APPENDIX P
DECISION ANALYSIS AND DATA QUALITY

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1.0 Decision Analysis

1.1 Decision Support

The Upper Rio Grande Water Operations Review and EIS (Review and EIS) evaluated impacts on the human and natural environment for 22 possible water operations alternatives analyzed over a 40-year planning period. With three joint lead agencies (JLAs), five cooperating agencies and tribal governments, more than twenty actively participating stakeholders and tribal representatives, and over 400 interested stakeholders, the identification of a top-ranked alternative is a complicated process.

Reclamation and the Corps operate facilities for different purposes and objectives and must balance their legal responsibilities with respect to the environment, endangered species, Indian Tribes, international treaties, water contractors, and the protection of other resources. The NMISC has legal mandates regarding water deliveries for interstate Compact compliance and protection of water rights. Tribal and private stakeholders have interests regarding property rights for water rights and lands, water quality, and environmental and cultural resource preservation. With so many interests, competing legal mandates, and the varying water values represented, identifying a top-ranked alternative for this Review and EIS is complicated (USWRC 1983).

Also complicating decision-making are traditional assumptions that the “most likely” or “expected” values for impacts provide an appropriate basis for evaluating and comparing alternative plans. A more robust evaluation could include considerations for data quality, parameter ranges for impacts, and the implications of the uncertainties as they relate to the evaluation of alternatives. When factoring data quality, uncertainty, and risk in the analysis, the “best choice” may be less obvious. This Review and EIS attempts to understand and disclose the current state of data quality, the range and propagation of uncertainty, and how they affect the decision process leading to the identification of a top-ranked alternative. The ultimate goal is to improve the quality of the decision made.

1.1.1 Methods

Faced with a complex, multi-faceted decision, multiple agencies and stakeholders, and competing issues and values, the JLAs selected a formal structured decision-making process to lend transparency to the identification of the top-ranked alternative.

The National Environmental Policy Act of 1969 requires that Federal, State, and local decision-makers consider and disclose the environmental implications of their proposed actions in order to allow decision-makers and the public to make informed decisions. NEPA also requires consideration of alternative strategies to achieve project objectives with consideration of the entire project in the context of other projects and the human environment. The JLAs also have responsibilities under the ESA in ensuring that their discretionary actions and operations do not jeopardize the continued existence of any Federally listed or proposed species, or result in adverse modification or destruction of designated or proposed critical habitat (Reclamation 2003; Corps 2003).

Water management agencies also have broad goals in moving from crisis-management to a longer-term sustainable operation of water resources that are sufficiently flexible to accommodate the multiple uses and needs in the river system (Corps 2002). Key science and data needs must be filled along multiple factors including water operations; water gaging; streamflow forecasting; biological and biodiversity measures; land use and vegetation; cultural and tribal resources; and economic analysis. Data was integrated through the use of GIS database and data quality, quantity, and consistency were evaluated and factored into the analysis process.

Taking scientific analysis by each of the resource teams and translating that knowledge and analysis into an informed decision that selects a preferred alternative also required a structured process.

The decision process for making informed decisions in a complex situation can be broken down as follows:

- Identify the decision problem (Basis for Conducting this EIS)
- Identify the objectives (EIS Purpose and Need Statement)
- Identify the alternatives (22 action alternatives identified based on scoping and water operations review)
- Identify the consequences (Preliminary screening and detailed screening of alternatives)
- Adjust for the tradeoffs (Identification of impacts and mitigation)
- Identify the uncertainty (Evaluate data quality and propagation of uncertainty)
- Identify the risk tolerance (Uncertainties in alternative preference and JLA willingness to accept and manage risk)
- Select and implement the preferred alternative (Record of Decision and Adaptive Management Plan) and identify the top-ranked alternative

The decision process used to select alternatives for detailed analysis and subsequently perform the detailed analysis on the retained alternatives is depicted on **Figure P-1**.

The logical steps in developing the detailed decision structure were as follows:

- Identify the goal (Select an Alternative)
- Identify the factors and criteria important in satisfying the goal (Decision Criteria)
- Where appropriate, identify subcriteria and performance measures (Team Criteria)
- Use objective performance measures wherever possible (Performance Measures)
- Value the importance of the criteria (Ranks and Weights)
- Evaluate alternatives against the objective performance measures (Scores, Ranks, Weights)
- Check reasonableness (Tradeoff and Uncertainty Analysis)
- Finalize the decision (Executive Committee Concurrence)
- Document the results (Criterium Decision Plus V3.0)

This process needed to identify uncertainties and risks and provide a transparent assessment of tradeoffs involved in plan selection. Therefore, a decision support tool was needed to supplement and aggregate the information obtained from the suite of scientific models used for this EIS: URGWOM, FLO-2D, MODBRANCH, RMA-2, Aquatic Habitat Model, Water Quality Model, and economic models.

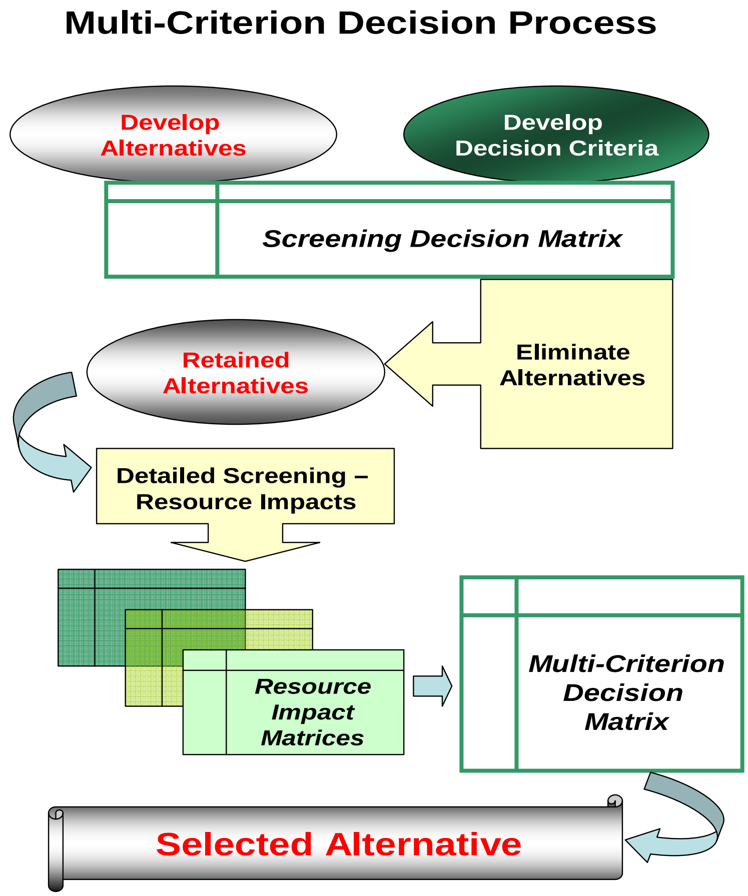

Figure P-1. Decision Process Diagram

Following a review of commercially available decision support software, Criterium Decision Plus (CDP) Version 3.0 distributed by InfoHarvest Inc. (InfoHarvest 2001) was selected to structure and document the decision process. CDP offered the following benefits: easy to use interfaces, visual hierarchies, modular construction for nested criteria, incorporation of uncertainty, tradeoff analysis, integration with GIS, export files compatible with Excel, and a free software reader allowing any stakeholder to examine the resulting decision models. The CDP decision analysis information is also being used in development of the Sandia National Laboratories dynamic simulation model. This model provides a user-friendly platform to ask "what if" questions and see the change in results. It is anticipated that the dynamic simulation model will be used in support of future public meetings presenting the results of this EIS.

1.1.2 Developing Decision Criteria

Decision criteria were established prior to initiating the screening and detailed analysis of alternatives in order to disclose JLA and Steering Committee values and preferences among competing and potentially conflicting requirements and mandates. The list of potential criteria was developed during public scoping and alternatives development meetings and from the statements of project Purpose and Need as appended to the JLA Memorandum of Agreement (Appendix D).

Upon review of these criteria, the Executive Committee identified three minimum threshold criteria that had to be met in order for an alternative to be carried forward for detailed analysis. These criteria were considered to be equally important and were as follows.

(1) Meets water storage and delivery needs
(2) Meets interstate Compact and Treaty requirements
(3) Meets flood control and safe dam operations criteria

Threshold criteria were used as heavily weighted benchmarks by the Water Operations technical team in the preliminary screening of draft alternatives.

Prior to the screening of alternatives, decision criteria were established to differentiate between alternatives and to identify, in advance, the means by which decisions would be made. In this way, a non-biased ranking could occur without prejudging the relative merits of individual alternatives. Each JLA and members of the Steering Committee provided rankings for the decision criteria using three different methods.

- Fixed Point Rank (Numerical) – Assign points to each criterion up to a 100-point total
- Scaled Rank (Independent) – On a scale of 1 to 10, rank each criterion independently in terms of importance
- Ordinal Rank (Relative) – Rank from high (1) to low (9) the relative importance of each criterion

The weights for each of the three JLAs and the Steering Committee weights were assigned equal importance. The overall ranking of each criterion was obtained by an averaging of scores among the three ranking methods. The results are provided in **Figure P-2** and were posted to the project website in November 2003 (Corps 2003).

1.2 Preliminary Screening of All Alternatives

The Water Operations team performed the initial screening of the 22 alternatives considered for this Review and EIS. The team identified ten decision criteria that included the three JLA-designated threshold criteria. Technical performance was assessed by analyzing the URGWOM and MODBRANCH modeling results for each alternative over the 40-year planning period. The following are examples of parameters considered for threshold criteria performance.

- Water storage and delivery needs were evaluated by analyzing total reservoir storage and by water accounts (Rio Grande and San Juan-Chama (SJC) Project accounts)
- Compact compliance was evaluated by analyzing annual Otowi gage-based Compact delivery requirements versus actual water delivered to Elephant Butte Reservoir and an evaluation of New Mexico’s Compact credit/debit status at the conclusion of the 40-year period
- Flood Control and Safe Dam operations were incorporated into model rules concerning reservoir operations and were analyzed against physical channel capacity constraints, waivers, and other restrictions on water conveyance and storage

AGENCY or STAKEHOLDER: JLA & Steering Committees Combined
Date: 11/13/2003
Participants: COE, BOR, ISC & Steering Committee Participants

FINAL RANKINGS	DECISION CRITERION	Fixed Point Criterion Score (Numerical)			Scaled Criterion Rating (Independent)			Ordinal Criterion Rank (Relative)			OVERALL RANK
		JLAs	SC	RANK	JLAs	SC	RANK	JLAs	SC	RANK	
A	**Meets Water Storage & Delivery Needs**	Threshold			Threshold			Threshold			EQUAL
B	**Meets Interstate Compact & Treaty Requirements**										EQUAL
C	**Meets Flood Control & Safe Dam Operations**										EQUAL
1	Meets Ecosystem Needs	15	20	**2**	7.7	8.8	**2**	1.7	1	**1**	**1**
4	Provides Sediment Management	13	12	**4**	6.0	6.4	**4**	3.3	3	**3**	**4**
3	Preserves Water Quality	17	15	**1**	6.7	8.6	**3**	4.0	2	**4**	**3**
2	Provides System Operating Flexibility	15	12	**3**	8.7	8.1	**1**	2.7	5	**2**	**2**
7	Preserves Desirable Land Uses	4	8	**8**	4.7	6.9	**6**	7.7	4	**7**	**7**
8	Preserves Recreational Uses	9	6	**7**	4.0	5.4	**8**	7.3	9	**8**	**8**
6	Preserves Cultural Resources	12	7	**5**	4.7	4.8	**7**	6.0	8	**6**	**6**
9	Alternative is Fair and Equitable	4	9	**9**	3.3	5.4	**9**	8.7	7	**9**	**9**
5	Preserves Indian Trust Assets	11	9	**6**	5.3	6.3	**5**	3.7	6	**5**	**5**

ABBREVIATIONS:
JLAs - Joint Lead Agencies
COE = U.S. Army Corps of Engineers
BOR = U.S. Department of Interior - Bureau of Reclamation
ISC = New Mexico Interstate Stream Commission
SC - Steering Committee - input from participants in November 13, 2003 meeting choosing to participate in ranking

Figure P-2 – Decision Criteria

Each alternative was scored on a scale of 1 to 10 relative to how well it performed on each technical performance measure. The performance score (scale of 1 to 10) multiplied by the criterion weight (percentage) summed across all criteria provided the overall alternative score (maximum = 100%). Alternatives were then ranked from high (1) to low (22) in overall performance and the top five alternatives were presented to the ID-NEPA team for concurrence in December 2003. The No Action Alternative was retained for detailed analysis in accordance with NEPA and CEQ requirements (CEQ; Reclamation 2000).

1.2.1 Detailed Analysis of Retained Alternatives

The individual decision criteria ranked by the JLAs and Steering Committee are the top tier hierarchy in the decision matrix. These decision criteria were expanded in detail by the individual ID-NEPA technical and resource teams. The technical criteria are summarized as second- and third-tier criteria assessed using explicit quantitative and qualitative performance measures, with underlying performance data founded in models and technical analyses. This detailed analysis process was shown on Figure DSS-1.

The ID-NEPA teams performed detailed analysis of the retained alternatives by developing a series of subcriteria and performance measures. Results of URGWOM, FLO-2D, Aquatic Habitat, MODBRANCH, GIS, and other modeling/analyses were used by the teams to evaluate the technical performance of each alternative over the 40-year planning period. The results of their detailed analyses were summarized in spreadsheets and translated into a decision hierarchy using performance measures and weights, as documented in the CDP decision model (**Attachment A**) and shown on the decision hierarchy presented on **Figure P-3**.

1.3 Results of Screening and Analysis of Alternatives

1.3.1 Preliminary Screening of Alternatives

The Water Operations team presented preliminary draft screening results for alternatives A-1 through H to the ID-NEPA team at the December 2003 monthly meeting. The Water Operations team recommended five alternatives be retained for detailed analyses: B-3, C-3, D-3, E-3, and the no action alternative. They also suggested that, based on similarities in performance, Alternatives C-3 and E-3 be combined into a single alternative, E-3, for detailed analysis.

Upon examination of this list of recommended alternatives in December 2003, the ID-NEPA team was concerned that all alternatives selected by the Water Operations criteria maximized upstream reservoir storage. They requested that a series of "I" alternatives be established to consider potential impacts of allowing more water in the river channel by capping upstream reservoir storage in Abiquiu Reservoir (20,000 and 75,000 acre-feet (AF)) and explicitly limiting Low Flow Conveyance Channel (LFCC) capacities to 500 and 1,000 cfs. Subsequent to this December 2003 ID-NEPA team meeting, the Water Operations team performed additional model runs to analyze alternatives I-1, I-2, and I-3 and incorporated these alternatives into their preliminary screening analysis as shown on **Figure P-4**. While the I-1 and I-2 alternatives were not ranked as high as the others, they were retained for detailed analysis at the express request of the ID-NEPA team. As a result, the alternatives selected for detailed analysis were: B-3, D-3, E-3, I-1, I-2, I-3 and the no action alternative.

As shown on Figure DSS-4, alternatives were rejected if they did not meet minimum performance standards for threshold criteria and/or if the sum of their weighted performance scores did not rank sufficiently high to merit further consideration.

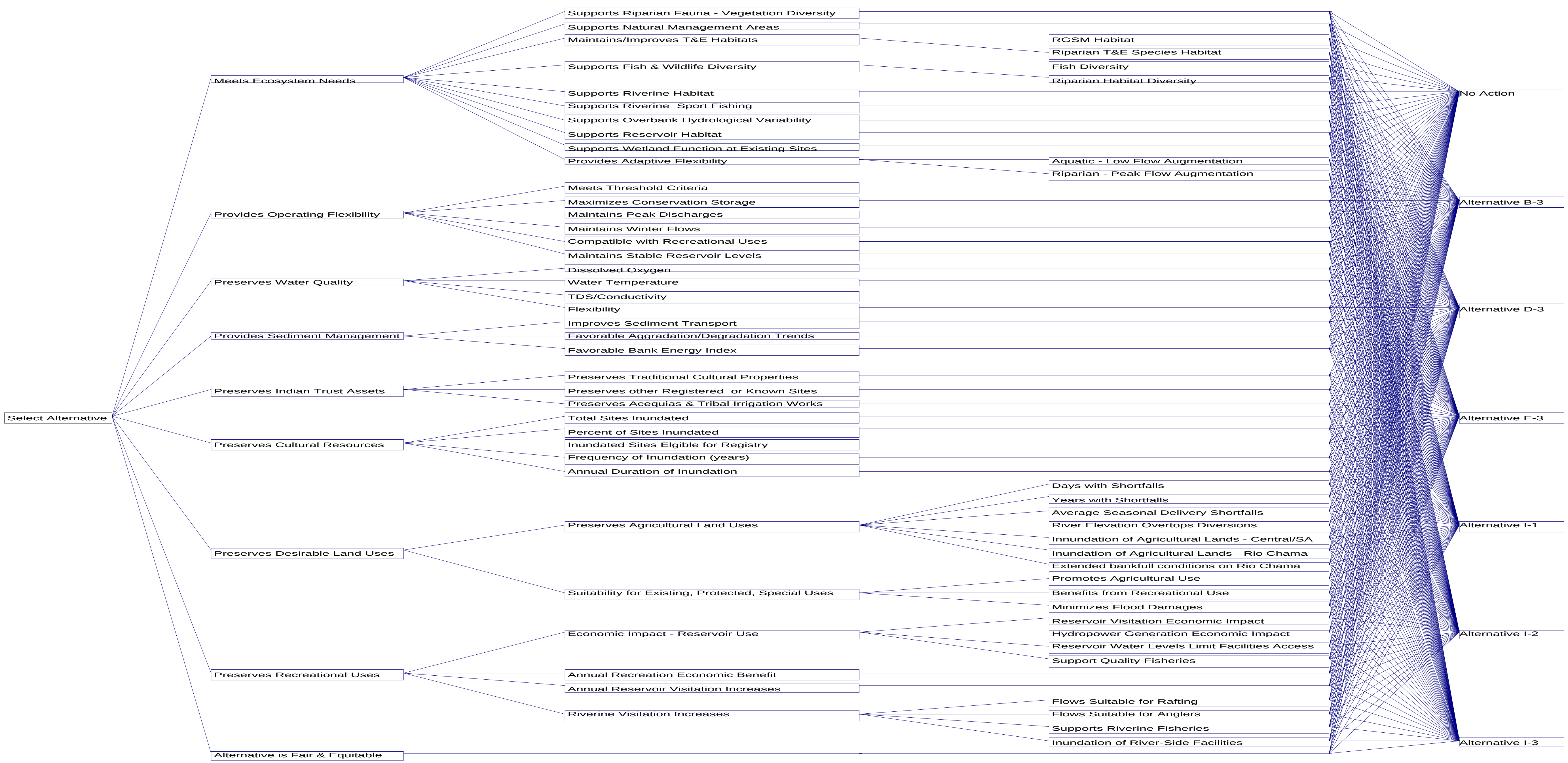

Figure P-3. Decision Hierarchy

DECISION SUPPORT: Alternative Performance vs. Water Operations Performance Measures

	Performance Measure	Compatibile w/Flood Control Operations	Compatibile w/Rio Grande Compact	Improves System Operational Flexibility	Supports Water Delivery	Maximizes Conservation Storage Opportunities	Maximizes Peak Discharge Opportunities	Maximizes Sediment Transport Opportunities	Supports Desirable Winter Flows	Supports Recreational Uses	Supports Stable Reservoir Levels		
	Threshold Criterion	X	X		X								
	ALTERNATIVE / Weight	0.20	0.20	0.15	0.15	0.10	0.08	0.05	0.04	0.02	0.01	Weighted Average Percent Met	Rank
1	**Plan G - No Action (Baseline)**	**7**	**4**	**5**	**8**	**0**	**6**	**6**	**5**	**5**	**5**	**52.80%**	**19**
2	Plan A1- Dry Hydrology Criteria	4	5	3	2	3	2	2	3	3	3	33.20%	22
3	Plan A2 - Normal Hydrology Criteria	4	5	4	2	7	2	2	1	1	1	37.30%	21
4	Plan A3 - Wet Hydrology Criteria	4	5	5	2	10	2	2	1	1	1	41.80%	20
5	Plan B1 - Dry Hydrology Criteria	6	7	6	7	3	5	5	4	4	4	57.80%	18
6	Plan B2 - Normal Hydrology Criteria	7	7	8	8	7	7	7	5	5	5	71.60%	16
7*	**Plan B3 - Wet Hydrology Criteria**	**9**	**9**	**10**	**8**	**10**	**8**	**9**	**5**	**5**	**5**	**87.40%**	**6**
8	Plan C1 - Dry Hydrology Criteria	7	8	6	8	3	6	6	5	5	5	65.30%	17
9	Plan C2 - Normal Hydrology Criteria	10	10	8	9	7	9	8	6	5	5	87.60%	5
10***	**Plan C3 - Wet Hydrology Criteria**	**10**	**10**	**10**	**10**	**10**	**9**	**9**	**6**	**5**	**5**	**95.60%**	**1**
11	Plan D1 - Dry Hydrology Criteria	10	8	7	10	3	8	8	5	5	5	78.40%	11
12	Plan D2 - Normal Hydrology Criteria	10	8	8	10	7	8	8	5	5	5	83.90%	8
2*	**Plan D3 - Wet Hydrology Criteria**	**10**	**10**	**10**	**10**	**10**	**8**	**8**	**5**	**5**	**5**	**93.90%**	**3**
14	Plan E1 - Dry Hydrology Criteria	10	10	6	8	3	9	9	5	6	5	79.40%	10
15	Plan E2 - Normal Hydrology Criteria	10	10	7	9	7	9	9	6	6	5	86.80%	7
16*	**Plan E3 - Wet Hydrology Criteria**	**10**	**10**	**9**	**10**	**10**	**9**	**9**	**6**	**6**	**5**	**94.30%**	**2**
17	Plan F1 - Dry Hydrology Criteria	10	8	5	10	0	9	9	6	6	6	74.40%	13
18	Plan F2 - Normal Hydrology Criteria	10	8	5	10	0	9	9	6	6	6	74.40%	13
19	Plan F3 - Wet Hydrology Criteria	10	8	5	10	0	9	9	6	6	6	74.40%	13
20**	**Plan I1 - Dry Hydrology Criteria**	**10**	**6**	**6**	**10**	**3**	**7**	**7**	**6**	**6**	**6**	**72.30%**	**15**
21**	**Plan I2 - Normal Hydrology Criteria**	**10**	**8**	**8**	**10**	**7**	**7**	**7**	**6**	**6**	**6**	**83.30%**	**9**
22*	**Plan I3 - Wet Hydrology Criteria**	**10**	**10**	**10**	**10**	**10**	**7**	**7**	**6**	**6**	**6**	**93.30%**	**4**

NOTES:

1. Performance Measure weights sum to 100 points total
2. Weighted Average Percent Met multiplies sums (scores * weights) for all measures
3. Alternatives are ranked from highest to lowest score
4. Top four alternatives selected for detailed analysis; supplemented by ID-NEPA Team dry and normal alternative selections

7*	**Alternative Selected by Water Operations Rankings for Detailed Analysis**
20**	**Alternative Selected by ID-NEPA Team for Broader Sepctrum Operations Analysis**
10***	**Alternative combined with E-3 for detailed analysis**

Figure P-4. Preliminary Screening

1.4 Detailed Analysis of Retained Alternatives

The detailed analyses of retained alternatives was performed on a resource-specific basis by the individual ID NEPA teams: Aquatic, Riparian, Geomorphology, Water Operations, Hydrology and Hydraulics, Water Quality, Cultural Resources, and Land Use etc. teams. Each team was responsible for the detailed evaluation of at least one top level decision criterion. In some cases, team evaluations were combined into a single decision criterion – for example, the criterion "Meets Ecosystem Needs" synthesized results from both the Aquatic and Riparian team evaluations. The detailed weighted and scored decision hierarchy is shown on **Table P-1**. CDP decision model files and the CDP reader are provided in electronic format as Attachment A.

Each team provided its own subcriteria and performance measures linked through the hierarchy to the top tier decision criteria. In this way, uncertainty analyses at the performance measure level could be easily updated as to impacts on the identification of the top-ranked alternative. ID-NEPA team spreadsheets with actual values for explicit performance measures by river section and alternative, (e.g., acres of habitat area, duration of overbank flooding, peak flow duration, cumulative reservoir storage, recreation days, etc.) are provided in Attachment A.

Once a top-ranked alternative was identified, an evaluation of tradeoffs, uncertainty, reasonableness, and robustness was performed to aid in understanding the sensitivities in the selection process (Corps 2002; Corps 1997).

1.4.1 Uncertainty

Our environment is inherently variable (intrinsic variability) and we are continually evolving in our abilities to understand and describe these processes (knowledge variability). Floods and droughts are inherently unpredictable, but have tangible environmental, safety, and economic consequences. Hydraulic variability was incorporated into the 40-year planning model input hydrograph to simulate periods of drought and abundant rainfall (Appendix I, Water Operations). Geographic information system (GIS) analysis was used to document, on a river reach basis, the quality of data available for each resource that was used for analyses supporting this Review and GIS. The discussion of data quality as it relates to decision-making was provided in previous sections of this technical report. Estimates of predictive error associated with data inputs and modeling have lead to a 10 percent factor applied to identify significant change from baseline conditions. The magnitude of error also increases from upstream to downstream, with the largest predictive error associated with the San Acacia and Southern Sections.

Table P-1. Decision Analysis Scores

Weights	Criteria	Weights	Performance Measure	Weights	Sub-Criteria	ALTERNATIVE SCORE No Action	B-3	D-3	E-3	I-1	I-2	I-3
20	Meets Ecosystem Needs	14	Supports Riparian Habitats - Vegetation Diversity			63.6	44	65.4	57.8	89.3	76.9	58.3
		4	Supports Natural Management Areas			93.4	57.7	53.8	59.2	88.1	79.9	60
		8	Maintains/Improves T&E Habitats	43.5	RGSM Habitat	94.71	95.77	95.92	95.95	99.52	99.5	95.78
				56.5	Riparian T&E Species Habitat	70.1	59	53.6	66.4	77.7	70.1	53.5
		10	Supports Fish & Wildlife Diversity	78.5	Fish Diversity	82.76	69.59	74.85	72.94	75.52	86.91	91.12
				21.5	Riparian Habitat Diversity	76.7	57.4	70	62.2	87.1	75.2	63.5
		22	Supports Riverine Habitat			99.52	92.05	91.15	91.78	93.79	93.75	90.58
		2	Supports Riverine Sport Fishing			99.32	98.25	98.76	98.48	100	99.43	98.39
		16	Supports Overbank Hydrological Variability			55.4	78.2	76	88.6	76.1	74.6	74.1
		10	Supports Reservoir Habitat			92.91	83.55	80.52	80.81	77.12	66.69	64.83
		8	Supports Wetland Function at Existing Sites			99.1	95	94.6	95	97.4	96.4	95
		6	Provides Adaptive Flexibility	50	Aquatic - Low Flow Augmentation	48.1	100	94.2	94.7	55.8	77.4	95.7
				50	Riparian - High Flow Augmentation	16	96	89	97	30	66	91
17.78	Provides Operating Flexibility	37.5	Meets Threshold Criteria			50	83	89	94	58	72	95
		25	Maximizes Conservation Storage			0	98	95	95	50	76	96
		20	Maintains Peak Discharges			83	90	87	88	85	100	88
		10	Maintains Winter Flows			94	100	96	97	96	96	97
		5	Compatible with Recreational Uses			100	92	92	90	95	92	90
		2.5	Maintains Stable Reservoir Levels			90	98	96	97	88	93	98
15.56	Preserves Water Quality	34.57	Dissolved Oxygen			99.75	90.75	92	93.25	93.25	94	93.25
		41.47	Water Temperature			73	99.5	97	96.75	96.75	93.25	97
		23.04	TDS/Conductivity			88.25	100	98.5	98.5	98.5	98.5	98.5
		0.92	Flexibility			0	100	14.37	19.38	1.17	2.47	21.11
13.33	Provides Sediment Management	34	Improves Sediment Transport			100	76	77	76	87	82	77

Weights	Criteria	Weights	Performance Measure	Weights	Sub-Criteria	ALTERNATIVE SCORE						
						No Action	B-3	D-3	E-3	I-1	I-2	I-3
		33	Favorable Aggradation/Degradation Trends			93	96	91	94	75	83	93
		33	Favorable Bank Energy Index			99	90	90	89	95	92	89
11.11	Preserves Indian Trust Assets	40	Preserves Traditional Cultural Properties			50	75	50	75	66.67	66.67	66.67
		30	Preserves other Registered or Known Sites			50	75	50	50	66.67	66.67	66.67
		30	Preserves Acequias & Tribal Irrigation Works			50	75	50	50	66.67	66.67	66.67
8.89	Preserves Cultural Resources	25	Total Sites Inundated			92	88	100	82	94	94	99
		20	Percent of Sites Inundated			86	83	97	73	92	92	100
		10	Inundated Sites Eligible for Registry			80	100	24	24	83	83	83
		20	Frequency of Inundation (years)			46	100	100	100	46	55	86
		25	Annual Duration of Inundation			29	100	100	100	29	50	50
6.67	Preserves Desirable Land Uses	50	Preserves Agricultural Land Uses	10	Days with Shortfalls	82.05	81.95	80.03	80.15	81.9	80.13	81.75
				10	Years with Shortfalls	49.38	50.63	49.08	50.63	50.63	49.08	49.08
				30	Average Seasonal Delivery Shortfalls	82.05	82	81.78	81.85	81.9	81.8	81.75
				10	River Elevation Overtops Diversions	57.9	66.5	61.7	59.6	56.7	58.8	59.6
				10	Inundation of Agricultural Lands - Central/SA	96.6	97.05	95.88	96.83	95.65	96.2	96.78
				10	Inundation of Agricultural Lands - Rio Chama	90.23	89.9	83.97	86.27	80.37	83.63	85.9
				20	Extended bankfull conditions on Rio Chama	78	100	86.7	87.3	78.7	87.3	78
		50	Suitability for Existing, Protected, Special Uses	40	Promotes Agricultural Use	7.7	8.3	6.6	7.9	7.6	7.7	7.9
				30	Benefits from Recreational Use	5.3	5.6	5.9	6	5	5.5	6
				30	Minimizes Flood Damages	4	15	100	11	6	12	86
4.44	Preserves Recreational Uses	40	Economic Impact - Reservoir Use	25	Reservoir Visitation Economic Impact	56	100	99	98	88	98	71
				25	Hydropower Generation Economic Impact	77	87	100	100	93	98	100
				45	Reservoir Water Levels Limit Facilities Access	51.98	54.48	59.7	60	46.73	53.78	60.05

Weights	Criteria	Weights	Performance Measure	Weights	Sub-Criteria	ALTERNATIVE SCORE No Action	B-3	D-3	E-3	I-1	I-2	I-3
				5	Support Quality Fisheries	59.7	52.8	51.2	50.9	100	94.3	92.2
		20	Annual Recreation Economic Benefit			56	100	99	98	88	98	71
		20	Annual Reservoir Visitation Increases			56	100	99	98	88	98	71
		20	Riverine Visitation Increases	53	Flows Suitable for Rafting	52	51	51	53	52	52	53
				32	Flows Suitable for Anglers	53.67	60.33	61.33	60.33	54.67	57.67	60.33
				11	Supports Riverine Fisheries	99.32	98.25	98.76	98.48	100	99.43	98.39
				4	Inundation of River-Side Facilities	100	100	98.33	100	95.67	99.17	100
2.22	Alternative is Fair & Equitable					3	1	7	5	4	2	6

While acknowledging the various sources and the magnitude of uncertainty in our performance analyses, single (expected) values were used in the current decision analysis. As indicated in the data quality discussion, in many cases there was insufficient statistical and probabilistic assessment of variability and quantitative incorporation of these uncertainties into our models and decision-making processes.

It is possible that in the future, the use of basic statistical descriptions of the data available could provide more robust knowledge of possible ranges in performance. Basic statistical measures such as the mean, median, maximum, minimum, standard deviation, variance, skew, kurtosis, etc. could offer a more realistic picture of alternative performance.

The uncertainty in each individual parameter, when aggregated into a decision matrix, filters up and is compounded, thereby introducing uncertainty and risk in the identification of a selected alternative. Without considering uncertainty, each alternative has a single decision score. Incorporating uncertainty, there may be occasions where a lesser-ranked alternative may be the better choice, depending on the risk tolerance and management needs of the decision makers. Understanding and communicating the level of risk associated with the choice assists decision makers in selecting a preferred alternative that best fits their risk tolerance.

Figure P-5 depicts a cumulative density function plot showing the uncertainty associated with these alternative. The almost vertical data plots show the least uncertainty because they are based on single-value (expected value) inputs. If desired, these analyses could be expanded using the statistical analyses cited above. Depending on risk tolerances, managers could use uncertainty analyses to understand the magnitude of risk undertaken in selecting a given alternative.

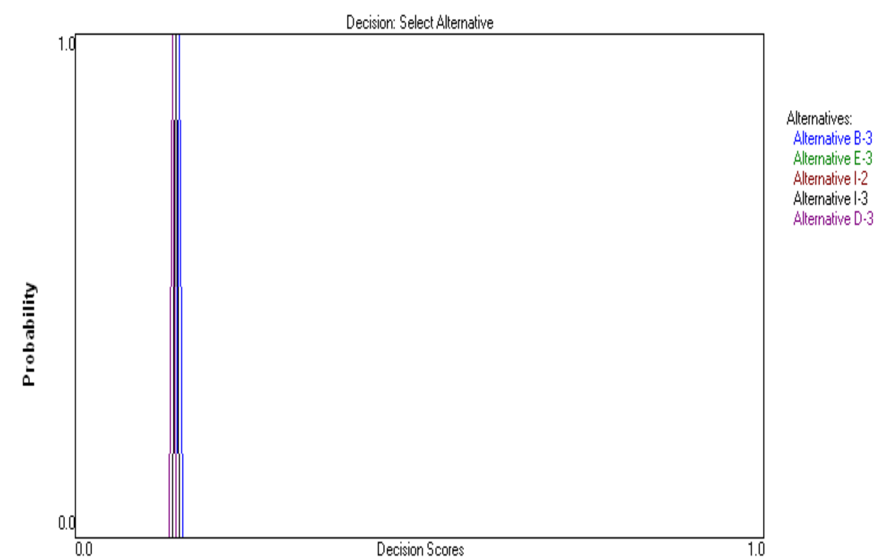

Figure P-5. Cumulative Density Function Plot

Figure P-6 shows an example of direct comparisons available between individual decision criteria. In this case, the performance of alternatives with respect to supporting RGSM show that all alternatives provide between 90 and 100% maximum possible support. In contrast, performance for threshold criteria ranges from 50 to 100%, and only alternatives B-3, D-3, E-3, and I-3 offering better than 75% performance on these key parameters. When viewing the actual decision files using the model reader, direct comparisons can be made between any two criteria in the model.

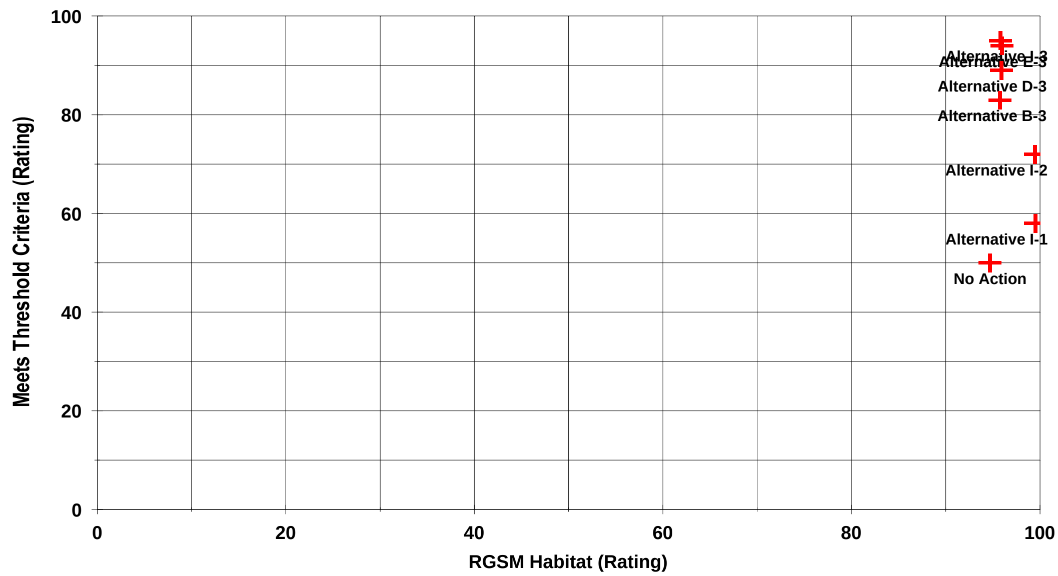

Figure P-6. Example of Direct Comparisons Between Criteria

1.4.2 Tradeoffs

The sensitivities to weights and ratings can also be evaluated depicting how selection of a preferred alternative depends upon the priorities of individual criteria. As shown on **Figure P-7**, the preferred alternative, B-3 shows the highest sensitivity towards the following criteria and measures (criterion-measure):

- Alternative is Fair and Equitable (3.2%)
- Preserves Water Quality - Flexibility (9.6%)
- Preserves Desirable Land Uses (14.4%)
- Preserves Indian Trust Assets (19.3%)
- Preserves Cultural Resources (27.8%)

In most cases, the next highly ranked alternative, I-3, would be selected if the priority or weight were to change more than the percentage identified. The alternative selection process is deemed to be robust in identifying a top-ranked alternative when the sensitivities to weights and ratings are subject to a greater than 5% change in weighting before a new alternative would emerge as top-ranked. The evaluation of water operations alternatives under this EIS involved fairly sensitive discrimination between alternatives that typically reveal only slight differences in impacts. However, upon analysis of sensitivities, the identification of Alternative B-3 as the top-ranked alternative is shown to be reasonably robust, with only one parameter of sixty showing a less than 5 % sensitivity. The importance of alternative fairness and equity would need to decrease a further 3.1 percent to result in a change in alternative preference.

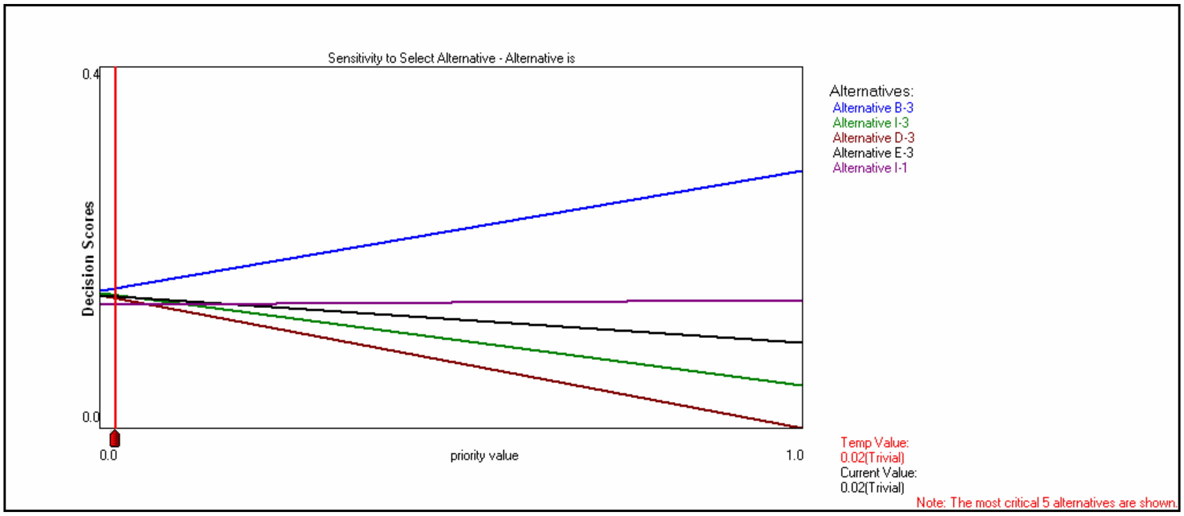

Figure P-7. Sensitivity by Weights

1.5 Identification of the Top-Ranked Alternative

Examination of reasonableness in capturing the thinking process is needed to further understand the implications of the ultimate choice. Examining the contributions by individual criteria allows decision makers and stakeholders to understand the values and tradeoffs supported by each alternative.

The radar graph is a useful tool in discriminating unique alternatives based on distinct value differences from those alternatives that are essentially slight variations of the similar values and priorities. The radar diagram spokes represent each criterion used in the decision for the overall goal or theme. The best-performing alternative for a given goal or theme should maximize available area across all spokes of the radar diagram. Top performing alternatives for a given criterion will plot along the outward extremes of a single criterion spoke. Minimally performing alternatives will score towards the center of the diagram.

Determining whether the top scoring alternative is a hybrid solution scoring well across all criteria, as opposed to an alternative that favors an extreme for one top-ranked criterion, is important to decision-makers answering to many stakeholders. Where there are broad similarities among multiple alternatives, the choice of the best scoring alternative is easily supported. Where two top scoring alternatives have radically different patterns on the radar diagram, the choice of a preferred alternative in effect supports one value system over another. By analyzing the radar diagram, one can document the value-basis for alternative selection and be prepared to discuss the merits and trade-offs reflected by the top-ranked alternative.

Figure P-8 shows the radar diagram for the preliminary screening of the retained alternatives against threshold criteria and water operations criteria. Alternatives had to meet minimum requirements in threshold criteria for the water operations team to forward their selection to the

ID-NEPA team. As shown on Figure DSS-9, alternatives B-3, D-3, E-3 and I-3 all met threshold criteria requirements, with alternative E-3 exhibiting the top rank at this stage. The ID-NEPA team added the I-1, I-2, and I-3 alternatives for detailed analysis based on a desire to provide a full examination of impact sensitivities in varying upstream storage allowances and operation of the Low Flow Conveyance Channel.

Figure P-9 shows alternative performance with respect to the three threshold criteria: 1) continued safety of dam and flood control operations; 2) meeting Compact deliveries; and 3) meeting contracted deliveries. Alternatives I-2, I-1, and No Action do not meet minimum criteria for meeting Compact Deliveries.

Figures P-10, P-11, and P-12 show the radar diagrams for the top three decision criteria: 1) meets ecosystem needs; 2) provides operating flexibility; and 3) preserves water quality.

As shown on Figure P-10, the ecologically preferred alternative is I-1. It delivers a hydrograph that is least encumbered by upstream storage and caps diversions to the LFCC at 500 cfs thereby leaving more water in the river channel in the San Acacia Section. However, this alternative offers less flexibility than others because there is the least upstream storage available for targeted delivery to ecosystem resources that could be used to provide additional water to augment peak flows, avoid intermittency, or provide late season supplementation for riparian interests.

The no action alternative was modeled with zero diversions to the LFCC, providing a best-case estimate for ecosystem impacts in the San Acacia Section. All other action alternatives were modeled exercising the full flexibilities offered. That is, upstream storage options were exercised whenever possible and LFCC diversions were conducted to the maximum allowed.

The top-ranked alternative, B-3, is the worst-ranked alternative from an ecosystem perspective, while being the top-ranked alternative for maximum conservation storage potential. Most ecosystem performance rankings compare B-3 at 2,000 cfs diversions to the LFCC against No Action with 0 cfs diversions. Therefore, ecosystem comparisons offer worst-best case comparisons in the San Acacia Section and did not account for the benefits of using stored conservation water at critical times of the year. Alternative B-3 performed well on riverine and reservoir habitat, hydrologic variability, and adaptive flexibility performance measures. Alternative B-3, in its present configuration, does not provide as much support for habitat diversity, but with increased channel capcities below Cochiti Dam, it offers the potential for carrying higher flows into the lower sections. Mitigation measures could be identified to use conservation water storage offered in this alternative to offset some of the undesirable seasonal impacts.

Operating flexibilities were weighted and ranked by from a water operations perspective as shown on Figure P-11. In this case, Alternative B-3 offers mid-range water management flexibility by maximizing conservation storage opportunities, and offering higher peak discharge opportunities; alternative I-3 was ranked best for water management flexibility. The No Action Alternative is least desirable as it offers no flexibility in the amount of stored conservation water available to modify the duration and timing of water deliveries for Compact delivery and ecosystem needs.

From a water quality perspective, Alternative B-3 is the top-ranked alternative offering the best combination of temperature, dissolved oxygen, and dissolved solids/conductivity conditions and the highest potential flexibility, as shown in Figure P-12. However, this alternative ranked the worst with respect to dissolved oxygen availability. The second choice alternative for water quality was I-3, outranking B-3 on dissolved oxygen. The flexibility measure for water quality was the most sensitive criterion evaluated – and is one of the measures least likely to change in relative importance to all other decision components. Thus, selection of the preferred alternative is unlikely to change with a change or deletion of this performance measure.

Figure P-13 shows the radar diagram identifying the top-ranked alternative selected based upon the relative importance among the nine decision criteria established by the JLAs and Steering Committee (see Figure DSS-2). The top-ranked alternative, B-3, is highly ranked water quality, indian trust assets, cultural resources, and land use issues. It is the worst-ranked alternative for ecosystem needs, but was the top scoring ecosystem alternative of those alternatives maximizing upstream conservation storage potential. Alternative B-3 ranked low on the scales for sediment management and recreational uses. Per the weights established among competing criteria, Alternative B-3 offers the best potential to manage the multiple objectives, multiple purposes, and competing goals for water management in the Upper Rio Grande.

PRELIMINARY SCREENING

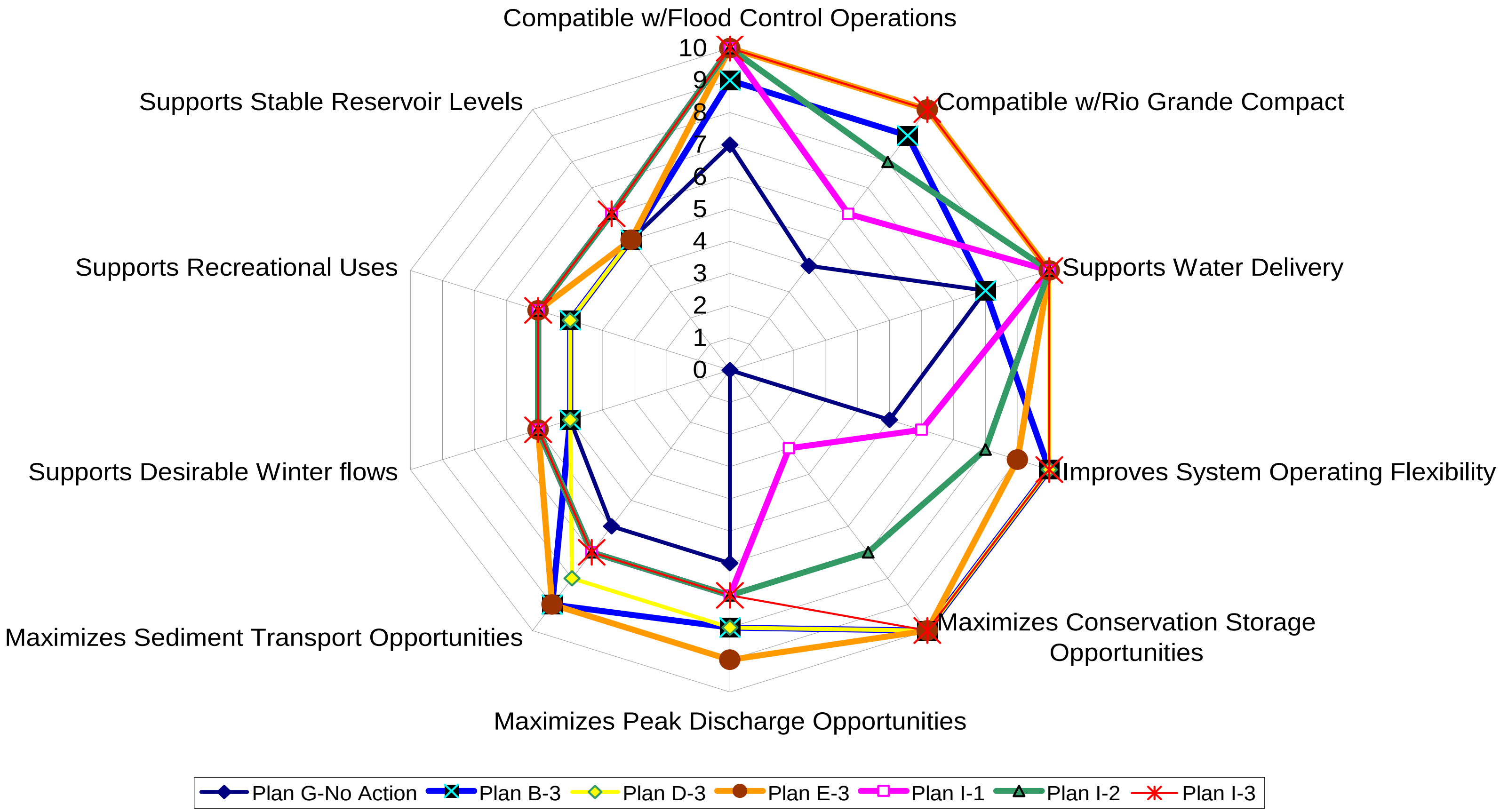

Figure P-8. Preliminary Screening Results

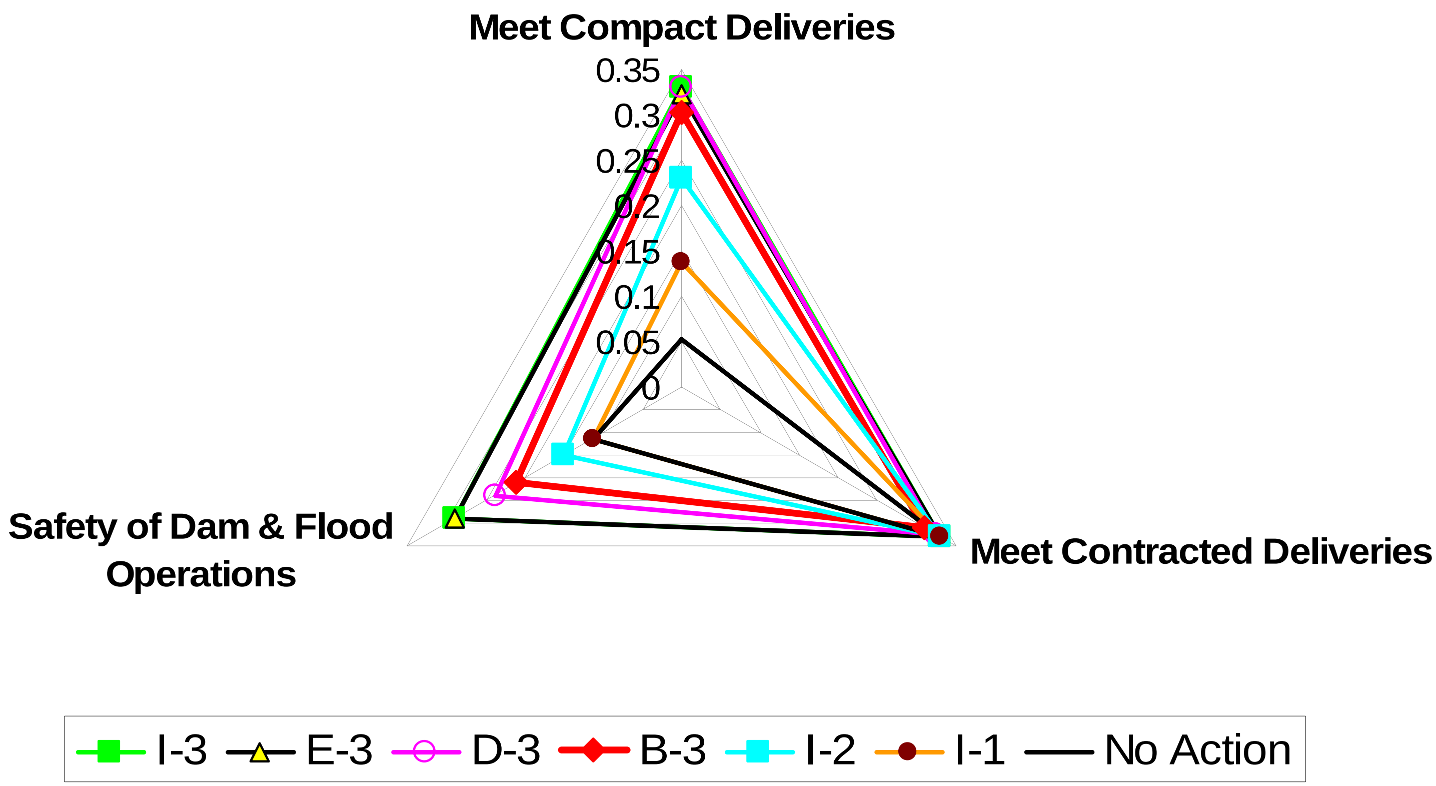

Figure P-9. Threshold Criteria

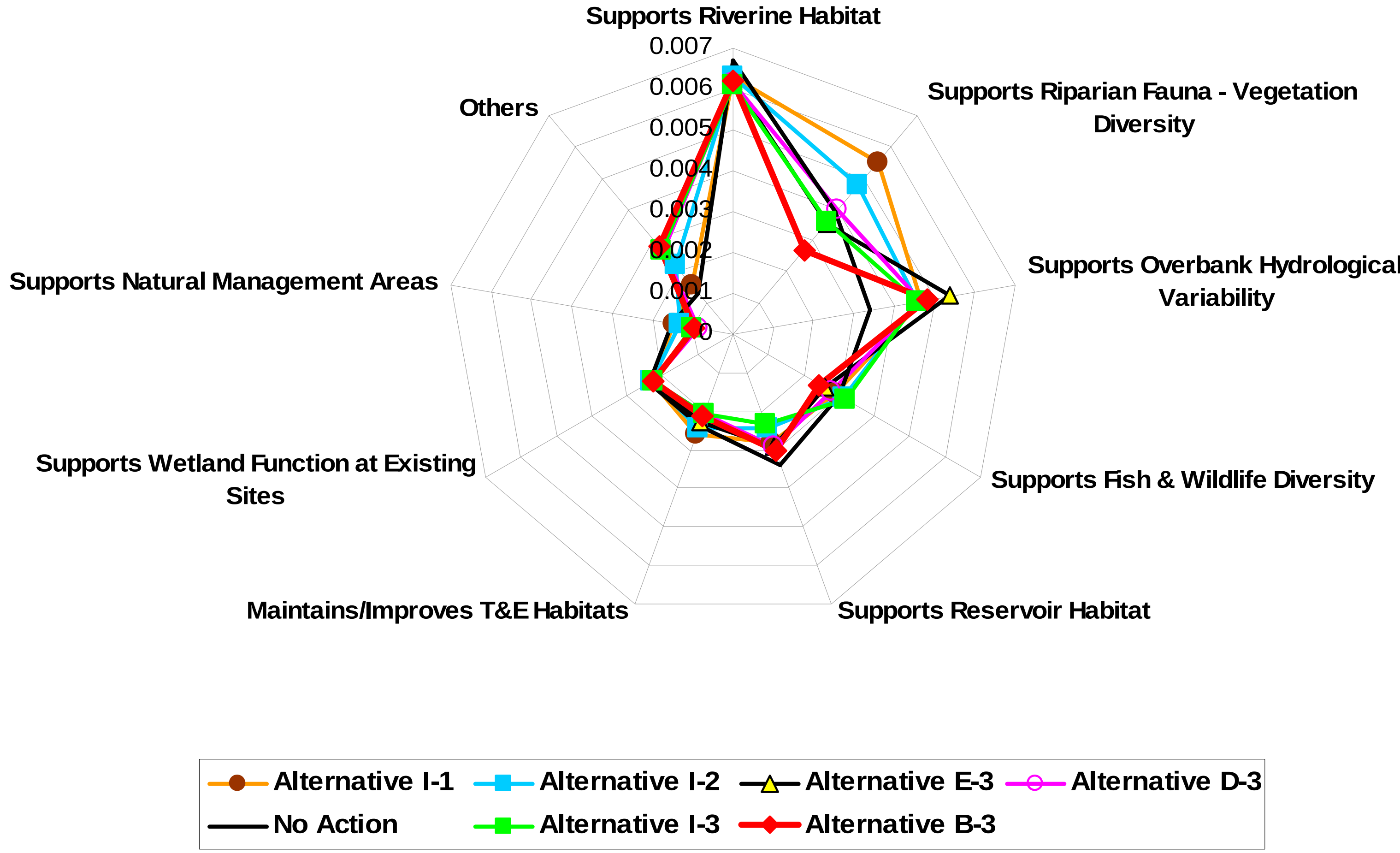

Figure P-10. Ecosystem Support

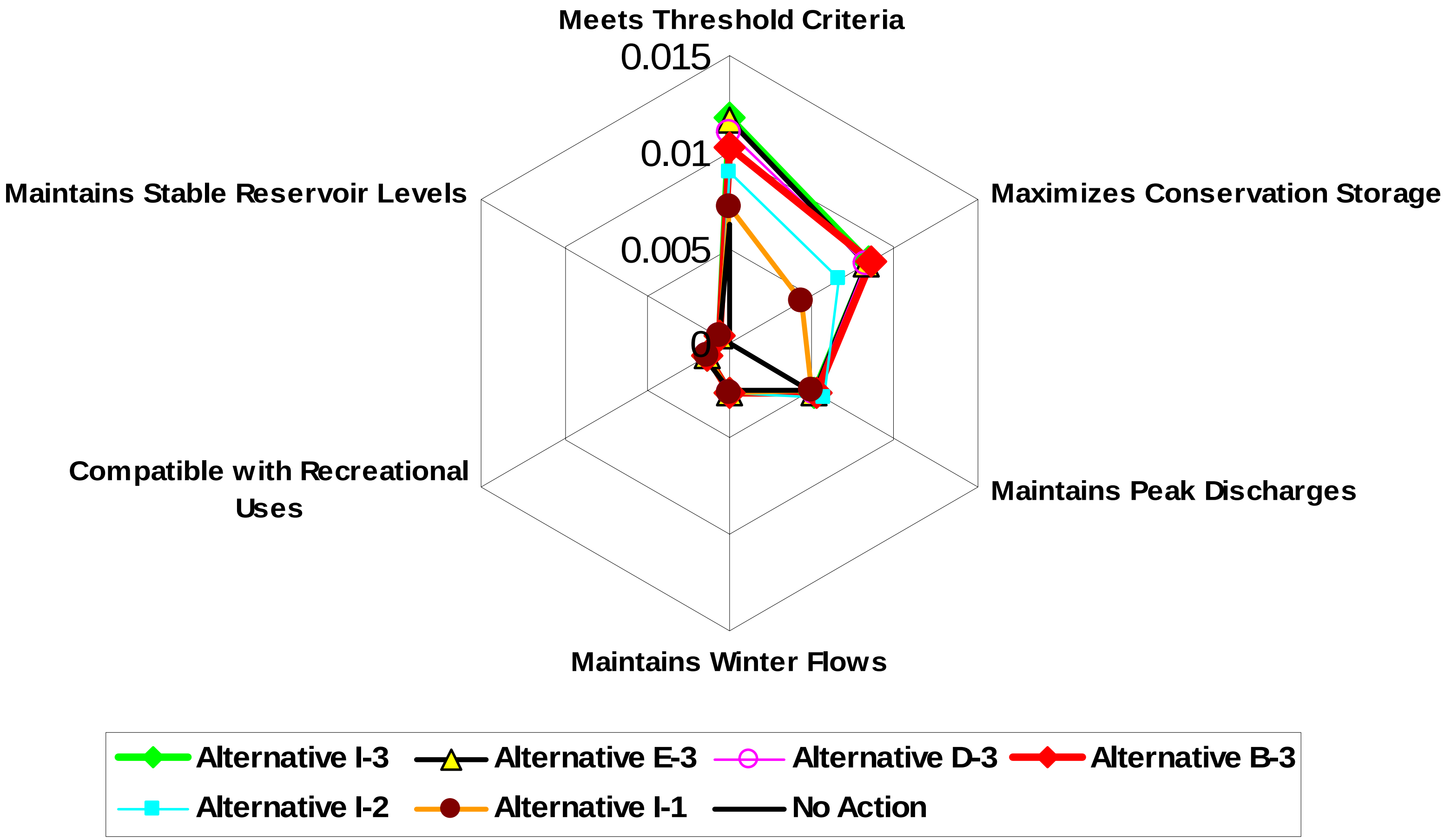

Figure P-11. Operating Flexibility

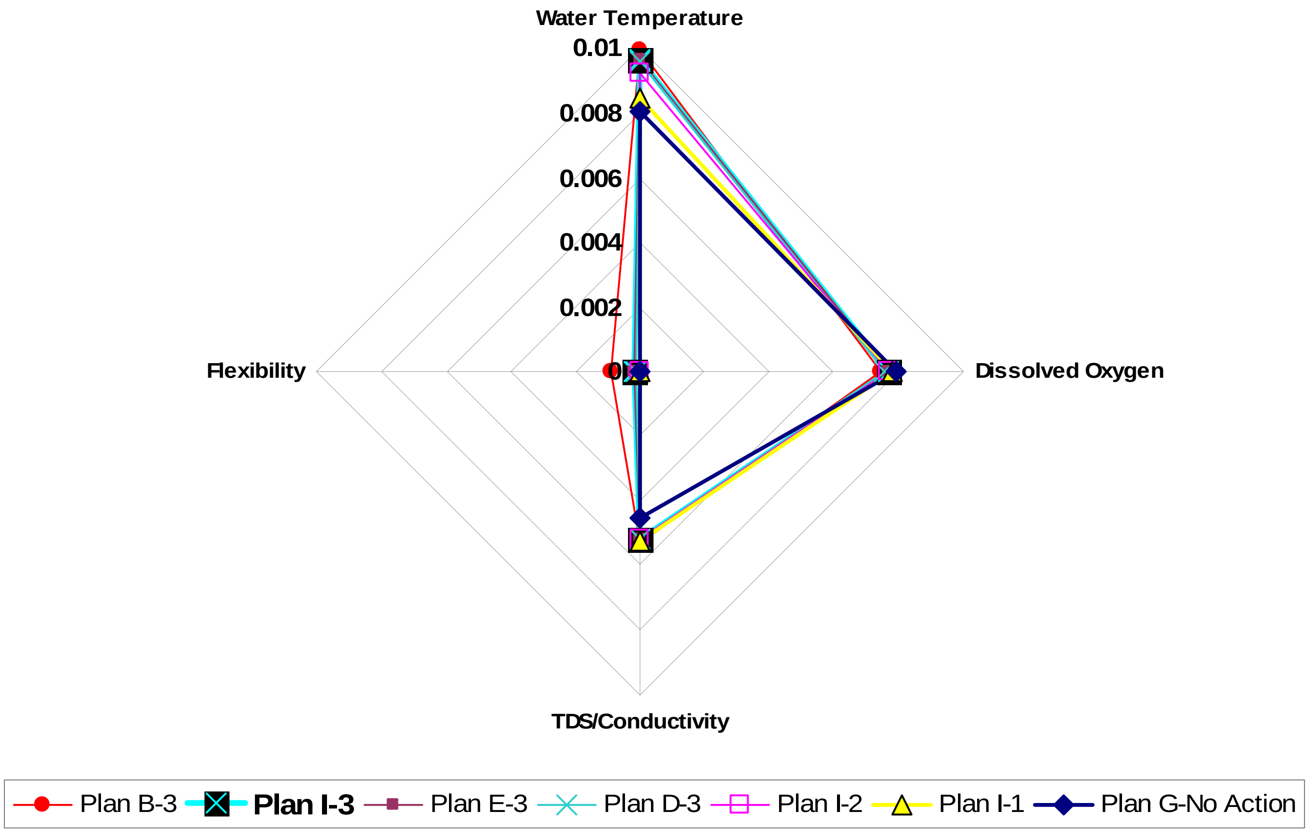

Figure P-12. Water Quality

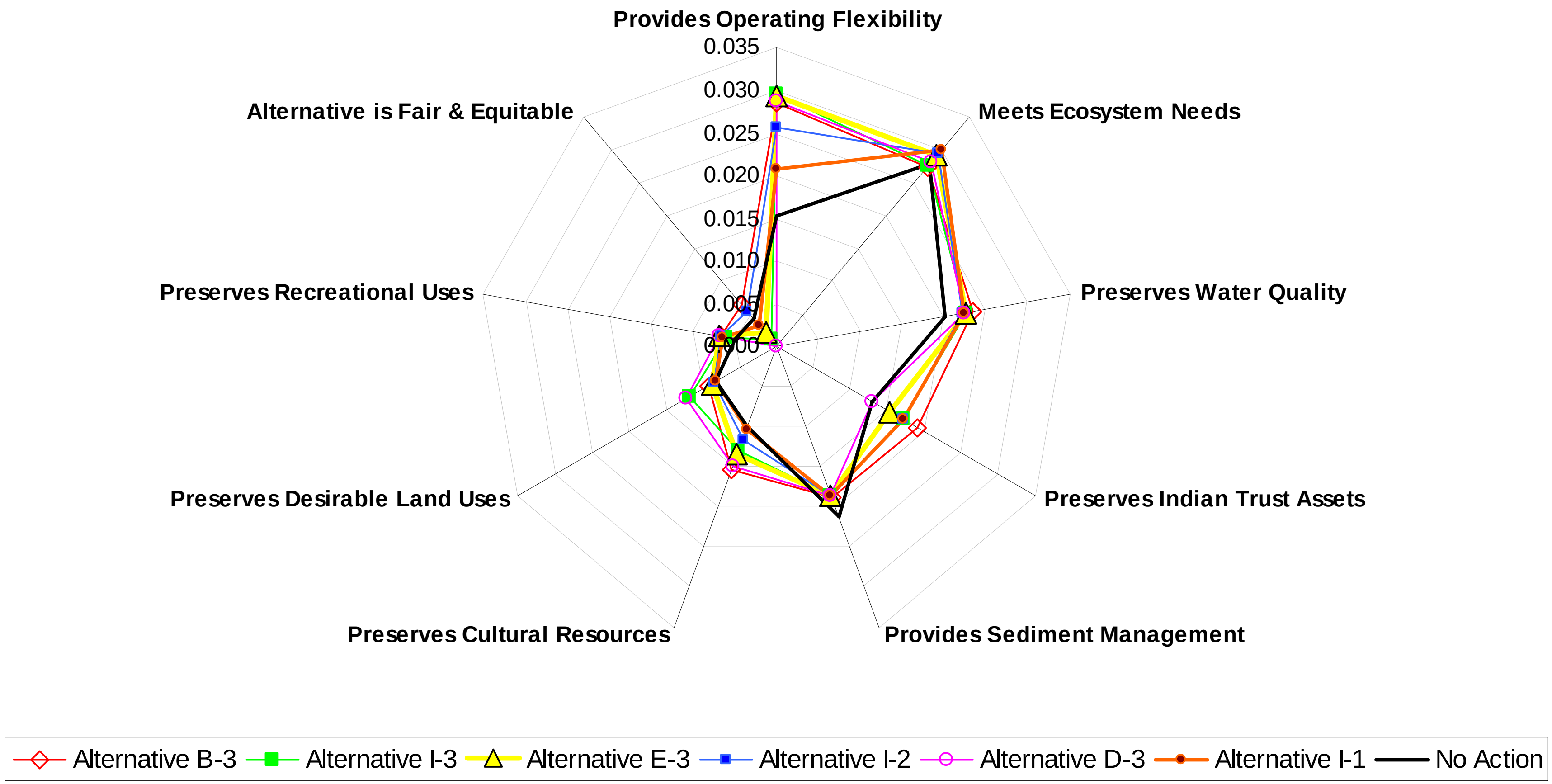

Figure P-13. Identifying the Top-Ranked Alternative

1.6 Conclusions

As documented with CDP, Alternative B-3 was identified as the top-ranked alternative based on:

- Comparisons among available alternatives
- Decision criteria and weights
- Alternative performance on discrete performance measures
- Analysis of tradeoffs and uncertainties

This alternative presents the water operations plan that best satisfies the multiple objectives, multiple purposes, and diverse values represented among the agencies and stakeholders participating in this Review and EIS. It best supports and balances the multiple decision criteria identified for this Review and EIS. A bar chart showing the final ranking of alternatives is shown on **Figure P-14**.

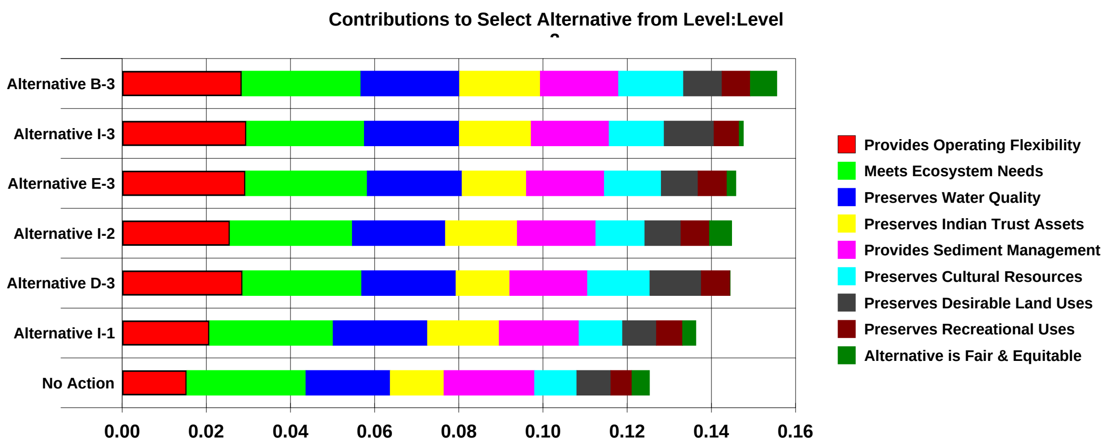

Figure P-14. Final Ranking of Alternatives

Alternative I-1 was identified as the environmentally preferred alternative based on rankings for the "Meets Ecosystem Needs" decision criterion. The environmentally-preferred alternative was not selected as the preferred alternative because it did not meet JLA threshold performance criteria for compact compliance.

The top-ranked alternative, Alternative B-3 is comprised of the following water operations elements:

Heron Reservoir Waivers: September 30

Abiquiu Conservation Storage: 0 – 180,000 AF

Abiquiu Channel Capacity: 1,500 cfs

Cochiti Channel Capacity: 8,500 cfs

Low Flow Conveyance Channel Operations: 0 – 2,000 cfs

Elephant Butte/Caballo Coordination: Improved Communication & Coordination

Improved Cooperation and Communications

2.0 Data Quality

2.1 Introduction

Members of the GIS Technical Team developed a database to enable all teams to document the datasets used in the EIS and to store information about the types of data, resolution, precision, accuracy, collection periods, and overall quality. In order to create this database, members of each technical team were required to enter known parameters of all datasets used in their respective analyses. In some cases specific parameters, such as accuracy and precision, could not be readily ascertained, and were not assigned. The intent of developing the data quality database was to disclose the quality of the datasets used in the evaluation of alternatives, determine areas where data are lacking, and to assist decision makers in understanding the comparison of alternatives in the context of data limitations. The database provides an evaluation of the assessment of impacts with respect to the overall quality and type of data used and available, independent of and complementary to the weighted decision criteria used in the decision support system.

2.2 Content of Data Quality Database

Essentially, the data quality database is a coarsely standardized and cataloged list of datasets specific to each resource team and their evaluation of the EIS alternatives. Technical experts of each team, considered the known parameters (i.e. spatial extent, accuracy, precision, resolution, collection period and method, etc.) of each dataset together with their professional opinion, in order to rate each dataset discretely as good, fair, or poor. Because the data quality rating was assigned based on a dataset's applicability and usefulness for this Review and EIS, a rating of fair or poor may only apply in the context of this analysis and may not reflect negatively on the source of the data. For example, some of the economic data, although accurate and correct, could only be applied at the county level, so it may have been rated as fair because the resolution was not ideal for this analysis, in spite of its high quality and confidence level for other uses. Although somewhat simplistic, these rating designations allow for a direct quality comparison of largely non-comparable data. Often, error estimation or confidence intervals (e.g. ± some value) were not available because the source did not provide such descriptive statistics, the raw data was not available, or it was qualitative. In such cases, the rating of that particular dataset relied on the team's relative confidence in the data and its applicability for evaluation of impacts under each alternative.

The dataset's ratings and descriptors were compiled and entered into a Microsoft Access™ database, allowing for queries to be formulated to selectively evaluate the quantity, quality, and other attributes of the data, grouped by subreach, reach, or river section to provide a spatial component. Descriptive fields in the database include, but are not limited to: source of the data, accuracy, precision, spatial resolution, method and date of collection, collection interval, and a general notes fields.

2.3 Use of Data Quality Information as Applied to the Review and EIS; Identification of Data Gaps

Data quality has an explicit and dependent relationship with the effects analyses under all alternatives. In other words, the quality and applicability of the data used to evaluate the performance of the alternatives directly affects the relative assessment of impacts to each resource. Hypothetically, if impacts were determined to be beneficial to a resource based on insufficient or inadequate data, then the decision makers may unwittingly make judgments supported by flawed conclusions. The data quality evaluation process and database were developed to facilitate understanding of such a complex and multivariate analysis as this Review and EIS in a comprehensive manner.

The data quality analysis has two principal goals:

1. To disclose the quantity and quality of data used in each resource analysis and consider the interaction of data quality with the hierarchy of decision criteria used in the decision support system. Thus, a more informed judgment can be rendered on the predicted impacts of a given alternative and why, potentially, that alternative may be more or less desirable.
2. To clearly identify data gaps by resource area so that future actions and analyses can plan for data collection to improve quality or spatial distribution as needed. This may apply to adaptive management monitoring, planning, and implementation, as well as for future modeling and NEPA analyses..

2.4 Underlying Model Data Quality

2.4.1 URGWOM

In this Review and EIS, URGWOM provides the necessary modeled flows over the 40-year sequence that was used either the sole basis for alternative evaluation (such as fishing and rafting flows, reservoir turnover rate, etc.) or as input to additional models (FLO-2D and Aquatic Habitat Model). As such, URGWOM data quality and reliability is central to all aspects of the analysis and efforts to quantify the performance of URGWOM focused on the ability to replicate historical hydrology (Thomas 2002; Wilkinson 2003).

Figure P-15 displays the estimated number and quality of URGWOM datasets that were utilized in the effects analyses for this Review and EIS. Although URGWOM performance is generally considered robust, Figure DQ-1 clearly shows a trend of decreasing data quality in a north-to-south direction. The reasons for this are varied and remain largely undefined, although some relate to the accuracy of gage data. Enhancements and improvements to URGWOM implemented in the future are likely to improve data quality so that it more closely matches historic flows.

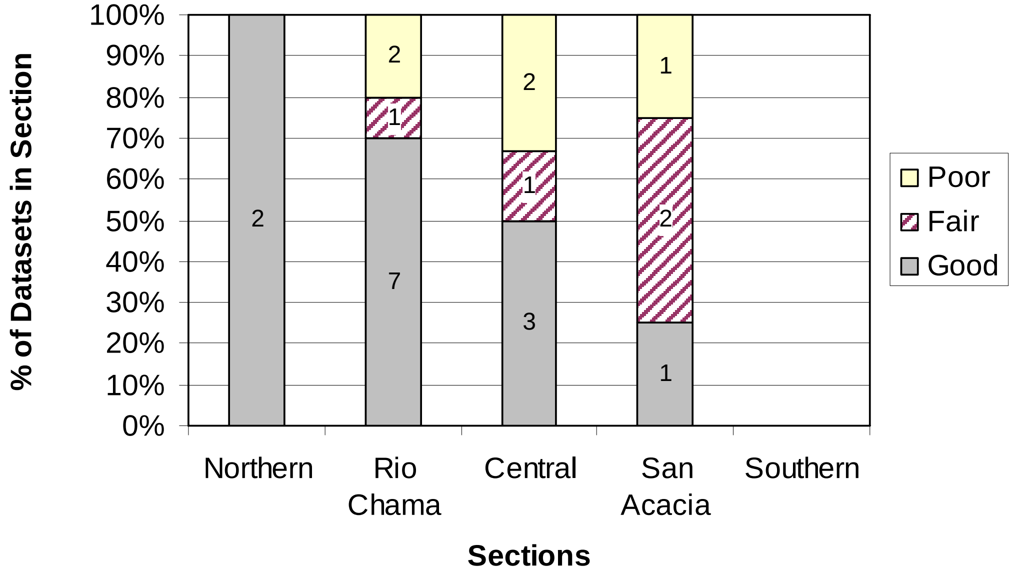

Figure P-15. URGWOM Data Quality

2.4.2 FLO-2D

In order to predict the extent and effect of overbank flows, this Review and EIS utilizes FLO-2D; a two-dimensional hydrology and hydraulics model (see Section 2.2.4 and Appendix J). FLO-2D uses URGWOM Planning Model predictive hydrology as input and numerically routes and attenuates flood flows spatially through a grid system within the channel and over the floodplain. The output from FLO-2D provides water depth and velocity in each grid cell. FLO-2D output data were used in the evaluation of the alternatives in terms of their impacts on riparian and wetland resources, as overbank flooding is an important factor in the sustainability of the riparian ecosystem. Other analyses based on FLO-2D output includes the Aquatic Habitat Model, flooding of recorded archaeological sites, frequency of overtopping of diversion dams for irrigation, and inundation of different land uses, especially agricultural land.

Figure P-16 shows decreasing data quality from north-to-south. The reasons for this are a general lack of high resolution topographic relief data and active river channel cross-section survey data. Grid cell size utilized in modeling the lower Rio Chama was smaller than that applied in the Rio Grande reaches, improving spatial resolution and resulting in better quality model output. FLO-2D utilizes URGWOM data, which also shows this pattern of decreasing data quality from north to south. FLO-2D was not used to model the Northern and Southern Sections.

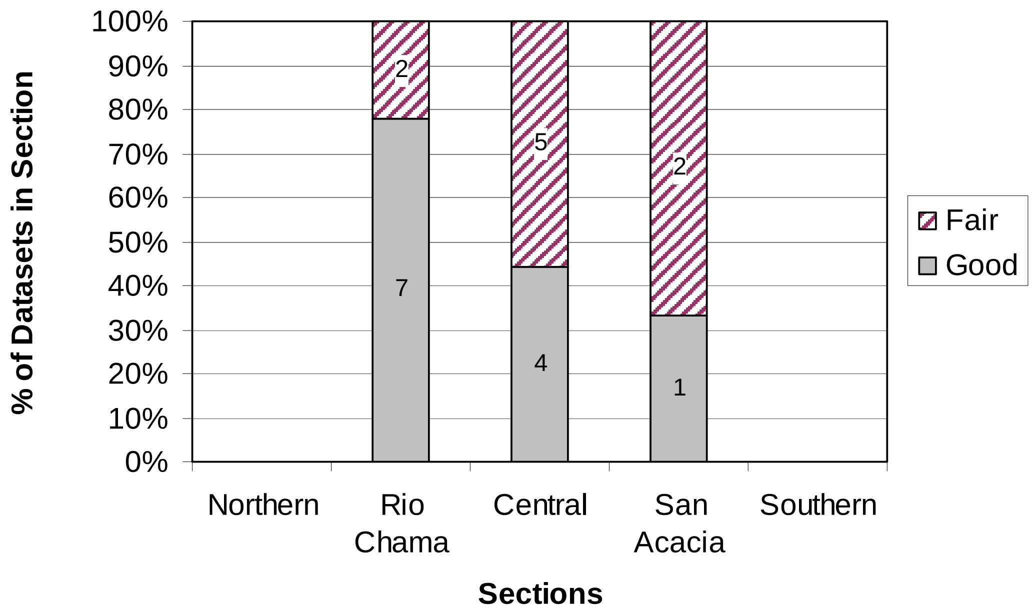

Figure P-16. FLO-2D Data Quality

2.5 Data Quality by Decision Criterion

The decision criteria developed for the decision support system provides a hierarchical framework in which to evaluate the overall and resource-specific data quality. Considering data quality according to the decision criteria hierarchy allows for evaluation of data quality according to the relative importance of the resources affected by water operations, without applying an additional layer of weighting or assuming that all resource datasets are of equal importance for alternatives analysis. Given the crucial role of URGWOM and FLO-2D model output in the analysis of impacts for many decision criteria, the resource-specific data are presented with the relevant URGWOM and FLO-2D data where appropriate. This accounts for the influence of URGWOM and FLO-2D data in conjunction with the resource-specific data.

In the following sub-sections, data quality is presented under each decision criterion, and each decision criterion is listed in order of importance (highest to lowest) based on the weights assigned in the decision support system, grouped by river section from north to south.

Specific information regarding the use, analysis, and conclusions for each of the following resource categories can be found in Chapter 4 and their appropriate appendices.

2.5.1 Meets Ecosystem Needs

The Riparian and Wetlands and Aquatic Systems Technical Teams analyzed how well each alternative met this decision criterion. These teams evaluated the alternatives in terms of the effects of proposed water operations on key habitat and wildlife species including threatened and endangered species. Analyses considered fish and fish habitat, riparian vegetation and wetlands, and potential impacts to specific terrestrial wildlife. The effects analyses for this decision criterion recognize the interrelated nature of the aquatic and terrestrial systems under an ecosystem approach.

Figure P-17 suggests that the effects analyses and conclusions are supported by generally good data. The lowest quality is in the Southern Section where slightly fewer than 50 percent of the datasets is fair and the remainder is good. In all other sections, at least 60 percent is good. In the San Acacia Section, which was identified as the most important reach for evaluating impacts to ecosystems, the overall number of datasets used was the least of the three sections most affected by proposed water operations. Only small proportions in the Rio Chama, Central, and San Acacia sections are classed as poor.

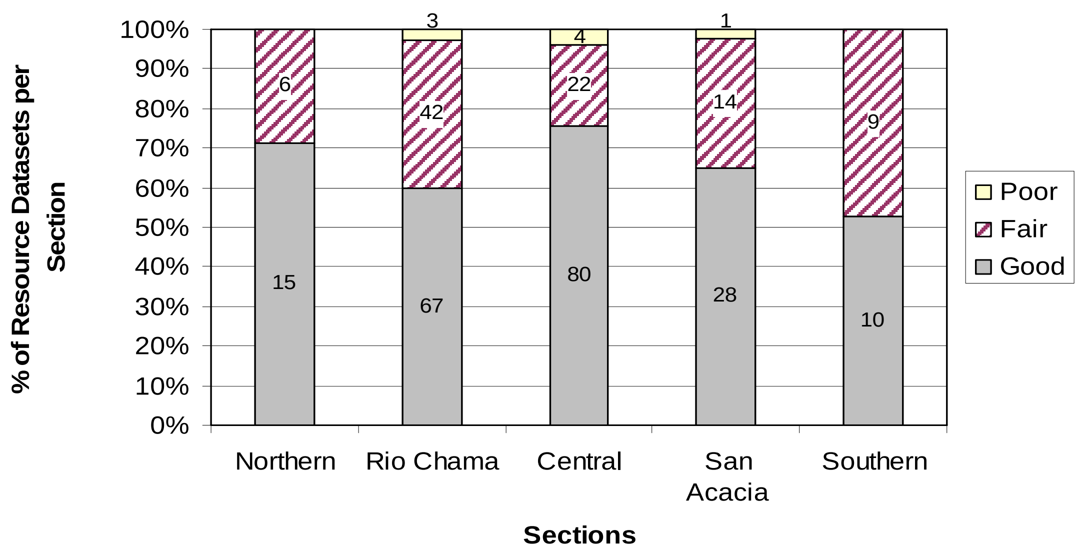

Figure P-17. Data Quality for "Meets Ecosystem Needs" Decision Criterion (Includes URGWOM and FLO-2D Datasets)

2.5.2 System Operating Flexibility

The Water Operations/URGWOM Integration Technical Team addressed how each alternative affected flexibility for water operations management. System operating flexibility includes maximizing conservation storage, maintaining discharges from reservoirs, maintaining winter flows, compatibility with recreational uses, and maintaining stable reservoir levels. Water managers would have varying degrees of operational latitude under each alternative, which is scored in terms of how well it meets the above metrics. URGWOM data quality is presented in Section 1.1.4.1, where it is characterized as generally good.

2.5.3 Preserves Water Quality

The analyses for this criterion were completed by the Water Quality Technical Team, and used URGWOM hydrology correlated with water quality behavior under each alternative. Metrics for the water quality analysis are dissolved oxygen, temperature, and total dissolved solids/conductivity.

Figure P-18 indicates that water quality data, in all but the Northern section, is at least 50 percent fair or poor. These data may be more robust than the rating suggests, but their applicability is not entirely suitable for this analysis, due in part to the year collected, discontinuity, and limited geographic scope. Water quality data is subject to a high degree of variability over space and time, so many more datasets would be needed to evaluate changes within the vast geographic area of the river sections, before data quality could be rated predominantly good for this type of analysis. Due to the high proportion of poor and fair datasets, the impact evaluations should be considered somewhat problematic on an absolute basis. However, because all alternatives were evaluated using the same data, the comparison of impacts across alternatives would apply the same error on a relative basis and would not adversely affect the conclusions.

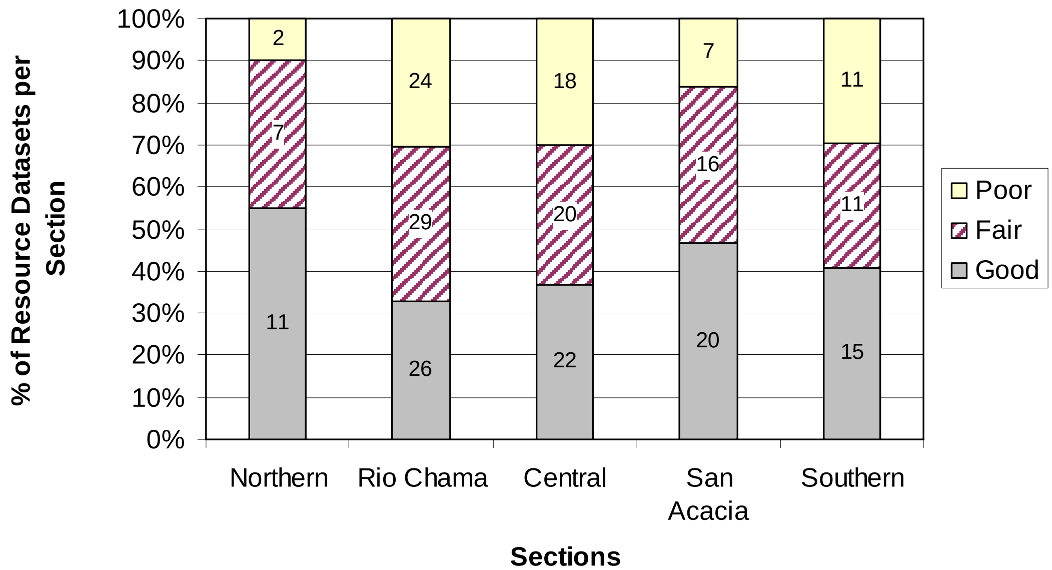

Figure P-18. Data Quality for "Preserves Water Quality" Decision Criterion Impact Analysis (Including URGWOM Datasets)

2.5.4 Provides Sediment Management

This criterion was addressed by the River Geomorphology, Sedimentation, and Mechanics Technical Team. The analysis evaluated the overall transport and management of sediment and how each alternative performs to improve sediment transport, create favorable aggradation/degradation trends, create favorable bank energy index, and increase sediment volume.

Figure P-19 suggests that the best data quality is in the Northern and Rio Chama Sections, with a higher proportion of fair and poor quality datasets in the Central and San Acacia Sections. The data in these downstream sections may be rated lower because most were not collected specifically for this Review and EIS. The Southern Section was not addressed due to limitations imposed by the JLA and the fact that no changes were anticipated as a result of proposed water operations.

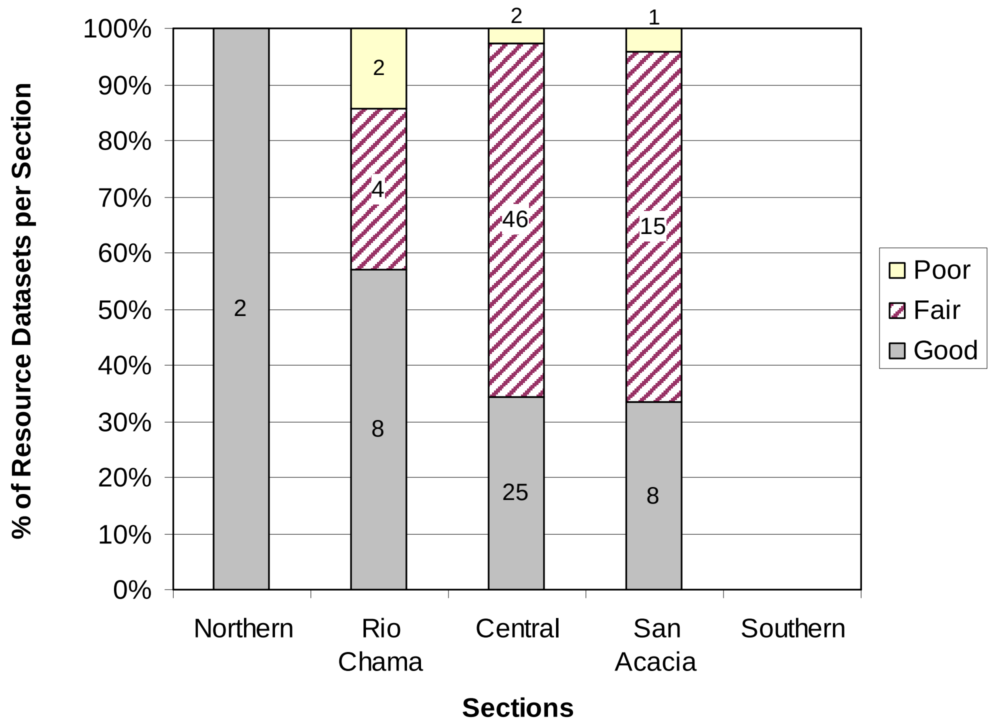

Figure P-19. Data Quality for "Provides Sediment Management" Decision Criterion Impact Analysis (Including URGWOM Datasets)

2.5.5 Preserves Indian Trust Assets and Cultural Resources

The Cultural Resources Technical Team was responsible for most of the data collection and analysis. Additional information provided through government-to-government consultations is being collected and will continue to be considered throughout the EIS process. However, the information collected through consultation may not be suitable or appropriate to evaluate for data quality using this process.

The analysis evaluated the impacts of implementing the alternatives upon known cultural resources, such as acequias and traditional cultural properties, and archaeological sites. For example, if a recorded archaeological site would be affected by overbank flooding under a certain alternative, that condition was counted as an adverse impact to cultural resources.

Figure P-20 indicates a high proportion of fair and poor quality datasets used in the effects analysis. The Central and San Acacia Sections contain the greatest proportion of fair datasets. The relatively low quality data can be attributed, in large part, to the fact that the density of recorded cultural resources, especially archaeological sites, is low. Surveys and documentation of cultural resources occurs primarily on state and federal lands along the river corridor, and the poor and fair ratings acknowledge the likelihood that there are many unreported sites that could not be included in the effects analyses. Impact analysis could be improved if additional surveys and site documentation were completed, especially in areas where flooding is projected.

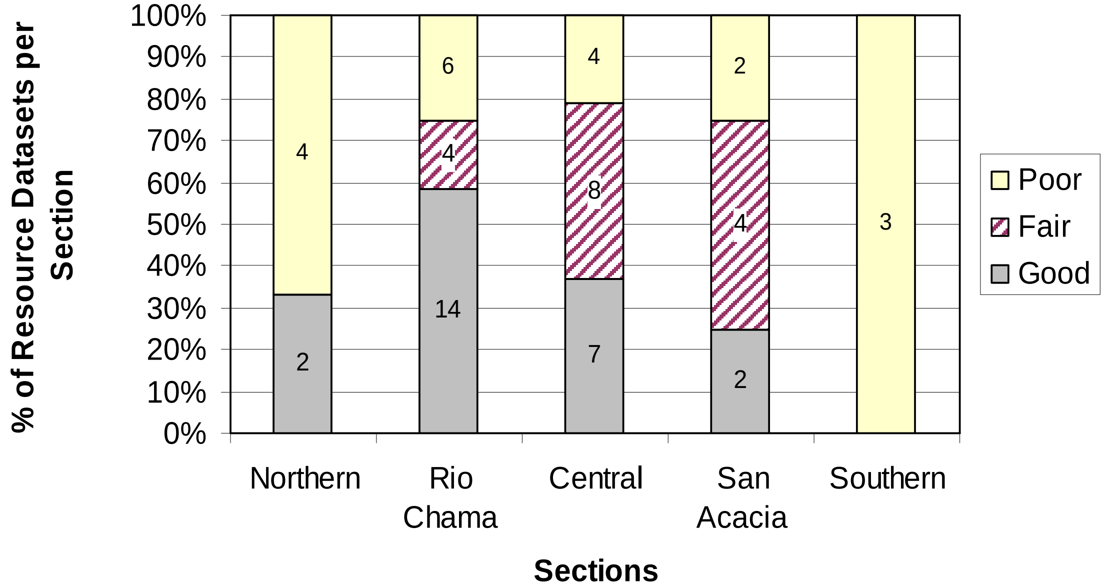

Figure P-20. Decision Criterion "Preserves Indian Trust Assets and Cultural Resources" Data Quality Impacts Analysis (Including URGWOM and FLO-2D Datasets)

2.5.6 Preserves Desirable Land Uses

This criterion was addressed by members of the Land Use, Recreation, Agriculture, Socioeconomics, and Environmental Justice Technical Team. The analysis evaluates the impacts of the alternatives upon existing land uses, with a focus on agriculture. The metrics evaluated include overtopping of irrigation structures, frequency and duration of periods in which irrigation delivery would not be met, inundation of agricultural lands, and suitability for existing, protected, and special uses.

Figure P-21 demonstrates that most of the data used for this analysis was of fair quality. This is primarily due to the lack of quantitative and spatial data for agricultural land that is comparable from section to section. It also reflects the relatively coarse resolution for evaluating factors such as the frequency of overtopping diversion dams annually that may result from water operations management.

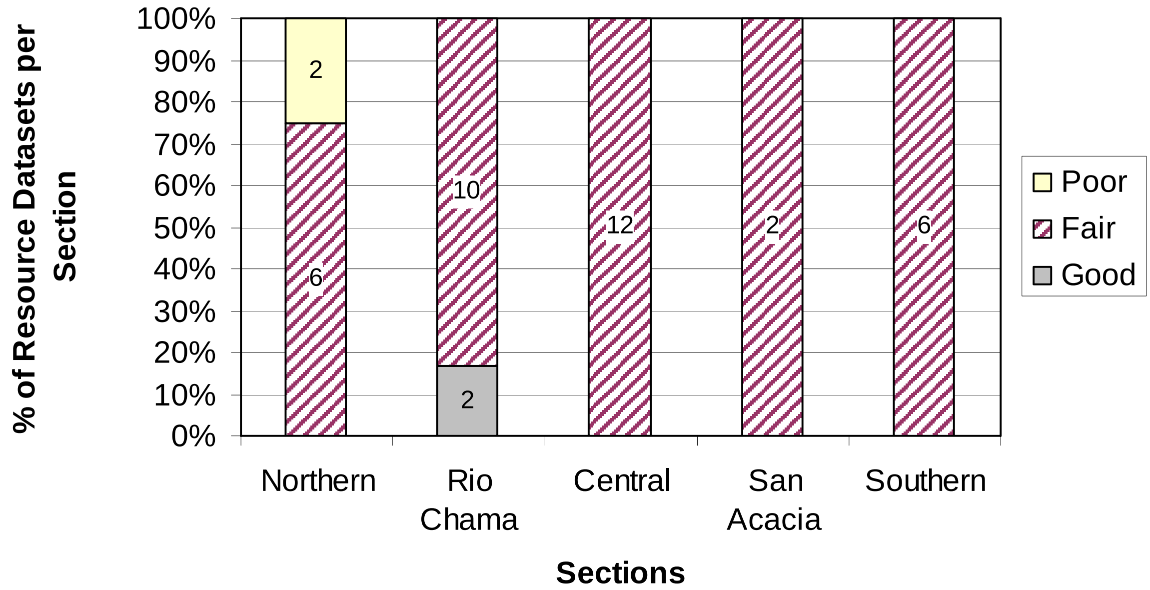

Figure P-21. Data Quality for "Preserves Desirable Land Uses" Decision Criterion Impacts Analysis (Including URGWOM and FLO-2D datasets)

2.5.7 Preserves Recreation Uses

This criterion was addressed by members of the Land Use, Recreation, Agriculture, Socioeconomics, and Environmental Justice. The analysis considers the alternative impacts on reservoir and riverine economics, visitation, as well as the frequency of conditions suitable for recreational opportunities like rafting boating, and fishing.

Figure P-22 displays the predominance of fair quality datasets for this analysis. The lack of good quality datasets reflects the relatively coarse resolution and qualitative nature of much of the information used for effects analysis.

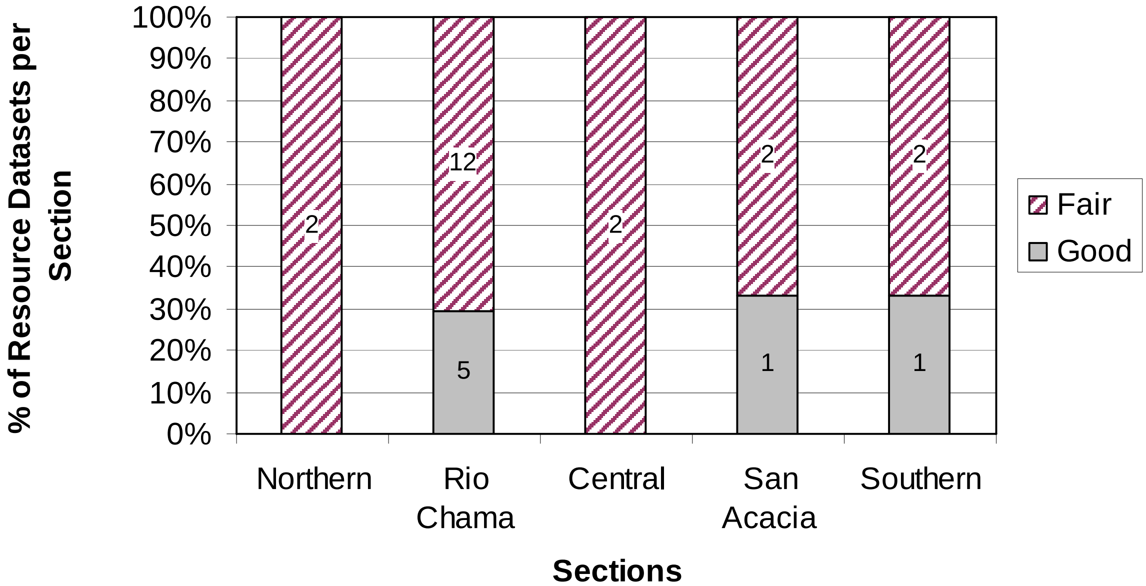

Figure P-22. Data Quality for "Preserves Recreational Uses" Decision Criterion Impacts Analysis (Including URGWOM and FLO-2D datasets)

2.5.8 Alternative Is Fair and Equitable

This criterion was addressed by members of the Land Use, Recreation, Agriculture, Socioeconomics, and Environmental Justice and is often referred to as environmental justice. Analysis of environmental justice addresses whether there are impacts under any alternative that disproportionately affect minority or low-income populations.

Figure P-23 shows that all datasets were rated fair as applied to the effects analysis under each alternative. The information was derived from Census data, which is generally of good quality. However, this rating was given primarily because the data was applied at the county or municipal level rather than scaled to populations in the river corridor.

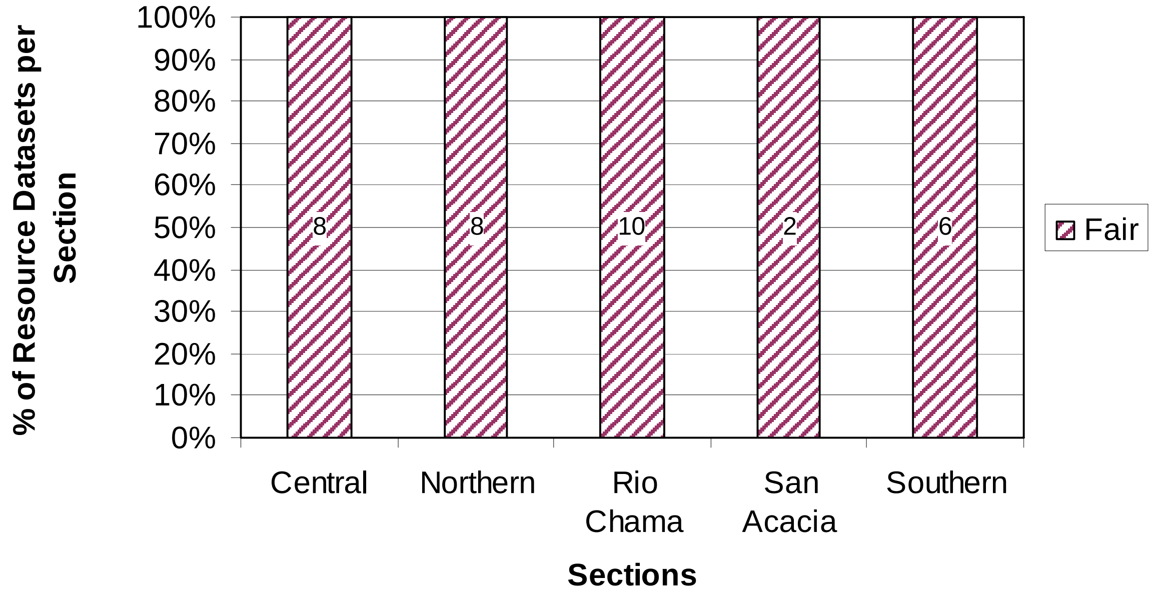

Figure P-23. Data Quality for "Alternative is Fair and Equitable" Decision Criterion Impacts Analysis

2.6 Data Gaps by Technical Team

Data gaps may be identified through documenting poor quality datasets or by determining missing data that would be useful for future analyses. As technical teams collected data for this Review and EIS, they often found that large quantities of data were available for specific reaches or sections, while other parts of the river corridor have not been studied as well and were lacking in available research and information. The differences in numbers of datasets, in addition to the varying proportions of good, fair, and poor datasets, can be seen in all of the following charts.

To disclose data gaps for future work, the following sections summarize the quality and number of datasets used by each technical team, independent of the URGWOM and FLO-2D model output used for analysis. Some suggestions related to the reasons for the gaps are included, but they are not comprehensive.

2.6.1 Water Operations/URGWOM Integration Technical Team

The decreasing quality of URGWOM data from north to south constitutes a significant data gap that could be improved through refinements and enhancements of the model, as well as more accurate gage data. Future model enhancements are planned for URGWOM, including improved methods of calculating river channel leakage rates, agricultural and riparian evapotranspiration rates, ungaged tributary and local inflows, MRGCD diversion volumes and return flows, and irrigation deep percolation rates (Thomas 2002). The Southern Section was not modeled for this Review and EIS, but efforts at coordinated data collection for future modeling is underway. Figure DQ-1 displays URGWOM data quality and quantity as evaluated for this EIS.

2.6.2 Hydrology and Hydraulics Technical Team

Improvements to URGWOM should also improve FLO-2D performance. The Northern and Southern Sections were not modeled mainly because no changes to flows were anticipated in these sections as a result of water operations considered under any alternative. Other hydrology and hydraulics datasets were not evaluated for this effort, so the data quality used by this team is displayed in Figure DQ-2.

2.6.3 Aquatic Systems Technical Team

Figure P-24 shows that URGWOM data did not have much influence on the data quality used by this team. However, the aquatic habitat data appears to influence the ecosystem decision criteria, as aquatic data trend closely tracks the ecosystem criteria trend shown in Figure DQ-3. Aquatic habitat data quality would be improved if additional studies and model sites were developed to evaluate aquatic habitat for fish species, especially in the Northern and Southern Sections. Currently, Aquatic Habitat Model output has limited application beyond the study sites evaluated, so habitat cannot be assessed for entire reaches or sections.

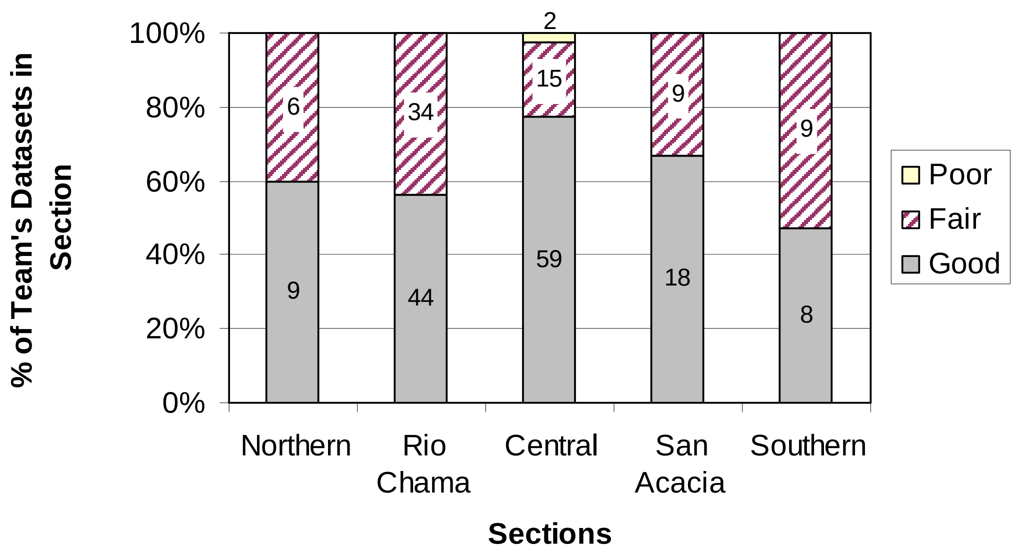

Figure P-24. Aquatic Systems Data Quality Gaps (Excluding URGWOM and FLO-2D Datasets)

2.6.4 Riparian and Wetlands Technical Team

Figure P-25 demonstrates that the information collected and used by the Riparian and Wetlands Technical Team is dominated by good and fair quality datasets. This reflects, in part, the vegetation mapping performed for this Review and EIS. Additional information is needed to characterize the Northern and Southern Sections.

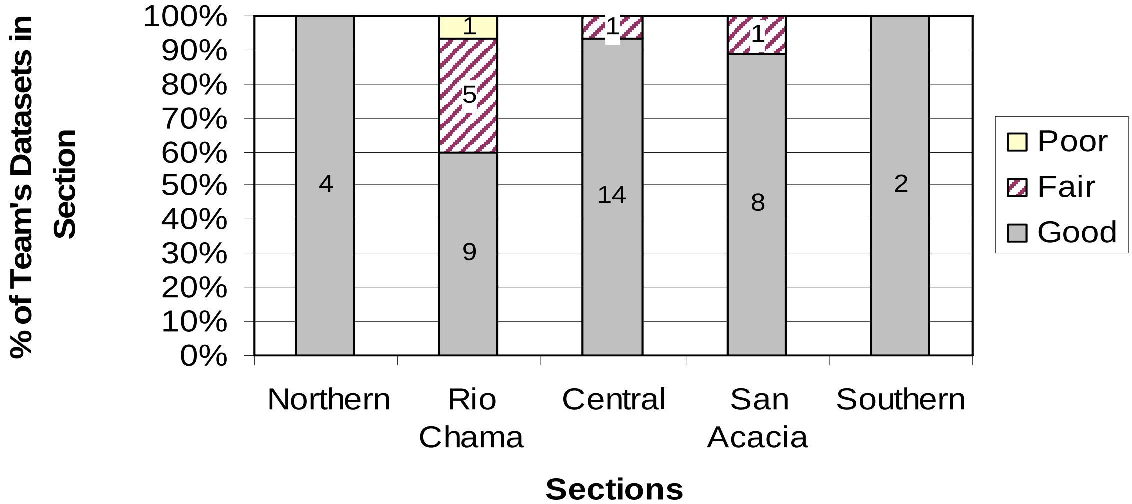

Figure P-25. Riparian and Wetlands Data Gap Analysis (Excluding URGWOM and FLO-2D Datasets)

2.6.5 Water Quality Technical Team

Figure P-26 shows that no section exceeds 50 percent good quality. Filling in data gaps should be considered a priority for future actions, a fact recognized by improvements in water quality data collection that are underway. As part of the ongoing development of URGWOM, a continuous monitoring network in the Central Section has been initiated, in cooperation with the FWS and the University of New Mexico. In addition, monthly longitudinal sampling and synoptic surveys are currently being conducted for nutrients and other water quality constituents. These data will require two or three years before proving useful in an assessment or predictive manner, but can be used eventually to model water quality in URGWOM.

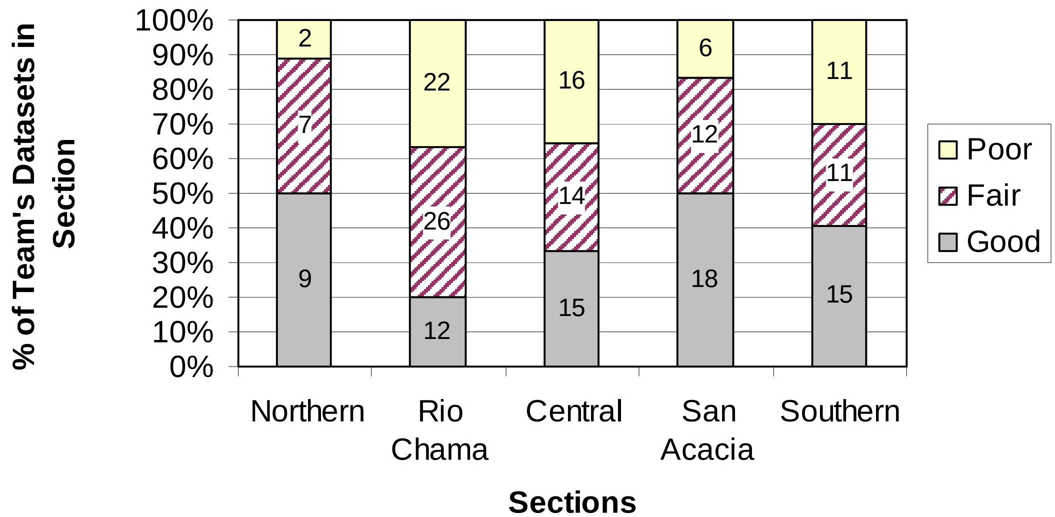

Figure P-26. Water Quality Data Gap Analysis (Excluding URGWOM Datasets)

2.6.6 River Geomorphology, Sedimentation, and Mechanics Technical Team

Figure P-27 shows significant data gaps although there are no poor quality datasets. Because no data were collected or used by this team for the Northern and Southern Sections for this EIS, none are shown in the graph. This only means that they are not part of the data quality evaluation for this Review and EIS, and may not reflect the current state of data in these regions. Due to the low numbers in the Rio Chama Section and the high proportions of fair quality data, data gaps should be considered prominent in all sections.

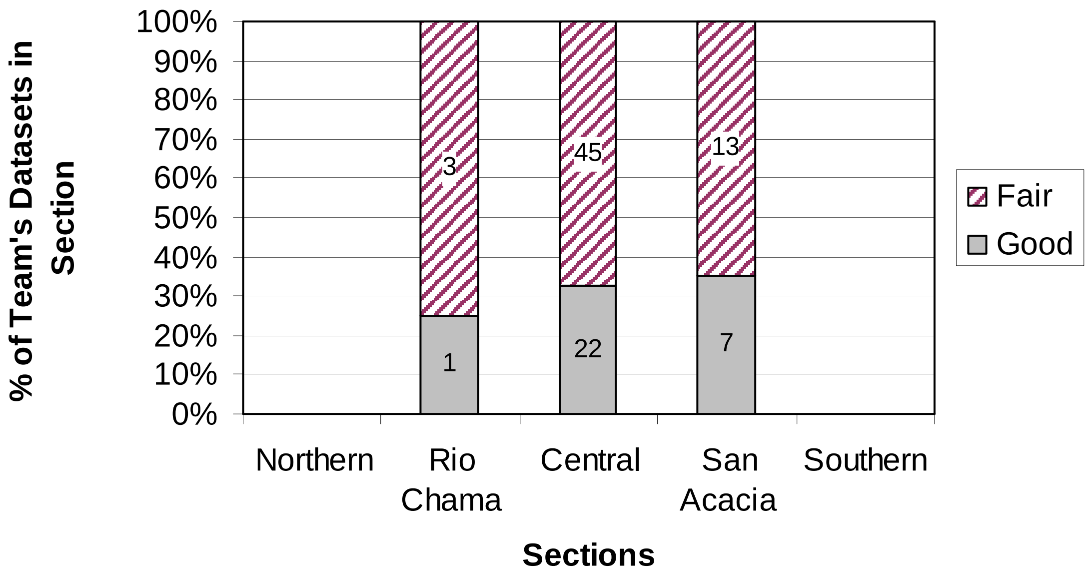

Figure P-27. Geomorphology, Sedimentation, and Mechanics Data Gap Analysis (Excluding URGWOM Datasets)

2.6.7 Cultural Resources Technical Team

Figure P-28 strongly suggests noteworthy data gaps. The Central and Rio Chama Sections have the highest number of fair datasets, but all sections contain a major proportion of poor quality data and low total numbers of datasets. This is due mainly to the low density of archaeological surveys along the river corridor, as well as the lack of site-specific information about traditional cultural properties. Data gaps are widespread and significant.

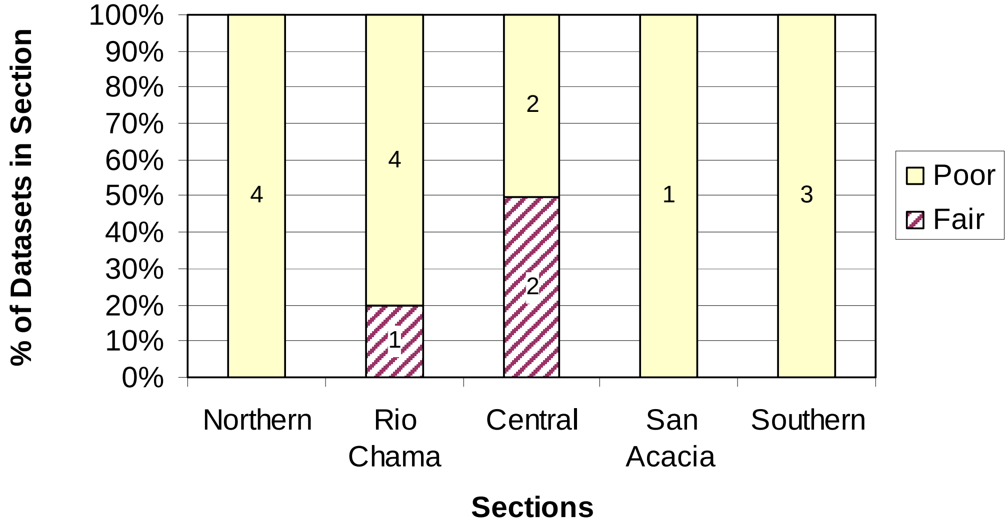

Figure P-28. Cultural Resources and Indian Trust Assets Data Quality Distribution – Impacts Analysis (not including appropriate URGWOM and FLO-2D datasets)

2.6.8 Land Use, Recreational Use, Socioeconomics, and Environmental Justice Technical Team

This technical resource team evaluated the alternative impacts for land use, recreation, agriculture, socioeconomics and environmental justice. **Figure P-29** shows that all sections are dominated by fair data quality. For data gap analysis, all data used by the technical team are considered together.

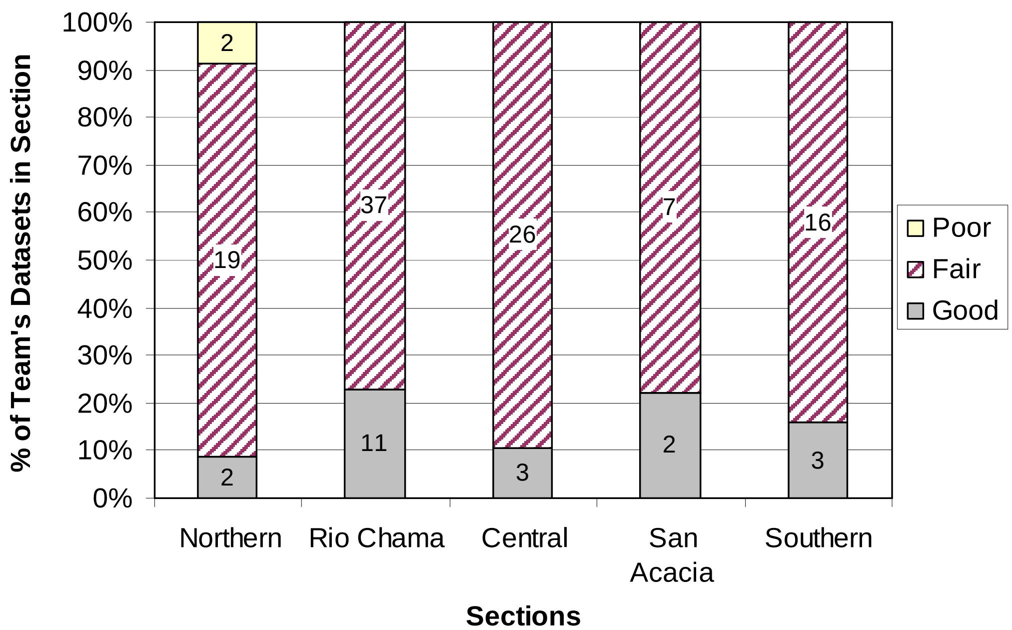

Figure P-29. Land Use, Recreation, Socioeconomics, and Environmental Justice Data Gaps (Excluding URGWOM and FLO-2D Datasets)

3.0 References

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4.0 ATTACHMENT

4.1 CD with FEIS Contains Criterium Decision Plus Reader and EIS Decision Analysis File

Criterium Decision Plus Files

Decision Analysis Data File – DEIS.cdp
CDP Reader

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