea Description	Disposition	With
03-006	Series of small dams	Pass	-
03-007	Use Lake Roberts	Supplemental Recommendation	-
03-008	Use Mogollon Creek area	Pass	-
03-009	Use Twin Sisters Canyon, can be used for recreation also	As Designed	-
	Convey Water		
04-001	Add a short tunnel section over the divide	Pass	-
04-002	Don't line the tunnel	Supplemental Recommendation	-
04-003	Use flume(s)	Combine	01-009
04-004	Deliver down the Mimbres River for a portion of the distribution system	Combine	03-007
	Clean Water		
05-001	Install a sedimentation basin at the diversion point	Fail	-
05-002	Settling pond near the river	Fail	-
05-003	Use a mechanical grit chamber	Fail	-
05-004	Move the sedimentation basins into the head end of the reservoirs	Pass	-

SECTION 8 – REVIEW BOARD DECISIONS

Summary of Responses to Value Engineering Proposals & Supplemental Recommendations

Definitions of Response Terminology

Accept: The VE proposal will be accepted and the original design concept will be modified accordingly.

Accept with Modifications: Portions of the VE recommendation will be accepted and/or the VE proposal will be modified somewhat.

Table the Decision: The proposal's disposition will be decided at future date. An individual should be assigned responsibility for follow-through.

Decline: The VE proposal will not be accepted and the original design concept will be implemented

VE Proposal No. or Supplemental Recommendation No.	VE Proposal or Supplemental Recommendation Description	Lead Responder	Response	Total Initial Savings ($)	Total Cost Savings ($) [1]
P01-003	Collect, use, and account for surface flows from Gila River tributaries that flow into the systems water storage reservoirs.		Table		
P01-009	Use steel pipe to convey diverted water from the Coanda intake screens only at the BHI diversion structure through buried and elevated alignment along the Gila River for discharges into the Spar Reservoir.		Decline		
P01-011	Include water conservation measures as a component of the project.		Accept		$2,864,430
P01-013	Consolidate Pope and Sycamore reservoirs into one larger reservoir in Greenwood canyon.		Accept	$70,000,000	$70,000,000

P01-014	Eliminate Winn Reservoir and add a second reservoir in Spar Canyon.	Accept	$17,000,000	$17,000,000
P01-015	Optimize the required number and size of pumping stations for Deming delivery flow (SWRWS) requirements.	Accept	$1,650,000	$1,650,000
P01-031	Use passive intake screens to replace the infiltration galleries in combination with Coanda screens at the BHI Gila River diversion point intake structure.	Table		
P01-048	Construct channels to allow tributary sediment to bypass the storage reservoirs.	Decline		
P01-055	Modify the feature of the dam discharge to allow greater temperature control of releases.	Accept		
P01-060	Use existing electrical infrastructure to feed the low horsepower pumps for Winn Reservoir.	Accept with Modifications	Not Determined	Not Determined
P01-061	Use 12.47kV or 13.8kV rather than 4.16kV for the large pump motors.	Accept	Not Determined	Not Determined
P01-062	Connect into PNM's 115kV source rather than the 69kV source voltage.	Table	Not Determined	Not Determined

P05-004	Eliminate or move the original concept sedimentation basins from upstream of the off-channel reservoirs into the reservoir inundation area.	Accept	$15,000,000	$15,000,000
SR01-064	Review and evaluate divertible water supply and project yield.	Accept		
SR01-012	Implement a staged project development plan that provides an initial Gila diversion and an initial or base level of storage, selected and designed to facilitate staged design and construction that is based on optimized supply potential versus current and projected demand.	Accept		
SR01-026	Develop project objectives and operational criteria for diversion-storage alternatives.	Accept		
SR01-006	Divert Gila River return flow by exchange or recapture.	Table		
SR01-019	Add additional erosion protection at the proposed diversion structures to prevent flanking of the structures by riverine erosion during large floods.	Accept		

SR01-020	Add an ALERT/SCADA system to enable optimized system operation and accounting of water flows into and out of the project.	Accept	
SR01-027	Align the technical (engineering), NEPA, and Section 404 alternatives development and evaluation processes.	Accept	
SR01-037	Develop purpose and need (P&N) statement as foundation for alternatives development and evaluation.	Accept	
SR01-030	Develop and/or expand and use the existing Freeport-McMoRan (FMI) Tyrone (Bill Evans Lake) facilities for water storage, pumping, and pipeline conveyance for Mimbres basin water requirements.	Table	
SR02-004	Construct a low head dam at the BHI diversion point on the Gila River comprised of concrete fixed weir wall, piling cutoff walls, and sediment bypass sluiceway to provide sufficient water depth, clean water, and adequate supplies of water diversions into the intake screen area for conveyance to Spar Reservoir.	Decline	
SR04-002	Do not provide a separate pipe or cast-in-place concrete lining for the tunnel.	Table	

SR01-005	Establish a target delivery amount and location(s) for environmental flow augmentation.	Table	
SR01-052	Develop an integrated ground water/surface water model to help define operational parameters, to monitor the effectiveness of environmental bypass flows, and to account for non-point discharges of return flows into the Gila River that could be recaptured and reused.	Accept	
SR01-007	Considering a) BHI's single-liner lined reservoir, homogenous dam over and an unimproved alluvial foundation, and b) Reclamation's zoned earthfill over a cutoff foundation without reservoir seepage control, additional alternative designs should be considered that robustly address dam safety and seepage management.	Accept	
SR01-050	Perform additional detailed hydraulic modeling of the proposed diversion structure to assess its performance under a wider range of likely flow rate and sedimentation conditions.	Accept	

SR01-021	Perform a Monte Carlo simulation of key system operations elements relating to the capture and delivery of AWSA waters to further demonstrate project feasibility, identify project vulnerabilities, and identify potential improvements in system performance.	Accept		
SR01-049	Make the climate change impact analysis in the ISC water availability model more robust by including likely changes in seasonal flow rates due to climate change.	Table		
SR01-035	Pump water from San Carlos Reservoir back to southwest New Mexico.	Decline		
		Total Cost Savings of Proposals Accepted =	$103,650,000	$106,514,430

Notes:

1. The Total Cost Savings is the simple sum of the accepted savings.
2. No deduction of the Total Cost Savings has been made for overlapping savings between proposals
3. No addition to the savings has been made for non-quantified savings
4. The assumptions could be made that notes Nos. 2 and 3 offset.
5. The savings are measured the <u>Draft</u> Final PER BHI Report. That number will likely change as design evolves.

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-003
Description:	Collect, use, and account for surface flows from Gila River tributaries that flow into the systems water storage reservoirs.
Recommended Action:	Table
Discussion:	Attractive idea and could be very helpful, but the legal issues are still undecided. The details would have to be worked out in accordance with Sub-term 1.10 of Exhibit 2.47 of Consumptive Use and Forbearance Agreement (CUFA). There are also other laws to which NM must adhere. The NM Office of the State Engineer (OSE) requires that dams release flood runoff within 96 hours.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-009
Description:	Use steel pipe to convey diverted water from the Coanda intake screens only at the BHI diversion structure through buried and elevated alignment along the Gila River for discharges into the Spar Reservoir.
Recommended Action:	Decline
Discussion:	Due to environmental concerns and the higher risk of environmental disturbance. In addition, it is not aesthetically desired. It also requires maintenance access road. Construction access would be challenging.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-011
Description:	Include water conservation measures as a component of the project.
Recommended Action:	Accept
Discussion:	Water conservation measures will be included as required by OSE. Those measures are already being considered separately. It would be helpful to know whether or not the savings calculation takes into account the loss of return flows from the fields.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-013
Description:	Consolidate Pope and Sycamore reservoirs into one larger reservoir in Greenwood canyon.
Recommended Action:	Accept
Discussion:	Due to cost savings. However, there needs to be more information on what is entailed in moving a federal highway. It seems that this would require a separate NEPA process.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-014
Description:	Eliminate Winn Reservoir and add a second reservoir in Spar Canyon.
Recommended Action:	Accept
Discussion:	
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-015
Description:	Optimize the required number and size of pumping stations for Deming delivery flow (SWRWS) requirements.
Recommended Action:	Accept
Discussion:	
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-031
Description:	
Recommended Action:	Table
Discussion:	This proposal appears to have a greater probability of long-term success than the infiltration gallery. In addition, the projected savings are large. However, USGS data indicates that when the flow is less than 50 cfs, the depth of the water at the gage is less than 5" above 4654'. Looking at the Tetratech bathymetric sketches, these might not be covered during low flows. Finally, security issues need to be addressed.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-048
Description:	Construct channels to allow tributary sediment to bypass the storage reservoirs.
Recommended Action:	Decline
Discussion:	Although this seems preferable to BHI's stormwater detention facilities, sediment removal dams have been in place and to good effect for decades. 12 of the tributaries along the Gila have sediment/flood control dams. Winn Canyon is the largest, and Sycamore has a check dam. But there are no such dams on either Spar or Greenwood.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-055
Description:	Modify the feature of the dam discharge to allow greater temperature control of releases.
Recommended Action:	Accept
Discussion:	This will likely be required in order to protect aquatic species.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-060
Description:	Use existing electrical infrastructure to feed the low horsepower pumps for Winn Reservoir.
Recommended Action:	Accept with Modification
Discussion:	Although the costs/savings are unknown, it seems that the existing electrical infrastructure could be used, especially if there is a pump station for Larger Spar (P01-014), or Greenwood (P01-013). This could also be combined with SR01-030 to use FMI's power infrastructure.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-061
Description:	Use 12.47kV or 13.8kV rather than 4.16kV for the large pump motors.
Recommended Action:	Accept
Discussion:	Due to savings.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P01-062
Description:	Connect into PNM's 115kV source rather than the 69kV source voltage.
Recommended Action:	Table
Discussion:	Costs/savings are unknown. Perhaps this could be studied further and some cost estimates generated.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	P05-004
Description:	Eliminate or move the original concept sedimentation basins from upstream of the off-channel reservoirs into the reservoir innundation area.
Recommended Action:	Accept
Discussion:	The maintenance issues should be addressed.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-064
Description:	Review and evaluate divertible water supply and project yield.
Recommended Action:	Accept
Discussion:	It is necessary.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-012
Description:	Implement a staged project development plan that provides an initial Gila diversion and an initial or base level of storage, selected and designed to facilitate staged design and construction that is based on optimized supply potential versus current and projected demand.
Recommended Action:	Accept
Discussion:	Given the time involved and the financial resources, this appears to be a necessity.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-026
Description:	Develop project objectives and operational criteria for diversion-storage alternatives.
Recommended Action:	Accept
Discussion:	
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-006
Description:	Divert Gila River return flow by exchange or recapture.
Recommended Action:	Table
Discussion:	This is probably challenging due to CUFA constraints and/or non-point return flows. In addition, returns are needed by downstream users. If NM can demonstrate return flow, it could probably just negotiate a credit and divert water under CUFA terms. There are also questions regarding how this affects water rights and enforcement, and how it takes into account the excess water diverted to provide adequate pressure head.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-019
Description:	Add additional erosion protection at the proposed diversion structures to prevent flanking of the structures by riverine erosion during large floods.
Recommended Action:	Accept
Discussion:	This would apparently be necessary for the project to continually accomplish its purpose.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-020
Description:	Add an ALERT/SCADA system to enable opitimized system operation and accounting of water flows into and out of the project.
Recommended Action:	Accept
Discussion:	NM may be able to partially fund this through (vii)(D)(2)Section 107 of the AWSA.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation **Project:**	
Proposal or SR No.:	SR01-027
Description:	Align the technical (engineering), NEPA, and Section 404 alternatives development and evaluation processes.
Recommended Action:	Accept
Discussion:	This would appear to save a great deal of time and effort.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-037
Description:	Develop purpose and need (P&N) statement as foundation for alternatives development and evaluation.
Recommended Action:	Accept
Discussion:	This will be formulated as part of NEPA, if NM chooses to develop the AWSA water.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-030
Description:	Develop and/or expand and use the existing Freeport-McMoRan (FMI) Tyrone (Bill Evans Lake) facilities for water storage, pumping, and pipeline conveyance for Mimbres basin water requirements.
Recommended Action:	Table
Discussion:	FMI's facilities are designed for the uses at the mine and for diversion of lower flows than those of AWSA. In addition, Bill Evans Lake likely does not have much additional capacity. Bill Evans Lake accepts only crystal clear, sediment free water. This might be solely to protect their pump impellers. They divert at low flows, whereas under the SWRWS project, sediment-laden water needs to be diverted at high flows. However, FMI's existing power infrastructure could be used to serve pump stations for the reservoirs (e.g. Greenwood). In addition, the route along Mangas Creek through Tyrone Mine could be used for SWRWS pipeline to Deming.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR02-004
Description:	Construct a low head dam at the BHI diversion point on the Gila River comprised of concrete fixed weir wall, piling cutoff walls, and sediment bypass sluiceway to provide sufficient water depth, clean water, and adequate supplies of water diversions into the intake screen area for conveyance to Spar Reservoir.
Recommended Action:	Decline
Discussion:	This seems more “invasive” of the channel than the Coanda screen, and the aesthetic appeal of the area might be lost. It is accepted, however, that something needs to be done to prevent flanking across the floodplain (SR01-019).
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR04-002
Description:	Do not provide a separate pipe or cast-in-place concrete lining for the tunnel.
Recommended Action:	Table
Discussion:	There needs to be additional geological/geotechnical information and research.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-005
Description:	Establish a target delivery amount and location(s) for environmental flow augmentation.
Recommended Action:	Table
Discussion:	This would have to be done at some point. However, it would likely be done when consulting with the US Fish and Wildlife Service and during the NEPA process, if NM chooses to pursue this project.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR-01-052
Description:	Develop an integrated ground water/surface water model to help define operational parameters, to monitor the effectiveness of environmental bypass flows, and to account for non-point discharges of return flows into the Gila River that could be recaptured and reused.
Recommended Action:	Accept
Discussion:	This could likely be built upon the model developed by SSPA.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-007
Description:	Considering a) BHI's single-liner lined reservoir, homogenous dam over and an unimproved alluvial foundation, and b) Reclamation's zoned earthfill over a cutoff foundation without reservoir seepage control, additional alternative designs should be considered that robustly address dam safety and seepage management.
Recommended Action:	Accept
Discussion:	Safety and seepage would need additional attention in next design phase.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-050
Description:	Perform additional detailed hydraulic modeling of the proposed diversion structure to assess its performance under a wider range of likely flow rate and sedimentation conditions.
Recommended Action:	Accept
Discussion:	This is necessary in the next design phase. Perhaps even a 3D scale model could be constructed in a laboratory.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-021
Description:	Perform a Monte Carlo simulation of key system operations elements relating to the capture and delivery of AWSA waters to further demonstrate project feasility, identify project vulnerabilities, and identify potential improvements in system performance.
Recommended Action:	Accept
Discussion:	This could be done In lieu of modifying the ISC CUFA model for additional climate variability (SR01-049).
Construction Cost Savings Comparison **VE Team Savings Estimate** **Designer Savings Estimate** **Reason for Difference in Estimates**	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-049
Description:	Make the climate change impact analysis in the ISC water availability model more robust by including likely changes in seasonal flow rates due to climate change.
Recommended Action:	Table
Discussion:	The seasonal flow rates have already been considered in the ISC model. This could be more expanded later.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	

Response to Value Engineering Proposal or Supplemental Recommendation Project:	
Proposal or SR No.:	SR01-035
Description:	Pump water from San Carlos Reservoir back to southwest New Mexico.
Recommended Action:	Decline
Discussion:	With the AWSA, NM already has terms negotiated and ratified. Legal and physical aspects of this proposal are really challenging.
Construction Cost Savings Comparison	
VE Team Savings Estimate	
Designer Savings Estimate	
Reason for Difference in Estimates	
Estimated Design Cost	
Total Cost Savings (Designer Savings Cost Estimate - Estimated Design Cost)	