RECLAMATION

Managing Water in the West

Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas

Final Environmental Impact Statement

U.S. Department of the Interior
Bureau of Reclamation
Upper Colorado Region
Albuquerque Area Office, Albuquerque

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MISSION STATEMENTS

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Cover photo – Elephant Butte Dam, Powerplant and Reservoir, New Mexico, (Kevin Doyle, EMPSi)

Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas, Final Environmental Impact Statement

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Responsible Official:	Brent Rhees, Regional Director
Cooperating Agencies:	Federal: U.S. Section, International Boundary and Water Commission State: Colorado Division of Water Resources Elephant Butte Irrigation District of New Mexico El Paso County Water Improvement District No.1 Texas Rio Grande Compact Commissioner
Abstract:	The proposed Federal action analyzed in this final environmental impact statement is to continue to implement the 2008 Operating Agreement for the Rio Grande Project and to implement long-term contracts for storage of San Juan-Chama Project water in Elephant Butte Reservoir. The Operating Agreement is a written agreement describing how Reclamation allocates, releases from storage, and delivers Rio Grande Project water to the Elephant Butte Irrigation District in New Mexico, the El Paso County Water Improvement District No. 1 in Texas, and to Mexico.
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Summary

The Bureau of Reclamation (Reclamation) has prepared this final environmental impact statement (FEIS) to analyze the environmental impacts of continuing to implement the Rio Grande Project Operating Agreement (OA) through 2050. The OA is a written agreement describing how Reclamation allocates, releases from storage, and delivers Rio Grande Project (RGP) water to diversion points (headings) of the Elephant Butte Irrigation District (EBID) in New Mexico, the El Paso County Water Improvement District No. 1 (EPCWID) in Texas, and the Republic of Mexico (herinafter Mexico). In addition, Reclamation will use this FEIS to evaluate the environmental effects of a proposal to renew a contract to store San Juan–Chama Project water in Elephant Butte Reservoir.

Purpose and Need for Action

Operating Agreement

The purpose for action is to meet contractual obligations to EBID and EPCWID and comply with applicable law governing water allocation, delivery, and accounting. These obligations are currently fulfilled under the 2008 OA (Appendix A). The need for action is to resolve the long and litigious history of the RGP and enter into mutually agreeable, operational criteria that comply with applicable law, court decrees, settlement agreements, and contracts. These include the 2008 Compromise and Settlement Agreement among Reclamation, EBID, and EPCWID and contracts between the U.S. and EBID and EPCWID.

San Juan–Chama Project Storage

The purpose and need for a similar action is to respond to a request to renew a multiyear storage contract of San Juan–Chama Project water in Elephant Butte Reservoir in accordance with Public Laws 97-140 and 87-483.

The Rio Grande Project and Geographic Scope

The study area for this FEIS is the RGP in southern New Mexico and far western Texas in the Rincon, Mesilla, and El Paso Valleys (Figure 1). The study area begins in the north with Elephant Butte Reservoir and extends southward and downstream along the Rio Grande to the El Paso-Hudspeth County line in Texas. The study area includes the service areas of the two irrigation districts and also includes deliveries to Mexico at the Acequia Madre at El Paso, Texas.

Cooperating Agencies

Reclamation is the lead Federal agency in the preparation of this FEIS. Cooperating agencies include the U.S. Section of the International Boundary and Water Commission (USIBWC), the Colorado Division of Water Resources, EBID, EPCWID, and the Texas Rio Grande Compact Commissioner.

Changes since the Draft EIS

Reclamation published a notice of availability of the draft EIS (DEIS) in the *Federal Register* (81 Fed. Reg. 14886) on March 18, 2016. Notice of the availability of the DEIS was published in newspapers, on Reclamation's internet web page, social media, and e-mail. Reclamation held two public hearings during the comment period to give the public an opportunity to learn more about the alternatives and impacts and to comment on the DEIS. After receiving multiple requests to extend the public comment period, the period was extended to June 8, 2016.

During this draft public comment period, Reclamation received 148 comments in 24 comment documents from Federal, state, and local agencies, and the public. Appendix E of this FEIS includes the comments received and responses. In assessing and considering these comments, Reclamation revised this FEIS. One of the comments pointed out an error in the hydrology model, so the FEIS includes some revised water resources data in Chapter 4 and Appendix C. Chapter 4 was reorganized by resource rather than by alternative to clarify the differences due to the alternatives versus climate change. Information for most resources was edited to better define and explain potential impacts, and cumulative actions and impacts were placed in a separate chapter. In response to comments, the No Action Alternative was changed from Alternative 1 to Alternative 5, as described below and in Chapter 2 and Appendix E. Alternative 1 has been selected as the agency's preferred alternative.

Alternatives

The Council on Environmental Quality's (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) require that all EISs include the alternative of no action. CEQ (1981; 46 Fed. Reg. 18026) says there are two distinct interpretations of no action. The first interpretation is "no change from current management direction" and is typically applied to management plans. CEQ explains that this interpretiation of no action involves continuing with the present course of action or management until the action is changed. The second interpretation of no action is where a proposed activity would not take place and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward. This is typically applied to construction actions.

Following CEQ's first interpretation of no action, the DEIS identfied Alternative 1 as the No Action Alternative because it involves continuation of the OA and San Juan-Chama storage contracts. The DEIS considered four other alternatives that vary in inclusion or exclusion of the allocation and accounting procedures established by the OA, the diversion ratio adjustment and carryover accounting , and storing San Juan-Chama Project water in Elephant Butte Reservoir. In the DEIS and this FEIS, Alternative 5 is consistent with past management practices prior to the OA, but based on comments received on the DEIS (see Appendix E, "Alternatives, No Action Alternative"), for this FEIS, Reclamation relabeled Alternative 5 as the No Action Alternative, applying CEQ's second interpretation of no action. The alternatives are summarized here and presented in detail in Chapter 2.

Alternative 1: Continuation of OA and San Juan-Chama Storage Contract, Preferred Alternative

Alternative 1 is Reclamation's preferred alternative. Alternative 1 includes continued implementation through the year 2050 of the operating procedures defined in the OA and corresponding Rio Grande Project Water Operations and Accounting Manual (Operations

Manual). Under Alternative 1, RGP allocation and accounting procedures would continue to include the diversion ratio adjustment and carryover accounting established by the OA and Reclamation would renew a contract to store up to 50,000 acre-feet of San Juan–Chama Project water in Elephant Butte Reservoir.

Alternative 2: No San Juan–Chama Project Storage

Alternative 2 is the same as Alternative 1 except that Reclamation would not store San Juan–Chama Project water in Elephant Butte Reservoir.

Alternative 3: No Carryover Provision

Alternative 3 is the same as Alternative 1 except that carryover accounting established by the OA would be excluded from RGP allocation and accounting procedures.

Alternative 4: No Diversion Ratio Adjustment

Alternative 4 is the same as Alternative 1 except that the diversion ratio adjustment established by the OA would be excluded from RGP allocation and accounting procedures.

Alternative 5: Prior Operating Practices, No Action Alternative

Alternative 5 (No Action) would eliminate both carryover accounting and the diversion ratio adjustment from RGP allocation and accounting procedures.

Selection of the Preferred Alternative

Based upon the analysis presented in this FEIS and after reviewing the comments and concerns of agencies, organizations and individuals (Appendix E), Reclamation's responsible official, the Regional Director of the Upper Colorado Region, selected Alternative 1 as the preferred alternative. At least 30 days after publishing a notice of availability of this FEIS, the Regional Director will sign a Record of Decision selecting an alternative and allowing implementation to proceed.

Major Conclusions

Based on the analysis of impacts of these alternatives in Chapters 4 and 5, major conclusions of the FEIS are as follows:

- **EBID's Annual Allocated Water**. Alternatives 1 and 2 would provide an average of 213,110 acre-feet under the central tendency climatic scenario. Alternative 3 would provide an average of 264,752 acre-feet; Alternative 4 would provide 272,269 acre-feet. Alternative 5 (No Action) would provide 314,327 acre-feet to EBID.
- **EPCWID's Annual Allocated Water**. Alternatives 1 and 2 would provide an average of 224,049 acre-feet under the central tendency climatic scenario. Alternative 3 would provide an average of 267,973 acre-feet; Alternative 4 would provide 207,296 acre-feet. Alternative 5 (No Action) would provide 239,317 acre-feet to EPCWID.
- **Total Storage**. Alternative 1 would provide an average of 483,445 acre-feet of total storage under the central tendency climatic scenario. Alternative 2 would provide an average of 455,233 acre-feet; Alternative 3 would provide 493,743 acre-feet; Alternative 4 would provide 465,907 acre-feet; and Alternative 5 (No Action) would provide 483,425 acre-feet.
- **Elephant Butte Reservoir Elevation**. Under the central tendency climate scenario, the average Elephant Butte Reservoir elevations would be 4,326 to 4,327 feet under all alternatives except that Alternative 2 would average 4,319 feet due to not storing San Juan-Chama Project water. As shown in Section 4.3, the differences in elevation would be greater

(10 to 12 feet) due to the projected effects of future climate change than due to implementation of the alternatives.

- **Special Status Species**. Reclamation concluded that implementation of Alterantive 1 “may affect, and is likely to adversely affect” the Southwestern willow flycatcher (*Empidonax traillii extimus*) and Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*). A “may affect, and is likely to adversely modify**”** determination for flycatcher critical habitat and cuckoo proposed critical habitat is based on water resources modeling presented in Sections 4.13-4.14 that shows that reservoir filling would inundate this habitat. The U.S. Fish and Wildlife Service (Service) concurred with these findings in a biological opinion issued on May 25, 2016.
- **Regional Economic Impacts**. Under the central tendency climate scenario, the regional economic impacts in Doña Ana and Sierra Counties, New Mexico, where EBID is located, would decrease compared to Alternative 5 for all action alternatives. The regional economic impacts estimated for El Paso and Hudspeth Counties, Texas, where EPCWID is located, would increase for all action alternatives compared to Alternative 5. Changes (positive and negative) would be small compared to the entire regional economies of the New Mexico and Texas and there would be no high or disproportionate adverse impacts on environmental justice communities.

Environmental Commitments

The EIS process will end with completion of a Record of Decision (ROD). The ROD shall explain the agency’s decision and discuss plans for mitigating potential environmental effects and monitoring those commitments. Should Alternative 1 become the selected alternative, the following future commitments would be implemented.

- Under Alternative 1, Reclamation would continue to work with the USIBWC, EBID, and EPCWID to assess and determine the available supply, the release from storage, and delivery of RGP water.
- Under unforeseen or adverse conditions, Reclamation would continue to work with the USIBWC, EBID, and EPCWID under the parameters of the OA to resolve issues in an adaptive management framework.
- Reclamation has accepted the Service’s biological opinion dated May 25, 2016 and would continue to monitor vegetation and listed species in coordination with the USIBWC.

Contents

Figures

Page

Tables

Page

Appendices

A. Operating Agreement
B. Operations Manual
C. Hydrology Technical Memorandum
D. Consultation and Coordination Correspondence
E. Comments-Responses

Acronyms and Abbreviations

Acronym	Full Phrase
ABCWUA	Albuquerque Bernalillo County Water Utility Authority
AFY	acre-feet per year
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CFS	cubic feet per second
Convention of 1906	Convention between the United States and Mexico
CWA	Clean Water Act
DEIS	draft environmental impact statement
EA	environmental assessment
EBID	Elephant Butte Irrigation District
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
EPCWID	El Paso County Water Improvement District Number 1
ESA	Endangered Species Act
ET_0	Evapotranspiration
FEIS	final environmental impact statement
Flycatcher	Southwestern willow flycatcher
Gwh	gigawatt-hour
HCCRD	Hudspeth County Conservation and Reclamation District No. 1
IMPLAN	IMpact analysis for PLANning
ITA	Indian trust assets
MF-OWHM	MODFLOW (modular finite-difference flow model); One Water Hydrologic Model
M&I	Municipal and industrial water
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMDA	New Mexico Department of Agriculture
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMEMNRD	New Mexico Energy, Minerals, and Natural Resources Department
NMOSE	New Mexico Office of the State Engineer
NMRPTC	New Mexico Rare Plant Technical Council
NMSP	New Mexico State Parks

Acronym	Full Phrase
OA	Operating Agreement for the Rio Grande Project
Reclamation	United States Department of the Interior, Bureau of Reclamation
RGP	Rio Grande Project, New Mexico and Texas
RMBHM	Rincon and Mesilla Basin Hydrologic Model
SEA	supplemental environmental assessment
Service	United States Department of the Interior, Fish and Wildlife Service
TCEQ	Texas Commission on Environmental Quality
U.S.	United States
URGIA	Upper Rio Grande Impact Assessment
URGSim	Upper Rio Grande Simulation Model
URGWOM	Upper Rio Grande Water Operations Model
USC	United States Code
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USIBWC	United States Section of the International Boundary and Water Commission
VIC	Variable Infiltration Capacity Hydrology Model
WWCRA	West Wide Climate Risk Assessment

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1 Purpose of and Need for Action

1.1 Introduction

The Bureau of Reclamation (Reclamation) has prepared this FEIS to analyze the environmental effects of continuing to implement the OA for the RGP through the year 2050. The OA is a written agreement describing how Reclamation allocates, releases from storage, and delivers RGP water to two irrigation districts, the EBID and EPCWID, and to Mexico. In addition, Reclamation will use this FEIS to evaluate the environmental effects of a request to renew a multiyear contract for storing San Juan–Chama Project water in Elephant Butte Reservoir.

This FEIS has been prepared in compliance with NEPA, CEQ's NEPA implementing regulations (40 CFR 1500-1508), the U.S. Department of the Interior's NEPA regulations (43 CFR 46), and other relevant Federal and state laws, regulations, and policies.

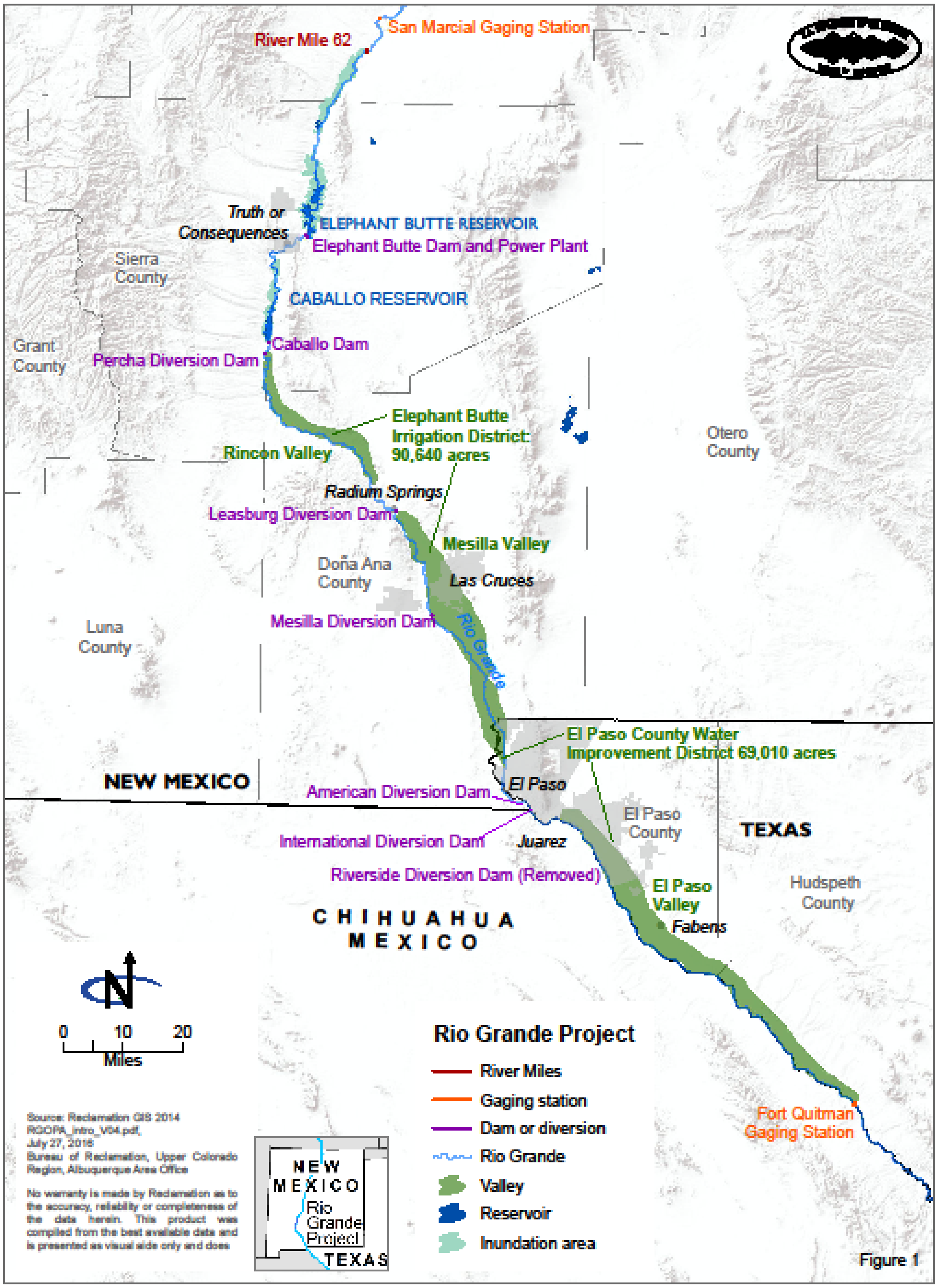
1.2 Rio Grande Project Operating Agreement

The OA is a written agreement describing how Reclamation allocates, releases from storage, and delivers RGP water to irrigation district diversion points (headings) of the EBID in New Mexico, EPCWID in Texas, and Mexico. The OA is Appendix A of this FEIS. It is described in Section 1.4.2.3 and in Chapter 2. The proposed action analyzed in this FEIS is continuing to implement the OA for the RGP for its remaining term, through 2050.

1.3 Rio Grande Project

The RGP is located in southern New Mexico and western Texas in the Rincon, Mesilla, and El Paso Valleys. Its facilities include the Elephant Butte and Caballo Dams and Reservoirs, a power generating plant, the Percha, Leasburg, Mesilla, American, and International Diversion Dams; 141 miles of canals, 462 miles of lateral ditches, and 457 miles of drains (Fig. 1). A sixth diversion dam, Riverside, was damaged by flood flows and was removed in 2003 to reduce flood hazards associated with further breaching.

Figure 1. Rio Grande Project in New Mexico and Texas.



Congress authorized the RGP under the authority of the Reclamation Act of 1902 and the Rio Grande Project Act of February 25, 1905, to serve lands in New Mexico and Texas. RGP water is made available to irrigate a variety of crops and for municipal and industrial (M&I) water uses. RGP water is also diverted to Mexico under the Convention between the United States and Mexico: Equitable Distribution of the Waters of the Rio Grande (Convention of 1906).

In 1907, Congress appropriated $1,000,000 to pay for the portion of the RGP necessary to provide storage of water for fulfillment of the Convention of 1906. As for funding the rest of the RGP, under the Reclamation Act of 1902, Congress intended that water projects would be self-supporting: each would generate sufficient revenue to cover the costs of construction, operation and maintenance, and the total estimated costs would be equitably borne by project beneficiaries. Therefore, EBID and EPCWID were required to enter into contracts with Reclamation under which they would cover these costs. The Reclamation Act of 1902 further states that the right to use RGP water "shall be appurtenant to the land irrigated and beneficial use shall be the basis, the measure, and the limit of the right" (32 Stat. 390; 43 USC Sections 372 and 383). The contracts among Reclamation, EBID and EPCWID establish the allocation of water between the two districts based on the irrigable acreage within each district.

A history of the RGP may be found in the *Rio Grande Project* (Autobee 1994) and Appendix C of Reclamation (2013a).

1.4 Background

1.4.1 Operations Overview

The RGP provides surface water for irrigation in southern New Mexico and for irrigation and M&I use in western Texas. It also provides for the delivery of surface water to Mexico under the Convention of 1906. The RGP also provides hydropower generation as a secondary function. Operation of the RGP involves four primary functions:

- Capture and storage of Rio Grande streamflow in Elephant Butte and Caballo Reservoirs
- Allocation of RGP water to EBID, EPCWID, and Mexico
- Release of RGP water to satisfy delivery orders from EBID, EPCWID, and the USIBWC on behalf of Mexico
- Diversion of RGP water from the Rio Grande and delivery of RGP water to headings and municipal water treatment facilities for beneficial use

The Rio Grande Compact contains a schedule for water that must be delivered to Elephant Butte Reservoir every year. In addition, Reclamation allows storage of San Juan–Chama Project water in Elephant Butte Reservoir currently under annual contracts with the Albuquerque-Bernalillo County Water Utility Authority (ABCWUA).

1.4.1.1 Surface Water Supply

At the beginning of the calendar year and prior to the onset of the irrigation season, Reclamation determines the total water in RGP storage. Total storage includes Rio Grande Compact deliveries, which are comprised of any accumulated inflows, less evaporative losses in Elephant Butte and Caballo Reservoirs. Reclamation then calculates the total usable RGP water by subtracting all non-RGP storage, including San Juan–Chama Project water and Rio Grande Compact credit water, from the total water in storage.

In years when the total usable RGP water at the beginning of the calendar year is not sufficient to provide a full allocation, Reclamation reevaluates RGP storage each month during the irrigation season until a final allocation is reached.

1.4.1.2 Allocation of Rio Grande Project Water

Reclamation allocates RGP water supplies such that the diversion allocations to EBID and EPCWID are proportionate to each district's respective acreages. EBID includes 90,640 acres authorized to receive RGP water in the Rincon and Mesilla Valleys of New Mexico. EPCWID includes 69,010 acres authorized to receive RGP water in the Mesilla and El Paso Valleys of Texas. Of the 159,650 acres, 57 percent of the acreage is in EBID and 43 percent is in EPCWID.

The annual diversion allocation is the quantity of RGP water that is allocated each year for delivery to EBID, EPCWID, and Mexico at their respective diversion headings. The annual diversion allocation is calculated based on the amount of RGP water in storage available for release and the estimated amount of water available for diversion at river headings accounting for canal bypass, drainage return flows, and other inflows or losses to the Rio Grande between Caballo Dam and International Dam.

In addition to their allocations of surface water from the RGP, irrigators within EBID and EPCWID have historically relied on groundwater pumping for supplemental irrigation. It is recognized that groundwater pumping in the Rincon and Mesilla Valleys depletes RGP surface water supplies by increasing seepage losses from the Rio Grande and decreasing groundwater discharge to the Rio Grande and to the network of drains that extends throughout the RGP. The magnitude of surface water depletions due to groundwater pumping is currently being studied. While groundwater is used for supplemental irrigation in both EBID and EPCWID, estimates of pumping for irrigation within EBID are an order of magnitude larger than corresponding estimates for EPCWID.

To determine how to provide each district with its annual diversion allocation, EBID and EPCWID do most of the water monitoring in the river and of water coming into the river from drains and other sources. These data are shared between parties and are used to schedule RGP orders, releases, and deliveries. Reclamation then executes the releases determined by the districts. Under the Convention of 1906, the U.S. is obligated to deliver 60,000 acre-feet of water annually in a full allocation year. In drought years when the full allocation is not available, the allocation to Mexico is reduced in the same proportion as water delivered to the districts.

1.4.1.3 Release and Diversion of Rio Grande Project Water

Reclamation delivers water to each district's diversion headings based on their water orders. Each district then distributes water through its conveyance system to its water users for irrigation or M&I use. The two districts use RGP water to irrigate a variety of crops, including lettuce, chilies, onions, cotton, sorghum, and pecans. Through contracts with EPCWID, El Paso Water[1] also receives RGP water. These contracts allow irrigation water to be converted to M&I uses. El Paso Water owns or leases farmland with first class water rights by which it is able to convert the associated irrigation water to M&I uses (Texas Water Development Board 2016).

Drainage and tailwater from RGP lands at the terminus of the RGP (the El Paso-Hudspeth County line) provides supplemental water to 18,000 acres in the Hudspeth County Conservation and

[1] El Paso Water is the new official name for what used to known as El Paso Water Utilities. See http://www.epwu.org/public_information/news_releases/nr_160630-01.html. They are a utility that delivers water to residents of the City of El Paso.

Reclamation District No. 1 (HCCRD) in Texas. Because HCCRD only receives seepage and drainage water through a contract with Reclamation by way of the EPCWID irrigation system and does not receive a direct allocation of RGP water, deliveries to HCCRD do not affect primary RGP operations.

The USIBWC carries out and schedules the deliveries at the request of Mexico. RGP water allocated to Mexico under the Convention of 1906 is officially delivered in the bed of the Rio Grande at the point adjacent to the head works of the Acequia Madre in Ciudad Juárez, about two miles downstream of the point where the river becomes the international border.

1.4.2 Historic Operations

1.4.2.1 Project Initiation to 1979-1980

From 1908 through 1979, Reclamation operated the RGP. Reclamation determined the annual allotment of RGP water per acre of authorized land and delivered the annual allotment to farm headgates and to the Acequia Madre for Mexico.

In 1937, Congress authorized the execution of amended repayment contracts with EBID and EPCWID. These contracts reduced the repayment obligations and established a corresponding right of use to a proportion of the annual water supply, based on an established irrigated acreage in each district: 57 percent to EBID and 43 percent to EPCWID, as explained in Section 1.4.1.2.

The districts' amended repayment contracts also required three changes to occur to historical operations. First, once the two districts paid the total reimbursable costs for the RGP, they were required to take over the day-to-day responsibility for operating and maintaining the irrigation delivery and drainage system. Second, once this transfer of operation and maintenance occurred, Reclamation and the two districts agreed to formalize a set of operating procedures that would govern the operations of transferred project works. Third, on transfer, Reclamation would no longer calculate, allocate, and deliver water to project land; instead, it would deliver an annual diversion allocation to each district's headings.

In 1979-1980, the two districts paid off their construction obligations to the U.S. In 1979, Reclamation contracted with EBID to assume responsibility for operating and maintaining the Percha, Leasburg, and Mesilla Diversion Dams in New Mexico. In 1980, Reclamation contracted with EPCWID to transfer operation and maintenance for the Riverside Diversion Dam (removed in 2003) and the distribution and downstream drainage system in Texas, which delivers tailwater to the HCCRD. Both contracts required Reclamation and the districts to create a mutually agreeable, "detailed operational plan…setting forth procedures for water delivery and accounting."

1.4.2.2 Operations from 1980 to 2007

Beginning in 1980, Reclamation determined annual diversion allocations to each district and delivered water to the authorized points of diversion. The districts were then responsible for conveying water from the point of diversion to individual farm gates. Until a mutually agreeable operations plan was in place, Reclamation imposed ad hoc operating procedures to govern operations. It modified these procedures as needed between 1980 and 2007. During that time, Reclamation calculated, allocated, and delivered each district's annual diversion allocation; however, it modified and optimized the methods, equations, and procedures according to real-time water conditions. The lack of an operations plan led to conflicts and litigation during this period.

1.4.2.3 Operations from 2008 to Present

In 2008, EBID, EPCWID, and Reclamation agreed to execute and implement the OA as a settlement of the litigation then pending and filed by both districts. The three parties are the signatories of the OA. The term of the resulting 2008 OA is from January 1, 2008, until December 31, 2050 (Appendix A).

As a part of the OA, the three parties prepared the RGP Water Accounting and Operations Manual (Reclamation 2012d) that contains more detailed information regarding the methods, equations, and procedures used to implement the OA. The Operations Manual is an addendum to the OA and is found in Appendix B. It is consistent with the OA and does not modify the provisions in the OA. The parties to OA consult with each other to review the Operations Manual. The most recent revision was in 2012.

1.4.2.3.1 The OA, Operations Manual, and Diversion Ratio

The OA largely reflects historical operation of the RGP, with two key changes. First, the OA provides carryover accounting for any unused portion of the annual diversion allocations to EBID and EPCWID. Under historical operations prior to the OA, the unused portion of a district's annual allocation balance contributed to the total amount of usable water available for allocation to both districts during the following year. As a result, a portion of one district's unused allocation became part of the other district's annual allocation the following year. Under the OA, any unused portion of the annual diversion allocations to EBID and EPCWID, based on a regression line reflecting past delivery performance, referred to as the D-2 Curve, is carried over to that district's allocation balance the following year. The carryover provision of the OA is designed to encourage water conservation in the RGP by allowing each district to retain its unused allocation up to a specified limit.

Second, the OA adjusts the annual allocations to EBID and EPCWID to account for changes in RGP performance[2], as characterized by the diversion ratio. The diversion ratio is calculated as the sum of net allocation charges (i.e., sum of allocation charges minus allocation credits) to EBID, EPCWID, and Mexico divided by the total (cumulative) Project release from Caballo Dam over a specified period. The diversion ratio provision of the OA was developed to adjust the annual RGP allocations to the districts so as to provide RGP deliveries to EPCWID consistent with historical operations, prior to substantial increases in groundwater pumping within EBID and corresponding decreases in RGP performance. The annual RGP allocation to EBID is then adjusted to reflect current-year RGP performance as represented by the diversion ratio. When the diversion ratio is high, greater than one (>1.0), EBID generally receives an increase in allocation compared to historical RGP operations. When the diversion ratio is low, less than one (<1.0), EBID generally receives a decrease in RGP allocation compared to historical RGP operations.

While numerous factors affect RGP performance, recent changes in performance are predominantly driven by the actions of individual landowners within the EBID service area. These changes are:

- Crop selection and related effects on crop irrigation requirement
- Irrigation practices and related effects on farm irrigation efficiency

[2] By "performance", we mean historical performance of the RGP. While this may not have been called "diversion ratio" in the past, historically Reclamation calculated the amount of water that was delivered to lands in relation to the amount that was released from storage to determine if there was enough water to increase the allocation to lands and Mexico.

- Widespread use of groundwater for supplemental irrigation, as permitted and regulated by the State of New Mexico

The diversion ratio provision of the OA ensures that annual allocations and deliveries to EPCWID are consistent with historical performance. Moreover, it ensures that deviations in performance relative to historical conditions would be accounted for by adjusting the annual allocation to EBID.

Under the diversion ratio provision, the annual project allocation to EPCWID is equal to the district's historical diversion allocation, based on a regression line reflecting past delivery performance, as defined by the D-2 Curve (Appendix A, Section 2.5). The annual allocation to EBID is adjusted to reflect current year (actual) project performance, as reflected by the project diversion ratio. Again, when the diversion ratio is high relative to the baseline delivery performance defined by the D-2 Curve, EBID generally receives an increase in annual allocation compared to its diversion allocation under prior operating practices. When the diversion ratio is low relative to the D-2 Curve baseline, EBID generally receives a decrease in project allocation compared to prior operating practices.

1.4.2.3.2 Principles Underlying the Operating Agreement

The provisions adopted in the OA for the RGP reflect Reclamation and the two districts' interest in equitable distribution of RGP water. These include Rio Grande surface waters and hydraulically connected groundwater in New Mexico and the portion of the Mesilla Valley in Texas. Implementing the OA fulfills contractual obligations among Reclamation and the two irrigation districts and resolves litigation in compliance with the legal settlement (Reclamation 2013a).

<u>Surface Water/Groundwater Interaction</u>

The interaction between the surface water and groundwater is a critical factor in understanding the OA. Previous studies (Conover 1954, Hanson et al. 2013, Haywood and Yager 2003, S.S. Papadopoulos & Associates, Inc. 2007 [henceforth SSPA 2007], Stringham et al. 2016) indicate a strong hydraulic connection between the Rio Grande and underlying groundwater aquifers in the areas served by the RGP, particularly in the Rincon and Mesilla Basins. Groundwater recharge via seepage and deep percolation of RGP water would continue under any alternative. In years when there is an increase in RGP allocation and delivery to EBID, there is a corresponding increase in recharge via seepage and deep percolation within EBID, as well as a decrease in demand for supplemental irrigation by groundwater pumping within EBID. Conversely, when there is a decrease in allocation, recharge and deep percolation decrease, demand for supplemental irrigation water increases, which may result in increased groundwater pumping within the district under permits issued by the State of New Mexico (Reclamation 2013a).

When groundwater elevations adjacent to the Rio Grande or a given drain segment are above the surface water elevation in the channel, the hydraulic gradient drives groundwater flows toward the channel (Fig. 2a). In this situation, groundwater discharge to the channel increases the available surface water supply. When groundwater elevations adjacent to the Rio Grande or a given drain segment are below the water elevation in the channel, the hydraulic gradient drives groundwater flow away from the river (Fig. 2b). In this situation, seepage from the channel into the underlying aquifer decreases the available surface water supply. In the event that groundwater elevations adjacent to a given channel segment fall substantially below the channel elevation, the channel may become hydraulically disconnected from the underlying aquifer (Fig. 2c). In this situation, seepage from the channel reaches a maximum rate and is no longer affected by fluctuations in groundwater elevation (Winter et al. 1998).

While numerous factors affect groundwater in the Rincon and Mesilla Valleys, groundwater pumping for supplemental irrigation is a primary driver of groundwater declines. In addition, irrigators within both the New Mexico and Texas portions of the RGP often supplement RGP surface water deliveries with groundwater from privately owned wells. Supplemental groundwater pumping is authorized and managed by the states, independently of the RGP and is currently the subject of litigation.

D-1 and D-2 Curves

The RGP serves irrigated lands in the Rincon, Mesilla and El Paso Valleys, as well as providing water to the City of El Paso for M&I uses. EBID provides water to 90,640 acres in the Rincon and Mesilla Valleys of New Mexico. EPCWID provides water to 69,010 acres in the Mesilla and El Paso Valleys of Texas (Fig. 1). Groundwater pumping in the El Paso Valley portion of EPCWID does not affect RGP deliveries (Reclamation 2015c). This is because the effects of pumping occur downstream of RGP diversion points for the El Paso Valley portion of EPCWID.

The OA represents mutually agreeable procedures for water delivery and accounting by Reclamation to satisfy objections by both districts in how deliveries were provided starting in 1980. The D-1 and D-2 Curves used by Reclamation to determine annual RGP allocations represent the effects of inflows and losses within the RGP on historical RGP performance.

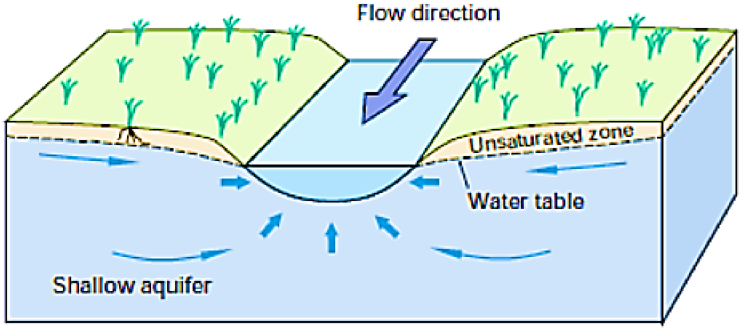
The D-1 and D-2 Curves were developed from operations data from 1951 to 1978. They reflect historical project performance during those years, including the effects of losses and inflows on project deliveries. The climatic and hydraulic conditions during these years ranged from low-flow drought conditions to high-flow full water supply. The D-1 Curve, used for making the allocation to Mexico, is a linear regression equation that represents the historical relationship between the total annual release from RGP storage and the total project delivery to lands within the U.S., plus delivery in the bed of the river at the point adjacent to the head works of the Acequia Madre. The D-2 Curve, used for making the water allocation to the districts, is a linear regression equation that represents the historical relationship between the total annual release from project storage and the total project delivery to canal headings on the Rio Grande. It includes delivery to all authorized points of diversion for EBID, EPCWID, and Mexico.

Adaptive Management

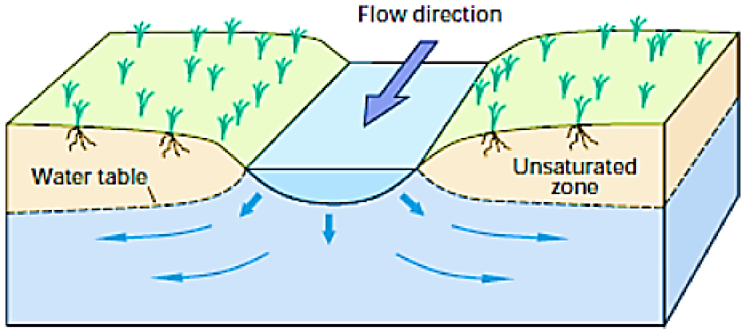
The OA and Operations Manual are intended to establish the overarching approach for management of the RGP, but it is recognized that they do not cover every possible contingency and may require adjustment. Under the principle of adaptive management (Holling 1978, Walters 1986), when unforeseen conditions or events occur in the future, the parties to the OA, consisting of Reclamation, EBID, and EPCWID, would consult and use their professional judgement and experience to adaptively manage the operations of the project.

Figure 2. Surface water and groundwater interaction; a gaining stream; b losing stream; c disconnected stream.

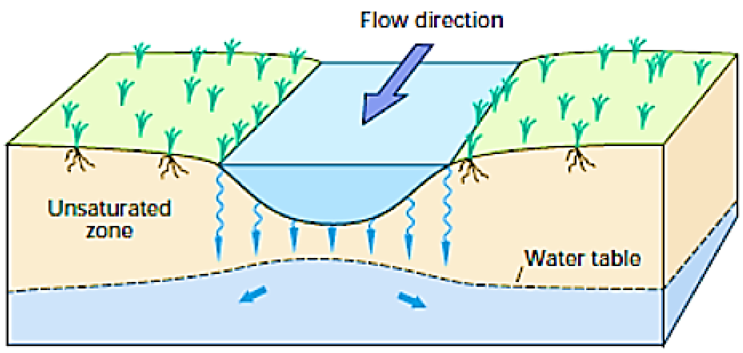
a. Gaining stream



b. Losing stream



c. Disconnected stream



Source: Winter et al. (1998).

1.4.3 San Juan-Chama Storage Contract

This FEIS evaluates the environmental effects of renewing multiyear contracts for storing San Juan–Chama Project water in Elephant Butte Reservoir, under the authority of Public Law 97-140 (95 Stat. 1718). The San Juan–Chama Project was authorized as a participating project of the Colorado River Storage Project Act in 1956. It consists of a system of diversion structures, trans-basin tunnels, and a storage reservoir to transfer water from the San Juan River in the Colorado River Basin to the Rio Chama in the Rio Grande Basin. San Juan–Chama Project repayment contractors receive their annual water allocations with no provisions for carryover; therefore, these contractors may benefit by storing unused annual allocations in Elephant Butte Reservoir for future use.

1.5 NEPA Analyses History

1.5.1 Operating Agreement

Two NEPA documents were prepared for the OA before this FEIS. In 2007, Reclamation prepared an environmental assessment (EA) to evaluate the effects of the OA through 2012. This EA committed Reclamation to gather data over the first five years of implementation to evaluate effects on the environment (Reclamation 2007).

In 2013, Reclamation supplemented the 2007 EA (SEA). This SEA was initially intended to analyze the potential impacts of implementing the OA through 2050. However, given the uncertainties of persisting drought and the need to improve analytical tools, Reclamation determined that analysis of a longer period would have been of limited use (Reclamation 2013a, b). In 2013, Reclamation began developing and refining modeling tools to thoroughly analyze the effects of implementing the OA through 2050, as documented in this FEIS.

1.5.2 San Juan–Chama Storage Contract

In 2010, Reclamation prepared an EA for a 40-year contract for storing ABCWUA's San Juan–Chama Project water in Elephant Butte Reservoir. The long-term contract was never implemented because information became available that rendered the associated Finding of No Significant Impact obsolete. Since 2010, Reclamation has been executing an annual contract with ABCWUA to store up to 50,000 acre-feet of San Juan–Chama Project water in Elephant Butte Reservoir, covered by categorical exclusions. Once stored, San Juan–Chama Project water is not included in the total RGP storage for purposes of allocations, but is maintained as a separate pool until exchanged upstream. The ABCWUA has proposed extending the contract to store San Juan-Chama Project water in Elephant Butte Reservoir through 2050.

1.6 Proposed Action

Reclamation is proposing to continue implementing the 2008 OA for the RGP for its remaining term, through 2050. In addition, it is proposing a similar action (as defined at 40 CFR 1508.25(a)(3)) of implementing long-term contracts for storing San Juan–Chama Project water in Elephant Butte Reservoir. The proposed action and alternatives are described in Chapter 2.

1.7 Purpose and Need for Action

1.7.1 Operating Agreement

The purpose for action is to meet contractual obligations to EBID and EPCWID and comply with applicable law governing RGP water allocation, delivery, and accounting. The purpose is also to provide a method to mitigate for the effects on the RGP of groundwater interaction in the Rincon and Mesilla Valleys. The need for action is to resolve the long and litigious history of the RGP by having mutually agreeable, detailed operational criteria.

1.7.2 San Juan–Chama Project Storage

The purpose and need for a similar action is to respond to a request to renew a multiyear storage contract of San Juan–Chama Project water in Elephant Butte Reservoir in accordance with the Act of December 29, 1981, Public Law 97-140. A similar action is defined by CEQ's regulations (40 CFR 1508.25(a)(3)) as actions that, when viewed with a proposal, have similarities such as common timing or geography that provide a basis for evaluation together. The analysis of a long-term contract for storing San Juan–Chama Project water in Elephant Butte Reservoir is a potentially similar action sharing common timing and geography with the OA. It is considered along with the proposed action of continuing to implement the 2008 OA.

1.8 Compliance with Other Authorities

In addition to meeting the requirements of NEPA, this FEIS documents compliance with other environmental laws and policies such as:

- Endangered Species Act (ESA)
- National Historic Preservation Act (NHPA)
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations
- Executive Order 13007, Indian Sacred Sites
- Executive Order 13112, Invasive Species
- Executive Order 13175, Tribal Consultation

1.9 Public Scoping

Public scoping began with publication of a notice of intent to prepare an EIS in the *Federal Register* (79 FR 2691) on January 15, 2014. The public was notified of the start of the NEPA review and scoping by:

- Placing newspaper advertisements in the *Santa Fe New Mexican* on January 27 and 28, 2014, the *Albuquerque Journal* on January 26, 2014, the *Las Cruces Sun News* on January 26, 2014, and the *El Paso Times* on January 26, 2014
- Announcing the public scoping meetings via Reclamation's social media sites and the project website (http://www.usbr.gov/uc/albuq/rm/RGP/)

Scoping meetings were held on both weekday and weekend dates and during both daytime and evening. Reclamation held three public scoping meetings at each of the following locations:

- Thursday, January 30, 2014, 3:00 p.m. to 5:00 p.m.—Reclamation, Albuquerque Area Office, 555 Broadway NE, Suite 100, Albuquerque, New Mexico
- Friday, January 31, 2014, 6:00 p.m. to 8:00 p.m.—Elephant Butte Irrigation District, 530 South Melendres Street, Las Cruces, New Mexico
- Saturday, February 1, 2014, 9:00 a.m. to 11:00 a.m.—Reclamation, El Paso Field Division, 10737 Gateway West, Suite 350, El Paso, Texas

Reclamation staff conducted the meetings, prepared the handouts, and answered questions. Persons attending the Albuquerque and Las Cruces meetings were primarily representatives of government agencies, but only Reclamation staff attended the meeting in El Paso. (Therefore, a hearing on the DEIS was not held in El Paso.)

Two comment letters were received during the scoping process, one from the New Mexico Interstate Stream Commission and the other from the City of Las Cruces. More information on the scoping process, including comments received, may be found in the NEPA Scoping Summary Report (Reclamation 2014c), which is also available on the project website (http://www.usbr.gov/uc/albuq/rm/RGP/). Reclamation took these comments into consideration in preparing this FEIS. In addition, comments received on the DEIS were considered in finalizing the FEIS.

1.10 Key Issues

Key issues or resources relevant to the analysis were identified based on the SEA (Reclamation 2013a), public comments and concerns raised during scoping, from internal scoping, and outreach to Federal, state, and local agencies and tribal governments; and legal, regulatory or policy requirements. The following issues or resources are analyzed in detail in this FEIS.

- Water Resources: total storage, Elephant Butte Reservoir elevations, allocation, releases, net diversion, farm surface water deliveries, farm groundwater deliveries, groundwater elevations, water quality
- Biological Resources: vegetation communities including wetlands, wildlife, aquatic species, and special status species and critical habitat
- Cultural Resources: historic properties, Indian sacred sites, and resources of tribal concern
- Socioeconomic Resources: Indian trust assets, recreation, hydropower, regional economic impacts and economic benefits, and environmental justice.

2 Alternatives

This chapter describes five alternatives analyzed in detail in this FEIS. This chapter also explains the criteria for selecting the preferred alternative and discusses alternatives that were considered, but not analyzed in detail.

2.1 Alternatives Development Process

Formulation of alternatives began in the fall of 2014 and continued through early 2015. Reclamation received suggestions for alternatives during scoping and these were considered during the alternatives development process. Additional alternatives were proposed during the public comment period for the FEIS in 2016.

A key step in the alternatives development process was a workshop held on November 4, 2014, at Reclamation's office in El Paso, Texas. Reclamation staff, contractors, and representatives of the cooperating agencies at that time: EBID, EPCWID, USIBWC, the City of Santa Fe, and the Rio Grande Compact Commission's Texas Commissioner—participated in the workshop in person or remotely. Workshop participants reviewed and discussed the purpose and need statement to assess where there was discretion for considering alternatives to current practices. The workshop included facilitated discussions of the alternatives. It also clarified the difference between annual implementation of the Operations Manual and the overall water supply allocation process described in the OA.

Reclamation reviewed the output of the screening exercise and outlined the elements of the alternatives to be carried forward for further review. Reclamation determined that the carryover provision and the diversion ratio adjustment were the basis of the settlement agreement and represented variables or elements for creating a reasonable range of alternatives. Reclamation also determined that due to similar geography and timing, the environmental effects of storing San Juan–Chama Project water in Elephant Butte Reservoir should be analyzed in the EIS.

2.2 Description of Alternatives

The alternatives were derived from the methods, equations, and procedures that Reclamation, EBID, and EPCWID use in determining the annual diversion allocation and water accounting for the RGP. As shown in Table 2-1, the alternatives vary in inclusion of the diversion ratio adjustment, carryover accounting, and the San Juan-Chama storage contract.

2.2.1 Operational Elements Common to All Alternatives

Some elements of project operations are common to all alternatives and would not vary. Reclamation would continue to store, allocate, release, and deliver RGP water for authorized uses in the U.S. and for delivery to Mexico under all alternatives. Reclamation would continue to determine annual allocations based on the usable water in RGP storage available for release during the current year. This includes usable water in storage at the start of the year. Added to this is any usable water that becomes available during the year as inflow to RGP storage or as relinquishment of Rio Grande Compact credit waters.

Under all alternatives, annual diversion allocations to EBID, EPCWID, and Mexico would continue to be based on two linear regression relationships between RGP releases and RGP deliveries, referred to as the D-1 and D-2 Curves, as described in Section 1.4.2.3.2 of Chapter 1. Reclamation and the USIBWC developed the D-1 Curve in 1980 to calculate the annual allocation to Mexico when less than a full supply is available. In accordance with the Convention of 1906, the annual RGP allocation to Mexico is 60,000 acre feet per year (AFY), except in years of extraordinary drought or serious accident to the U.S. irrigation system. The water for Mexico is officially delivered in the bed of the Rio Grande at the point adjacent to the head works of the Acequia Madre, in cooperation with the USIBWC.

The D-2 Curve represents the total (gross) amount of water available for diversion from the Rio Grande by EBID, EPCWID, and Mexico during the year under historical RGP performance conditions. The amount of water available for diversion in the U.S. by EBID and EPCWID would be determined by subtracting the annual allocation to Mexico from the total volume of water available for diversion during the year, as calculated by the D-2 Curve. EBID would then be allocated 88/155^{ths} (57 percent) of the volume of water available for diversion and EPCWID would be allocated 67/155^{ths} (43 percent).

The annual diversion allocations to EBID, EPCWID, and Mexico would continue to be based on the D-1 and D-2 Curves. RGP releases would continue to be scheduled and managed to meet delivery orders submitted by EBID, EPCWID, and USIBWC on behalf of Mexico.

2.2.2 Alternatives

Five alternatives are carried through detailed analysis in this FEIS. Table 0-1 highlights the differences among alternatives.

Alternative 1—Continuation of OA and San Juan-Chama Storage Contract, Preferred Alternative

- Continue to implement the diversion ratio adjustment provision of the OA in computing annual diversion allocations
- Continue to implement the carryover accounting provisions of the OA, which allows carryover of unused allotment balance from one year to the next
- Continue to store up to 50,000 acre-feet of San Juan–Chama Project water in Elephant Butte Reservoir

Alternative 1 is the continued implementation through 2050 of the operating procedures defined in the OA and Operations Manual, as amended for any given year. Under these operating procedures, the carryover accounting and diversion ratio provisions would continue. Reclamation would continue to implement a contract through 2050 with the ABCWUA to store up to 50,000 acre-feet of San Juan–Chama Project water in Elephant Butte Reservoir. Details of data, inputs, and calculations used in the allocation procedure are described in Table 4 of the OA (Appendix A). Additional details on allocation calculations are provided in the Operations Manual (Appendix B).

Under the OA, representatives of EBID, EPCWID, and Reclamation consult to establish the monthly and final water allocations for the year for each district and Mexico and review the Operations Manual. The manual was last updated in 2012 to clarify calculations used in the allocation procedure and to optimize operations (Reclamation 2012e).

Alternative 2—No San Juan–Chama Project Storage

- Continue to implement the diversion ratio adjustment provision of the OA in computing annual diversion allocations
- Continue to implement the carryover accounting provisions of the OA, which allows carryover of unused allotment balance from one year to the next
- Do not store any San Juan–Chama Project water in Elephant Butte Reservoir

Alternative 2 is the same as Alternative 1, except Reclamation would not continue with contracts to store San Juan–Chama Project water in Elephant Butte Reservoir. Alternative 2 allows Reclamation to model and determine the effects of storing San Juan-Chama Project water in the RGP.

Alternative 3—No Carryover Provision

- Continue to implement the diversion ratio adjustment provision of the OA in computing annual diversion allocations
- Do not implement the carryover accounting provisions of the OA
- Eliminate the carryover allocations and relinquish the unused allotment balance at the end of each calendar year
- Continue to store up to 50,000 acre-feet of San Juan–Chama Project water in Elephant Butte Reservoir

Alternative 3 is the same as Alternative 1, except Reclamation would not implement the carryover accounting provisions of the OA. Alternative 3 allows Reclamation to model and determine the effects of the carryover provision.

Alternative 4—No Diversion Ratio Adjustment

- Do not implement the diversion ratio adjustment provision of the OA
- Compute annual diversion allocations based only on the D-1 and D-2 regression equations without adjusting for variations in RGP performance
- Continue to implement the carryover accounting provisions of the OA, which allows carryover of unused allotment balance from one year to the next
- Continue to store up to 50,000 acre-feet of San Juan–Chama Project water in Elephant Butte Reservoir

Alternative 4 is the same as Alternative 1, except Reclamation would not implement the diversion ratio adjustment provision of the OA. Alternative 4 allows Reclamation to model and determine the effects of the diversion ratio adjustment provision.

Alternative 5—Prior Operating Practices, No Action Alternative

- Do not implement the diversion ratio adjustment provision of the OA
- Compute annual diversion allocations based only on D-1 and D-2 Curves regression equations that reflect historical conditions
- Do not implement the carryover accounting provisions of the OA
- Eliminate the provision for carryover allocations for each district
- Continue to store up to 50,000 acre-feet of San Juan–Chama Project water in Elephant Butte Reservoir

For this FEIS, Alternative 5 is the No Action Alternative. It allows a comparison through 2050 of operations under the OA and a simulation of procedures prior to the OA which did not apply the carryover allocation accounting for each district and diversion ratio adjustment provisions in the calculation of the allocation to EBID. Alternative 5 is the best possible representation of prior operating practices in a modeling context and is based on strict application of the D-1 and D-2 Curves.

Table 2-1 Key elements of alternatives

Alternative	Continue Diversion Ratio Adjustment	Continue Carryover Accounting	Continue Storage of San Juan–Chama Project Water
1	●	●	●
2	●	●	
3	●		●
4		●	●
5			●

Because they are not part of the OA, the alternatives do not include the following:

- Changes to the dams, storage facilities, the power generating plant, diversion facilities, and delivery points
- Negate obligations under the Convention of 1906 and the Rio Grande Compact or compliance with various court decrees, settlement agreements, and contracts
- Construction of new facilities or other actions that are physically different from or that exceed the bounds of historic operations within the RGP
- Changes to the basic operation of the dams and other RGP facilities
- Changes to the channel capacity

The alternatives analyzed in this FEIS vary in including or excluding the carryover provision, diversion ratio adjustment, and the San Juan-Chama storage contract. The range of alternatives is designed to determine whether these elements would result in environmental impacts when simulated using a hydrology model described in Section 4.1 of Chapter 4.

Continuing to implement the OA is part of the settlement of litigation between Reclamation and the two districts. Since 1979 and 1980, Reclamation, EBID, and EPCWID have had contractual obligations resulting from the transfer of the irrigation and drainage facilities from Reclamation to each district to agree on a detailed operational plan, setting forth procedures for allocation, delivery, and accounting of RGP water. This need was finally satisfied in 2008 when the three parties entered into the 2008 settlement agreement, which required implementing the OA and the Operations Manual (Reclamation 2014c). Alternative 1 represents the operational procedures in place since 2008 and an existing agreement among Reclamation and the districts to continue implementing the OA through 2050. Alternative 5 represents the No Action Alternative.

2.2.2.1 Carryover Provision

The carryover provision of the OA provides for carryover accounting for the unused allocation balances remaining on EBID's and EPCWID's respective RGP water accounts at the end of each year. If either district does not use all of its total diversion allocation during a given year, for purposes of modeling for this FEIS, the corresponding quantity of water that would have been released from RGP storage to satisfy the unused portion of the district's allocation instead would remain in storage at the end of the year.

Each district may accrue and maintain carryover balance for any period of years up to 60 percent of its respective full annual allocation under the OA. EBID, therefore, may accrue carryover balance up to a limit of 305,918 acre-feet and EPCWID may accrue carryover balance up to 232,915 acre-feet. In the event that either district accrues carryover balance in excess of their respective limit, the excess balance would be transferred to the other district's RGP water account.

The carryover provision of the OA does not affect the procedure used to determine the annual RGP allocation to Mexico. In accordance with the Convention of 1906, the allocation to Mexico would be 60,000 AFY, except in years of extraordinary drought or serious accident to the U.S. irrigation system. During extraordinary droughts, the annual allocation to Mexico would be determined based on the total release from storage and annual delivery to lands within EBID and EPCWID, plus total deliveries to the heading of the Acequia Madre, as calculated using the D-1 Curve. (See Section 1.4.2.3.2.)

2.2.2.2 Diversion Ratio Adjustment

As described in Section 1.4.2.3, the diversion ratio represents the amount of diversion allocation that is used per unit release of RGP water from Caballo Dam. It is a measure of RGP performance in meeting delivery obligations to EBID, EPCWID, and Mexico. The OA provides the method for determining the initial annual diversion allocations to EBID and EPCWID. It also includes the methods for adjusting these allocations based on RGP performance, as measured by the diversion ratio, which is affected by groundwater levels, and return flows to the Rio Grande.

As described in Section 1.4.2.3.1, Reclamation uses the diversion ratio to adjust allocations to EBID and EPCWID to account for changes in RGP performance. This is done to account for the effects of groundwater and surface water conjunctive use by irrigators in the Rincon and Mesilla Basins, on current year RGP performance. The diversion ratio adjustment ensures that the annual RGP allocation to EPCWID is consistent with historical RGP performance, as characterized by the D-2 Curve. It also ensures that deviations in RGP performance are accounted for by adjusting the annual RGP allocation to EBID.

Calculating annual allocations to EBID and EPCWID under the OA involves additional adjustments under some conditions. A positive adjustment (increase) is applied to both districts' allocations when the usable water available for current-year allocation is greater than 600,000 acre-feet and current (actual) RGP performance exceeds the historical D-2 baseline. A negative adjustment (decrease) is applied to both districts' allocations during extreme droughts. These are defined as consecutive years where RGP releases are below 400,000 AFY.

The OA implemented a minor modification to the application of the D-2 Curve. The 763,842 acre-feet for a full allocation release was increased to 790,000 AFY as specified as the normal release in the Rio Grande Compact.

2.2.2.3 San Juan–Chama Storage

Alternatives 1, 3, 4, and 5 include storing San Juan–Chama Project water in Elephant Butte Reservoir. The ABCWUA is seeking to renew a multiyear contract for storage of up to 50,000 acre-feet of San Juan–Chama Project water in Elephant Butte Reservoir through 2050.

2.3 Alternatives Eliminated from Detailed Study

This section discusses alternatives that were considered but eliminated from detailed study and explains the reasons for their elimination.

2.3.1 Removing Credits and Charges and Using Actual Deliveries of Water in Accounting

The New Mexico Interstate Stream Commission submitted an alternative during scoping and again during the DEIS comment period requesting analysis of an alternative to remove credits and charges in water accounting for the RGP. Allocation charges reflect the volume of surface water diverted from the Rio Grande; allocation credits reflect the volume of water bypassed or returned to the Rio Grande and available for diversion at a downstream diversion point. In general, allocation charges are computed as the greater of the volume of water ordered for diversion at a specified diversion point and the volume of water actually diverted; alternatively, allocation credits are computed as the lesser of the volume of water ordered or bypassed at specified bypass points and the actual volume of water bypassed or returned to the Rio Grande. Depending on the allocation charges and credits on corresponding RGP water orders promotes efficient operation of the RGP by creating an incentive to divert all water ordered or available. This was not carried forward for several reasons. First, because it would remove the incentives for efficient operations which would increase water use throughout the project area and reduce the amount of allocation for EBID due to a reduction to the diversion ratio. Second, charges are a method of tracking allocation use. If charges were removed, then there would be no way to track the allocation used by each district. This would be contrary to contracts among Reclamation and the two districts. Largely because of the second reason, i.e., being contrary to contracts, it means this alternative would not meet the purpose and need for action.

2.3.2 Change the Rio Grande Compact Accounting Point to San Marcial

During scoping, a request was made to change the Rio Grande Compact accounting point back to San Marcial. This alternative was not carried forward because it does not meet the purpose of and need for the proposed action. Specifically, changing the Compact accounting point is beyond Reclamation’s authority. Such a change would require a resolution of the Rio Grande Compact Commission, such as the change that was made in 1948 which changed the accounting point from San Marcial Station to storage in Elephant Butte Reservoir.

2.3.2 Add Point of Diversion for La Mancha Wetlands

During the comment period, the Southwest Environmental Center request a new diversion point on the river to divert surface water to the La Mancha wetlands. This alternative was not carried forward because it does not meet the purpose of and need for action. It is also beyond Reclamation's authority to grant this request. New diversions on the river would require coordination with the USIBWC, EBID, and others.

2.3.3 Change Carryover Accounting to Reflect Actual Conservation

Reclamation considered a suggestion to analyze changing carryover accounting to reflect conservation. Conservation is not how carryover is determined. Accumulation of carryover in each district’s account is not only dependent on conservation, but it is a summation of the water allotted at the point of diversion against the water diverted and charged against their account.

2.3.4 Changes in Drought Factor and Evaporation Calculations

Reclamation considered alternative elements to address how evaporation losses are calculated and potentially adjusting the drought factor. These elements were not carried forward as part of the final alternatives because they are potential adjustments that could be made by revising the Operations Manual.

2.3.5 Climate Change and Compact Modeling and Analysis Assumptions

Reclamation received requests for new alternatives to account for changes in RGP efficiency caused by climate change and alternatives looking at Rio Grande Compact credit water accounting. These requests are not true alternatives, but are modeling and analysis assumptions or parameters contributing to the effects analysis in Chapters 4 and 5.

2.3.6 Impairment from Groundwater Pumping

A proposal was submitted to consider taking action if impairment from groundwater pumping depletes the RGP water supply. Actions which Reclamation may take outside the OA are outside the scope of the proposed action and are too speculative to attempt to analyze in this FEIS.

2.3.7 Mimic Natural Hydrograph

During the public comment period on the DEIS, two comments were made requesting new alternatives of modifying releases to mimic the natural flow regime, with higher water released in spring and lower water released in summer and fall to benefit native plants and wildlife. The alternative to release water for such purposes is beyond Reclamation's authority and does not meet the purpose and need for action for this FEIS.

2.3.8 Mitigation Measure to Revegetate

A request was made during the public comment period on the DEIS to add a mitigation measure of planting cottonwoods and willows in the reservoir pool following reservoir drawdowns. Reclamation considered this request, but given the cycles of filling and drawdown of the reservoirs, there would be natural regeneration occurring and such proposed revegetation would not be required. However, Reclamation has committed to monitor vegetation changes and meet with the Service to assess the habitat (cottonwoods, willows, and tamarisk) available for the Southwestern willow flycatcher and the Yellow-billed cuckoo. Revegetation would be considered in the future as needed to comply with the ESA.

2.3.9 San Juan–Chama Storage Alternative Contract Options

During scoping, Reclamation considered various alternatives for differing amounts or durations of storage of San Juan–Chama Project water in Elephant Butte Reservoir. While working on the DEIS, the ABCWUA requested renewal of a long-term contract for storing up to 50,000 acre-feet. Analysis under Alternative 2 allows comparison of the effects of this proposed San Juan–Chama Project storage.

During the public comment period on the DEIS, Reclamation received several comments suggesting expansion of the geographic scope of analysis to analyze the effect of future exchanges of San Juan-Chama Project water upstream. The modelling approach used to evaluate the San Juan-Chama Project storage provides a reasonable analysis of environmental effects within the scope of this FEIS. Any environmental effects related to San Juan-Chama Project water above Elephant Butte Reservoir or exchanges are out-of-scope for this FEIS. Any environmental effects related to San Juan-Chama water flowing downstream or exchanges upstream are out-of-scope for this FEIS, but will be analyzed when such actions are ripe for analysis. This FEIS analyzes the effects of storage of San Juan-Chama water and the resulting higher water elevations in Elephant Butte Reservoir as a result of ABCWUA's proposed contract.

2.3.10 Store Project Water in Higher Elevation Reservoirs Upstream

An environmental organization requested evaluation of an alternative of storing water in upstream reservoirs that have lower evaporation rates and could offer benefits to riparian and riverine habitats. The Rio Grande Compact (Article IV) requires New Mexico to deliver water to Elephant Butte Reservoir. The Compact contemplates storage of water in upstream reservoirs and actually requires such storage of water in upstream reservoirs to the extent of any accumulated debit in Compact deliveries, consistent with the physical limitations of such reservoirs. Article VII, however, generally prohibits increases in storage in upstream reservoirs constructed after 1929 when there is less than 400,000 acre feet of water stored in Elephant Butte Reservoir. Upstream storage does not meet the purpose and need for action and this would require a Compact amendment. Therefore, this is not analyzed in this FEIS.

2.4 Comparison of Alternatives and Selection of Preferred Alternative

Table 2-1 illustrates the differences among alternatives. The preferred alternative is Alternative 1. It incorporates carryover accounting, the diversion ratio provision, and the storage of San Juan-Chama water in Elephant Butte Reservoir. The preferred alternative is the alternative Reclamation believes would fulfill its statutory mission and responsibilities, considering environmental, technical, economic, and other factors described in Chapters 4 and 5, and best meets the purpose and need for action. See Chapters 4 and 5 for comparisons of effects of the alternatives.

3 Affected Environment

This chapter describes the water resources, biological, cultural, and socioeconomic resources that would be affected by implementation of the alternatives presented in Chapter 2 or whose review is required by law, regulation, or policy.

3.1 Resources Considered

Resources or resource topics analyzed and not analyzed in this FEIS are presented in Table 3-1. The resources considered but not analyzed may not be present in the study area or they may not be relevant to the scope of the Federal action. In other cases, any potential to affect the resource may be negligible or speculative. This determination is based on scoping, input from cooperating agencies, prior NEPA review (Section 1.5), and the experience of interdisciplinary team members.

Table 3-1 Resources and issues analyzed in the FEIS

Resource	Relevance	Agency Determination
Aesthetics	Not included	This resource issue is not relevant to the scope of the action.
Agriculture, Farmlands	Included	Socioeconomic analysis includes economic benefits and impacts related to agriculture, but Farmland Protection Policy Act compliance is not required because of the assumption of a constant cropping pattern and no change in farm numbers or acreage. Contract freeze RGP acreage at 159,650 acres. Furthermore, RGP delivers water to the headings and not individual farms.
Air quality	Not included	There would be no effects to air quality related to the alternatives and no compliance with the Federal Clean Air Act is required.
Biological resources	Included	Aquatic species, vegetation and wetlands, and wildlife and special status species, and invasive species are relevant to the scope of the action and are included in the FEIS.
Climate change	Included	The alternatives would not affect climate change, but climate change would affect other resources and is included in the water resources modelling presented in Chapter 4.
Cultural resources	Included	Historic properties, Indian sacred sites, and resources of tribal concern are relevant to the scope of the action.
Environ-mental justice	Included	This is relevant to the scope of the Federal action based on the presence of minority and low-income communities in the study area per Executive Order 12898.
Geology, soils, paleontology	Not included	There would be no effects on geology and soils related to the alternatives. Although paleontological resources have been found within Elephant Butte Reservoir, there is negligible potential to affect paleontological resources based on the scope of the action.
Indian trust assets	Included	There are no Indian trust assets in the project area; however, Secretarial Order 3335 and Reclamation policy require description of this resource.

Noise	Not included	There are no effects on noise related to the action.
Hydro-power, Energy	Included	CEQ regulations at 40 CFR 1502.16 require consideration of energy requirements of alternatives. Hydropower is relevant due to generation at the Elephant Butte Powerplant.
Recreation	Included	Relevant due to public recreational opportunities provided by RGP reservoirs, state parks, and the river.
Socio-economics	Included	Relevant to the scope of the Federal action due to potential economic benefits and regional economic indicators.
Solid and hazardous waste	Not included	There would be no generation of solid or hazardous wastes related to the action.
Traffic	Not included	There would be no effects on traffic or transportation related to the action.
Water resources	Included	Surface water and groundwater are relevant to the scope of the action.
Water quality	Included	Water quality is relevant to the scope of the action.

3.2 Geographic Scope

Geographic areas of analysis vary by resource or resource issue. For all resources, the geographic area of analysis begins with Elephant Butte Reservoir in the north and extends downstream along the Rio Grande to the El Paso-Hudspeth County line. Reservoirs located upstream of Elephant Butte Reservoir are operated independently of the RGP and any environmental effects related to operations of these reservoirs or the effects of San Juan-Chama water flowing downstream to Elephant Butte Reservoir have either been analyzed in prior NEPA reviews or would be analyzed in the future depending on the alternative selected and when such actions would be ripe for analysis.

The El Paso-Hudspeth County line forms the southern boundary for the analysis because it marks the downstream end of RGP facilities and effects of the alternatives are not measurable beyond this line.

Implementation of the alternatives would not involve constructing new facilities or other actions that are physically different from or that exceed the bounds of historical operations of the RGP. The alternatives would not change the structure of the storage or diversion dams nor change obligations under the Convention of 1906, the Rio Grande Compact, or compliance with various court decrees, settlement agreements, and contracts.

3.2.1 Rio Grande Project

As shown in Fig. 1, the RGP is located in southern New Mexico and western Texas. The constructed features of the RGP are the Elephant Butte and Caballo Dams and Reservoirs, six diversion dams, 139 miles of canals, 457 miles of laterals, 465 miles of drains, and a hydroelectric powerplant. Reclamation and multiple entities own and operate the facilities and distribution infrastructure of the RGP.

As described in Section 1.4.1.2, Reclamation allocates RGP water proportionate to the districts' respective acreages. EBID includes 90,640 acres authorized to receive RGP water in the Rincon and Mesilla Valleys of New Mexico. EPCWID includes 69,010 acres authorized to receive RGP water in the Mesilla and El Paso Valleys of Texas. RGP water allocated to Mexico under the

Convention of 1906 is delivered in the bed of the Rio Grande at the point adjacent to the head works of the Acequia Madre in Cuidad Juárez, Mexico.

The HCCRD, below the RGP boundary in Texas, uses excess flows from the RGP. Under a Warren Act contract between HCCRD and Reclamation, HCCRD has used drainage and wastewater from the RGP since 1925. The contract extends only to the return water; it does not obligate the RGP or Reclamation to deliver specific amounts of water.

3.3 Water Resources

This section summarizes existing water resources, including surface water, groundwater, and water quality. The study area includes Elephant Butte and Caballo Reservoirs, the Rio Grande between the reservoirs, and the Rio Grande below Caballo Reservoir to diversion points to EBID and EPCWID lands, and Mexico.

3.3.1 Regulatory Framework

The legal and regulatory framework governing surface water in the study area is complex. Important authorities and agreements are:

- Reclamation Act of 1902 and the Rio Grande Project Act of 1905
- 1906 Convention between the U.S. and Mexico.
- Rio Grande Compact of 1939
- Public Law 97-140, 95 Stat. 1717, Section 5(c) (authority for storage of San Juan-Chama water in Elephant Butte Reservoir)
- Public Law 102-575, Title XXXIII—Elephant Butte Irrigation District, New Mexico, Section 3301 Transfer (authority for transfer to the two districts title to easements, ditches, laterals, canals, drains, and other rights-of-way)
- Court Order No. CIV-90-95-HB/WWD of 1996 (Court order to keep Caballo Reservoir storage level below 50,000 acre-feet from October 1 to January 21 annually under most conditions)

3.3.2 Data Sources

Water resources data were compiled primarily from Reclamation sources (e.g. Reclamation 2013a; Appendix F).

3.3.3 Elephant Butte and Caballo Reservoirs Storage

Reclamation stores RGP water in Elephant Butte and Caballo Reservoirs. Elephant Butte Reservoir has a capacity of 2,024,586 acre-feet, all of which is conservation storage for later release for authorized project purposes (Reclamation 2008b). Caballo Reservoir has a total capacity of 324,934 acre-feet, which includes 224,934 acre-feet of conservation storage and 100,000 acre-feet of flood control space (Reclamation 2008b). Total conservation storage within the RGP is 2,249,520 acre-feet.

In a typical year, storage in Elephant Butte Reservoir increases in the spring due to snowmelt and decreases during the irrigation season (generally March to October), although its contents can swing dramatically due to variations in runoff from summer monsoons. Storage in Caballo Reservoir generally increases from January through March, decreases from March through April, increases from May through June, decreases from June through October, and increases from October through December (Reclamation 2013a).

3.3.4 Releases and Rio Grande below Caballo Dam

The study area for releases from the dams includes the Rio Grande below Elephant Butte Dam and the Rio Grande below Caballo Dam to the El Paso-Hudspeth County line in Texas. This marks the geographic end of the RGP facilities.

EBID, EPCWID, and USIBWC on behalf of Mexico, place orders with Reclamation for releases from storage to meet their delivery requirements at authorized points of diversion. Orders are placed daily during the irrigation season. If the districts cannot agree on the volume or timing of releases, Reclamation makes the final determination. Reclamation releases water from RGP storage for diversion by Mexico. Reclamation determines the amount and schedule of release for Mexico to meet the delivery schedule set by Mexico at its point of delivery.

Historically, the Rio Grande between the reservoirs and below Caballo Dam dries during the non-irrigation season when no surface water is released. Portions may remain wet due to rain and snowfall, groundwater, or municipal discharges. The annual flow below Caballo Dam was constant from 1960 to 2013 with the exception of a few wet and dry periods. The most significant dry period occurred during the mid-1960s, while the two wettest periods occurred during the mid-1980s and mid-1990s. In a typical year, flow below Caballo Dam is low in January, gradually increases until March, decreases during April and May, peaks in July, and decreases until December.

3.4 Groundwater

In addition to the background information in Chapter 1, this section summarizes existing conditions for groundwater in the Rincon Valley of New Mexico, the Mesilla Valley of New Mexico and Texas, and the El Paso Valley of Texas. The Mesilla Valley extends from Radium Springs, New Mexico, to the El Paso Narrows in El Paso, Texas, near the New Mexico-Texas-Mexico border. El Paso Valley is the low-lying area containing the Rio Grande channel, from south of the El Paso Narrows to near Fabens, Texas.

3.4.1 Regulatory Framework

Groundwater in New Mexico is regulated by the New Mexico Office of the State Engineer (NMOSE). In 1980, NMOSE recognized the Lower Rio Grande Underground Basin and imposed a permit system on well drilling. Before this declaration, there were no restrictions on well drilling in this area. The volume of groundwater that may be pumped under pre-basin groundwater rights[3] is currently being determined through a basin adjudication process by the State of New Mexico.

Groundwater within Texas is managed and regulated by local or regional groundwater conservation districts, if present.[4] The portion of the study area in Texas is governed by the rule of capture and a landowner needs no authorization or permit to pump.

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[3] That is, under water rights established by groundwater use prior to the basin being declared.

[4] No Texas groundwater conservation districts currently exist in the RGP study area (Texas Water Development Board 2016).

3.4.2 Data Sources

Groundwater information was reviewed from Conover (1954), Frenzel (1992), Frenzel and Kaehler (1992), Reclamation (2013a, 2015c), and Stringham et al. (2016). Groundwater data also came from the following sources:

- Groundwater elevation data by the USGS using records extracted for individual groundwater measurement sites from a geo-database compendium (Burley 2010).
- Groundwater recharge data estimated by assessing deep percolation of irrigation water, channel seepage from the Rio Grande and RGP conveyance facilities, and mountain-front and slope-front recharge from surrounding areas. Values have been extracted from the final model input files for the NMOSE and collaborators' groundwater model of the Rincon and Mesilla Basins (SSPA 2007).
- Groundwater pumping for irrigation in the Rincon and Mesilla Basins has been estimated based on the Lower Rio Grande Groundwater Flow Model. While metering of groundwater pumping has occurred since the 1980s and has been required since 2009, comprehensive metering records of groundwater pumping for irrigation in the Rincon and Mesilla Basins are unavailable.

3.4.3 Existing Groundwater Conditions

As described in Chapter 1, adapting to and managing for the impact on the RGP supply caused by groundwater pumping by irrigators in the RGP service area was a purpose of the OA.

3.4.3.1 Aquifers

As described in Section 1.4.2.3.2, the shallow unconfined aquifer systems in the Rincon and Mesilla Valleys are hydraulically connected to the Rio Grande; therefore, groundwater pumping from these aquifers in New Mexico and Texas has the potential to affect RGP supply and deliveries. The unconfined aquifer system in the El Paso Valley is also hydraulically connected to the Rio Grande. However, most of the RGP diversions and return flows occur upstream of the portion of this aquifer system that is affected by groundwater pumping and are not substantially affected by fluctuations in groundwater conditions in the El Paso Valley (Reclamation 2013a; Appendix F).

3.4.3.2 Groundwater Recharge and Demand

Groundwater use and recharge are currently affected by factors including drought, increasing demands, and changing farm irrigation efficiencies (Stringham et al. 2016). In the Lower Rio Grande Underground Water Basin (NMOSE 2015), including the Rincon and Mesilla Valleys of New Mexico, groundwater use has recently been estimated to range from 50,000 to 100,000 AFY in years of full RGP surface water supply and from 200,000 to 300,000 AFY in years of low RGP supply. Groundwater use for supplemental irrigation depends on irrigated acreage, crop distribution, and weather conditions during the growing season in addition to RGP supply (Barroll 2005, Reclamation 2013a). Average seasonal groundwater pumping is greater from March through October than from November to February, which reflects the use of the groundwater for supplemental irrigation. Pumping has varied over time with the volume in years of extremely heavy pumping up to six times that of years with the lowest pumping. Accurate estimates of historical and current groundwater pumping for supplemental irrigation of RGP lands in the Texas portion of the Mesilla Valley and in the El Paso Valley of Texas are not available at this time. Water quality considerations and other factors limit the groundwater use on RGP lands in the El Paso Valley of Texas, which overlies the Hueco Bolson groundwater aquifer.

In general, an increase in RGP allocation and surface water diversions to either district is expected to increase groundwater recharge from canal seepage and deep percolation of irrigation water in that district, along with a corresponding decrease in groundwater demand for supplemental irrigation. Conversely, a decrease in RGP allocation and diversions to either district is expected to decrease groundwater recharge in the district and increase groundwater demand for supplemental irrigation.

Previous analysis in the SEA determined that it was not possible to quantify the total change in groundwater recharge and demand from 2008 to 2012 nor the portion of that total change that would be attributable to the OA. An order of magnitude estimate suggests that incremental changes in groundwater recharge and groundwater demand for supplemental irrigation in the Rincon and Mesilla Valleys during this period were small compared to the total recharge and pumping in the region (Reclamation 2013a; Appendix F).

Groundwater pumping is not an authorized function of the RGP and is not directly a part of RGP operations. However, it is worth noting that groundwater pumping from aquifers hydraulically connected to the Rio Grande, or to the network of canals, laterals, ditches, drains, and wasteways used to convey RGP deliveries and return flows, is likely to affect RGP supplies and deliveries through the interaction of the groundwater and surface water systems. In addition, groundwater demand for supplemental irrigation depends in part on the availability of surface water from the RGP. Previous studies have indicated that seepage from the Rio Grande and deep percolation of irrigation water from RGP lands to the underlying aquifer system are a primary source of groundwater recharge to the shallow unconfined aquifers of the Lower Rio Grande Underground Water Basin (Hanson et al. 2013, Haywood and Yager 2003, SSPA 2007, Stringham et al. 2016).

3.4.3.3 Groundwater Trends

Analysis based on historical measurements of groundwater elevations from monitoring wells in the RGP and surrounding areas of the Rincon and Mesilla Valleys demonstrates widespread and statistically significant negative trends in groundwater elevation from 1980 to the present. Analysis of previous decades suggest that this trend is confined to the past decade, indicating that sustained groundwater pumping in excess of recharge (i.e., groundwater mining) was not prevalent in the RGP or adjacent lands before the current drought (Reclamation 2013a; Appendix F).

Other groundwater trends are:

- Trends in groundwater elevation are predominantly negative, although some wells exhibit neither negative nor positive trends over the same period. Trends in groundwater elevation at each measurement site reflect conditions near that site.
- Full allocations each year in the early 1990s to early 2000s lessened concerns about allocations and no substantial changes in RGP operations, district operations, or groundwater use for supplemental irrigation in the RGP or adjacent areas of the Rincon or Mesilla Valleys occurred between the late 1990s and early 2000s.
- Efforts to increase irrigation efficiency and to reduce distribution losses, including lining and piping portions of the distribution system, may have contributed to recent groundwater declines in some portion of the Mesilla Valley by reducing recharge from deep percolation of irrigation and canal seepage. It is likely that recent groundwater declines are associated with the severe and sustained drought conditions that have affected the RGP since 2003 (Reclamation 2013a, Appendix F).

The analysis presented in the SEA (Reclamation 2013a, Appendix F) indicates a statistically significant positive correlation between groundwater elevation and annual flow below Caballo Dam, as well as the total annual RGP diversions under both wet and dry conditions. These results are intuitively consistent with conjunctive use of surface water and groundwater in the RGP. During periods of high surface water availability, streambed recharge from the Rio Grande to the underlying aquifer increases and groundwater pumping decreases, resulting in higher groundwater elevations. Conversely, during periods of low surface water availability, streambed recharge decreases and pumping increases, resulting in declining groundwater levels. Results suggest a strong connection between surface water and groundwater resources in areas served by the RGP, particularly in the Rincon and Mesilla Basins, as indicated by numerous previous studies (Deb et al. 2012, Reclamation 2013a; Appendix F, Stringham et al. 2016).

3.5 Water Quality

This section summarizes existing water quality between Elephant Butte Reservoir and the Rio Grande at the El Paso-Hudspeth County line.

3.5.1 Regulatory Framework

The legal and regulatory framework for water quality includes:

- Federal Water Pollution Control Act or Clean Water Act (CWA; 33 USC Section 1251 et seq.)
- Public Health Service Act, Safe Drinking Water Act (Title XIV of the Public Health Service Act; Public Law 107-377)
- New Mexico Administrative Code 20.6.4
- Texas Administrative Code Title 30, Chapter 307

Under the CWA, water quality is managed by the New Mexico Environment Department (NMED) and Texas Commission on Environmental Quality (TCEQ). These state agencies have developed water quality standards based on designated uses for which the body of water is suitable. Both state agencies divide the Rio Grande into water quality segments for which standards must be met.

3.5.2 Data Sources

Water quality data are from Hogan (2013), New Mexico Environment Department (NMED 2016), Reclamation (2013a; SEA Appendix H), Texas Commission on Environmental Quality (TCEQ 2016), and the U.S. Environmental Protection Agency (EPA 2015a, b).

3.5.3 Existing Reservoir Water Quality Conditions

The NMED Surface Water Quality Bureau (2016:175-176) reports that water quality in Elephant Butte Reservoir (HUC 13020211) has improved recently and the reservoir has been taken off the state's impaired list, but there is still a fish consumption advisory due to mercury in fish tissue. Caballo Reservoir (HUC: 13030101) is impaired due to mercury in fish tissue and high levels of nutrients. Fish consumption advisories are in place (NMED 2016:176).

3.5.4 Existing Rio Grande Water Quality

The Rio Grande between Elephant Butte and Caballo Reservoirs has historically been impaired by low dissolved oxygen levels and excessive nutrients, but in 2016, no impairments were found (NMED 2016:177-178). However, the state plans to reassess the dissolved oxygen levels. The

NMED (2016:178) has listed the Rio Grande in the HUC: 13030102, El Paso-Las Cruces reach, as impaired due to exceedances of the *E. coli* criterion.

The TCEQ (2016) lists the Rio Grande River (Basin 23; AUID 2312-2) as impaired for aquatic life from the Texas-New Mexico border to International Dam due to depressed dissolved oxygen levels and a toxic substance (methylene chloride) in sediment. For general uses, total dissolved solids and nutrients exceed standards. In addition, groundwater quality may be a concern within the districts' service areas.

The Rio Grande is impaired for primary contact recreational use from Percha Dam to the Texas boundary due to exceedance of the *E. coli* bacteria standard. The Rio Grande downstream of the New Mexico border is impaired due to excessive *E. coli* and high salinity or total dissolved solids. At El Paso, the average total dissolved solids is about 750 mg/L, and at Fort Quitman it commonly is in excess of 2,000 mg/L and up to an average of 3,200 mg/L during the irrigation season (Hogan 2013, Phillips et al. 2003, Stringham et al. 2016). Total dissolved solids are typically elevated in the winter when flows are lower and are reduced in the summer when higher flows dilute concentrations (Michelsen et al. 2009).

3.6 Vegetation Communities, Wetlands and Special Status Plant Species

This section describes vegetation communities including wetlands and special status plant species within the Elephant Butte and Caballo Reservoir pools and along riverbanks between the reservoirs and down to the El Paso-Hudspeth County line. "Special-status species" includes species given varying levels of protection with the highest level of protection given to species listed or proposed for listing as endangered or threatened under the ESA.

3.6.1 Regulatory Framework

A number of laws, regulations, and policies apply to vegetation communities and plant species. These include:

- ESA
- CWA Section 404
- Executive Order 11990, Protection of Wetlands
- New Mexico Energy, Minerals, and Natural Resources Department (NMEMNRD) Forestry Division (NMEMNRD 2015) Section 75-6-1 NMSA 1978
- Texas Parks and Wildlife Department Code Chapter 88 and Sections 69.01 through 69.9 of the Texas Administrative Code

3.6.2 Data Sources

Data sources for vegetation in the study area include the U.S. Geological Survey's (USGS) Southwest Regional Gap Analysis (USGS 2011), the New Mexico Rare Plant Technical Council (NMRPTC 2015), New Mexico State Parks' (NMSP) management plans (NMSP 2000, 2006), endangered plant information from the New Mexico Energy, Minerals, and Natural Resources Forestry Division (NMEMNRD 2015), and the Service's National Wetland Inventory, and publications such as Muldavin et al. (2000).

Field surveys and aerial photography conducted by Reclamation (2003a, 2012b), USIBWC (various), and others (e.g. Sogge et al. 1997) to document habitat for the endangered Southwestern willow flycatcher (*Empidonax traillii extimus*, flycatcher) also provide data about vegetation communities in the five county biological resources study area.

3.6.3 Existing Vegetation Conditions

The study area is in the Chihauhuan Desert on the ecotone[5] between Desert Scrub and Desert Grassland (Brown 1982, Dick-Peddie 1993). Riparian-wetland vegetation borders the study area along the shoreline of the reservoirs and the floodplain of the Rio Grande. Within the study area, the location and distribution of individual plant species depends on the soil, elevation, degree of slope, and proximity to water, etc.

The Southwest Regional Gap Analysis Project (USGS 2011) provides land cover data for the study area, classified according to the National Vegetation Classification System. Following this system, vegetation within the full-pool footprint of Elephant Butte Reservoir and its delta include the following:

- Western Great Plains Riparian Woodland and Shrubland
- North American Arid West Emergent Marsh
- North American Warm Desert Playa
- North American Warm Desert Wash
- North American Warm Desert Riparian Woodland and Shrubland

Since 1995, Elephant Butte Reservoir has receded more than 24 miles downstream, exposing thousands of acres of bare soil (Fig. 3). This area is dominated by Goodding's willow (*Salix gooddingii*), interspersed with broadleaf cattails (*Typha latifolia* L.), and marsh grasses (Muldavin et al. 2000). To the east, opposite the Low Flow Conveyance Channel outfall, dense monotypic stands of nonnative tamarisk or saltcedar (*Tamarix* spp.) are dominant (Reclamation 2012a).

Scant riparian development exists along the floodplain of the Rio Grande between Elephant Butte and Caballo Reservoirs. Vegetation in this reach is typically limited to a narrow band of tamarisk with a few overstory cottonwoods (*Populus fremontii*) (Reclamation 2012a).

Where the Rio Grande broadens into the upper delta of Caballo Reservoir, several patches of tamarisk and overstory cottonwoods and a variety of herbaceous and grass species persist (Reclamation 2012a). The broadening of the floodplain and Caballo Reservoir account for the relatively high water table that supports this vegetation.

Little vegetation is found in and around Caballo Reservoir due to annual mowing and management (Reclamation 2012a). However, a 40-acre parcel has been fenced to exclude livestock. This parcel, known as the Las Palomas site, supports a mosaic of native riparian and wetland vegetation that provides wildlife habitat. Downstream of the Las Palomas site, several large patches of native willows (*Salix* spp.) have developed in the bottom of the reservoir pool. Several of these patches are comparable to the high-quality wildlife habitat in the Elephant Butte Reservoir and consist of young to middle-aged coyote willow (*Salix exigua*) and Goodding's willow. These patches are classified as North American Arid West Emergent Marsh, North American Warm Desert Playa, and North American Warm Desert Riparian Woodland and Shrubland.

[5] A transitional area between two biological communities

Downstream of Percha Dam (2.0 miles below Caballo Dam) to the American Dam at El Paso, the affected environment is the floodway managed by the USIBWC. The floodway ranges in width from approximately 50 to 2,100 feet for over 100 miles. In most of the floodway there is little to no vegetation, but portions of it are described by USIBWC (2003, 2009b) as a combination of farmland and North American Arid West Emergent Marsh and North American Warm Desert Riparian Woodland and Shrubland.

Through the years, the USIBWC has managed vegetation to reduce erosion potential, remove potential obstructions that could reduce flood containment capacity, help stabilize stream banks, control weeds and brush including saltcedar, and provide wildlife habitat at suitable locations. The USIBWC's Record of Decision for River Management Alternatives for the Rio Grande Canalization Project (USIBWC 2009a) calls for enhancing native vegetation within the floodway by reducing mowing and revegetation.

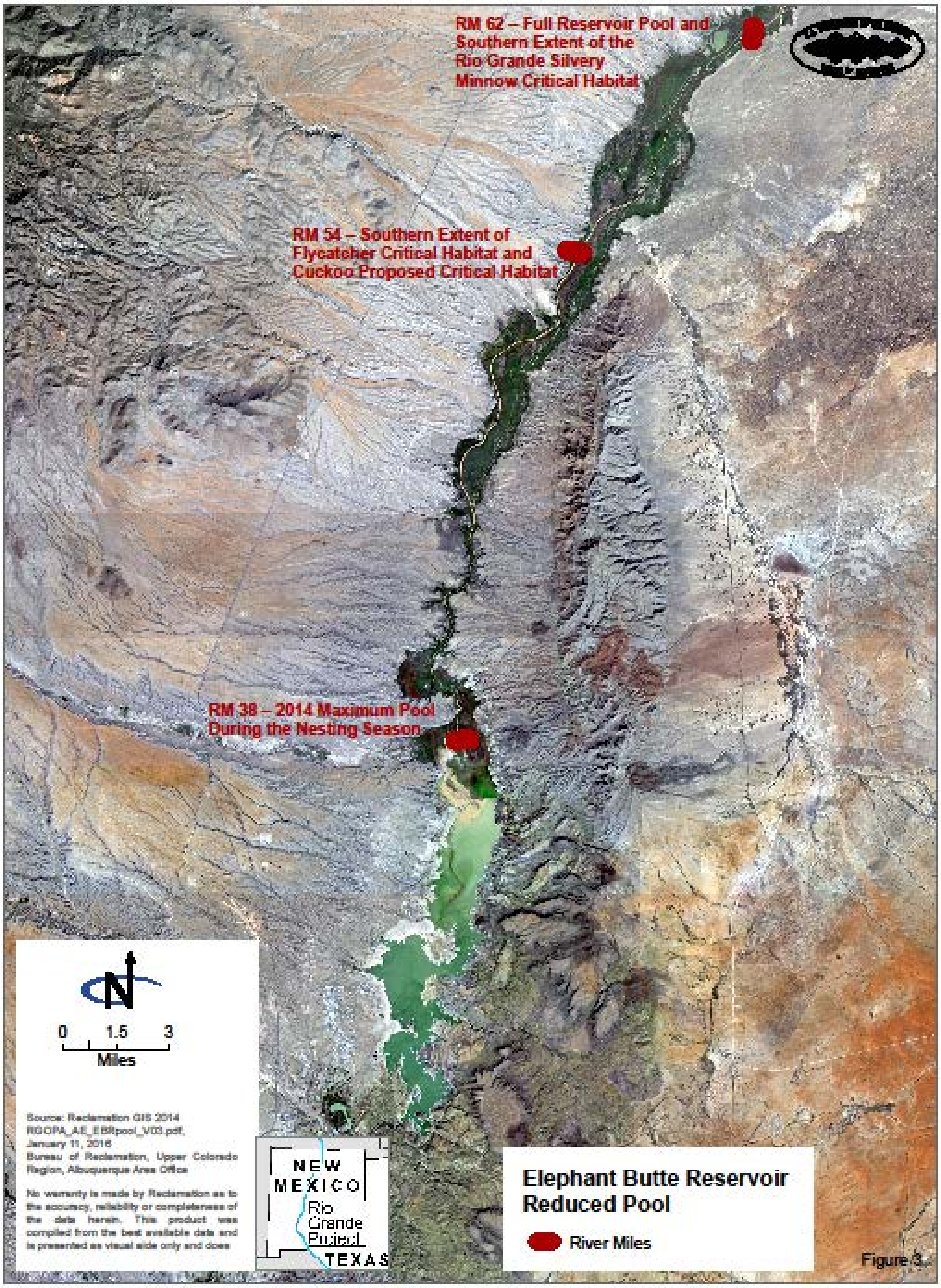
3.6.4 Vegetation Trends

The recession of Elephant Butte Reservoir over the last decade has allowed the development of a mosaic of native and nonnative vegetation (Fig. 3, Reclamation 2012a). Downstream, at the sediment delta of Caballo Reservoir, several patches of tamarisk and overstory cottonwoods and a variety of herbaceous and grass species have grown, including the densely vegetated Las Palomas site referenced in Section 3.6.3 (Reclamation 2012a). These vegetated patches within the full pool footprint of both reservoirs are dynamic due to both natural succession and to changes brought about by fluctuating reservoir levels.

While defoliation of tamarisk due to the tamarisk leaf beetle (*Diorhadba* spp.), has yet to occur in the study area, it is likely that individual trees and patches of dense, monotypic tamarisk will become defoliated as the beetle expands over time.

Below Caballo Reservoir, there is minimal native vegetation along the Rio Grande. The river is channelized to accommodate agricultural and urban land uses, but additional acres adjacent to the river has recently been allocated for riparian restoration and managed grasslands. Approximately 350 additional acres may be designated as no-mow zones in future years to accommodate new conditions, such as increased flycatcher habitat buffer areas or new restoration sites (USIBWC 2014b).

Figure 3. Elephant Butte Reservoir reduced pool, 2014



3.6.5 Special Status Plant Species

There are 13 Federal- or state-listed special status plant species in the five counties in the biological resources study area, but based on habitat requirements and soil associations, only the Pecos sunflower (*Helianthus paradoxus*) and Wright's marsh thistle (*Cirsium wrightii*) have any potential to occur in the study area. To date, no occurrences of either species have been reported. These species are discussed in more detail below.

3.6.5.1 Pecos sunflower (Helianthus paradoxus)

The Pecos sunflower is a wetland species that requires saturated saline soils of desert wetlands. It is usually associated with desert springs (cienegas) or the wetlands created from modifying desert springs at 3,300 to 6,600 feet of elevation. Some activities that degrade or destroy wetlands and therefore threaten Pecos sunflower are channel incision that reduces water tables, groundwater depletion, water diversions, filling, and saltcedar invasion. Livestock will eat Pecos sunflower, especially the flower heads, when other green forage is scarce. Disturbance may facilitate hybridization (NMRPTC 2015).

3.6.5.2 Wright's marsh thistle (Cirsium wrightii)

Wright's marsh thistle grows in wet, alkaline soils in spring seeps and marshy edges of streams and ponds at elevations of 3,450 to 8,500 feet. Desert springs (cienegas) are susceptible to drying up or being diverted. Populations in the City of Roswell, Chavez County, at Lake Valley, Sierra County, and at the San Bernardino Cienega in Arizona appear to be extirpated. Introducing insects as biological control for weedy thistles may pose a grave hazard for non-weedy thistle species. The effects of fire and livestock grazing on this species have not been studied (NMRPTC 2015).

3.7 Wildlife and Special Status Wildlife Species

This section summarizes existing conditions for terrestrial wildlife and special status wildlife species, including consideration of birds, mammals, reptiles, amphibians, arthropods, and gastropods. For this FEIS, special status species are those protected by the laws listed below.

3.7.1 Regulatory Framework

The primary laws protecting wildlife are:

- ESA
- Bald and Golden Eagle Protection Act (16 USC, Sections 668-668d)
- Migratory Bird Treaty Act of 1918 (16 USC, Sections 703-712), as amended
- New Mexico Wildlife Conservation Act (17-2-40.1 NMSA 1978)
- Texas Parks and Wildlife Department Code, Chapters 67 and 68, and Texas Administrative Code, Sections 65.171-65.176, of Title 31

3.7.2 Data Sources

Data sources for wildlife in the study area are based on descriptions of the vegetation communities in Section 3.6, plus data provided by the Service on special status species in the five counties: Doña Ana, Sierra, and Socorro Counties, New Mexico, and El Paso and Hudspeth Counties, Texas. Wildlife data from New Mexico State Parks' (NMSP) management plans (2000, 2006) are incorporated by reference. Reclamation also reviewed the Service's online Critical Habitat Portal (Service 2014a) and *Federal Register* notices for designated critical habitat for special status species. The New Mexico Department of Game and Fish's (NMDGF) online database, the Biota Information System of New Mexico, was reviewed for Federal and state threatened, endangered, and species of concern (NMDGF 2015a). Also, reviewed were data from the New Mexico natural heritage program sensitive species by county database (NMDGF 2015a) and the Texas natural diversity database and rare, threatened, and endangered species of Texas by county database maintained by Texas Parks and Wildlife Division (TPW 2016).

The New Mexico Ornithological Society has an online database of bird sightings throughout the state (New Mexico Ornithological Society 2015), and there are several available lists showing documented bird species for these counties that were reviewed. Publications of the Service listing species, designating critical habitat, recovery or management plans, and biological opinions were reviewed and data from these publications are incorporated by reference (e.g. Service various).

3.7.3 Existing Wildlife Conditions

This section provides a general overview of the wildlife and bird species and their habitats that could be in the study area, with an emphasis on special status species. As with vegetation, the potentially affected habitat focused on potential inundation areas associated with reservoir pools and the effects of the frequency, timing, and extremes in reservoir elevation changes over the long term.

The vegetation in and around the two reservoirs and along the floodplain of the Rio Grande provides habitat for a diversity of wildlife species (USIBWC 2001; Reclamation 2002, 2003b). Common wildlife at both Elephant Butte and Caballo Reservoirs are mule deer, coyote, rabbits, pocket gopher, ground squirrel, chipmunk, raccoon (NMSP 2000, 2006). NMSP (2000, 2006) has documented more than 250 species of birds in and around the reservoirs, with common species including woodpecker, egret, killdeer, quail, great blue heron, and shorebirds.

The reservoirs and shorelines support many species of reptiles, amphibians, and invertebrates. Among the invertebrates, currently no tamarisk leaf beetles (*Diorhadba* spp.) have been documented in the study area, but the beetle has been dispersing in Texas and New Mexico since at least 2010. *Diorhabda* has been known to defoliate over 90 percent of tamarisk at some sites, with possible tamarisk mortality after 3-5 years of repeated defoliation. The defoliation of tamarisk could affect the use of the study area by birds including the endangered flycatcher, as described below.

Downstream of Caballo Reservoir, typical wildlife includes the black-tailed jackrabbit, desert cottontail, cotton rat, ground squirrel, mourning dove, meadowlark, kestrel, red-tail hawk, skunk, burrowing owl, several species of waterfowl, other migratory birds, and non-game animals (USIBWC 2007, 2014a).

Riparian areas constitute less than one percent of the land area in the arid Southwest, yet provide habitat to a greater number of wildlife species than any other ecological community in the region. These areas are also critical corridors for migratory species, especially migratory birds. When analyzing the river portion of the study area from Caballo Reservoir to El Paso, USIBWC assessed the quality of wildlife habitat in the area as below average to poor (USIBWC 2003).

Some riverine wetlands in the river channel offer high-quality habitat, but these are small and far apart. Wildlife habitat along the river, from the Elephant Butte Dam to El Paso, has been impacted by agricultural and urban development. In general, the remaining high-value wildlife habitat is associated with the Elephant Butte and Caballo Reservoirs and a riparian strip next to the Rio Grande. The dynamic nature of flooding and drying at the upper portions of the Elephant Butte Reservoir has allowed large areas of riparian vegetation to establish itself, which provides important wildlife habitat. Smaller patches of similar vegetation have developed on the drought-exposed bed of Caballo Reservoir.

3.7.4 Special Status Wildlife Species

The endangered flycatcher and the threatened Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*; cuckoo) are seasonally present within the study area/action area. Reclamation also considered potential for the endangered New Mexico meadow jumping mouse (*Zapus hudsonius luteus*; mouse), the endangered Interior least tern (*Sterna antillarum*), and the threatened piping plover (*Charadruis melodus*; plover) in the action area. For the mouse (see Section 3.7.4.3), the Service (2014c, 2013c) indicates it could be present in Socorro County, New Mexico, but surveys for the species, as well as examination of its potential habitat based on vegetation communities, indicate this species is not present in the action area. While migrating individual Interior least tern and plover could occur during transitory stopover periods, no habitat for these species has been found along the riverine portion of the action area.

3.7.4.1 Southwestern Willow Flycatcher

The flycatcher is a small perching bird (order Passeriformes), about six inches long, with a life span of generally one to three years; some live four to seven years (Langridge and Sogge 1997, Netter et al. 1998, Paxton et al. 1997). They winter in neotropical areas of southern Mexico and Central America and begin to arrive at New Mexico breeding sites in early May. Flycatcher habitat along the Rio Grande has two primary functions: habitat for breeding and feeding during the breeding season and stopover habitat while migrating.

The flycatcher was originally listed as endangered due to loss of habitat, brood parasitism, and lack of adequate protective regulations (Service 1995). The greatest ongoing threats to flycatchers in the Rio Grande are the decline in the quality of critical nesting habitat related to drought and loss of dense riparian vegetation, invasion of the saltcedar leaf beetle (*Diorhabda* spp.), and nest predation by brown-headed cowbird (*Molothrus ater*).

The Service published the final rule designating critical habitat for the flycatcher in 2013 and included about 14.4 kilometers (9.0 miles) of the upper part of Elephant Butte Reservoir in the Middle Rio Grande Management Unit (Service 2013a:380).

Regarding the sediment delta at the north of Elephant Butte Reservoir, the Service reported that:

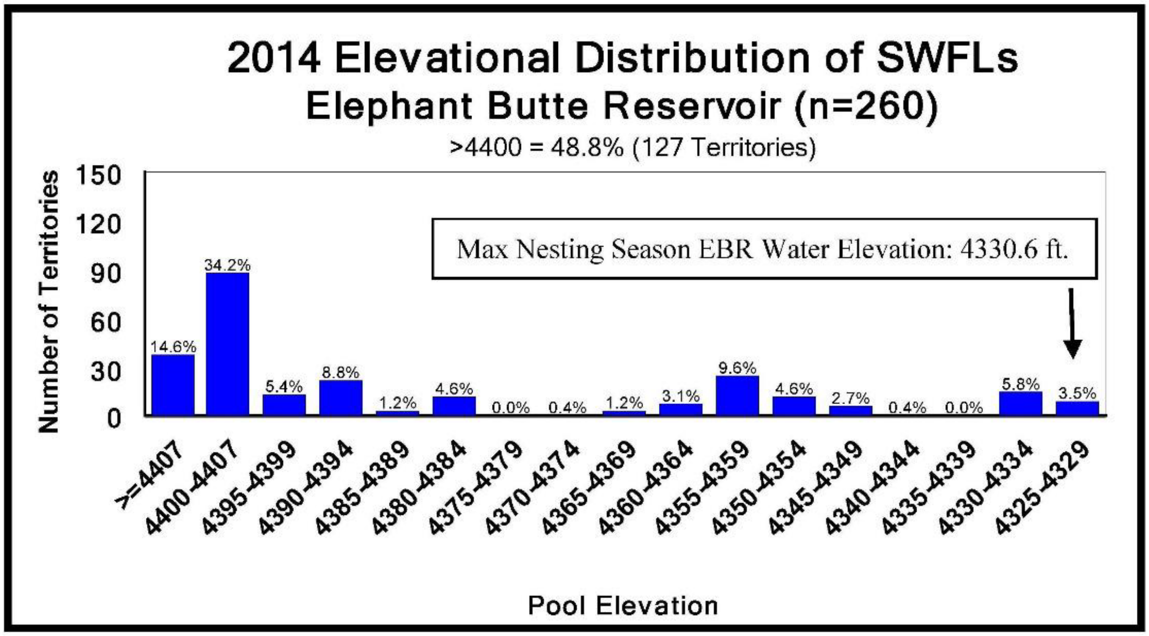
> "Over time, as the lake at Elephant Butte has declined, there has been an increase of willows and other trees in the delta of Elephant Butte Reservoir, and also an increase in flycatcher territories within the reservoir pool and north of the reservoir pool where the habitat is supported by the low-flow conveyance channel. The area within and north of Elephant Butte Reservoir supports the largest known population of flycatchers in the range of the subspecies." [Service 2013a:365]

The final rule also found that the southerly margin of Elephant Butte Reservoir contains some elements of flycatcher habitat (Service 2013a:380). However, the Service determined that this southern segment in the active conservation pool of the Elephant Butte Reservoir is not necessary for the conservation of flycatcher and it was not designated as critical habitat (Service 2013a:349).

3.7.4.1.1 Presence

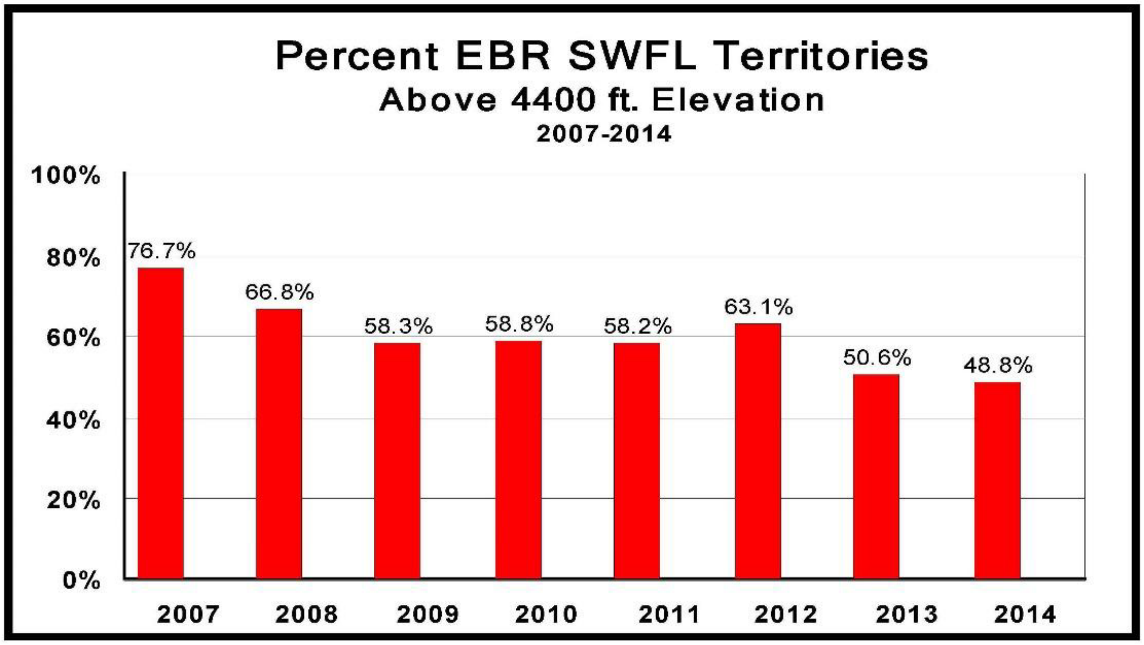
The upper or northern part of Elephant Butte Reservoir is located in the Service's Middle Rio Grande Management Unit. Patches of vegetation at the northernmost extent within the historic reservoir (considered south of River Mile 62) became suitable for flycatchers in the mid-1990s. Flycatcher habitat is dynamic system, with the birds requiring dense patches of vegetation with tall trees. High-quality flycatcher habitat within the reservoir that has developed is a result of more recent reservoir recession that continues to improve and is providing new habitat for nesting and migrant flycatchers (Reclamation 2015a).

Figure 4. Elevational distribution of Southwestern Willow Flycatcher territories within Elephant Butte Reservoir, 2014, with maximum water levels.



Source: Reclamation (2015d).

Figure 5. Percentage of Southwestern Willow Flycatcher territories above the high pool of Elephant Butte Reservoir, 2007-2014.



Source: Reclamation (2015d).

During the 2014 surveys, 598 resident flycatchers were documented throughout the Middle Rio Grande Management Unit, which included resident birds forming 234 pairs and establishing 364 territories (Reclamation 2015a). Consistent with previous years, the San Marcial reach was the most productive, with 307 territories and 205 pairs. The 2014 surveys showed a second consecutive year of increased territory numbers after a large drop in 2012. The 2014 monitoring included nesting success rates, productivity, and brown-headed cowbird (*Molothrus ater*) parasitism. The San Marcial reach was again most productive, with 255 nests and 151 flycatcher fledglings. Overall, nesting success for all of the Middle Rio Grande Management Unit was the lowest observed in the past 16 years of monitoring, with most failures due to depredation (Reclamation 2015a).

Figure 4 presents the distribution of flycatchers by elevation in Elephant Butte Reservoir during 2014. Because the elevation of the full reservoir is approximately 4,400 feet, the reservoir is important in providing flycatcher habitat**.** Figure 5 shows the percent of flycatcher territories above the high reservoir pool from 2007 to 2014.

3.7.4.2 Yellow-Billed Cuckoo

Cuckoos are insect specialists but also prey on small vertebrates, such as tree frogs and lizards; they are also known to be nest parasites of other bird species, including flycatchers. In the arid west, cuckoos are usually found in cottonwood-willow riparian associations along watercourses. The cuckoo requires large tracts of willow-cottonwood or mesquite (*Prosopis* spp.) forest or woodland for its nesting season habitat. Hydrologic conditions at cuckoo breeding sites can vary between years. This year-to-year change in hydrology can affect food availability and habitat suitability for cuckoos. Extended inundation reduces habitat suitability because the larvae of sphinx moths pupate, and the eggs of katydids are laid underground; prolonged flooding kills the larvae and eggs (Service 2014b), thus removing important food sources.

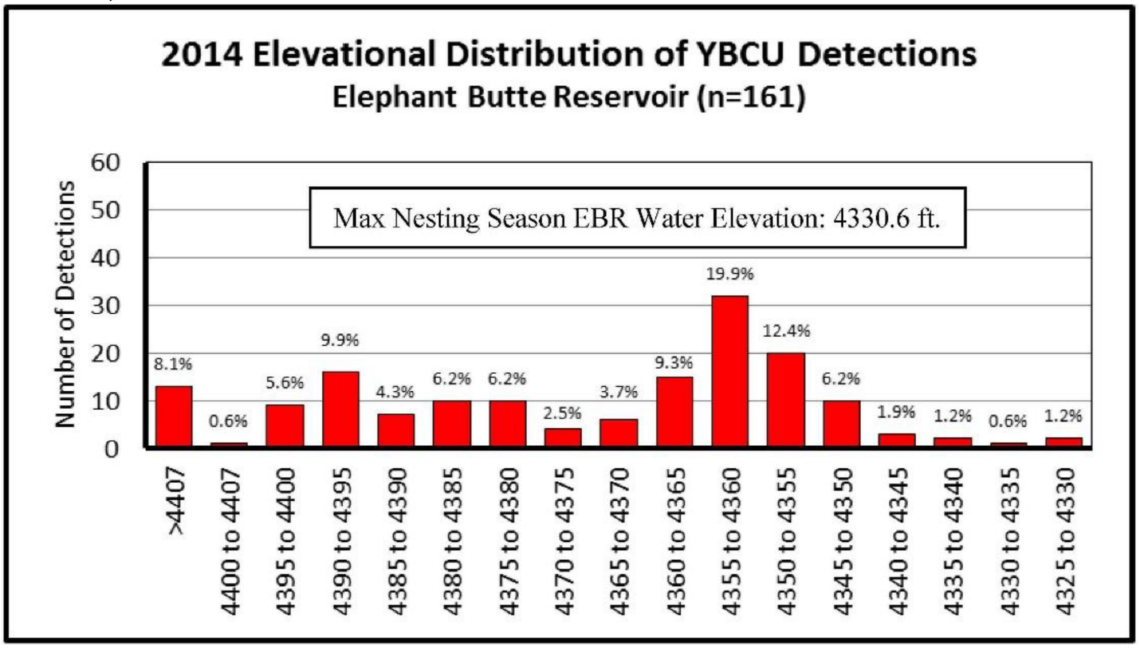
The cuckoo was listed as threatened due to the "habitat loss associated with [man-made] features that alter watercourse hydrology so that the natural processes that sustained riparian habitat in western North America are greatly diminished" (Service 2013b:59992). In addition to habitat loss, reduction of prey insect abundance due to the use of pesticides has been identified as a major threat to the cuckoo (Service 2014e).

In 2014, the Service proposed designating critical habitat for the cuckoo, which included the Middle Rio Grande Unit NM-8 (Service 2014b). It is 61,959 acres in extent and is an approximately 170-mile-long continuous segment of the Rio Grande, from the Elephant Butte Reservoir in Sierra County at approximately River Mile 54, upstream through Socorro, Valencia, and Bernalillo Counties to below Cochiti Dam in Cochiti Pueblo in Sandoval County, New Mexico. This unit is consistently occupied by a large number of breeding cuckoos and currently is the largest breeding group of the species north of Mexico. The site also provides a movement corridor for cuckoos moving farther north. Tamarisk, a nonnative species that reduces habitat quality for cuckoos, is a major component of habitat in this unit. The Service has not yet finalized critical habitat designation for the species, including identifying actual boundaries at Elephant Butte Reservoir.

3.7.4.2.1 Presence

In Reclamation's 2013 survey of cuckoos from State Highway 60 downstream to the Elephant Butte Reservoir, the San Marcial Reach (River Mile 68.5 to 38.5) had the most cuckoo habitat of any of surveyed reaches (Reclamation 2014b). In 2013, the exposed pool of the Elephant Butte Reservoir constituted 86 percent of all cuckoo detections and 86 percent of all territories found within the San Marcial Reach. This subset of San Marcial also contained 48 percent of all cuckoo detections and 50 percent of all territories found in the entire Middle Rio Grande study area. The biological assessment (Reclamation 2015d) includes more information on the cuckoo and its distribution in the study area. The distribution of cuckoos by elevation in Elephant Butte Reservoir during the 2014 surveys is provided in Fig. 6.

Figure 6. Elevational distribution of Yellow-billed Cuckoo detections within Elephant Butte Reservoir, 2014.



Source: Reclamation (2015d).

3.7.4.3 New Mexico Meadow Jumping Mouse

There have been relatively few studies of this endangered mouse and its natural life history. The mouse is unique in that it hibernates about eight to nine months out of the year, longer than most mammals, and it is active for only three to four months during the summer. Within this short time frame, it must breed, give birth, raise young, and store up sufficient fat reserves to survive the next year's hibernation period. As a result, if resources are not available in a single season, populations may be greatly impacted. In addition, New Mexico meadow jumping mice live three years or less and have one small litter annually, with seven or fewer young, so the species has limited capacity for high population growth rates due to this low fecundity.

According to the Service (2013c), the New Mexico meadow jumping mouse has specialized habitat requirements in that it appears to only utilize two riparian community types: 1) persistent emergent herbaceous wetlands (beaked sedge and reed canarygrass); and 2) scrub-shrub wetlands found in riparian areas along perennial streams that are composed of willows and alders. It especially uses microhabitats or patches or stringers of tall dense sedges on moist soil along the edge of permanent water. Habitat requirements are characterized by tall (averaging at least 24 inches) dense herbaceous riparian vegetation, composed primarily of sedges and forbs. This suitable habitat is found only when wetland vegetation achieves full growth potential associated with perennial flowing water

The mouse was originally listed as endangered due to the "present or threatened destruction, modification, or curtailment of its habitat or range; the inadequacy of existing regulatory mechanisms; and the natural and manmade factors affecting its continued existence" (Service 2014c:33120). In addition, isolated populations make natural recolonization of impacted areas highly unlikely or impossible in most areas (Service 2014c). Because the species occurs only in areas that are water saturated, populations have a high potential for extirpation when habitat dries due to ground and surface water depletion, draining of wetlands, or drought.

In April 2014, the Service reopened comment on proposed designated critical habitat for the mouse along the Rio Grande Valley (Service 2014d). Areas proposed for critical habitat for the mouse in this unit incorporate the Bosque del Apache National Wildlife Refuge, which is the only habitat believed to be occupied by the subspecies in the Middle Rio Grande with the capability to support its breeding and reproduction. Final designation of critical habitat has not yet occurred.

3.7.4.3.1 Presence

Based on work conducted in support of delta channel maintenance (Reclamation 2013c), the New Mexico meadow jumping mouse is not expected to occur in the study area. Frey and Kopp (2014) completed a preliminary assessment of mouse habitat down to River Mile 38 using GIS-based vegetation mapping and field evaluations of irrigation drains and the Low Flow Conveyance Channel. Mapping did identify potentially suitable habitat (herbaceous and regenerating willow) next to the Low Flow Conveyance Channel. Because of the quality of available data, this was a conservative effort that overestimated the amount of habitat. Further assessment and surveys have not found potentially suitable mouse habitat (Frey and Kopp 2014).

3.8 Aquatic Resources and Special Status Fish Species

This section summarizes existing conditions for aquatic habitats, the fish community, and special status fish species in this potentially affected environment. The area of analysis includes the full-pool of Elephant Butte and Caballo Reservoirs, the Rio Grande between the reservoirs, and the Rio Grande downstream of Caballo Dam to diversion facilities for the irrigation districts and the American Diversion Dam. Hydrological modeling simulates reservoir filling and drying affecting aquatic habitats along the Elephant Butte Reservoir delta reach, from River Mile 62 to River Miles 38 to 36, and the Elephant Butte and Caballo Reservoirs. Such habitat changes can affect the numbers and life stage of fish.

3.8.1 Regulatory Framework

The same laws applicable to wildlife apply to aquatic species.

3.8.2 Data Sources

No original aquatic resource or fish data were collected for the FEIS. Data used to describe existing conditions for aquatic resources and special status fish species in the study/action area include Reclamation sampling surveys for the endangered Rio Grande silvery minnow and habitat, including maps. Additional data were derived from NMDGF reports on sport and game fish species (NMDGF 2015b). Aquatic resource conditions are described through 2014, which marked the baseline for consultation with the Service.

3.8.3 Existing Fisheries Conditions

Beyond the irrigation season, except for relatively limited durations of stormflow input from the watershed, the Rio Grande channel between the reservoirs and downstream of Caballo Dam has long periods of low to no flows. The reaches of the Rio Grande below the reservoirs do not develop a sustainable or transient fishery or aquatic community, precluding needs for aquatic life assessment. Consequently, fisheries and other aquatic life resources of concern included in this assessment are limited to those in the delta reach inflows through the full-pool footprints and within the changing wetted perimeters of the two reservoirs.

3.8.3.1 *Elephant Butte Reservoir Headwaters*

With the drawdown of the water surface elevation since 1995, more than 24 miles of channel formed through the delta reach at Elephant Butte Reservoir, from River Mile 62 to River Miles 38 to 36. Reclamation surveyed fish populations in this channel from 2010 through 2012 (Table 3-2). In 2010, minnows were the most abundant fish collected from this temporary delta channel. They were captured in a variety of habitat types at the four survey sites selected, based on accessibility between River Miles 45.8 and 51.3.

Table 3-2 Fish species collected during September sampling in the temporary channel in Elephant Butte Reservoir, 2010-2012

Species	2010		2011		2012	
	No.	Number per 100 m^2	No.	Number per 100 m^2	No.	Number per 100 m^2
Rio Grande silvery minnow	233	24.07	65	2.83	0	0
Red shiner	78	6.68	219	9.53	1044	29.74
Western mosquitofish	41	3.70	26	1.13	1287	36.66
Channel catfish	24	1.93	55	2.39	11	0.31
Flathead chub	2	0.30	3	0.13	2	0.06
Threadfin shad	1	0.09	0	0	0	0
Yellow bullhead	1	0.08	0	0	0	0
River carpsucker	0	0	7	0.30	0	0
Common carp	0	0	0	0	2	0.06
Logperch	0	0	0	0	2	0.06
Fathead minnow	0	0	0	0	1	0.03

Source: Reclamation 2013a; Key m^2 = square meters

In 2011, silvery minnow was the second most abundant fish collected; however, overall fish densities were much lower than those observed in 2010. In October 2012, Reclamation sampled four sites from River Miles 46 to 52 and captured seven fish species. No silvery minnows were captured during any of the 2012 field season. Sampling at two sites produced no fish and there were no dry sites. Western mosquitofish were the most abundant, followed by red shiners. Red shiners were distributed evenly across the sites and mosquitofish were slightly more abundant at the downstream sites.

3.8.3.2 *Elephant Butte Reservoir*

Elephant Butte Reservoir is New Mexico’s largest lake and most popular state park for recreation. The fish community is monitored annually, in the spring and fall. The most recent available spring fish electroshocking survey reports provide information for the years 2007 through 2010 and fall experimental gill net surveys for 2007 to 2011 (NNDGF 2012). Ten fish species were reported in these surveys, as follows:

- Smallmouth bass (*Micropterus dolomieu*)
- Largemouth bass (*M. salmoides*)
- Bluegill (*Lepomis macrochirus*)
- Longear sunfish (*Lepomis megalotis*)
- Green sunfish (*L. cyanellus*)
- White crappie (*Pomoxis annularis*)

- Black crappie (*P. nigromaculatus*)
- White bass (*Morone chrysops*)
- Striped bass (*M. saxatilis*)
- Walleye (*Sander vitreus*)

Although based on a relatively small sample size, the collection data for smallmouth bass indicated a relative imbalance, dominated by older, larger fish (NNDGF 2012). The condition was most likely the result of "poor habitat, due to fluctuating water levels during the spring spawn, poor spawning substrate, water clarity, and inadequate forage fish" (NMDGF 2012). In contrast, collection data for largemouth bass indicated that their population had shifted to larger, healthier fish until 2010, when this trend reversed. It appeared that natural recruitment was very low (NMDGF 2012).

Capture rates for other centrarchids (white bass, crappie, sunfish, striped bass, and walleye) were low. Catch data for populations for these fish was inconsistent between years, most likely due to sample bias, inappropriate habitat in the survey sites, and relatively low densities of many of these fish. Overall, Reclamation concluded that habitat quality undoubtedly restricted the abundance of centrarchids at Elephant Butte Reservoir, with the lack of suitable spawning habitat and escape cover attributable to the age of the lake and water use practices (NMDGF 2012).

The fall gill net surveys, conducted during November from 2007 to 2011, found the number of fish captured remained stable (NMDGF 2012). However, gizzard shad, normally the most commonly captured and abundant forage fish, showed a substantial population decrease through the survey period, and with an increase in size, makes the population potentially less available as forage. Blue catfish became the most abundant fish in the reservoir based on percent captured data, with their abundance more than doubling from 2009 to 2011. The relative abundance of both striped bass and white bass declined appreciably throughout the survey period.

Table 3-3 Fish in Elephant Butte Reservoir, 2014

Name	Number	% Caught	% Biomass
Blue catfish	597	52.09	27.08
Gizzard shad	207	18.06	9.38
Smallmouth buffalo	98	8.55	42.05
Channel catfish	48	4.19	1.26
Common carp	29	2.53	6.01
Walleye	23	2.01	4.95
White bass	18	12.04	7.34
Striped bass	1	0.09	1.71
Largemouth bass	1	0.09	0.18
Freshwater drum	1	0.09	0.03
Longear sunfish	1	0.09	0.01
Bluegill	1	0.09	0.01
Threadfin shad	1	0.09	0.01

Source: Mammoser (2015).

Table 3-3 provides data from the 2014 fall fish community gill net survey in Elephant Butte Reservoir. Blue catfish, gizzard shad, white bass, smallmouth buffalo, channel catfish, common carp, and walleye comprised most of the surveyed fish community; all other species accounted for less than 2 percent of the fish caught (Mammoser 2015).

From a fish community perspective, Elephant Butte Reservoir suffers from age and management practices that have been, and will continue to be, detrimental to some species while benefitting others" (New Mexico Department of Game and Fish [NMDGF] 2012). Present day management of the fishery populations is viewed to be affected by yearly fluctuating water levels due to irrigation demands and poor habitat created by severe drought conditions; centrarchid populations (e.g., bass and sunfish) are much below state management objectives (NMDGF 2011).

The lack of submerged vegetation in the reservoir has limited the recruitment and survivorship of bass. The absence of vegetation to help filter suspended particulates, reduce the water's turbidity, and stabilize the lake's banks negatively affects many fish species, including white, largemouth, and smallmouth bass, which tend to avoid turbid areas. In contrast, other fish species, like blue catfish, can tolerate increased turbidity, with populations quadrupling in Elephant Butte Reservoir in recent years, while channel catfish populations have markedly declined.

3.8.3.3 Caballo Reservoir

Caballo Reservoir fishery data come from experimental gill net surveys in mid-November 2008 (NMDGF 2012). At that time due to very low water levels in the reservoir, only three randomly selected sites were sampled. Catfish and walleye were the main game species captured, representing most of the community in percent captured and percent of biomass. Walleye, catfish, and white bass are the primary species targeted by anglers in the reservoir.

Gizzard shad represented 17.5 percent of the fish captured in 2008, a percent similar to those captured in 2006. The capture data indicate a well-balanced population with moderate recruitment (NMDGF 2012). Walleye represented 27 percent of the 2008 fish captured. Walleye fry have been stocked in Caballo Reservoir every year since 2007. While their capture number was lower than in 2004 and 2006, their population remained abundant. Their population size reduction was attributed to the decrease in lake levels and the increase in the percent catch of blue catfish. Blue catfish capture numbers increased in 2008 from previous surveys in 2004 and 2006, and they had become the dominant game fish in 2008. The report suggested that water level effects on habitat conditions likely dictate which species are more prevalent each year.

3.8.4 Special Status Species, Rio Grande Silvery Minnow

The Rio Grande silvery minnow is the only ESA-listed fish species present in the study area. The Rio Grande silvery minnow was listed as endangered in 1994 (Service 1994, 59 Fed. Reg. 36988). Silvery minnows are pelagic spawners,[6] producing numerous semi-buoyant, non-adhesive eggs. Most spawning typically has been observed in the spring, from late April through June, accompanying the period of snowmelt runoff (Reclamation 2012c). Spawning also has been observed during runoff following summer monsoons. Both juvenile and adult minnows primarily use meso-habitats with moderate depths (15 to 40 centimeters), low water velocities (4 to 9 centimeters per second), and silt/sand substrates. During the winter, these minnows become less active and seek habitats with cover, such as debris piles and other areas with low water velocities.

During spring sampling, large concentrations of reproductively mature silvery minnows are often collected on inundated lateral overbank habitats (Hatch and Gonzales 2008). Further study is

[6] They lay their eggs in open water

needed to determine whether minnows exhibit preferential use of lateral habitat (including overbank) for spawning. Surveys of inundated overbank habitats often have captured large numbers of gravid females and ripe male minnows (Gonzales and Hatch 2009).

3.8.4.1 Threats

According to the Service (2010, 75 Fed. Reg. 7625 and 1994:36988), decline of the fish is due to destruction and modification of its habitat due to dewatering and diversion of water, water impoundment (including Elephant Butte and Caballo Dams), and modification of the river (channelization). Competition and predation by non-native species, water quality degradation, and other factors have contributed to its status as endangered.

Silvery minnow populations remain at risk in the Rio Grande due to:

- Channel drying and the lack of suitable perennial refugia habitat during the irrigation season and periods of drought, leading to complete desiccation of potential habitat for minnows
- The lack of abundant feeding habitat consisting of channel flows less than a half a foot per second, and high flow velocities suspending and scouring away potential benthic and other attached food supplies for minnows, decreasing survival
- Floodplain habitats that fail to connect and inundate during spawn-stimulating flows, stranding minnow eggs and developing fry in high-velocity channel flows that have long been known to produce very high to total mortality of eggs and developing fry in small-bodied fish species (Harvey 1987)

3.8.4.2 Critical Habitat

The Service (2003, 68 Fed. Reg. 8087) designated critical habitat for the Rio Grande silvery minnow from the San Acacia Diversion Dam to the headwaters of Elephant Butte Reservoir at River Mile 62. The lateral extent of critical habitat was defined as areas bounded by levees, or in areas without levees, 300 feet of riparian zone adjacent to each side of the river (Service 2003:8119). Areas other than the Rio Grande, including the study area, were excluded from the designation of critical habitat for silvery minnow under Section 4(b)(2) of the ESA.

3.8.4.3 Presence

Historically, silvery minnows were distributed throughout most of the Rio Grande, from near the Gulf of Mexico to the upper reaches of both the Pecos River and the Rio Grande, reaching into the Rio Chama. The only reach in the FEIS study area where silvery minnows currently occur is in the channel through the Elephant Butte delta reach from River Mile 62, extending south to the active pool at approximately River Miles 38 to 36; i.e., at the headwaters of Elephant Butte Reservoir.

3.9 Invasive Species

An invasive species as defined by Executive Order 13112 is a species that is non-native or alien to the ecosystem and whose introduction is likely to cause economic or environmental harm or harm to human health.

3.9.1 Regulatory Framework

Authorities for combating the introduction or spread of invasive species are:

- Executive Order 13112
- New Mexico Noxious Weed Control Act

- New Mexico Aquatic Invasive Species Control Act
- Texas Agricultural Code Chapter 71, Subchapters D and T

3.9.2 Existing Invasive Species Conditions

According to the NMDA (2009) and U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (2015), invasive species within the project area are mostly noxious weeds, or plants that are not native, that are targeted for management and control, and that have a negative impact on the economy or the environment. The New Mexico State Noxious Weed List suggests the potential presence of the following noxious weeds:

- Five Class A species—camelthorn (*Alhagi maurorum*), hoary cress/whitetop (*Cardaria* spp.), parrot feather watermilfoil (*Myriophyllum aquaticum*), ravennagrass (*Saccharum ravennae*), and Scotch cottonthistle (*Onopordum acanthium*)
- Five Class B species—African rue (*Peganum harmala*), Malta starthistle (*Centaurea melitensis*), perennial pepperweed (*Lepidium latifolium*), Russian knapweed (*Acroptilon repens*), and tree of heaven (*Ailanthus altissima*)
- Six Class C species—cheatgrass (*Bromus tectorum*), field bindweed (*Convolvulus arvensis*), jointed goatgrass (*Aegilops cylindrical*), Russian olive (*Elaeagnus angustifolia*), saltcedar (*Tamarix* spp.), and Siberian elm (*Ulmus pumila*)
- Four watch list species—crimson fountaingrass (*Pennisetum setaceum*), giant cane (*Arundo donax*), Sahara mustard (*Brassica tournefortii*), and spiny cocklebur (*Xanthium spinosum*)

In Texas, noxious weeds identified as particularly worrisome invasive species in the Trans-Pecos ecoregion and study area are camelthorn (*Alhagi maurorum*), field bindweed (*Convolvulus arvensis*), giant reed (*Arundo donax*), Japanese dodder (*Cuscuta japonica*), and tamarisk or saltcedar (*Tamarix ramosissima*).

As mentioned in Section 3.6.4, the release of tamarisk leaf beetle (*Diorhadba* spp.) at locations along the Rio Grande in Texas is expected to result in the defoliation of saltcedar as the beetles arrive in Elephant Butte and Caballo Reservoirs.

Quagga mussels (*Dreissena bugensis)* were discovered in Nevada in 2007 and have subsequently spread throughout the west. Zebra mussels (*Dreissena polymorpha*) were documented in California in 2008 and they have also been spreading throughout Western waters. NMDGF has recently adopted new rules to combat the spread of invasive mussels and other aquatic invasive species. In Texas, six lakes are infested with zebra mussels. At this time, Elephant Butte and Caballo Reservoirs are mussel-free.

3.10 Cultural Resources

Cultural resources refer to historic and prehistoric buildings, structures, sites, objects, districts, Indian sacred sites, and resources of tribal concern. Historic properties are the subset of cultural resources listed on or eligible for listing on the National Register of Historic Places. The study area or area of potential effects for cultural resources includes Elephant Butte and Caballo Dams and Reservoirs, the Rio Grande floodplain between the two reservoirs, and the Rio Grande below Caballo Dam to the El Paso-Hudspeth County line.

3.10.1 Regulatory Framework

The principal Federal law addressing cultural resources is the NHPA (54 USC 306108), formerly known as Section 106. Its implementing regulations are found at 36 CFR 800. These require Federal agencies to take into account the effects of their actions on historic properties and to allow the Advisory Council on Historic Preservation an opportunity to comment. Executive Order 13007 requires consultation with Indian tribes regarding Indian sacred sites. The executive memorandum from the White House of April 29, 1994, requires government-to-government consultation on issues of tribal concern that may include cultural resources.

3.10.2 Existing Conditions

Listed historic properties in the area of potential effects of this undertaking include Elephant Butte Dam, the diversion dams, and the Franklin Canal. Other historic properties are the Garfield Lateral (LA-111726), Pittsburg Placer Mine (LA-13557), a Mogollon pithouse site (LA-2806), and an Apache battle site (LA-132559). Class III surveys of the Elephant Butte and Caballo Reservoirs were conducted in 1998 and 1999 and there are archaeological resources in the reservoir pools (Reclamation 2013a).

As part of the tribal consultation supporting the SEA, the Mescalero Apache Tribe expressed concerns with native plants growing along the irrigation canals in the service areas of EBID and EPCWID. The Mescalero Tribe collects plant material for cultural purposes.

For this undertaking, Reclamation consulted with the New Mexico State Historic Preservation Officer and they concurred with Reclamation's determination of "no historic properties affected" (Appendix D). In addition, Reclamation consulted with the Mescalero Apache Tribe and Ysleta del Sur, but they did not identify any resources or issues of concern.

3.11 Indian Trust Assets

Indian trust assets (ITAs) are legal interests in property held in trust by the U.S. for Federally-recognized Indian tribes or individual Indians.

3.11.1 Regulatory Framework

Management of ITAs is based on the several policies:

- Secretarial Order No. 3175, Departmental Responsibilities for Indian Trust Resources
- Secretarial Order No. 3206, American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the ESA
- Secretarial Order No. 3215, Principles for the Discharge of the Secretary's Trust Responsibility
- Departmental Manual 512 DM Chapter 2, Departmental Responsibilities for Indian Trust Resources
- Indian Policy of Reclamation

3.11.2 Data Sources

No ITAs have been identified in the project area through consultation with Indian tribes or the Bureau of Indian Affairs.

3.12 Socioeconomics

The study area for socioeconomics includes Doña Ana and Sierra Counties, New Mexico, and El Paso and Hudspeth Counties, Texas. A small portion of Elephant Butte Reservoir is in Socorro County; however, no RGP-irrigated lands are in this county so it is not included in the socioeconomic study area. Recreation facilities associated with Elephant Butte Reservoir are in Sierra County.

3.12.1 Regulatory Framework

The NEPA and its implementing regulations are the authorities requiring analysis of socioeconomics.

3.12.2 Data Sources

Data sources include the U.S. Department of Commerce, Bureau of Economic Analysis (2014, 2015)), U.S. Department of Labor (2015), Census of Agriculture (USDA 2014), U.S. Department of Commerce Bureau of Economic Analysis (2015), and IMPLAN (2013).

3.12.3 Existing Conditions, Farm Employment and Income

Indicators include employment, labor income, and output. According to the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Accounts (2014), during the years from 1970 to 2014, farm employment in the four counties shrank from 5,230 to 4,792 jobs, an 8.4 percent decrease, while non-farm employment grew from 174,608 to 510,948 jobs, a 192.6 percent increase. In 2014, Hudspeth County, Texas had the largest percent of total farm employment (11.9 percent), and El Paso County, Texas had the smallest (0.23 percent).

From 1970 to 2014, farm earnings grew from $141.0 million to $171.6 million, a 21.6 percent increase, while non-farm earnings grew from $7,114.2 million to $22,993.0 million, a 223.2 percent increase. In 2014, Hudspeth County, Texas had the largest percent of total earnings from farm earnings (11.52 percent), and El Paso County had the smallest (0.04 percent).

From 1970 to 2014, net income, including corporate farms, grew from $77.6 million to $84.2 million, an 8.5 percent increase. During this period, cash receipts from crops grew from $214.3 million to $301.7 million, a 40.8 percent increase.

3.12.4 Existing Conditions, Industry Output

Industry output or sales represent the value of goods and services produced by businesses within a sector of the economy. The New Mexico study area (Doña Ana and Sierra Counties) had $12.1 billion in industry output. The Texas study area (El Paso and Hudspeth Counties) had $2.866.6 billion in industry output. The service sectors make up the largest percentage of industry sales in both study areas. Non-service-related industries make up the second largest portion of total output. Agriculture makes up 4.4 percent and 0.9 percent of total output in the New Mexico and Texas study areas, respectively. Table 3-4 summarizes the percent of output by industry.

Table 3-4 Percent of total output by industry

	Doña Ana and Sierra Counties, New Mexico	El Paso and Hudspeth Counties, Texas
Non-Service Industries	**28.8%**	**44.2%**
Agriculture, Forestry, Fishing, and Hunting	4.4%	0.9%
Mining	0.3%	5.8%
Utilities	2.9%	2.3%
Construction	7.4%	6.1%
Manufacturing	13.8%	29.1%
Service Industries	**54.1%**	**49.6%**
Wholesale trade	2.4%	5.4%
Retail trade	5.3%	4.2%
Transportation and warehousing	2.7%	3.5%
Information	2.9%	3.6%
Finance and insurance	3.7%	5.6%
Real estate and rental	10.6%	7.7%
Professional, scientific, and technical services	7.1%	5.8%
Management of companies	0.1%	0.9%
Administrative and waste services	2.4%	2.4%
Educational services	0.4%	0.5%
Health and social services	9.3%	4.8%
Arts, entertainment, and recreation	0.9%	0.5%
Accommodation and food services	3.8%	2.5%
Other services	2.6%	2.2%
Government	**17.1%**	**6.2%**
Government and other	17.1%	6.2%

Source: IMPLAN (2013).

Table 3-5 Farmland by type by county, 2012

Farmland	Doña Ana	Sierra	El Paso	Hudspeth
Number of farms	2,184	256	657	167
Land in farms (acres)	659,970	1,250,136	209,393	2,251,109
Average farm size (acres)	302	4,883	319	13,480
Approximate land area (acres)	2,437,000	2,674,533	648,206	2,925,329
Approximate percent of land area in farms	27.1	46.7	32.3	77

Source: U.S. Department of Agriculture, National Agricultural Statistics Service, Census of Agriculture (2014b).

Table 3-6 Number of farms by type and county, 2012

Farms by type	Doña Ana	Sierra	El Paso	Hudspeth
All Farms	2184	256	657	167
Oilseed & grain	14	0	1	0
Vegetable & melon	64	9	0	4
Fruit & nut tree	1310	24	193	0
Greenhouse, nursery	29	0	2	3
Other crop	356	67	225	52
Beef cattle ranch, farm	123	110	57	74
Animal, all types	288	46	179	34
Percent of Total				
Oilseed & grain	0.6%	0.0%	0.2%	0.0%
Vegetable & melon	2.9%	3.5%	0.0%	2.4%
Fruit & nut tree	60.0%	9.4%	29.4%	0.0%
Greenhouse, nursery	1.3%	0.0%	0.3%	1.8%
Other crop	16.3%	26.2%	34.2%	31.1%
Beef cattle ranch, farm	5.6%	43.0%	8.7%	44.3%
Animal, all types	13.2%	18.0%	27.2%	20.4%

Source: U.S. Department of Agriculture, National Agricultural Statistics Service, Census of Agriculture (2014b).

3.12.6 Agricultural Conditions, Farmland and Type

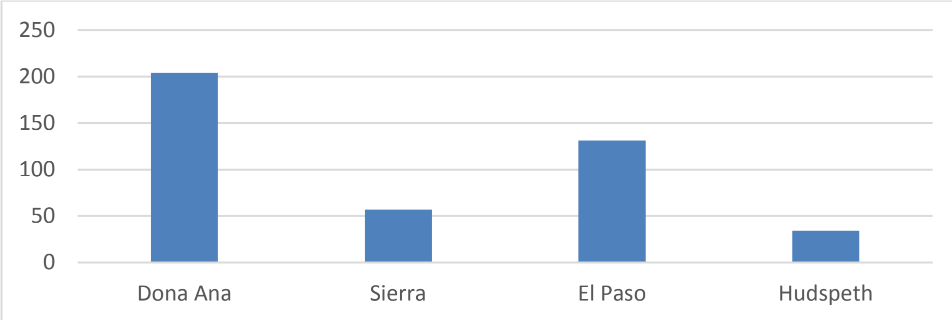
Table 3-5 presents statistics for agricultural conditions in the four-county study area in 2012. As shown, Hudspeth County had the largest percent of land area in farms (77 percent) while Doña Ana County had the smallest (27.1 percent). In the four-county study area, some 50.3 percent of the land was in farms in 2012. Table 3-6 presents the number and percentage of farms by type. As shown, in 2012, Hudspeth County has the smallest number or percent of oilseed and grain farming and the largest percent of beef cattle ranching and farming (44.3 percent) and Dona Ana County had the smallest percent in beef cattle ranching and farming (5.6 percent).

3.12.7 Population Growth and Income

According to the U.S. Department of Commerce, Bureau of Economic Analysis (2015) and as shown in Fig. 7, between 1970 and 2014, Doña Ana County, New Mexico had the largest percent change in population (204 percent) and Hudspeth County, Texas has the smallest (34 percent). During this period, the population of the four county study area increased by 141 percent and the population of the U.S. increased by 56 percent.

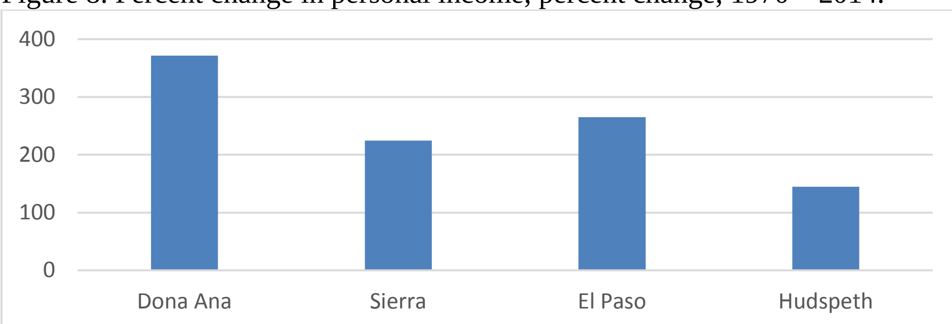
As shown in Fig. 8, between 1970 and 2014, Doña Ana County, New Mexico had the largest percent change in personal income (372 percent) and Hudspeth County, Texas had the smallest (145 percent). During this period, the change in personal income in the four county study area was 281 percent and the change in the U.S. was 182 percent.

Figure 7. Percent change in population by county, 1970 – 2014.



Source: U.S. Department of Commerce, Bureau of Economic Analysis (2015)

Figure 8. Percent change in personal income, percent change, 1970 – 2014.



Source: U.S. Department of Commerce, Bureau of Economic Analysis (2015)

3.13 Hydropower

3.13.1 Regulatory Framework

Energy requirements and conservation potential are required analyses under the CEQ's regulations at 40 CFR 1502.16.

3.13.2 Data Sources and Existing Conditions

The hydroelectric plant at Elephant Butte Dam generates power that is dependent on flow volume and head. Power production does not occur during the winter when RGP releases do not occur; hydropower calculations are based on the calculated average elevation from March to October only.

The Elephant Butte Powerplant has a rated head of 140 feet and is assumed to operate with 90 percent efficiency. Energy generation is calculated from reservoir elevation, with the rated head achieved at the maximum elevation over the study period and the potential energy conversion of 1.024 kilowatt-hours per acre-foot per foot of head. Calculated production based on the average March to October monthly elevation and release data for 2014 is 3 percent below the actual powerplant production of 13.4 gigawatts per hour (Gwh) reported by Reclamation (2015b).

3.14 Recreation

3.14.1 Regulatory Framework

The NEPA and its implementing regulations are the primary authorities requiring analysis of economic resources, including contributions of the travel and tourism sector to the regional economy.

3.14.2 Data Sources

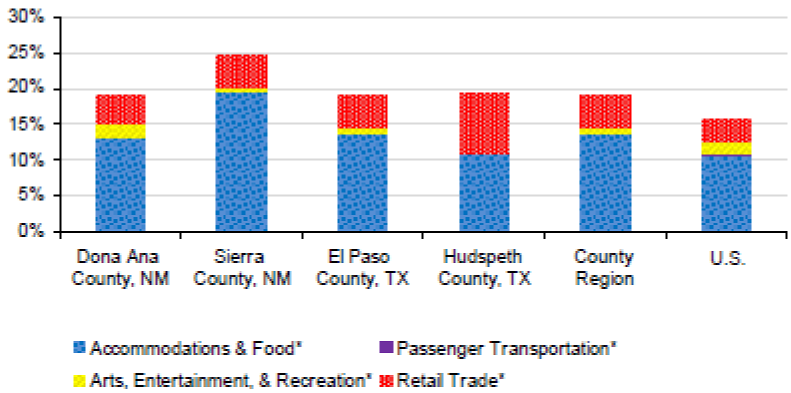
Data on recreation, or travel and tourism, are from the U.S. Department of Commerce, Census Bureau (2015b).

3.14.3 Existing Conditions

In 1998, travel and tourism represented 16 percent of total employment in the four counties. By 2013, travel and tourism represented 19 percent of total employment. From 1998 to 2013, travel and tourism employment grew from 36,584 to 51,346 jobs, a 40.4 percent increase (U.S. Department of Commerce, Census Bureau 2015b).

In 2014, Fig. 9 shows that Sierra County, New Mexico had the largest percent of total jobs in industries that include travel and tourism. In 2014, accommodations and food was the largest component of travel and tourism-related employment (13.6 percent of total jobs) in the four county study area.

Figure 9. Travel and tourism industries by county (percent of total private employment), 2014.



Source: U.S. Department of Commerce, Census Bureau (2015b)

3.15 Environmental Justice

3.15.1 Regulatory Framework

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs Federal agencies to identify and address disproportionately high and adverse effects of its programs and activities on minority and low-income populations.

3.15.2 Data Sources

Guidelines provided by the CEQ (1997) and the Federal Interagency Working Group (2016) indicate minority communities may be defined where minorities comprise more than 50 percent of the population. Minorities include people who self-identify as Hispanic, Black or African-American, American Indian, Asian, Native Hawaiian, or some other race alone or combined. In this FEIS, the study area is the four counties, Doña Ana, Sierra, El Paso, and Hudspeth. The CEQ and Federal Interagency Working Group (2016) guidelines indicate that low-income communities may be defined following the Office of Management and Budget's Directive 14 poverty thresholds which vary by family size.

3.15.3 Low-income Populations

Table 3-7 presents the number and percent of people living in poverty during the 2010-2014 period. While none of the counties had half of their population living below the poverty threshold, based on a comparison of the percent of individuals living below the poverty threshold to the total county percentage (24.3 percent), Doña Ana County had slightly more persons living in poverty (27.8 percent), while Hudspeth County had the highest estimated percent of persons living below the poverty threshold (43.2 percent).

For families, 20.6 percent of the County families were living below the poverty threshold. Doña Ana County had slightly more than that (21.8 percent) and Hudspeth County had the highest estimated percent of families living below the poverty threshold (33.8 percent). These statistics define Doña Ana and Hudspeth Counties as environmental justice communities based on their comparatively high percentages of low-income persons or families.

Table 3-7 Poverty by county, 2010-2014

	Doña Ana	Sierra	El Paso	Hudspeth
People	207701	11486	809165	3017
Families	51778	2467	194230	742
People below poverty	57837	2037	189586	1303
Families below poverty	11304	235	39622	251
Percent of Total				
People below poverty	27.8	17.7	23.4	4302
Families below poverty	21.8	9.6	20.4	33.8

Source: U.S. Department of Commerce, Census Bureau, American Community Survey Office. (2015a). Key: Calculated using average ACS annual surveys during 2010-2014.

3.15.4 Minority Populations

In the 2009-2014 period, Table 3-8 shows Doña Ana, El Paso, and Hudspeth Counties had more than 50 percent of the population self-identifying as Hispanic or Latino. Hispanic or Latino refers to a cultural identification, not a race. In the 2009-2014 period, El Paso County, Texas had the highest estimated percent of the population that self-identify as Hispanic or Latino of any race (81.4 percent). This makes these three counties environmental justice communities.

Table 3-8 Minority populations by county, 2009- 2014

	Doña Ana	Sierra	El Paso	Hudspeth
Total Population	212,942	11,774	823,862	3,344
Hispanic of any race	141,087	3,394	670,946	2,634
White alone	62,649	7,929	110,287	671
Black alone	3,223	26	24,393	23
American Indian alone	1,702	120	2,177	0
Asian alone	2,291	113	8,331	16
Pacific Islander alone	12	0	1,014	0
Some other race	154	366	697	0
Two or more races	1,824	192	6,017	0
Percent of Total				
Hispanic of any race	66.3	28.8	81.4	78.8
White alone	29.4	67.3	13.4	20.1
Black alone	1.5	0.2	3	0.7
American Indian alone	0.8	1	0.3	0
Asian alone	1.1	1	1	0.5
Pacific Islander alone	0	0	0.1	0
Some other race	0.1	0	0.1	0
Two or more races	0.9	1.6	0.7	0

Source: U.S. Department of Commerce, Census Bureau, American Community Survey Office (2015a.)

4 Environmental Consequences

This FEIS is not intended to review the existence of the RGP or its historical operations; the focus is on how the alternatives described in Chapter 2 might change the water resources, biological, cultural, and socioeconomic resources in the study area. The temporal scope of the analysis and the proposed action extends to 2050. As such, the analyses in this chapter are based on modeling of RGP operations under each alternative through 2050 using an integrated hydrologic and water operations model. Model results are subsequently used as inputs to the evaluation of potential changes to other resources. Modeling of future RGP operations incorporates assumptions regarding future climatic and hydrologic conditions, cropping and irrigation practices, and M&I water demands. This chapter begins with a summary of the hydrologic model developed to assess the effects of the alternatives on water resources.

4.1 Water Resource Modeling Methods and Assumptions

Analyses of potential environmental consequences presented in this chapter are based on simulations of future RGP operations through the year 2050, including the storage, release, and delivery of surface water for beneficial use to EBID, EPCWID, and to Mexico under the Convention of 1906. These simulations were carried out using the Rincon and Mesilla Basins Hydrologic Model (RMBHM), as described in this section and Appendix C.

As discussed in Chapter 1, previous studies indicate a strong interaction between the Rio Grande and underlying groundwater aquifers, particularly in the Rincon and Mesilla basins (Conover 1954, Hanson et al. 2013, Haywood and Yager 2003, SSPA 2007). Groundwater pumping in the Rincon and Mesilla Basins results in depletion (capture) of surface-water supplies, including increased seepage losses from the Rio Grande as well as decreased drainage and return flows from irrigated lands. Depletion of RGP surface-water supplies, in turn, increases the amount of water that must be released from storage to meet delivery orders from EBID, EPCWID, and Mexico, and ultimately reduce the amount of RGP surface water that can be delivered to project diversion points (headings). Conversely, RGP operations affect the timing, distribution, and volume of groundwater recharge that occurs as seepage from the Rio Grande and unlined canals and laterals and as deep percolation of applied irrigation water. Simulation of future RGP operations therefore requires an integrated modeling approach capable of representing RGP operations, groundwater demand and use, and groundwater/surface-water interactions between Caballo Dam and the RGP’s downstream-most diversion point at International Dam.

The RMBHM was developed by Reclamation in collaboration with USGS to allow for simulation of RGP operations under the five alternatives described in Chapter 2, while accounting for the role of groundwater/surface-water interactions on RGP operations and surface-water and groundwater resources. The RMBHM builds on previous hydrologic models of the Rincon and Mesilla Basins (SSPA 2007) and the USGS (Hanson et al. 2013). The RMBHM uses the One-Water Hydrologic Flow Model (MF-OWHM; Hanson et al. 2013), an integrated hydrologic modeling software based on the USGS Modular Groundwater Model, MODFLOW. To simulate RGP operations under each alternative, the MF-OWHM was enhanced with additional software features. These features, developed and implemented by Reclamation in collaboration with the USGS (Ferguson et al. 2014), allow for dynamic simulation of storage, allocation, release, and diversion of RGP surface water supplies according to specified allocation and accounting procedures.

The RMBHM is used to simulate RGP operations and corresponding surface-water and groundwater resources under each alternative, including surface water storage in Elephant Butte and Caballo Reservoirs; allocations to EBID, EPCWID, and Mexico; releases from Caballo Dam; and diversions to EBID, EPCWID, and Mexico at their respective diversion points (headings). A spreadsheet post-processing tool was subsequently used to calculate the maximum volume of San Juan–Chama Project water in Elephant Butte Reservoir under each alternative on a monthly basis. All alternatives were simulated under a common set of future climatic and hydrologic conditions. Model results were post-processed and compiled to facilitate comparison of RGP operations and surface water and groundwater resources under the alternatives.

Details of the RMBHM are provided in Appendix C, Hydrology Technical Memo. Model configuration and inputs to RMBHM for the FEIS are summarized below, along with verification of RMBHM with respect to simulation of historical RGP operations. Assumptions regarding future climatic and hydrologic conditions, cropping and irrigation practices, and municipal and industrial water demands and uses are also summarized below.

4.1.1 Model Configuration

Model configuration refers to the extent and discretization of the simulated area (spatial domain) and simulation period (temporal domain), as well as the specified physical and hydraulic properties (constant parameters) of the Rincon and Mesilla Basins. The spatial domain of RMBHM extends from Caballo Dam at the northern end of the Rincon Valley to below American Dam at the southern end of the Mesilla Valley. The spatial domain is discretized using a uniform horizontal grid, with each grid cell encompassing 0.25 miles by 0.25 miles (1320 feet by 1320 feet, equal to 40 acres), and five vertical layers of varying thickness. The spatial domain and discretization used by RMBHM are identical to previous models (SSPA 2007) and USGS (Hanson et al. 2013).

For the FEIS, the temporal domain of RMBHM extends from the start of the 2007-2008 non-irrigation season (November 1, 2007) through the end of the 2050 irrigation season (October 31, 2050). There are 43 years in the simulation. Each simulated year is divided into a non-irrigation season from November through February (120.25 days) and an irrigation season from March through October (245 days). Each season is simulated using approximately monthly time step, with four time-steps of equal length during each non-irrigation season and eight time-steps of equal length during each irrigation season. Model results are output for 516 approximately monthly time steps. Representation of the simulation period based on irrigation and non-irrigation seasons is consistent with previous models (SSPA 2007) and USGS (Hanson et al. 2013); however, previous models used four time steps of varying length for each season rather than the monthly time steps used by RMBHM.

RMBHM requires constant parameters representing physical and hydraulic properties throughout its spatial domain, including subsurface properties (e.g., aquifer hydraulic conductivity, specific storage, and yield), channel properties (e.g., hydraulic conductivity of channel beds, channel slope and geometry, and channel roughness), and vegetation-related parameters (e.g., soil properties, root profiles). RMBHM also requires parameters related to irrigation practices, including on-farm irrigation efficiency. The majority of constant parameters used in RMBHM are identical to those used in the previous model by USGS (Hanson et al. 2013). Parameters related to subsurface and channel bed hydraulic conductivities, aquifer specific storage and specific yield, capillary fringe depth, and on-farm irrigation efficiency were adjusted on a trial-and-error basis during model evaluation to provide better agreement between simulated and observed reservoir storage, releases, and diversions as summarized in Appendix C.

4.1.2 Model Inputs

Model inputs refer to specified time-varying values representing hydrologic, climatic, and anthropogenic stressors to the surface-water and groundwater systems over the simulated area. Hydrologic stressors in RMBHM include surface water inflows to RGP storage. Climatic stressors include reservoir precipitation and evaporation rates and climate factors affecting irrigation demands (e.g., precipitation and temperature). Anthropogenic stressors include human factors affecting irrigation demands (e.g., cropping patterns and irrigated acreage), as well as on-farm irrigation efficiency of agricultural lands, M&I groundwater pumping rates and locations, and discharge of treated effluent from municipal wastewater treatment facilities.

In addition to hydrologic, climatic, and anthropogenic stressors, the storage and relinquishment of Rio Grande Compact credit water in Elephant Butte Reservoir is represented as a time-varying input. The amount of water available for allocation and release by the RGP is equal to the total RGP storage less any non-project water in storage, including Rio Grande Compact credit water. The amount of credit water in Elephant Butte Reservoir at any given time is determined according to Rio Grande Compact accounting procedures, which are not represented in RMBHM. The volume of compact credit water in Elephant Butte Reservoir must therefore be specified for each time step as an input to RMBHM. Certain provisions of the Rio Grande Compact may affect reservoir storage and releases upstream of Elephant Butte Reservoir—and thus inflows to Elephant Butte Reservoir—when RGP storage falls below a specified threshold. RMBHM does not consider the potential feedbacks under the Rio Grande Compact between RGP operations, storage in Elephant Butte Reservoir, and reservoir operations upstream of Elephant Butte Reservoir.

The simulation period for the FEIS extends through November 1, 2050. Model inputs are therefore based on projected future conditions, rather than observed historical conditions. It is not possible to reliably predict the year-to-year and month-to-month evolution of climate and hydrologic conditions through the end of the simulation period, such as the timing, duration, and severity of wet and dry periods. Similarly, it is not possible to reliably predict future cropping and irrigation practices or changes in future municipal, industrial and domestic (collectively referred to as M&I) water demands. Therefore, model inputs for the FEIS were based on a combination of recent historical conditions and projections of effects of future climate change.

Model inputs representing hydrologic and climate stressors over the simulation period were obtained from previous analyses carried out by Reclamation and others as part of the West Wide Climate Risk Assessment (WWCRA; Reclamation 2011a, 2011b) and Upper Rio Grande Impact Assessment (URGIA; Reclamation 2013d). Projections of monthly precipitation and temperature throughout the simulation area were obtained from downscaled projections of future climate developed as part of WWCRA (see Reclamation 2011a, 2011b). Projections of monthly inflows to Elephant Butte Reservoir and monthly reservoir precipitation and evaporation were obtained from simulations carried out for URGIA with the Upper Rio Grande Simulation Model (URGSim; Roach 2007). Analyses of future climate change and its impacts on surface water supplies and management in the upper Rio Grande Basin carried out by WWCRA and URGIA are based on a set of 112 projections of future climate conditions. Three sets of model inputs were developed to represent the range of projected climate and hydrologic conditions over the simulation period, including one representing the drier end of the projected range, one representing the wetter end, and one representing the central tendency (median). Climate projections consistently indicate drier conditions over the Rio Grande Basin over the simulation period; as a result, the average annual inflow to Elephant Butte Reservoir over the simulation period is less than the observed average annual inflow over the past several decades, even under the scenario representing the wetter end of the projected range of future conditions. Additional details regarding model inputs representing future climate and hydrologic conditions are provided in Appendix C and references therein.

Model inputs representing future M&I water uses were based on recent estimates of M&I groundwater pumping within the simulated area. All M&I demand within the simulated area is met by groundwater. Estimates of M&I groundwater pumping exist through 2004 (SSPA 2007) and were subsequently updated through 2009 by USGS (Hanson et al. 2013). For the FEIS, model inputs representing future M&I groundwater pumping were developed based on average annual M&I pumping over the period 2000-2009. See Section 4.1.4 for additional discussion of assumptions regarding future M&I water uses.

Lastly, model inputs representing future irrigation demands throughout the simulated area were developed based on recent estimates of consumptive irrigation requirements[7] for the water year 2000 irrigation season, adjusted based on projected changes in reference evapotranspiration (ET_0) and effective precipitation. Projected changes in ET_0 and effective precipitation were calculated from projected monthly precipitation and temperature from the three climate projections selected for the FEIS. Additional details regarding model inputs representing future irrigation demands are provided in Appendix C. See Section 4.1.4 for additional discussion of assumptions regarding future irrigation demands.

4.1.3 Model Evaluation

The suitability of RMBHM for simulating RGP operations and their interaction with surface-water and groundwater resources in the Rincon and Mesilla Valleys was evaluated by simulating RGP operations under historical hydrology, climate, and cropping conditions for the period 1960-2009 and comparing simulation results to observed historical operations during this period. Historical hydrology and climate conditions were represented through time-varying model inputs, including historical inflows to Elephant Butte Reservoir, historical reservoir precipitation and evaporation rates, and historical crop irrigation requirement computed based on historical meteorology, crop distribution, and irrigated acreage data. For evaluation purposes, historical project operations were represented by implementing a consistent set of project allocation and accounting procedures representative of historical operations for the period 1990-2006. It should be noted that RMBHM uses a fixed set of operating rules over the duration of the evaluation period (1960-2009), whereas actual operating procedures varied over this period. Simulated operations are therefore not expected to perfectly match historical operations.

Model results were compared to historical records of project storage, releases, diversions, and flow in the Rio Grande below Caballo Dam and at El Paso, and to previous estimates of project surface-water deliveries and groundwater deliveries for supplemental irrigation in the Rincon and Mesilla Valleys. Project operations simulated by RMBHM closely match historical operations. As illustrated in Fig. 10, simulated total project storage is well correlated with observed historical storage ($R^2 = 0.94$) and exhibits little systematic bias. Similarly, Fig. 11 shows that simulated annual releases from Caballo Dam also agree well with observed historical releases. The simulated average annual project release is within one percent of the historical average, and the simulated average annual total project diversion from the Rio Grande is within five percent of the historical average. Simulated surface-water and groundwater deliveries to irrigated lands in the Rincon and Mesilla valleys also agree well with previous estimates (SSPA 2007). Strong agreement of RMBHM with historical records and previous modeling studies suggests that RMBHM accurately represents the key operational and hydrologic factors that drive surface-

[7] The quantity of irrigation water, exclusive of precipitation, stored soil moisture, or groundwater that is required consumptively for crop production.

water and groundwater management and use in the Rincon and Mesilla Basins. See Appendix C for additional details.

Figure 10. Observed and simulated monthly total project storage in Elephant Butte and Caballo Reservoirs (acre-feet), 1960-2010.

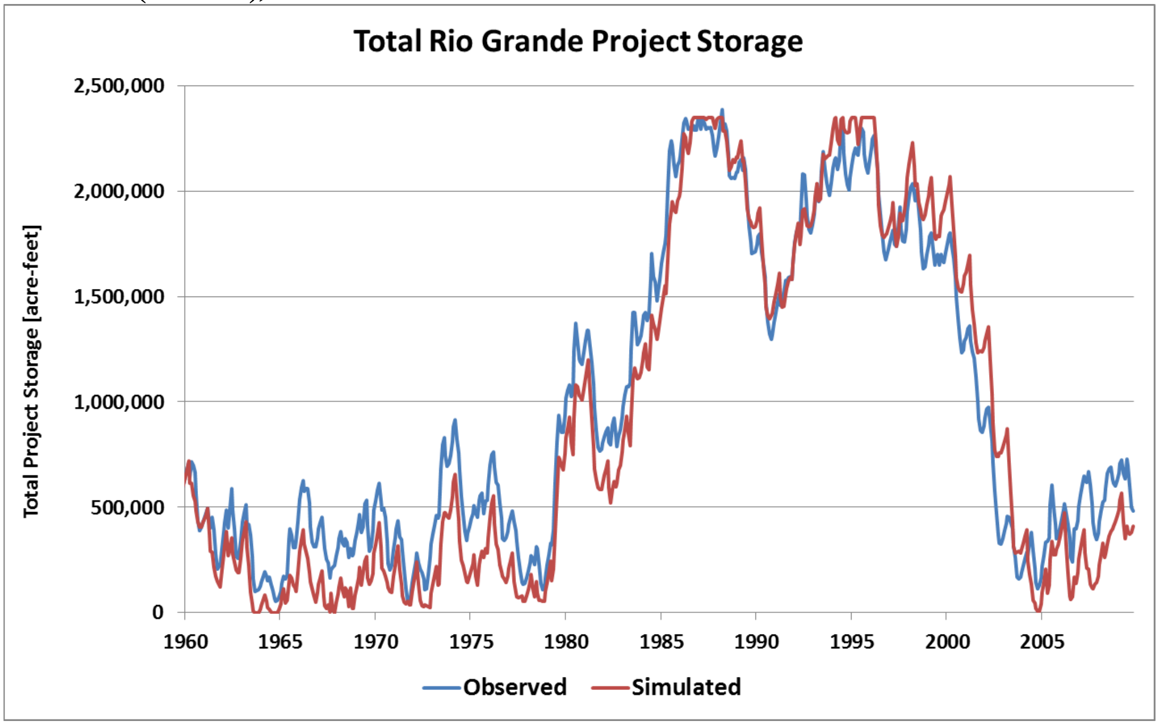
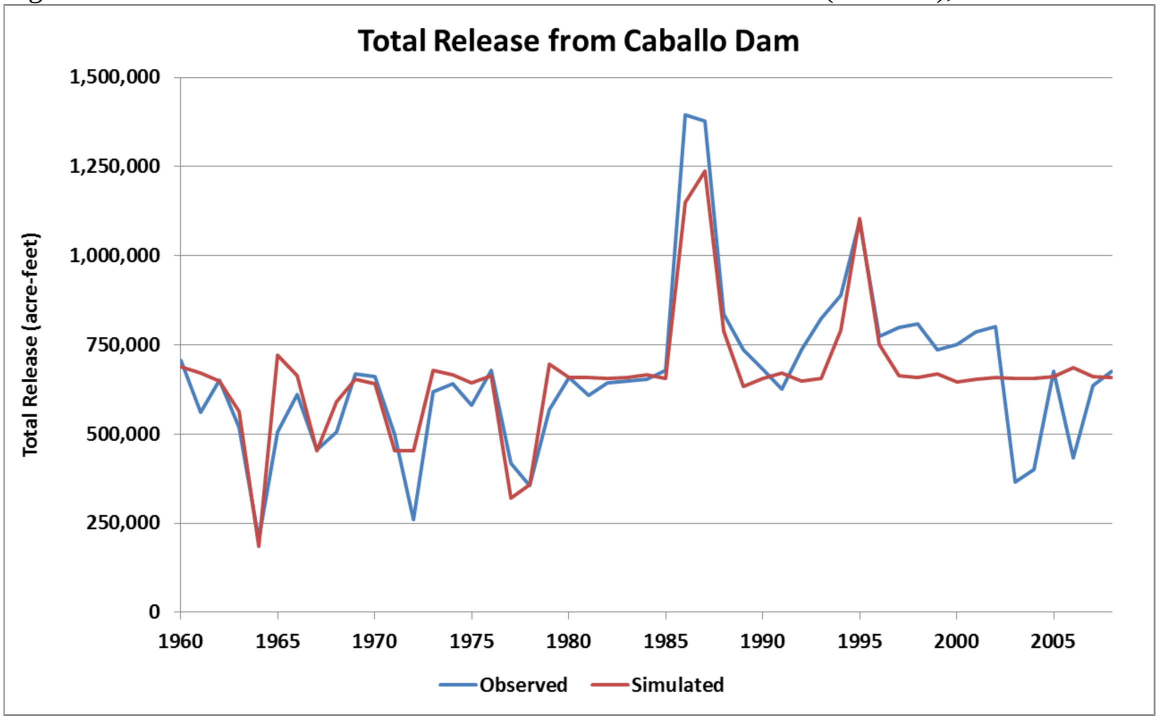


Figure 11. Observed and simulated annual release from Caballo Dam (acre-feet), 1960-2010.



4.1.4 Simulation of Alternatives

Each alternative evaluated in this FEIS was simulated by modifying the portion of the RMBHM source code that computes allocations to EBID, EPCWID, and Mexico, including calculation of annual allocations as well as carryover allocations where applicable. All other aspects of the RMBHM source code, configuration, and inputs are identical across all alternatives. Modifications implemented to simulate each alternative are summarized in Table 4-1. Additional discussion of modeling methods and assumptions is provided in Appendix C.

4.1.5 Modeling Assumptions

The simulation period for the FEIS extends through November 1, 2050. As discussed in Section 4.1.2, it is not possible to reliably predict the evolution of climate and hydrologic conditions, cropping and irrigation practices, M&I water uses, and other stressors through the end of the simulation period. Simulation of future RGP operations therefore requires reasonable assumptions regarding future conditions within the simulated area.

Modeling assumptions were consistent across all alternatives. Key assumptions used in developing model inputs representing future climate and hydrologic conditions, crop irrigation requirements, and M&I water use in Rincon and Mesilla Valleys are summarized below. Additional modeling assumptions are discussed in Appendix C.

Table 4-1 Simulation of FEIS alternatives using RMBHM

Alter-native	Alternative Name	Alternative Description	Summary of Modifications to RMBHM
1	Preferred Alternative, Continuation of OA and San Juan–Chama Project Storage	Continue to implement the OA and continue to store up to 50,000 acre-feet of San Juan–Chama Project (SJCP) water in Elephant Butte Reservoir.	Calculation of annual allocations to EBID and EPCWID incorporate diversion ratio adjustment. Calculation of total allocations to EBID and EPCWID incorporate carryover accounting. Calculation of maximum SJCP storage calculated via post-processing.
2	No San Juan–Chama Project Storage	Continue to implement the OA but do not store SJCP water in Elephant Butte Reservoir.	Same as Alternative 1, except that SJCP storage is equal to zero (eliminates SJCP storage).
3	No Carryover	Implement only 1 of the 2 components of the OA and continue to store up to 50,000 acre-feet of SJCP water in Elephant Butte Reservoir.	Same as Alternative 1, except that RMBHM source code modified to exclude carryover accounting from calculation of total allocations to EBID and EPCWID.
4	No Diversion Ratio Adjustment	Implement only 1 of the 2 components of the OA and continue to store up to 50,000	Same as Alternative 1, except that RMBHM source code modified to exclude the diversion ratio adjustment

Alter-native	Alternative Name	Alternative Description	Summary of Modifications to RMBHM
		acre-feet of SJCP water in Elephant Butte Reservoir.	from calculation of annual allocations to EBID and EPCWID.
5	No Action Alternative, Prior Operating Practices	Revert to operations before the OA (as summarized for the modeling) into the future.	Same as Alternative 1, except that RMBHM source code modified to exclude the diversion ratio adjustment from calculation of annual allocations to EBID and EPCWID and to exclude carryover accounting from calculation of total allocations to EBID and EPCWID.

4.1.5.1 Climate and Hydrology Inputs

As summarized in Section 4.1.2, model inputs representing future climate and hydrologic conditions were obtained from previous analyses of projected climate and hydrologic conditions (Reclamation 2011a, b; 2013c). Previous analyses consider the range of projected climate change over the Rio Grande basin from its headwaters to Elephant Butte Reservoir and corresponding changes in surface water supplies and management. Projected climate conditions were developed based on an ensemble of 112 statistically downscaled climate projections. Projected surface water supplies and management were then developed by using the Variable Infiltration Capacity (VIC) hydrology model to simulate changes in runoff and streamflow and the Upper Rio Grande Simulation Model (URGSim) to simulate corresponding changes in surface water management and use. In addition to reservoir operations, URGSim represents interstate water delivery obligations and accounting under the Rio Grande Compact. While there is considerable uncertainty regarding future climate and hydrologic conditions and water management in the simulated area, the projections developed by WWCRA and URGIA constitute the best available information on future inflows to Elephant Butte Reservoir and Compact credit water in Elephant Butte Reservoir over the simulation period.

It should be noted that under Article VII of the Rio Grande Compact, the volume of water in RGP storage could influence the operation of upstream reservoirs and thus the inflow to Elephant Butte Reservoir. RMBHM, which was developed for this FEIS, does not simulate this interaction between RGP storage and inflow to Elephant Butte Reservoir under the Compact. As discussed in Section 3.2, interactions between RGP operations and water management and use upstream of Elephant Butte Reservoir are beyond the scope of this analysis. Furthermore, despite the availability of existing models representing surface-water management and use upstream of Elephant Butte Reservoir (e.g., URGWOM and URGSim), modifying these models to interact with RMBHM would require very significant technical efforts, including substantial involvement from the agencies who lead development of these models. Reclamation, in consultation with the cooperating agencies, determined that such efforts are not necessary to accurately evaluate potential changes to resources resulting from implementation of the five alternatives.

4.1.5.2 Crop Irrigation Requirement Inputs

Model inputs representing future irrigation demands throughout the simulated area were developed based on estimates of crop irrigation requirement for the water year 2000 irrigation season. Crop irrigation requirements for each year of the simulation period were calculated by adjusting the year 2000 crop irrigation requirements to reflect projected changes in annual reference evapotranspiration (ET_0) and effective precipitation, where changes in ET_0 and effective precipitation were derived from projected monthly precipitation and temperature from the three climate projections selected for the FEIS. This approach implicitly assumes that irrigated acreage and cropping patterns over the duration of the simulation period remain consistent with water year 2000.

Previous studies have assumed that any shortage in RGP surface water supply relative to crop irrigation requirements in Rincon and Mesilla Valleys is made up for by the use of groundwater for supplemental irrigation (e.g., Appendix F of SSPA 2007). Under this assumption, widespread use of groundwater to supplement RGP surface water supplies precludes the need to fallow land or shift to lower water-use crop during periods of low surface water supply. Analysis of irrigated acreage in Rincon and Mesilla Valleys over the past several decades shows no relationship between irrigated acreage and RGP surface water supply. Similarly, year-to-year fluctuations in cropping patterns (percent of acreage in a given crop) exhibit no relationship with RGP surface water supply. Historical cropping and acreage data thus support the assumption that cropping decisions are primarily influenced by market drivers, rather than by RGP surface water supplies. As a result, it is not possible to reliably predict future changes in cropping patterns and irrigated acreage based on simulated changes in RGP supplies.

4.1.5.3 M&I Groundwater Pumping Inputs

While plans of the cities of Las Cruces and El Paso are discussed in Chapter 5 as cumulative actions with potential cumulative impacts, there is considerable uncertainty regarding future M&I water demands and use in the study area. As noted in Chapter 5 (Section 5.3.10), future M&I water demands or use will depend on population growth, economic development, and other factors or actions that are not reasonably foreseeable. Given the large uncertainties related to M&I water demands and use through the year 2050, model inputs representing groundwater pumping for M&I use were developed based on estimates of M&I groundwater pumping for the period 2000-2009. This assumption is consistent with the fact that despite significant population and economic growth over the past two decades, water conservation programs have reduced per capita water demands and resulted in little change in actual M&I water use over this period (Hanson et al. 2013, McCoy et al. 2007, SSPA 2007). This assumption is also supported by the possibility that any further increases in pumping could be offset by fallowing of agricultural land or other conservation measures.

4.1.6 Analysis and Presentation of Model Results in FEIS

Potential environmental consequences of each alternative are evaluated based on simulations of future RGP operations and corresponding surface-water and groundwater resources. RMBHM was used to simulate the effects of the alternatives over the 43-year simulation period (November 2007 to October 2050), including year-to-year fluctuations in hydrology and climate and resulting fluctuations in water supplies, demands, and operations. Detailed results are in Appendix C, Hydrology Technical Memorandum.

Sections 4.2 to 4.11 summarize data from Appendix C, presenting averages for each simulated water resource variable (RGP allocations, releases, diversions, deliveries, etc.). Tables 4-2 to 4-13 are organized such that each column presents a single alternative and each row presents a single climate scenario with three climate scenarios presented to characterize uncertainties in future RGP operations and surface water and groundwater resources. Differences between alternatives may be evaluated by comparing columns in these tables. Differences due to potential climate change may be evaluated by comparing row. In addition, effects of climate change may be evaluated as the difference in a given water resource variable or indicator between historical (observed) climate conditions and projected future climate conditions.

The three climate scenarios considered in the FEIS—the drier scenario (P25), central tendency or median scenario (P50), and wetter scenario (P75)—are all based on the best available projections of future climate and hydrologic conditions in the Rio Grande Basin and are each considered equally likely projections of future conditions. To assess impacts on special status species in Elephant Butte Reservoir, Reclamation used the wetter climate scenario. The wetter scenario represents a conservative worst case for the species and their habitat in the reservoir pool due to the impact of fluctuations of the water surface elevation and area, but the drier scenario would be the worst case for biological resources downstream of Caballo Dam.

4.2 Reservoir Storage

Total storage is the total volume of water (acre-feet) in Elephant Butte and Caballo Reservoirs at the end of each month. Project storage is the total volume of RGP water[8] in the reservoirs at the end of each month, excluding Rio Grande Compact credit water and San Juan–Chama Project water. Table 4-2 presents average monthly total storage by alternative and climate scenario. Table 4-3 presents average monthly storage in Elephant Butte Reservoir and Table 4-4 presents average monthly storage in Caballo Reservoir.

As shown, the FEIS alternatives are not likely to have a strong effect on reservoir storage. Differences in average monthly storage among the alternatives range from 38,421 to 44,360 acre-feet, while differences among future climate scenarios range from 175,224 to 193,452 feet. In other words, uncertainties in future climate conditions are significantly greater than the effect of implementing one or another alternative.

Table 4-2 Average monthly total storage (acre-feet) by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	311,875	279,081	317,502	281,367	293,084
Central	483,445	455,233	493,743	465,907	483,425
Wetter	487,099	462,627	506,987	464,527	486,536

[8] Project storage is the combined capacity of Elephant Butte Reservoir and all other reservoirs actually available for the storage of usable water below Elephant Butte and above the first diversion to lands of the RGP, but not more than a total of 2,638,860 acre-feet (http://www.wrri.nmsu.edu/wrdis/compacts/Rio-Grande-Compact.pdf).

Table 4-3 Average monthly Elephant Butte Reservoir storage (acre-feet) by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	293,148	259,152	298,307	264,678	275,596
Central	449,822	419,547	458,839	433,580	449,601
Wetter	447,860	421,558	465,693	426,740	446,448

Table 4-4 Average monthly Caballo Reservoir storage (acre-feet) by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	18,727	19,929	19,195	16,689	17,488
Central	33,624	35,686	34,904	32,327	33,825
Wetter	39,238	41,068	41,294	37,786	40,088

4.2.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, Table 4-2 shows the average monthly total storage would be 483,445 acre-feet under the central tendency future climatic scenario. Alternative 1 would be almost identical to Alternative 5 (No Action) under central tendency or wetter conditions, but under drier conditions, the average monthly storage under Alternative 1 would be 18,791 acre-feet higher than Alternative 5 (No Action).

4.2.2 Alternative 2: No San Juan–Chama Project Storage

Under Alternative 2, the average monthly total storage would be 455,233 acre-feet under the central tendency climatic scenario. Alternative 2 would be 14,002 acre-feet, 28,192 acre-feet, or 23,909 acre-feet below Alternative 5 (No Action) under drier, central tendency, or wetter climatic conditions respectively.

4.2.3 Alternative 3: No Carryover Provision

Under Alternative 3, the average monthly total storage would be 493,743 acre-feet under the central tendency climate scenario. Alternative 3 would be 24,418 acre-feet, 10,318 acre-feet, or 20,451 acre-feet higher than Alternative 5 (No Action) under drier, central tendency, or wetter conditions respectively.

4.2.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the average monthly total storage would be 465,907 acre-feet under the central tendency climate scenario. Alternative 4 would be 11,716 acre-feet, 17,518 acre-feet, or 22,009 acre-feet below Alternative 5 (No Action) under drier, central tendency, or wetter conditions respectively.

4.2.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5 (No Action), the average monthly total storage would be 483,425 acre-feet under the central tendency climate scenario. It would range from 311,875 to 447,099 acre-feet under drier to wetter climates.

4.3 Elephant Butte Reservoir Elevation

Because of the biological importance of the elevation of the water surface in Elephant Butte Reservoir, Table 4-5 provides the simulated average monthly water surface elevation in feet above sea level. As shown, the simulated maximum difference in average Elephant Butte Reservoir water surface elevation among the five alternatives is 7 to 9 feet, while the simulated maximum difference among the three future climate scenarios is 10 to 12 feet.

Table 4-5 Average monthly Elephant Butte Reservoir elevation (feet above sea level) by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	4,316	4,307	4,316	4,313	4,315
Central	4,326	4,319	4,327	4,325	4,326
Wetter	4,325	4,319	4,327	4,324	4,325

4.3.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, Table 4-5 shows the average monthly elevation of the water surface in Elephant Butte Reservoir would be 4,326 feet above sea level under the central tendency climatic scenario. Alternative 1 would be almost identical to Alternative 5 (No Action) under all climatic scenarios.

4.3.2 Alternative 2: No San Juan–Chama Project Storage

Under Alternative 2, the average monthly elevation would be 4,319 feet under the central tendency climatic scenario. Alternative 2 would be an average of 7 feet lower than Alternative 5 under central tendency climatic conditions or 8 feet under drier conditions. There would be no difference from Alternative 5 under wetter conditions.

4.3.3 Alternative 3: No Carryover Provision

Under Alternative 3, the average monthly elevation would be 4,327 feet under the central tendency climatic scenario. Alternative 3 would be 1 to 2 feet higher than Alternative 5 (No Action) under all climate scenarios.

4.3.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the average monthly elevation would be 4,325 feet under the central tendency climatic scenario. Alternative 4 would be 1 to 2 feet lower than Alternative 5 (No Action) under all climate scenarios.

4.3.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the average monthly elevation would be 4,326 feet under the central tendency climatic scenario, 4,315 feet under the drier climate scenario and 4,325 under the wetter climate scenario.

4.4 Annual Allocation to EBID and EPCWID

Table 4-6 shows the simulated average annual allocations in acre-feet to the two districts by alternative and climate scenario. The maximum difference to EBID among the alternatives would be 91,665 acre-feet under drier conditions, 101,217 under central tendency conditions, and 90,915 acre-feet under wetter conditions. The maximum difference to EPCWID among the alternatives would be 64,668 acre-feet under drier conditions, 60,677 acre-feet under central tendency conditions, and 59,925 acre-feet under wetter conditions.

Table 4-6 Average annual allocation (acre-feet) to districts by alternative and climate scenario

District &	Alternative				
Climate	1	2	3	4	5
EBID					
Drier	176,988	176,988	207,180	230,319	268,652
Central	213,110	213,110	264,752	272,269	314,327
Wetter	271,315	271,315	298,875	320,104	362,229
EPCWID					
Drier	196,833	196,833	240,025	175,357	204,542
Central	224,049	224,049	267,973	207,296	239,317
Wetter	258,768	258,768	303,640	243,716	275,788

4.4.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the mean annual allocation to EBID would be 213,110 acre-feet under the central tendency climatic scenario. The mean annual allocation to EPCWID would be 224,049 acre-feet under the central tendency climatic scenario.

4.4.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Table 4-6, Alternative 2 would be the same as Alternative 1.

4.4.3 Alternative 3: No Carryover Provision

Under Alternative 3, the mean annual allocation to EBID would be 264,752 acre-feet under the central tendency climatic scenario and 267,973 acre-feet to EPCWID.

4.4.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the mean annual allocation to EBID would be 272,269 acre-feet under the central tendency climatic scenario and 207,296 acre-feet to EPCWID .

4.4.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5 (No Action), the mean annual allocation to EBID would be 314,327 acre-feet under the central tendency climatic scenario. The mean annual allocation to EPCWID would be 239,317 acre-feet under the central tendency climatic scenario.

4.5 Total Allocation to EBID and EPCWID

Table 4-7 shows the simulated average total allocation in acre-feet to the two districts by alternative and climate scenario. The total allocation to each district is calculated as the sum of its annual allocation and carryover allocation. The maximum difference to EBID among the alternatives would be 63,354 acre-feet under wetter conditions, 59,177 acre-feet under central tendency conditions, and 61,472 acre-feet under wetter conditions. The maximum difference to EPCWID among the alternatives would be 97,650 acre-feet under central tendency conditions, 97,352 acre-feet under wetter conditions, and 80,013 acre-feet under drier conditions.

Table 4-7 Average total allocation (acre-feet) to districts by alternative and climate scenario

District &	Alternative				
Climate	1	2	3	4	5
EBID					
Drier	222,539	222,539	207,180	278,015	268,652
Central	255,150	255,150	264,752	321,955	314,327
Wetter	335,499	335,499	298,875	410,996	362,229
EPCWID					
Drier	284,556	284,556	240,025	260,666	204,542
Central	336,967	336,967	267,973	310,152	239,317
Wetter	373,140	373,140	303,640	356,520	275,788

4.5.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the mean total allocation to EBID would be 255,150 acre-feet under the central tendency climatic scenario. The mean total allocation to EPCWID would be 336,967 acre-feet under the central tendency climatic scenario. The mean total allocation to EBID would range from 222,539 acre-feet under the drier climate scenario to 335,499 acre-feet under the wetter scenario. The mean total allocation to EPCWID would range from 204,542 acre-feet under the drier scenario to 275,788 acre-feet under the wetter climate scenario.

4.5.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Table 4-7, Alternative 2 would be the same as Alternative 1.

4.5.3 Alternative 3: No Carryover Provision

Under Alternative 3, the mean total allocation to EBID would be 264,752 acre-feet under the central tendency climatic scenario. The mean total allocation to EPCWID would be 310,152 acre-feet under the central tendency climatic scenario.

4.5.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the mean total allocation to EBID would be 321,955 acre-feet under the central tendency climatic scenario. The mean total allocation to EPCWID would be 310,152 acre-feet under the central tendency climatic scenario.

4.5.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5 (No Action), the mean total allocation to EBID would be 314,327 acre-feet under the central tendency climatic scenario with a range from 268,652 to 362,229 acre-feet under the drier to wetter climate scenarios respectively. The mean total allocation to EPCWID would be 239,317 acre-feet under the central tendency climatic scenario with a range from 204,542 to 275,788 acre-feet under the drier to wetter climate scenarios respectively.

4.6 Rio Grande Project Releases

Figure 11 shows that simulated releases from Caballo Dam agree well with observed historical releases. Table 4-8 shows the simulated average annual project release in acre-feet by alternative and climate scenario. The maximum difference to EBID among the alternatives would be 91,665 acre-feet under drier conditions, 101,217 acre-feet under central tendency climatic conditions, and 90,915 acre-feet under wetter conditions. The maximum difference to EPCWID among the alternatives would be 64,668 acre-feet under drier conditions, 60,677 acre-feet under central tendency climatic conditions, and 59,925 acre-feet under wetter conditions.

Table 4-8 Average annual RGP release (acre-feet) by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	479,601	479,601	478,320	482,903	480,759
Central	529,170	529,170	525,808	531,229	527,421
Wetter	585,623	585,623	578,858	587,718	527,421

4.6.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, Table 4-8 shows the central tendency annual project release would be 529,170 acre-feet under the central tendency climatic scenario and the total release would average 541,019 acre-feet.

4.6.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Table 4-8, Alternative 2 would be the same as Alternative 1.

4.6.3 Alternative 3: No Carryover Provision

Under Alternative 3, the average annual project release would be 525,808 acre-feet under the central tendency climatic scenario and the total release would average 539,140 acre-feet.

4.6.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the average annual project release would be 531,229 acre-feet under the central tendency climatic scenario and the total release would average 543,089 acre-feet.

4.6.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5 (No Action), the average annual project release would be 527,421 acre-feet under the central tendency climatic scenario and the total release would average 539,807 acre-feet.

4.7 Net Diversions

Table 4-9 shows the simulated average annual net diversions in acre-feet to the two districts by alternative and climate scenario. The simulations for EPCWID are for Rincon and Mesilla Valleys only. The maximum difference to EBID among the alternatives would be 49,426 acre-feet under wetter conditions, 49,165 acre-feet under central tendency conditions, and 41,220 acre-feet under drier conditions. The maximum difference to EPCWID among the alternatives would be 14,720 acre-feet under central tendency conditions, 12,794 acre-feet under drier conditions, and 7,678 acre-feet under wetter conditions.

Table 4-9 Average annual net diversion (acre-feet) to districts by alternative and climate scenario

District &	Alternative				
Climate	1	2	3	4	5
EBID					
Drier	148,818	148,818	154,454	190,038	189,864
Central	179,198	179,198	198,287	227,069	228,363
Wetter	223,271	223,271	217,316	266,742	256,654
EPCWID					
Drier	34,155	34,155	30,554	24,968	21,361
Central	40,262	40,262	34,805	29,491	25,543
Wetter	37,075	37,075	36,805	30,701	29,397

4.7.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the mean annual net diversion to EBID would be 148,818 acre-feet under the central tendency climatic scenario. The mean annual net diversion to EPCWID would be 40,262 acre-feet under the central tendency climatic scenario.

4.7.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Table 4-9, Alternative 2 would be the same as Alternative 1.

4.7.3 Alternative 3: No Carryover Provision

Under Alternative 3, the mean annual net diversion to EBID would be 198,287 acre-feet under the central tendency climatic scenario. The mean annual net diversion to EPCWID would be 34,805 acre-feet under the central tendency climatic scenario.

4.7.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the mean annual net diversion to EBID would be 227,069 acre-feet under the central tendency climatic scenario. The mean annual net diversion to EPCWID would be 29,491 acre-feet under the central tendency climatic scenario.

4.7.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5 (No Action), the mean annual net diversion to EBID would be 228,363 acre-feet under the central tendency climatic scenario. The mean annual net diversion to EPCWID would be 25,543 acre-feet under the central tendency climatic scenario.

4.8 Farm Surface Water Deliveries

Table 4-10 shows the simulated average farm surface water deliveries in acre-feet to the two districts by alternative and climate scenario. The simulations for EPCWID are for Mesilla Valley only. The maximum difference to EBID among the alternatives would be 31,194 acre-feet under wetter conditions, 26,728 under central tendency conditions, and 23,908 acre-feet under drier conditions. The maximum difference to EPCWID among the alternatives would be 2,259 acre-feet under drier conditions, 2,058 acre-feet under central tendency conditions, and 1,699 acre-feet under wetter conditions.

Table 4-10 Average farm surface water deliveries (acre-feet) to districts by alternative and climate scenario

District &	Alternative				
Climate	1	2	3	4	5
EBID					
Drier	66,053	66,053	70,101	89,961	88,532
Central	84,054	84,054	94,477	110,782	110,314
Wetter	101,217	101,217	99,232	130,426	123,473
EPCWID					
Drier	13,259	13,259	12,416	11,949	10,999
Central	15,954	15,954	15,029	14,964	13,896
Wetter	17,156	17,156	16,553	15,935	15,456

4.8.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the mean annual farm surface water delivery to EBID would be 84,054 acre-feet under the central tendency climatic scenario. The mean annual farm surface water delivery to EPCWID would be 15,954 acre-feet under the central tendency climatic scenario.

4.8.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Table 4-10, Alternative 2 would be the same as Alternative 1.

4.8.3 Alternative 3: No Carryover Provision

Under Alternative 3, the mean annual farm surface water delivery to EBID would be 94,477 acre-feet under the central tendency climatic scenario. The mean annual farm surface water delivery to EPCWID would be 15,029 acre-feet under the central tendency climatic scenario.

4.8.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the mean annual farm surface water delivery to EBID would be 110,782 acre-feet under the central tendency climatic scenario. The mean annual farm surface water delivery to EPCWID would be 14,964 acre-feet under the central tendency climatic scenario.

4.8.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5 (No Action), the mean annual farm surface water delivery to EBID would be 110,314 acre-feet under the central tendency climatic scenario. The mean annual farm surface water delivery to EPCWID would be 13,896 acre-feet under the central tendency climatic scenario.

4.9 Groundwater

Based on the assumptions described in Section 4-1 and Appendix C, Table 4-11 shows the simulated change in total groundwater storage in Rincon and Mesilla Valleys in acre-feet over the 43-year simulation period by alternative and climate scenario. The change in total groundwater storage is calculated as the difference in the total groundwater storage, summed over the simulated area of RMBHM, at the end of the simulation period compared to the start of the simulation period. The maximum difference among alternatives in the simulated change in groundwater storage would be 9,875 acre-feet under the wetter climate scenario, 5,513 acre-feet under the central tendency scenario, and 3,444 acre-feet under the drier scenario.

Table 4-11 Change in total groundwater storage (acre-feet) by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	-56,632	-56,632	-56,162	-44,472	-46,575
Average	-29,470	-29,470	-28,055	-25,657	-23,957
Wetter	-2,277	-2,277	-4,361	937	-2,508

4.9.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the total volume of groundwater storage in Rincon and Mesilla Valleys would decline by 29,470 acre-feet between 2007 and 2050 under the central tendency climatic scenario. The total volume of groundwater storage would decline by 56,632 acre-feet under the drier scenario and by 2,277 acre-feet under the wetter scenario.

4.9.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Table 4-11, Alternative 2 would be the same as Alternative 1.

4.9.3 Alternative 3: No Carryover Provision

Under Alternative 3, the total volume of groundwater storage in Rincon and Mesilla Valleys would decline by 28,055 acre-feet between 2007 and 2050 under the central tendency climatic scenario. The total volume of groundwater storage would decline by 56,162 acre-feet under the drier scenario and by 4,361 acre-feet under the wetter scenario.

4.9.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the total volume of groundwater storage in Rincon and Mesilla Valleys would decline by 25,657 acre-feet between 2007 and 2050 under the central tendency climatic scenario. The total volume of groundwater storage would decline by 44,472 acre-feet under the drier scenario and increase by 937 acre-feet under the wetter scenario.

4.9.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the total volume of groundwater storage in Rincon and Mesilla Valleys would decline by 23,957 acre-feet between 2007 and 2050 under the central tendency climatic scenario. The total volume of groundwater storage would decline by 46,757 acre-feet under the drier scenario and by 2,508 acre-feet under the wetter scenario.

4.10 Farm Groundwater Deliveries

Irrigation requirements that are not satisfied by RGP surface water deliveries are assumed to be met through supplemental groundwater pumping. As a result, combined total delivery of RGP surface water and supplemental groundwater to RGP lands in the Rincon and Mesilla Valleys would be nearly identical under all alternatives. Table 4-12 shows the simulated average annual farm groundwater deliveries in acre-feet to the two districts by alternative and climate scenario. The simulations for EPCWID are for Rincon and Mesilla Valleys only. The maximum difference to EBID among the alternatives would be 31,194 acre-feet under wetter conditions, 26,728 acre-feet under central tendency conditions, and 23,908 acre-feet under drier conditions. The maximum difference to EPCWID among the alternatives would be 2,259 acre-feet under drier conditions, 2,058 acre-feet under central tendency conditions, and 1,699 acre-feet under wetter conditions.

Table 4-12 Average annual farm groundwater deliveries (acre-feet) to districts by alternative and climate scenario

District &	Alternative				
Climate	1	2	3	4	5
EBID					
Drier	243,662	243,662	239,489	217,637	219,276
Central	214,370	214,370	202,791	184,273	185,061
Wetter	194,619	194,619	197,481	161,595	169,660
EPCWID					
Drier	15,563	15,563	15,951	16,406	17,357
Central	11,850	11,850	12,486	12,533	13,607
Wetter	10,593	10,593	10,859	11,454	11,939

4.10.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the mean annual farm groundwater delivery (pumping of groundwater) to EBID would be 214,370 acre-feet under the central tendency climatic scenario. The mean annual farm groundwater delivery to EPCWID would be 11,850 under the central tendency climatic scenario.

4.10.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Table 4-12, Alternative 2 would be the same as Alternative 1.

4.10.3 Alternative 3: No Carryover Provision

Under Alternative 3, the mean annual farm groundwater delivery to EBID would be 202,791 acre-feet under the central tendency climatic scenario. The mean annual farm groundwater delivery to EPCWID would be 12,486 acre-feet under the central tendency climatic scenario.

4.10.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the mean annual farm groundwater delivery to EBID would be 184,273 acre-feet under the central tendency climatic scenario. The mean annual farm groundwater delivery to EPCWID would be 12,533 acre-feet under the central tendency climatic scenario.

4.10.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the mean annual farm groundwater delivery to EBID would be 185,061 acre-feet under the central tendency climatic scenario. The mean annual farm groundwater delivery to EPCWID would be 13,607 acre-feet under the central tendency climatic scenario.

4.11 Groundwater Elevations at Selected Wells

Water elevation data for 15 wells in the Rincon and Mesilla Basins were used for simulation analysis (Appendix C). Simulated fluctuations in groundwater elevations are qualitatively similar among all wells within each basin, so data from only one well in each basin are presented here. The mean monthly groundwater elevation for the representative well in the Rincon Basin (Rin-2) is shown in Table 4-13, along with the data from the well in the Mesilla Basin (Mes-6). As shown, the maximum difference in well elevations among the alternatives would be 3 feet for the Rin-2 well under central tendency climatic conditions, and 1 foot for the Mes-6 well under all climate scenarios.

Table 4-13 Average annual farm groundwater elevations at selected wells (feet above sea level) by alternative and climate scenario

Well &	Alternative				
Climate	1	2	3	4	5
Rin-2					
Drier	4,059	4,059	4,060	4,062	4,062
Central	4,061	4,061	4,062	4,063	4,063
Wetter	4,063	4,063	4,063	4,065	4,065
Mes-6					
Drier	3,813	3,813	3,813	3,814	3,814
Central	3,814	3,814	3,815	3,816	3,815
Wetter	3,816	3,816	3,816	3,817	3,817

4.11.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the mean elevation in the Rincon-2 well would be 4,061 feet under the central tendency or central tendency climatic scenario with the mean under drier conditions of 4,059 feet to 4,063 feet under wetter climate conditions. The mean elevation in the Mesilla-6 well would be 3,814 feet under the central tendency climatic scenario with the mean under drier conditions of 3,813 feet to 3,816 feet under wetter conditions.

4.11.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Table 4-13, Alternative 2 would be the same as Alternative 1.

4.11.3 Alternative 3: No Carryover Provision

Under Alternative 3, the mean elevation in the Rincon-2 well would be 4,062 feet under the central tendency or central tendency climatic scenario. The mean elevation in the Mesilla-6 well would be 3,815 feet under the central tendency climatic scenario.

4.11.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the mean elevation in the Rincon-2 well would be 4,063 feet under the central tendency or central tendency climatic scenario. The mean elevation in the Mesilla-6 well would be 3,816 feet under the central tendency climatic scenario.

4.11.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the mean elevation in the Rincon-2 well would be 4,063 feet under the central tendency or central tendency climatic scenario. The mean elevation in the Mesilla-6 well would be 3,815 feet under the central tendency climatic scenario.

4.12 Water Quality

4.12.1 Analysis Methods and Assumptions

This FEIS incorporates by reference the water quality analysis from SEA (Reclamation 2013a). Assumptions are that increased reservoir storage or increased releases to the river would improve water quality. Other assumptions include:

- Water is generally not released from Caballo Reservoir in the non-irrigation season under any alternative. As such, water quality may fluctuate during this period but is not related to the alternatives.
- Water used by municipal users is treated, and the level of treatment would not change under the various alternatives.
- Changes in nonpoint source runoff would be the same under the various alternatives.

4.12.2 Effects Common to All Alternatives

Water quality effects are common to all alternatives. These are identified and described below.

4.12.2.1 Mercury and PCBs in Fish

Concentrations of methylmercury and other contaminants in fish would not be affected by the alternatives. Mercury and other contaminants in water bioaccumulate in fish due to complex ecological and biogeochemical processes and would not be affected by the volume of water in storage.

4.12.2.2 Dissolved Oxygen

Low dissolved oxygen below the two dams is a seasonal condition caused by upstream sources of deoxygenated water and nutrient levels, as well as release patterns. Given the common volumes and timing of released water among the alternatives, none of the alternatives would alter the existing seasonally low dissolved oxygen concentrations.

4.12.2.3 Total Dissolved Solids, Salinity and Nutrients

As shown in Section 4.6 and Table 4-8, across all alternatives, the differences in releases would be minor and insufficient to change the existing impairment of water quality due to high concentrations of dissolved oxygen, dissolved solids, nutrients, or salinity.

4.12.2.4 Groundwater Quality

As noted by the Texas Water Development Board (2016), groundwater quality issues in the study area are generally related to naturally high concentrations of total dissolved solids (TDS) or to the occurrence of elevated concentrations of individual dissolved constituents, and while there are local instances of groundwater quality degradation, there are no major trends suggesting a widespread water quality problem due to the downward percolation of surface contaminants. The groundwater well elevations may be suggestive of groundwater water quality. Results presented in Section 4.11 and Table 4-13 show the differences among alternatives in groundwater elevations are likely too small to result in any measurable differences in groundwater quality.

4.13 Vegetation and Wetlands

This section projects changes to vegetation communities and wetlands due to implementation of the alternatives. (No special status plants are present, as described in Chapter 3.) The study area for vegetation is the action area for special status aquatic and wildlife species and their designated or proposed critical habitats under the ESA. The action area is defined as all areas affected directly or indirectly by the Federal action (50 CFR 402.02) and is subdivided into the following reaches or segments:

- Elephant Butte Reservoir from full pool to dead pool
- The Rio Grande downstream from Elephant Butte Dam to Caballo Reservoir
- Caballo Reservoir from full pool to dead pool
- The Rio Grande from Caballo Dam downstream to International Dam

While vegetation in all these reaches was considered, the analysis focuses on vegetation in and around Elephant Butte Reservoir for three reasons. One, upland desert shrub communities further from the river would be unaffected by the alternatives because none of the alternatives would change the volume or pattern of releases from the dams to the extent that these vegetation communities would be affected.

Two, there is only a narrow band of riparian vegetation, including some wetlands, along the river banks between the reservoirs and downstream of Caballo Dam that could be affected by releases and this vegetation has been previously considered by Reclamation in the SEA (Reclamation 2013a) or by the USIBWC (various). Release data from Section 4.6 and Table 4-8 are provided below, but the vegetation communities and wetlands along the river would be unaffected by implementation of one or another alternative.

Three, Caballo Reservoir pool levels would be relatively stable under all alternatives. The vegetation in and around this reservoir is relatively constant: it is dense near the water's edge and gradually reduces in density away from the water line. For these reasons, the analysis focuses on Elephant Butte Reservoir vegetation.

4.13.1 Analysis Methods and Assumptions

The RMBHM hydrologic modeling of reservoir elevations (Appendix C, Section 4,3) and surface area (Table 4-14) is used to project changes in vegetation communities in and around Elephant Butte Reservoir because, as noted by Dick-Peddie et al. (1999:27-32), moisture availability is the primary factor influencing vegetation patterns in New Mexico, although climatic regime and disturbances such as fire, flood, grazing, plowing, etc. influence the distribution of individual plants and some vegetation communities. However, the moisture availability caused by fluctuating water levels of Elephant Butte, like all reservoirs (cf. Lesica and Miles 2004), creates habitats different from those associated with natural riparian systems due to the repeated cycles of inundation that tend to prevent vegetation from proceeding beyond the earliest stages of succession.

Section 4.3 and Table 4-5 describe the projected average Elephant Butte Reservoir elevations by alternative and Table 4-14 shows the surface area of the reservoir, but the indicator for change in vegetation is the duration of cycles of inundation or drawdown, shown by the time series simulations for reservoir elevations (Figs. 12, 13).

4.13.1.1 Drawdown and Low Reservoir

Presently most of the vegetation at Elephant Butte Reservoir occurs in the sediment delta, from full pool at River Mile 62 to where the Rio Grande enters into the current baseline pool at River Miles 38 to 36, and there is a gradient in density/quality from west to east and south to north. In the future, as simulated by the RMBHM and Section 4.3, reservoir levels will fluctuate and the assumption is that when the reservoir recedes, as it has over the last decade, it will expose moist, bare alluvium that is rapidly colonized by annuals, biennials, short-lived perennials, as well as woody species such as cottonwood, willow, and tamarisk. If the water level of the reservoir remains low, without periodic inundation, the vegetation upstream and adjacent to the reservoir pool would mature over time through natural succession and would eventually shift to longer-lived, more xeric, upland species.

Tamarisk appears to be better adapted to colonizing drawdown reservoir pools, but tamarisk greater than five years old rarely grow in most reservoirs because three months of inundation may kill them (Ellis et al. 2008, Lesica and Miles 2004).

4.13.2.2 Inundation and High Reservoir

Historically, Elephant Butte Reservoir has fluctuated and this is expected to occur under all alternatives and all climate scenarios. In the future when the reservoir water surface elevation rises, some plants (including mature cottonwoods) and patches of riparian vegetation would benefit from the rising water table. Habitat that is partially inundated could be enhanced through deposition of new sediments and nutrients, flushing of accumulated salts, and irrigation of the respective site.

However, prolonged or complete inundation could result in the total loss of particular plants and patches of riparian habitat, with the losses depending on the particular species and age class. Based on monitoring of Elephant Butte Reservoir vegetation, young Goodding's willows are more flood tolerant than saltcedars (Reclamation 2009). Following a period of six months of inundation with 18 to 24 inches of water over the terminal bud primarily during the dormant season, Goodding's willow densities and heights increase. Similar observations have been reported by Ellis et al. (2008), who reported a die-off of saltcedar understory and survival of Goodding's willow at Roosevelt Lake, and by Lesica and Miles (2004) who found that tamarisk in reservoir pools were destroyed after two summers (three months) of inundation.

Prolonged or complete inundation, which is expected to occur during the analysis period, could result in the loss of some riparian habitat, and survivability would depend on species composition and age class. Ellis and others (2008) also found that most species were not able to survive more than one year of complete inundation. Reclamation (2009) has also previously reported that partial (10 to 15 feet) and temporary (less than six months) flooding would likely cause a reduction in woody vegetation. The shrub layer, if present, could be slow to recover.

Figures 12 and 13 provide the time series outputs from the hydrological model, showing projected durations of time or cycles when Elephant Butte Reservoir would be rising or falling. These figures, combined with the data on surface area of the reservoir in Table 4-14, are used to project vegetation effects of the alternatives. As shown by Table 4-14, the maximum difference in average values among the alternatives would be about 1,000 acres.

Table 4-14 Elephant Butte Reservoir mean surface area (acres) by alternative and climate scenario

Area &	Alternative				
Climate	1	2	3	4	5
Drier	8,780	7,637	8,878	8,299	8,533
Average	11,425	10,493	11,570	11,127	11,404
Wetter	11,349	10,478	11,661	10,958	11,306

Figure 12. Time series of Elephant Butte Reservoir by alternatives under a drier climate scenario.

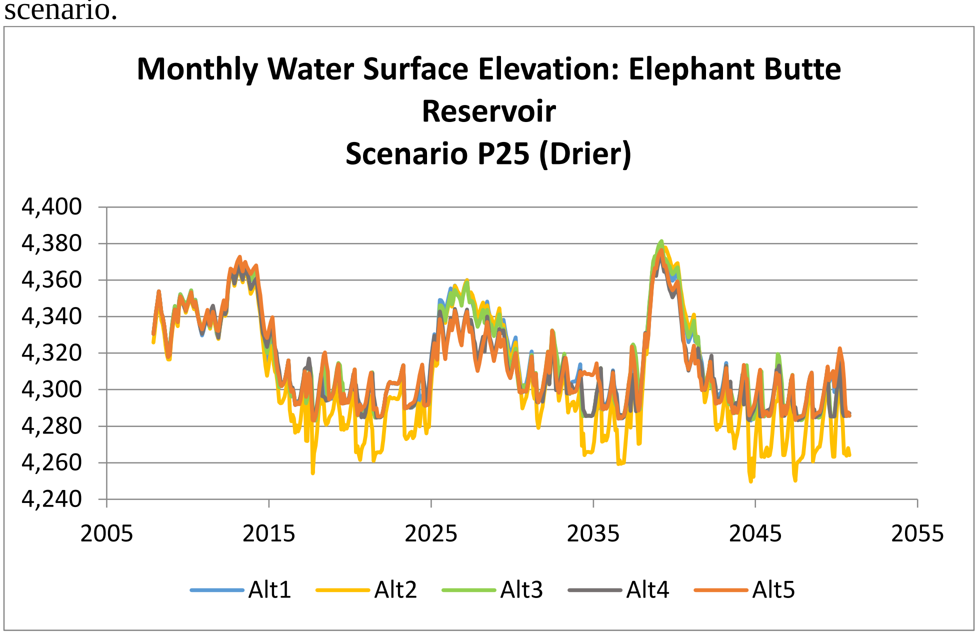
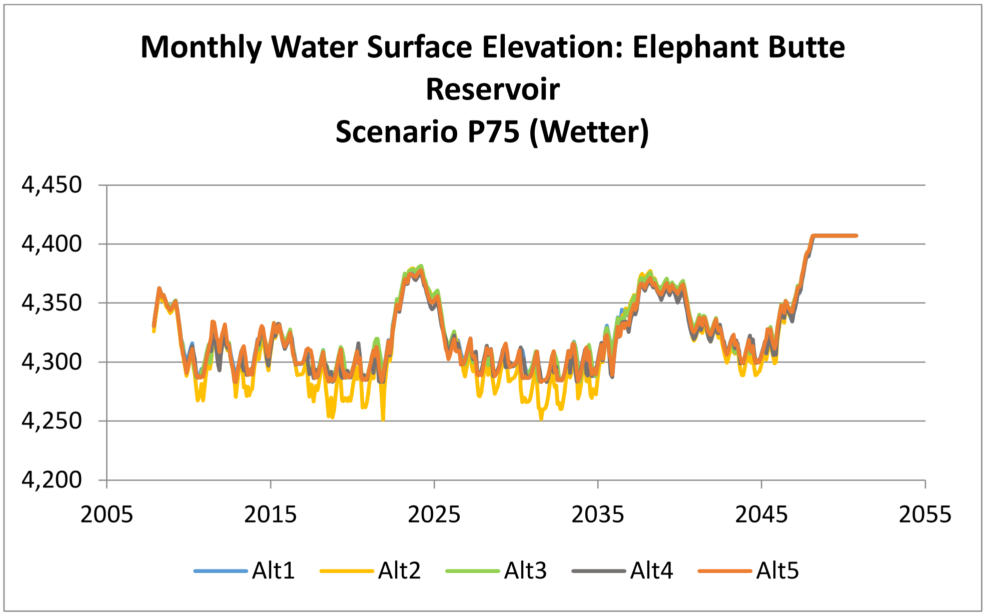


Figure 13. Time series of Elephant Butte Reservoir by alternatives under a wetter climate scenario.



4.13.3 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Alternative 1 is projected to have three periods of reservoir drawdown that could affect vegetation under all climate scenarios. As shown in Table 4-14, under Alternative 1, the average surface area of Elephant Butte Reservoir under the central tendency climate scenario would potentially cover or inundate 11,425 acres. The difference from No Action is projected to be an average of only 21 acres under central tendency climate conditions. Under central tendency climate conditions, releases under Alternative 1 would tend to be slightly higher (1,212 acre-feet) than Alternative 5 (No Action), but for the reservoir and river, there would be no difference to vegetation between Alternative 1 (Preferred) and Alternative 5 (No Action).

4.13.4 Alternative 2: No San Juan–Chama Project Storage

Alternative 2 would also have the same three periods of reservoir drawdown, but would tend to remain at lower levels than the other alternatives. Under Alternative 2, average surface area of Elephant Butte Reservoir under the central tendency climate scenario would be 10,493 acres, a difference of 910 acres from Alternative 5 (No Action). Releases would be the same as Alternative 1.

4.13.5 Alternative 3: No Carryover Provision

Alternative 3 would have the same three periods of reservoir drawdown that could affect vegetation. Average surface area under central tendency climate would cover or inundate 11,570 acres. Under the wetter climate scenario, vegetation would be the most affected with a projected mean of 11,661 acres inundated. For vegetation, the releases would be virtually the same as Alternative 5; the average difference in total releases would be -667 acre-feet.

4.13.6 Alternative 4: No Diversion Ratio Adjustment

Alternative 4 would tend to be the same as Alternative 5, which exhibits the same three periods of reservoir drawdown periods as the other alternatives. Average surface area under the central tendency climate scenario would cover or inundate 11,127 acres; i.e., 298 acres less than Alternative 1 and 277 acres less than Alternative 5. Under Alternative 4, releases would vary the most from Alternative 5 (No Action), with the average total release under the central tendency climate condition 3,282 acre-feet higher than Alternative 5.

4.13.7 Alternative 5: Prior Operating Practices, No Action Alternative

Alternative 5 (No Action) is projected to have the same three periods of reservoir drawdown that could affect Elephant Butte Reservoir vegetation. Average surface area under the central tendency climate scenario would cover or inundate 11,404 acres, less vegetation (surface acres) than Alternatives 1, 2, or 3, but it would tend to cover more surface acres than Alternative 4. Releases would be most similar to Alternative 3, with slightly higher total releases under Alternatives 1, 2, and 4, but again, no differences in moisture availability to riverine plants or wetlands is expected under any of the alternatives.

4.14 Wildlife and Special Status Species

Effects on wildlife are mostly based on how the alternatives would affect vegetation that serves as wildlife habitat in and around Elephant Butte Reservoir, especially the delta reach. The analysis focuses on the potential effects to flycatcher and the cuckoo. The endangered mouse is not expected to occur in the study area because of the lack of suitable habitat. Further, there is no proposed critical habitat for the mouse in the study area; the nearest proposed critical habitat is approximately 16 river miles upstream, at Bosque del Apache National Wildlife Refuge.

4.14.1 Analysis Methods and Assumptions

The analysis method for special status species is to determine the potential for the alternatives, particularly Alternative 1, the Preferred Alternative, to affect listed species or their critical habitat. Reclamation prepared a biological assessment of the effects of Alternative 1 on listed species and their critical habitat and consulted with the Service. The Service's biological opinion is provided in Appendix F.

In addition to how the cycles of rising or falling reservoir levels affect vegetation or wildlife habitat, indicators specific to wildlife include:

- Decline in reservoir elevations, which degrades the riparian habitat along the outside edge of the reservoirs, but also enhances and creates riparian habitat within the reservoir area from River Mile 62 to River Miles 38 to 36
- Death or decreased reproductive success of wildlife species due to habitat alteration

Current and historical information from field surveys conducted by Reclamation or others, as well as a literature review, was used to document the status of the species and their habitat in 2014—the environmental baseline for consultation with the Service under the ESA. If the presence of a listed species or supporting habitat features were determined to be likely, then the alternatives' potential effects were analyzed to determine whether they would affect the species or associated habitat. The following considerations apply:

- Fluctuations in Elephant Butte Reservoir and Caballo Reservoir water levels up to the full pool have historically been a normal feature of the reservoirs.

- The habitat that currently supports the largest flycatcher population in the Southwest was created when the Elephant Butte Reservoir receded, allowing various age classes of vegetation to develop.
- Based on hydrologic data collected since 2004, a large part of the northern portion of the reservoir pool receives water throughout the year. The source of this water is agricultural return from the outfall of the low flow conveyance channel (Reclamation 2005) and not from the river channel into the Elephant Butte Reservoir. Though habitats are changing, suitable habitat in this portion of the reservoir pool remains relatively abundant.
- The revised designated critical habitat for the flycatcher and proposed critical habitat for the cuckoo includes a part of the Elephant Butte Reservoir delta reach, downstream to River Mile 54. Above River Mile 54, the reservoir inundates designated critical habitat.
- The flycatcher and cuckoo are presently restricted to elevations in Elephant Butte Reservoir above 4,325 feet, which was the baseline for consultation with the Service. Flycatcher designated critical habitat and cuckoo proposed critical habitat extends to River Mile 54, at approximately the 4,380-foot elevation. The action's primary determinant of effect on birds would be months when Elephant Butte Reservoir surface elevation rises and remains greater than 4,325 feet. Above this elevation, rising waters might inundate and potentially affect flycatcher.
- Based on the 2014 flycatcher surveys, approximately 31 percent of the flycatcher territories (260) and 65.1 percent (161) of cuckoo territories would be affected by the reservoir rising to 4,380 feet (Moore and Ahlers 2015, Reclamation 2015b). The reservoir elevations typically begin rising in November, after minimum storage occurs in October, continuing to maximum storage peaks for the year as the spring releases begin, following irrigation demands. Thus, reservoir levels typically increase in the fall after flycatchers and cuckoos have departed for over-wintering territories and higher reservoir levels due to runoff end in the spring when the birds begin to establish breeding territories.

4.14.2 Effects Common to All Alternatives

References such as Reitan and Thingstad (1999) and the simulated reservoir water surface elevations presented in Section 4.3 and Table 4-5, were used to extrapolate potential effects of the alternatives into the future, relative to the range in water surface elevations from full pool (4,407 feet) to the 4,325 foot elevation level where flycatcher and cuckoo territories are currently, and the 4,380 foot elevation at River Mile 54 where the flycatcher designated critical habitat and the proposed cuckoo critical habitat extend into Elephant Butte Reservoir. The modeling simulates recurring cycles during which Elephant Butte Reservoir elevation would rise above the 4,325-foot level for different lengths of time. As shown in Figs. 12, 13 and Table 4-14, there are times when the reservoir is projected to rise above 4,325 feet, but most of the time, the reservoir would be below this level. As such, implementing one or another of the alternatives through 2050 is projected to produce little, if any, differences in direct effects on flycatchers, cuckoo, or their habitat in these segments, beyond impacts associated with current operations and climate variability.

Effects on flycatcher and cuckoo habitat under all alternatives are projected to be as follows:

- Without inundation from rising pool elevations, nutrients would not be replenished and salts would not be flushed in areas of trees associated with flycatchers and cuckoos. This would reduce the vigor of vegetation, degrading its overall habitat suitability for flycatchers and cuckoos. Periods of lower water inflows and lower pool elevations in Elephant Butte Reservoir would lead to maturation of vegetation communities and changes in species composition that could eventually render flycatcher and cuckoo nesting habitat unsuitable. This would come about without other types of disturbance in the delta reach, such as fire or mechanical disturbance.
- Inundation could create short-term impacts on birds and shrubs through the physical loss of riparian vegetation (Service 2014a); however, over the long term, a rising reservoir would support riparian vegetation by increasing the water table in some areas, resulting in denser vegetation and taller trees favored by the birds. Inundation would also flush accumulated salts from the soils, replenish nutrients, and deposit new sediments.

4.14.3 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, Table 4-14 and Figs. 12-13, and show there would be periods of both increasing and decreasing reservoir levels under all climate scenarios. To assess impacts on special status species, Reclamation consulted with the Service on the effects of the wetter climate scenario, which provided a conservative worst-case, based on the potential impacts to vegetation used by listed species. Reclamation's finding is that implementation of Alternative 1 "may affect, and is likely to adversely affect" flycatcher and cuckoo that could be present in Elephant Butte Reservoir. Compared to the 2014 baseline, individual birds may be displaced and some territories/nests may be inundated by a rising reservoir. Such a rising reservoir would result in only minor adverse effects because there is more suitable habitat available that is not being used, and vegetation regrowth could occur quickly under the right conditions.

Reclamation's finding for critical habitat is that Alternative 1 "may affect, and is likely to adversely modify" flycatcher designated critical habitat and cuckoo proposed critical habitat. Modeling presented in Section 4.3 and Table 4-5 shows that reservoir rising/filling would inundate existing critical habitat. This determination is also appropriate for indirect effects related to the habitat south of River Mile 54, which is projected to be regularly inundated due to water level increases in the reservoir.

Additionally, note that willow habitat, documented to be preferred for nesting in the delta reach of the Elephant Butte Reservoir, matures with time, becoming unsuitable for flycatcher nesting (Reclamation 2013a, Service 2002). Similarly, as described in the proposed critical habitat designation (Service 2014b), cuckoos require large tracts of willow-cottonwood forest or woodland for their nesting habitat. This habitat also matures with time, becoming unsuitable for cuckoo nesting. Prolonged flooding of the overly mature habitat would likely destroy the old vegetation. Quality nesting habitat would then be regenerated after the reservoir water level recedes.

4.14.4 Alternative 2: No San Juan–Chama Project Storage

Alternative 2 tends to reduce the reservoir water surface elevation relative to Alternative 5 (No Action). Under Alternative 2, Elephant Butte Reservoir would reach a lower elevation than under the other alternatives, and there would most likely be longer periods of lower elevations.

Therefore, the impacts on flycatchers and cuckoos associated with a rising reservoir and a greater number of acres of habitat inundated would occur.

When the reservoir recedes, reservoir bottomlands or nutrient-enriched exposed soils would quickly be revegetated with both desirable species, such as willow, and undesirable species, such as nonnative or invasive plants. This recession could create habitat for the flycatcher and cuckoo. If the reservoir were to remain at low water levels, habitat upstream to River Mile 62 and next to the reservoir pool would ultimately mature through natural succession past a point of suitability for the flycatcher and cuckoo. A low reservoir level equates to lower water in the Rio Grande system overall, so under drier conditions in the future degrading riparian vegetation would eventually be replaced by more upland species until the reservoir levels increase and this older vegetation is replaced.

Alternative 2 has the greatest potential for creating habitat, if the reservoir were to fill, depending on the timing and duration of filling. Alternative 2 also has the greatest amount of habitat that could be inundated and potentially destroyed. Therefore, under Alternative 2, riparian vegetation would expand, leading to more flycatcher and cuckoo habitat. Conversely, under Alternative 2, flycatcher and cuckoo habitat has the greatest potential for maturing beyond the point of suitability. It could also lead to increased drying and expansion of upland vegetation into formerly riparian areas.

4.14.5 Alternative 3: No Carryover Provision

Under Alternative 3, Elephant Butte Reservoir water surface elevations would fluctuate over time. The birds currently are above the 4,325-foot elevation level, so some impacts are expected when the reservoir rises above that elevation.

4.14.6 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, Elephant Butte Reservoir water surface elevations would fluctuate over time. The birds are presently located above 4,325 feet, so under Alternative 4 some impacts are expected when the reservoir rises above that elevation.

4.14.7 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the No Action Alternative, Elephant Butte Reservoir water surface elevations would fluctuate over time. Again, the birds are presently located above the 4,325-foot elevation level, so under Alternative 5 (No Action), some impacts would be expected when the reservoir rises above that elevation.

4.15 Aquatic Resources and Special Status Fish Species

This section projects effects of the alternatives on sport fish in the reservoirs and on the endangered Rio Grande silvery minnow, which is found in the riverine portion of Elephant Butte Reservoir.

4.15.1 Analysis Methods and Assumptions

Previous studies indicate the sport fishery benefits when the reservoirs rise or with full, stable reservoirs (Ozen 2002, Sammons and Bettoli 2000). The New Mexico Department of Game and Fish (NMDGF 2011, 2015b) reported that fluctuating water levels, both annual and inter-annual, plus resulting high turbidities and a general lack of emergent vegetation produce poor habitat conditions for centrarchid species,[9] white bass, gizzard shad, and channel catfish in the reservoirs. Fluctuating water levels apparently result in increased populations of other species, such as blue catfish.

The NMDGF reported that declining water levels during spawning, water turbidity, and inadequate forage seem to be the limiting factors for smallmouth bass and largemouth bass populations. Because Elephant Butte Reservoir is 100 years old, it tends to have very little aquatic emergent or sub-emergent vegetation to provide a viable seed bank in years when water levels rise. As such, the development of necessary emergent vegetation communities commonly associated with healthy bass populations is lacking. The NMDGF (2011) adds that it is important to have flooded vegetation every three to four years to produce strong year classes of largemouth bass, which is what occurs as the reservoir fills since the upper portion of the reservoir is flatter with more recurring vegetative growth.

The NMDGF (2015b) suggests that centrarchid habitat could be improved if the lake would refill to near capacity. However, multiple years of low lake levels have allowed natural revegetation in the upper lake and have depressed centrarchids and other fish populations.

The analysis method is considering the potential effects of the alternatives on water resources to determine whether these would affect aquatic wildlife and their habitats. Reclamation considered data and information related to hydrology modeling used to develop the baseline conditions for aquatic resources in the study area. It used these data to assess potential biological responses to habitat condition modifications, including reservoir inundation extremes, during the assessment period (relative to baseline conditions of 2014).

Fluctuations in reservoir water surface elevations are anticipated during the 43-year simulation period for all alternatives and climate scenarios. In general, the Rio Grande silvery minnow would be expected to benefit from lower water levels and a longer river channel into Elephant Butte Reservoir.

In addition, Elephant Butte Reservoir is projected to reach capacity or full pool during both the central tendency and wetter climate scenarios (Appendix C). In general, sport fish would benefit from an increasing reservoir shoreline and flooded vegetation; although riverine fish would have slightly less riverine habitat in the reservoir pool, they are expected to move upstream to suitable habitat as the reservoir fills.

4.15.2 Effects Common to All Alternatives

Under all alternatives, there would be cycles of rising and falling reservoirs. During wetter periods, when the RMBHM model simulates rising water levels in the reservoirs, the populations of sport fish may increase or improve, while periods of reservoir decline would benefit the endangered Rio Grande silvery minnow due to increased riverine conditions.

For sport fish, periods of low water elevations might result in the localized loss of some species and restocking would be necessary to maintain or enhance the public’s recreational opportunities. Fish stocking by NMDGF is commonly practiced to augment various fish species populations in both reservoirs.

[9] e.g., largemouth and smallmouth bass, crappie, and bluegill

4.15.3 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, Elephant Butte Reservoir is predicted to reach slightly higher maximums during modeled wet periods than predicted for the other alternatives (Fig. 13). Sport fish would benefit from an increasing reservoir shoreline and flooded vegetation; riverine fish would have slightly less habitat in the reservoir pool, but they are expected to move upstream to suitable habitat as the reservoir levels increase. Riverine fish species in Elephant Butte Reservoir headwaters would benefit from a lower reservoir and a longer river channel into the reservoir, while lake fish would have slightly less habitat in the reservoir pool.

4.15.3.1 Rio Grande Silvery Minnow

The model simulation indicates that Elephant Butte Reservoir would fill under both average and wetter climate scenarios (Fig. 13) and would displace minnows in the delta channel as the water elevation rises. The minnows would be displaced to more upstream reaches of the river in the delta reach until Elephant Butte Reservoir reaches its full storage volume. This gradual upstream movement of minnows could extend into their critical habitat reach of the Rio Grande, upstream of the full pool extent of Elephant Butte Reservoir (River Mile 62).

As the reservoir pool subsequently contracts, the minnows could and likely would again repopulate the river channel within the reservoir. Minnows could swim freely in the available delta channel habitat of the reservoir. Reclamation would continue to maintain the delta channel for efficient delivery of water to the reservoir; even without a maintained channel, a naturally formed river channel would develop as long as upstream river flows were sufficient to enter the Elephant Butte Reservoir pool. The minnow is not considered to live within the Elephant Butte Reservoir past the furthest south point of the river channel due to a lack of appropriate food and habitat. Minnows do not occur in the other downstream Rio Grande reaches of the OA study area below Elephant Butte Reservoir. The minnow has been extirpated from the river below Elephant Butte Reservoir, except for the pilot population of introduced minnows in Big Bend, Texas. Due to the absence of minnows in these reaches of the study area, continued implementation of the OA would not affect this species.

Reclamation consulted with the Service on the effects of implementing Alternative 1 on the Rio Grande silvery minnow and the Service's biological opinion is presented in Appendix F. The analysis was based on the wetter climate scenario, which constitutes a conservative, worst-case for the minnow and its habitat. Reclamation's finding was that given future fluctuations under Alternative 1, and based on the observations of biologists that in low water conditions, the minnow is able to move upstream/downstream, following the water, the action "may affect, is not likely to adversely affect" the minnow. With sufficient magnitude and duration of reservoir filling, critical habitat upstream of River Mile 62 may receive beneficial effects due to increased deposition of sediment north of the full pool of the reservoir.

4.15.4 Alternative 2: No San Juan–Chama Project Storage

The effects of Alternative 2 on the sport fish and the Rio Grande silvery minnow would be similar to those described under Alternative 1. The delta channel may extend farther into the reservoir for longer periods and would provide some additional riverine habitat due to fluctuations in reservoir levels.

4.15.5 Alternative 3: No Carryover Provision

The effects of Alternative 3 on sport fish and the Rio Grande silvery minnow would be almost identical to those described under Alternative 1 because of the fluctuations in reservoir levels over time.

4.15.6 Alternative 4: No Diversion Ratio Adjustment

The effects of Alternative 4 on sport fish and the Rio Grande silvery minnow would be almost identical to those under Alternative 1 because of the fluctuations in reservoir levels over time.

4.15.7 Alternative 5: Prior Operating Practices, No Action Alternative

Under the No Action Alternative (Alterantive 5) the effects on sport fish and the Rio Grande silvery minnow are projected to be the same as those under Alternative 1.

4.16 Invasive Species

4.16.1 Analysis Methods and Assumptions

As described in Section 4.13, the assumption is that lower reservoir levels may lead to the spread of noxious weeds and invasive plants including saltcedar, which competes with native, riparian vegetation. The spread of invasive animal species, including zebra and quagga mussels, is unrelated to reservoir elevations or releases from the dams. Therefore, these species are not relevant to the alternatives.

4.16.2 Effects Common to All Alternatives

The potential for spread and continued presence of invasive species, both plant and animal, would be the same under all alternatives. Invasive zebra and quagga mussels have been detected in upstream reservoirs. Under all alternatives, there is a potential for mussels to become established in Elephant Butte and Caballo Reservoirs; however, slight alterations in reservoir operations or flows in the river reaches do not affect the potential for the reservoirs' colonization or infestation by mussels. Preventative measures to clean boats entering and leaving reservoirs would continue under all alternatives.

4.17 Cultural Resources

4.17.1 Analysis Methods and Assumptions

Reclamation evaluated the effects of the alternatives on historic properties using the criteria defined in 36 CFR 800, which define adverse effects as "direct or indirect alteration of the characteristics that qualify a property for inclusion in the NRHP in a manner that diminishes integrity of location, design, setting, materials, workmanship, feeling, or association." The integrity of historic properties is assessed by the ability of the property to convey the important traditional, scientific, and public values for which it is determined to be historically significant.

4.17.2 Effects Common to All Alternatives

Under all alternatives, the effects would be the same: "no historic properties affected," in accordance with 36 CFR 800.4(d)(1). In November 2015, the New Mexico State Historic Preservation Officer concurred with this finding. (See Chapter 6 and Appendix D).

Because RGP water would continue to flow under all alternatives and allow the growth and harvesting of plants valued by the Mescalero Apache Tribe, there should be no effects to resources of tribal concern. No Indian sacred sites have been identified to date, and thus there would be no effect on these cultural resources.

4.18 Indian Trust Assets

4.18.1 Effects Common to All Alternatives

Government-to-government consultation to date with potentially affected tribes, including the Mescalero Apache Tribe and the Pueblo of Ysleta del Sur, has not identified any ITAs. Therefore, implementing any of the alternatives would have no impact on ITAs.

4.19 Socioeconomics

4.19.1 Impact Indicators

The socioeconomic analysis evaluated impacts of the alternatives on economic benefits and regional economic indicators, as listed below. The summary of the results is found in Section 4.19.5. Economic benefit (direct impact) indicators are:

1. Economic value of agricultural water use in EBID
2. Economic value of agricultural water use in EPCWID
3. Economic value of urban water use in EPCWID
4. Economic value of recreation at Elephant Butte Reservoir
5. Economic value of hydropower generation at Elephant Butte Powerplant

Regional economic indicators are:

1. Employment (full and part-time jobs)
2. Income (employee compensation and proprietors' income)
3. Output (sales)

4.19.2 Analysis Methods and Assumptions

The proposed alternatives are analyzed using two economic measures: 1) the economic benefits, or direct impacts; and 2) the regional economic impacts. The economic benefits or direct impacts measure the effects of each alternative from a societal standpoint (a gain or loss to society from a change in activities). The regional economic impacts measure the effects of each alternative on a region's economy (such as changes in employment and income).

For this FEIS, the net economic benefit and regional economic impact calculations rely on hydrologic outcomes of project alternatives as provided by the hydrology technical memorandum (Reclamation 2015c; Appendix C) and available economic data.

The economic benefits and regional economic impacts stemming from the use of RGP water under each alternative are calculated and presented along with the differences from Alternative 5, the No Action Alternative. The economic benefits or direct impacts and regional economic impacts are calculated for the following categories of water use or users:

1. EBID
2. EPCWID
3. Hydropower production at Elephant Butte Powerplant

4. Recreation benefits at Elephant Butte Reservoir

Note that the regional economic impacts are measured based on the same general water use categories except for hydropower production at Elephant Butte Powerplant.

4.19.2.1 Economic Benefits (Direct Impacts)

4.19.2.1.1 Elephant Butte Irrigation District

The estimation of net economic benefit value is limited to agricultural users and is based on the findings shown in the hydrology technical memorandum (Appendix C). The hydrologic simulation found that although depletion of shallow groundwater within the EBID service area occurs under all alternatives, the available supply to project irrigators was never exhausted, and therefore all crops received a full irrigation supply under all simulated conditions. The full impact of changes in project deliveries between alternatives is thus calculated as the differences in costs of pumping groundwater between alternatives.

The hydrologic modeling identified complete substitution of groundwater when surface water deliveries were not available. No changes in cropping or acreage resulted during the study period. Focusing solely on the Rincon and Mesilla Basins, the difference in the economic benefits between alternatives is limited to the differences in pumping costs incurred by project irrigators when surface water is not available.

Differences in costs of RGP surface water delivery between alternatives are not considered because costs are almost entirely fixed and are not volume dependent. While irrigators may experience differences in labor costs and other factors in using surface water instead of groundwater, there is no basis for quantifying these differences and so they are not considered.

Pumping costs are determined by the total volume pumped and the total head. Because both volume and head differ by alternative, each factor is used in calculating pumping costs. Capital costs are not considered, as all project irrigators are assumed by the hydrology technical memorandum (Appendix C) to have access to available supplemental groundwater as needed, and the relatively small volumes that differentiate alternatives are assumed to have no effect on pump lifetimes or maintenance costs.

Groundwater pumping cost calculation

The calculation of groundwater pumping costs was based on the energy costs of delivering the quantity of groundwater identified under each project alternative. The annual average groundwater delivery and the elevations and beginning of period well depths were taken from the hydrology technical memorandum (Appendix C), and the static head was taken from crop enterprise budgets for Sierra and Doña Ana Counties (New Mexico State University 2005). Energy (electric) costs and pump efficiency were likewise obtained from the crop enterprise budgets. The wells cover all cropping areas in EBID, and the simple average well elevation changes within each cropping area were used to calculate average pumping heads for each alternative.

Groundwater elevations for regions served by major canals were taken from the hydrology technical memorandum (Appendix C), which calculated groundwater elevations and initial groundwater depths. Groundwater elevations reported under each alternative for the 15 wells in the project area were averaged for the Rincon Valley and the Mesilla Valley Leasburg, Eastside, and Westside Canals. The total groundwater deliveries to EBID were allocated to each region based on the acreage reported in the hydrology technical memorandum (Appendix C). The starting well depth was also taken from the hydrology technical memorandum (Appendix C). The typical head across the region and study period was 70 to 80 feet with 50 feet of static head (New Mexico State University 2005) and a calculated 20 to 30 feet well depth to water.

A pump efficiency of 0.47 for electric pumps and an electricity cost of $0.1098/kilowatt-hour for electricity were taken from crop enterprise budgets (New Mexico State University 2005). The cost of electricity was adjusted to 2015 levels using the producer price index for North American Industry Classification System 2211, electric utilities. A resulting energy cost of $0.152/kilowatt-hour was used (price index 2015 = 144.3; 2005 index = 104.2). The potential energy conversion is 1.024 kilowatt-hour /acre-foot/foot, meaning that at 100 percent efficiency, 1.024 kilowatt-hour of energy is required to lift one acre-foot of water to a height of 1 foot.

4.19.2.1.2 El Paso County Water Improvement District Number 1

RGP deliveries to water users from the American Diversion Dam are not treated in the hydrologic modeling and there is no specific information on the disposition of RGP waters after delivery (Appendix C). The most recent financial report from El Paso Water (2015) gives an average year surface water delivery of 60,000 acre-feet for M&I uses, with these flows providing approximately half of the El Paso Water supply. The balance of the M&I water supplies is pumped from the Hueco and Mesilla Basins. All other surface water deliveries at the American Diversion Dam are then available for diversion for agricultural uses. (Deliveries to Mexico at the International Diversion Dam are included within the hydrologic modeling [Appendix C], and do not vary by alternative; therefore, they are not further considered in the economic analysis.) The historical full EPCWID allocation of 376,842 acre-feet then gives surface diversions of 316,842 acre-feet available for agricultural uses. Acreages of 6,494 and 62,516 in the Mesilla and El Paso Valleys, respectively, are used to calculate Mesilla and El Paso Valley full allocation diversions of 29,816 and 287,026 acre-feet, respectively. Any greater levels of urban surface water use would result in proportionally lower levels of Rio Grande agricultural diversions; this possibility is not considered here.

EPCWID El Paso Valley agricultural water users

Net benefits of RGP water use reported by Ward and Pulido-Velazquez (2012) are used to estimate the economic benefits associated with RGP surface water deliveries at the American Diversion Dam to El Paso Valley agricultural users. Their base scenario reports average deliveries to agricultural users of 237,000 acre-feet, with average net benefits of $112 per acre-foot. This is taken as the value of RGP surface water deliveries to El Paso Valley agricultural users when diversions fall below the full allocation level. According to Ward and Pulido-Velazquez (2012), agricultural users have not developed much groundwater pumping infrastructure and therefore are not reported to make significant use of groundwater to supplement their surface water use.

EPCWID El Paso Valley urban water users

El Paso urban uses rely heavily on groundwater, and sustainability of both the quantity and quality of groundwater supplies are a concern. To value the Rio Grande surface water delivered for urban use, the Ward and Pulido-Velazquez (2012) “sustaining” and “renewing” natural capital scenarios were used, which report a difference in urban water use of 6,000 acre-feet. The difference in the reported net benefits to urban water users is $574 per acre-foot and is taken here as the value of RGP water in El Paso urban uses when supply falls below 60,000 acre-feet.

Distribution between agricultural and urban users

The hydrology technical memorandum hydrologic studies provide no guidance on the distribution of RGP water to urban versus agricultural uses (Appendix C). Because values in urban and agricultural uses can be substantially different, economic valuation would be sensitive to this distribution. The economic analysis here assumes that RGP water is distributed proportionally to urban and agricultural uses throughout the study period, and that urban uses are held to 60/376.842 = 15.9 percent of total EPCWID diversions, and agricultural uses receive 84.1 percent of diversions.

EPCWID Mesilla Valley agricultural water users
Deliveries of RGP water to EPCWID agricultural water users in the Mesilla Valley are valued identically to EBID agricultural water users. The hydrologic studies show full availability of groundwater to substitute for surface water when diversions fall below allocations. Total benefits from the use of groundwater and RGP surface water are calculated identically to EBID project users.

4.19.2.1.3 Hydropower
The hydroelectric plant at Elephant Butte Dam generates power that is dependent on flow volume and head. Because both flows and reservoir elevation would differ between alternatives, expected power generation would also vary. There is currently no hydroelectric production at Caballo Dam, and thus no economic differences between alternatives exist, despite differing releases between alternatives.

Reservoir elevation and releases
The hydrology technical memorandum provides monthly elevations at Elephant Butte Reservoir for each alternative (Appendix C, Reclamation 2015c). Power production does not occur during winter months when RGP releases do not occur. Hydropower calculations are thus based on the calculated average elevation during the March to October period only. Annual releases from Elephant Butte Reservoir reported by the hydrology technical memorandum, reduced by the volume of spills, are used with the March to October average elevations (Appendix C) to calculate hydropower generation.

Power plant characteristics and valuation
The Elephant Butte Powerplant has a rated head of 140 feet and is assumed to operate with 90 percent efficiency. Energy generation is calculated from reservoir elevation, with the rated head achieved at the maximum elevation over the study period, and the potential energy conversion of 1.024 kilowatt-hour per acre-foot per foot of head. Calculated production based on the average March to October monthly elevation and release data for 2014 is 3 percent below the actual power plant production of 13.4 gigawatt-hours reported by Reclamation (2015d). Economic valuation of production is based on the economic opportunity cost concept and uses the same $0.152/ kilowatt-hour value as is assigned to the cost of groundwater pumping. This neglects distribution costs and losses (which would suggest a lower figure), but also does not consider use of the power plant for short-term peaking operations (which suggest an increased valuation). Reservoir elevation for purposes of hydropower calculations use only Alternative 1 reported values.

4.19.2.1.4 Recreation
Elephant Butte Reservoir provides a variety of recreational benefits that vary based on reservoir storage. Because storage varies between project alternatives, recreational benefits are calculated for Elephant Butte Reservoir. Similarly, Caballo Reservoir provides recreational benefits. These benefits are not addressed, however, because the differences in Caballo Reservoir storage among alternatives are small and would not result in significant differences in economic benefits from recreation at Caballo Reservoir under each alternative.

Annual recreation benefits reported by Ward and Pulido-Velazquez (2012) are based on:

$$\text{Value of Elephant Butte Reservoir recreation} = 379.82 + 2.21\,X - 0.0005030852\,X^2$$

where X equals the average annual storage in thousand acre-feet and the economic value is in thousand dollars. Management costs of $0.31 per acre-foot of storage (due to increased visitation) are also identified (Ward 2014) and deducted from the economic benefit calculation reported here. The hydrology technical memorandum annual average reservoir storage is used with the above equation to estimate direct economic benefits of recreation (Reclamation 2015c, Appendix C).

4.19.2.2 Regional Economic Impacts

In addition to considering the net economic benefits or direct impacts of each alternative, the socioeconomic analysis estimates the potential regional economic impacts. The regional impacts may stem from changes in agricultural pumping costs, the costs of providing urban water, and recreation visitation expenditures. These direct economic impacts are input into the IMPLAN model to estimate total regional impacts. The direct economic impacts of hydropower are assumed to have no impacts on the regional economy.

IMPLAN is the modeling package used to assess the regional economic impacts stemming from the direct impacts associated with each alternative. IMPLAN is an economic input-output modeling system that estimates the effects of economic changes in a defined analysis area. IMPLAN is a static model that estimates impacts for a snapshot in time when the impacts are expected to occur, based on the makeup of the economy at the time of the underlying IMPLAN data. IMPLAN measures the initial impact on the economy but does not consider long-term adjustments as labor and capital move into alternative uses. Realistically, the structure of the economy would adapt and change; therefore, the IMPLAN results can only be used to compare relative changes between the No Action Alternative and the action alternatives and cannot be used to predict or forecast future employment, labor income, or output (sales).

Input-output models measure commodity flows from producers to intermediate and final consumers. Purchases for final use (final demand) drive the model. Industries produce goods and services for final demand and purchase goods and services from other producers. These other producers, in turn, purchase goods and services. This buying of goods and services (indirect purchases) continues until leakages from the analysis area (imports and value added) stop the cycle. These indirect and induced effects (the effects of household spending) can be mathematically derived using a set of multipliers. The multipliers describe the change in output for each regional industry caused by a $1.00 change in final demand.

This analysis used 2013 IMPLAN data for the counties encompassing the study areas. IMPLAN data files for the analysis area are compiled from a variety of sources, including the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, and the U.S. Census Bureau.

4.19.3 Economic Benefits (Direct Impacts)

4.19.3.1 Elephant Butte Irrigation District

The hydrologic modeling assumes there are no changes in cropping or acreage during the study period. Focusing solely on the Rincon and Mesilla Basins, the difference in the economic benefits or direct impacts between alternatives is limited to differences in pumping costs incurred by project irrigators when surface water is not available. The hydrology modeling assumes that the cropping pattern for each service area within the model domain is based on cropping data available for the year 2000.

The average annual ground water supply available to EBID as estimated by the hydrology model (Appendix C) are shown above in Section 4.10 entitled Farm Groundwater Deliveries. These EBID deliveries are split between the Rincon (roughly 20 percent) and Mesilla (roughly 73 percent) Valleys based on the acreage distribution between the two valleys (including EPCWID land in the Mesilla Valley).

Table 4-15 EBID average annual pumping costs (millions of dollars) by alternative and climate scenario

Valley & Climate	Alternative 1	2	3	4	5
Rincon					
Drier	1.3	1.3	1.3	1.1	1.1
Central	1.1	1.1	1.1	0.9	0.9
Wetter	1.0	1.0	1.0	0.8	0.9
Mesilla					
Drier	4.7	4.7	4.6	4.1	4.2
Central	4.1	4.1	3.8	3.4	3.4
Wetter	3.6	3.6	3.7	2.9	3.1

Table 4-16 EBID Agricultural benefit values (millions of dollars) relative to a change between No Action and action alternatives and climate scenario

Valley & Climate	Alternative 1	2	3	4	5
Rincon					
Drier	-0.2	-0.2	-0.2	0.0	No Action
Central	-0.2	-0.2	-0.2	0.0	No Action
Wetter	-0.1	-0.1	-0.1	0.1	No Action
Mesilla					
Drier	-0.5	-0.5	-0.4	0.1	No Action
Central	-0.7	-0.7	-0.4	0.0	No Action
Wetter	-0.5	-0.5	-0.6	0.2	No Action
Total					
Drier	-0.7	-0.7	-0.6	0.1	No Action
Central	-0.9	-0.9	-0.6	0.0	No Action
Wetter	-0.6	-0.6	-0.7	0.3	No Action

4.19.3.1.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the estimated pumping costs equal $1.1 million in the Rincon Valley and $4.1 million in the Mesilla Valley based on the central climate scenario as shown in Table 4-15. The impact of this alternative is measured relative to Alternative 5 (No Action) as shown in Table 4-16. Under Alternative 1, pumping costs increase relative to Alternative 5, therefore under this alternative, economic benefits decrease, based on the central climate scenario, by $0.2 in the Rincon Valley and $0.7 in the Mesilla Valley.

4.19.3.1.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Tables 4-15 and 4-16, Alternative 2 would be the same as Alternative 1.

4.19.3.1.3 Alternative 3: No Carryover Provision

Under Alternative 3, the estimated pumping costs equal $1.1 million in the Rincon Valley and $3.8 million in the Mesilla Valley based on the central climate scenario as shown in Table 4-15. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-16. Under Alternative 3, pumping costs increase relative to Alternative 5, therefore under this alternative economic benefits decrease, based on the central climate scenario, by $0.2 and $0.4, in the Rincon Valley and Mesilla Valley, respectively.

4.19.3.1.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the estimated pumping costs equal $0.9 million in the Rincon Valley and $3.4 million in the Mesilla Valley based on the central climate scenario as shown in Table 4-15. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-16. Under Alternative 4, pumping costs do not change relative to Alternative 5, therefore under this alternative economic benefits are unchanged, based on the central climate scenario, in both the Rincon and Mesilla Valleys.

4.19.3.1.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the estimated pumping costs equal $0.9 million in the Rincon Valley and $3.4 million in the Mesilla Valley based on the central climate scenario as shown in Table 4-15. Alternative 5 is the No Action Alternative, therefore the impacts of the action alternatives are relative to this alternative.

4.19.3.2 El Paso County Water Improvement District No. 1

As discussed in Section 4.19.2, EPCWID supplies water to both agricultural water users and urban or M&I users. The economic benefits and regional economic impacts are analyzed separately for agricultural and M&I water uses. The average annual water supply available to EPCWID is estimated by the hydrology model (Appendix C). The economic analysis here assumes that RGP water is distributed proportionally to M&I (15.9 percent of diversions) and agricultural (84.1 percent of diversions) uses throughout the study period.

4.19.3.2.1 El Paso Valley agricultural use

EPCWID El Paso Valley agricultural water use value is based on the net benefits of RGP water use reported by Ward and Pulido-Velazquez (2012). Agricultural users in this area are not reported to make significant use of groundwater to supplement their surface water use. Therefore, the agricultural benefit value is based on the effects of surface water deliveries for each alternative as it relates to surface water deliveries.

Table 4-17 EPCWID El Paso Valley average annual agricultural benefits (millions of dollars) by alternative and climate scenario

Valley & Climate	Alternative 1	2	3	4	5
Drier	20.6	20.6	20.5	19.2	19.5
Central	23.4	23.4	22.8	22.0	21.7
Wetter	26.2	26.2	26.3	25.3	25.2

Table 4-18 EPCWID El Paso Valley average annual agricultural benefits changes (millions of dollars) between alternatives and climate scenario

Valley & Climate	Alternative 1	2	3	4	5
Drier	1.1	1.1	1.0	-0.3	No Action
Central	1.7	1.7	1.1	0.3	No Action
Wetter	1.0	1.0	1.1	0.1	No Action

4.19.3.2.1.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the estimated value of production is $23.4 million in the El Paso Valley based on the central climate scenario as shown in Table 4-17. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-18. Under Alternative 1 based on the central climate scenario, the change in value of production is $1.7 million compared to Alternative 5.

4.19.3.2.1.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Tables 4-17 and 4-18, Alternative 2 would be the same as Alternative 1. Under Alternative 2 based on the central climate scenario, the change in value of production is $1.7 million compared to Alternative 5 (No Action).

4.19.3.2.1.3 Alternative 3: No Carryover Provision

Under Alternative 3, the estimated value of production is $22.8 million in the El Paso Valley based on the central climate scenario as shown in Table 4-17. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-18. Under Alternative 3 based on the central climate scenario the change in value of production is $1.1 million compared to Alternative 5.

4.19.3.2.1.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the estimated value of production is $22.0 million in the El Paso Valley based on the central climate scenario as shown in Table 4-17. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-18. Under Alternative 4 based on the central climate scenario the change in value of production is $0.3 million compared to Alternative 5.

4.19.3.2.1.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the estimated value of production is $21.7 million in the El Paso Valley based on the central climate scenario as shown in Table 4-17. Alternative 5 is the No Action Alternative, therefore the impacts of the action alternatives are relative to this alternative.

4.19.3.2.2 Mesilla Valley agricultural use

In the Mesilla Valley, the hydrologic studies show full availability of groundwater to substitute for surface water when diversions fall below allocations. The difference in the economic benefits or direct impacts between alternatives is limited to differences in pumping costs incurred by project irrigators when surface water is not available.

Table 4-19 EPCWID Mesilla Valley agricultural benefit values relative to a change ($ millions) between No Action and action alternatives and climate scenario

Mesilla Valley & Climate	Alternative 1	2	3	4	5
Drier	0.3	0.3	0.4	0.4	0.4
Central	0.3	0.3	0.3	0.3	0.3
Wetter	0.2	0.2	0.2	0.2	0.3

Table 4-20 EPCWID Mesilla Valley annual agricultural benefits changes ($ millions) between No Action and action alternatives by alternative and climate scenario

Mesilla Valley & Climate	Alternative 1	2	3	4	5
Drier	0.1	0.1	0.0	0.0	No Action
Central	0.0	0.0	0.0	0.0	No Action
Wetter	0.1	0.1	0.1	0.1	No Action

4.19.3.2.2.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the estimated pumping cost is $0.3 million in the Mesilla Valley based on the central climate scenario as shown in Table 4-19. The impact of this alterative is measured relative to the No-Action Alternative (Alternative 5) as shown in Table 4-20. There is no change in pumping costs under Alternative 1 compared to the No-Action Alternative; therefore, the economic benefit value is unchanged.

4.19.3.2.2.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Tables 4-19 and 4-20, Alternative 2 would be the same as Alternative 1. There is no change in pumping costs under Alternative 2 compared to Alternative 5 (No Action); therefore, the economic benefit value is unchanged.

4.19.3.2.2.3 Alternative 3: No Carryover Provision

Under Alternative 3, the estimated pumping cost is $0.3 million in the Mesilla Valley based on the central climate scenario as shown in Table 4-19. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-20. There is no change in pumping costs under Alternative 3 compared to Alternative 5; therefore, the economic benefit value is unchanged.

4.19.3.2.2.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the estimated pumping cost is $0.3 million in the Mesilla Valley based on the central climate scenario as shown in Table 4-19. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-20. There is no change in pumping costs under Alternative 4 compared to Alternative 5; therefore, the economic benefit value is unchanged.

4.19.3.2.2.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the estimated pumping cost is $0.3 million in the Mesilla Valley based on the central climate scenario as shown in Table 4-19. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-20. Alternative 5 is the No Action Alternative; therefore, the impacts of the action alternatives are relative to this alternative.

4.19.3.2.3 EPCWID El Paso Valley urban use

The Ward and Pulido-Velazquez (2012) values were used to estimate the economic benefit values for urban water use in EPCWID as explained in Section 4.19.2. A value of $574 per acre-foot was applied to the estimated average annual urban deliveries to estimate the average annual benefits value for the alternative.

Table 4-21 EPCWID El Paso Valley urban use average annual economic benefits ($ millions) by alternative and climate scenario

El Paso Valley & Climate	Alternative 1	2	3	4	5
Drier	19.9	19.9	19.6	18.3	18.3
Central	22.8	22.8	21.8	21.2	20.7
Wetter	25.3	25.3	25.1	23.8	23.7

Table 4-22 EPCWID El Paso Valley urban use average annual economic benefits ($ millions) changes between No Action and action alternatives by alternative and climate scenario

El Paso Valley & Climate	Alternative 1	2	3	4	5
Drier	1.6	1.6	1.3	0.0	No Action
Central	2.1	2.1	1.1	0.5	No Action
Wetter	1.6	1.6	1.4	0.1	No Action

4.19.3.2.3.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the estimated value of urban water in EPCWID is $22.8 million based on the central climate scenario as shown in Table 4-21. The impact of this alterative is measured relative to Alternative 5 (No Action), as shown in Table 4-22. Under Alternative 1 based on the central climate scenario the change in value is $2.1 million compared to Alternative 5.

4.19.3.2.3.2 Alternative 2: No San Juan–Chama Project

As shown in Tables 4-21 and 4-22, Alternative 2 would be the same as Alternative 1. Under Alternative 2 based on the central climate scenario, the change in value is $2.1 million compared to Alternative 5 (No Action).

4.19.3.2.3.3 Alternative 3: No Carryover Provision

Under Alternative 3, the estimated value of urban water in EPCWID is $21.8 million based on the central climate scenario as shown in Table 4-21. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-22. Under Alternative 3 based on the central climate scenario, the change in value is $1.1 million compared to Alternative 5.

4.19.3.2.3.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the estimated value of urban water in EPCWID is $21.2 million based on the central climate scenario as shown in Table 4-21. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-22. Under Alternative 4 based on the central climate scenario the change in value is $0.5 million compared to Alternative 5.

4.19.3.2.3.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the estimated value of urban water in EPCWID is $20.7 million based on the central climate scenario as shown in Table 4-21. Alternative 5 is the No Action Alternative; therefore, the impacts of Alternatives 1 to 4 are shown relative to this alternative.

4.19.3.3 Hydropower

Flows and reservoir elevations differ between alternatives; therefore, the expected power generation (gigawatt-hour) would also vary between alternatives. The estimated generation at Elephant Butte Dam by alternative is shown in Table 4-23. The estimated economic value of this generation is shown in Table 4-24 and the impacts by alternative are shown in Table 4-25.

Table 4-23 Elephant Butte hydropower (Gwh) average annual economic benefits by alternative and climate scenario

Benefit &	Alternative				
Climate	1	2	3	4	5
Drier	25.2	25.2	26.2	24.8	25.0
Central	34.8	34.8	34.3	33.5	33.7
Wetter	39.6	39.6	36.1	34.7	35.0

Table 4-24 Elephant Butte hydropower average annual economic benefits ($ millions) by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	3.8	3.8	4.0	3.8	3.8
Central	5.3	5.3	5.2	5.1	5.1
Wetter	6.0	6.0	5.5	5.3	5.3

Table 4-25 Elephant Butte hydropower average annual economic benefits ($ millions) changes between No Action and action alternatives by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	0.0	0.0	0.2	0.0	No Action
Central	0.2	0.2	0.1	0.0	No Action
Wetter	0.7	0.7	0.2	0.0	No Action

4.19.3.3.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the estimated value of hydropower is $5.3 million based on the central climate scenario as shown in Table 4-24. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-25. Under Alternative 1 based on the central climate scenario the change in value is $0.2 million compared to Alternative 5.

4.19.3.3.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Tables 4-24 and 4-25, Alternative 2 would be the same as Alternative 1. Under Alternative 2 based on the central climate scenario, the change in value is $0.2 million compared to Alternative 5 (No Action).

4.19.3.3.3 Alternative 3: No Carryover Provision

Under Alternative 3, the estimated value of hydropower is $5.2 million based on the central climate scenario as shown in Table 4-24. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-25. Under Alternative 3 based on the central climate scenario the change in value is $0.1 million compared to Alternative 5.

4.19.3.3.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the estimated value of hydropower is $5.1 million based on the central climate scenario as shown in Table 4-24. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-25. Under Alternative 4 based on the central climate scenario there is no change in value compared to Alternative 5.

4.19.3.3.5 Alternative 5: Prior Operating Practices, No Action Alternative

Under Alternative 5, the estimated value of hydropower is $5.1 million based on the central climate scenario as shown in Table 4-24. Alternative 5 is the No Action Alternative; therefore, the impacts of the action alternatives are relative to this alternative.

4.19.3.4 Recreation

Elephant Butte Reservoir provides a variety of recreational benefits that vary based on reservoir storage. Because storage varies between alternatives, recreational benefits are calculated for Elephant Butte Reservoir (Mesilla Valley). Recreational activities at Caballo Reservoir also provide recreational benefits. Because the differences in Caballo storage between project alternatives are small and would not result in significant differences in economic benefits from Caballo recreation, these benefits were not estimated.

Table 4-26 Elephant Butte recreation average annual economic benefits ($ millions) by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	0.9	0.9	0.9	0.8	0.9
Central	1.1	1.1	1.1	1.1	1.1
Wetter	1.1	1.1	1.2	1.1	1.1

Table 4-27 Elephant Butte recreation average annual economic benefits changes ($ millions) between No Action and Action Alternatives by alternative and climate scenario

	Alternative				
Climate	1	2	3	4	5
Drier	0.0	0.0	0.0	-0.1	No Action
Central	0.0	0.0	0.0	0.0	No Action
Wetter	0.0	0.0	0.1	0.0	No Action

4.19.3.4.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

The estimated value of recreation is shown in Table 4-26. The impact of this alterative is measured relative to Alternative 5 (No Action) as shown in Table 4-27. The differences in Elephant Butte Reservoir storage compared to Alternative 5 are small and would not result in significant differences in economic benefits.

4.19.3.4.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Tables 4-26 and 4-27, Alternative 2 would be the same as Alternative 1. The differences in Elephant Butte Reservoir storage compared to Alternative 5 (No Action) are small and would not result in significant differences in economic benefits.

4.19.3.4.3 Alternative 3: No Carryover Provision

The estimated value of recreation is shown in Table 4-26. The impact of this alterative is measured relative to Alternative 5 as shown in Table 4-27. The differences in Elephant Butte Reservoir storage compared to Alternative 5 (No Action) are small and would not result in significant differences in economic benefits.

4.19.3.4.4 Alternative 4: No Diversion Ratio Adjustment

The estimated value of recreation is shown in Table 4-26. The impact of this alterative is measured relative to Alternative 5 as shown in Table 4-27. The differences in Elephant Butte Reservoir storage compared to Alternative 5 are small and would not result in significant differences in economic benefits.

4.19.3.4.5 Alternative 5: Prior Operating Practices, No Action Alternative

Alternative 5 is the No Action Alternative; therefore, the impacts of the action alternatives are relative to this alternative.

4.19.4 Regional Economic Impacts

4.19.4.1 Elephant Butte Irrigation District

The regional economic impacts in EBID would result from a change in pumping costs. Pumping cost changes would result in higher or lower net farm income, which translates to farm households having more or less money to spend within the regional economy.

Table 4-28 EBID regional economic impacts by alternative under the central tendency climate change scenario (incremental to Alternative 5)

	Alternative				
EBID Ag.	1	2	3	4	5
Employment	-5	-5	-4	0	No Action
Labor Income	(185,947)	(185,947)	(123,965)	0	No Action
Output	(599,166)	(599,166)	(399,444)	0	No Action

4.19.4.1.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Pumping costs in the Rincon and Mesilla Valleys are estimated to increase by $0.9 million compared to Alternative 5 (No Action) under the central tendency climate change, as discussed in Section 4.19.3. The regional impacts of this alternative stem from a decrease ($0.9) in farm household income, because of the pumping cost increase, relative to Alternative 5. The changes in employment, labor income, and output under Alternative 1 are shown in Table 4-28.

4.19.4.1.2 Alternative 2: No San Juan–Chama Project Storage

As shown in Table 4-28, Alternative 2 would be the same as Alternative 1. The regional impacts of this alternative stem from a decrease ($0.9) in farm household income because of the pumping cost increase relative to Alternative 5 (No Action).

4.19.4.1.3 Alternative 3: No Carryover Provision

Pumping costs in the Rincon and Mesilla Valleys are estimated to increase by $0.6 million compared to Alternative 5, under the central tendency climate change, as discussed in Section 4.19.3. The regional impacts of this alternative stem from a decrease ($0.6) in farm household income, because of the pumping cost increase, relative to Alternative 5 (No Action). The changes in employment, labor income, and output under the Alternative 3 are shown in Table 4-28.

4.19.4.1.4 Alternative 4: No Diversion Ratio Adjustment

Compared to Alternative 5, under the central tendency climate scenario there is no estimated change in pumping costs in the Rincon and Mesilla Valleys under Alternative 4 as discussed in Section 4.19.3. Therefore, there is no change in the estimated regional impacts under this alternative as shown in Table 4-28.

4.19.4.1.5 Alternative 5: Prior Operating Practices, No Action Alternative

The regional economic impacts are measured based on incremental changes from Alternative 5 conditions; therefore, the total regional impacts associated with Alternative 5 (No Action) were not measured.

4.19.4.2 El Paso County Water Improvement District No. 1

4.19.4.2.1 El Paso Valley agricultural use

The regional impacts stemming from El Paso Valley agricultural use are based a change in production value as shown in Table 4-18.

Table 4-29 EPCWID, El Paso Valley agriculture regional impacts under the central tendency climate change scenario by alternative (incremental to Alternative 5)

	Alternative				
EPCWID Ag. El Paso	1	2	3	4	5
Employment	45	45	29	8	No Action
Labor Income	1,107,627	1,107,627	716,700	195,463	No Action
Output	3,194,525	3,194,525	2,067,046	563,740	No Action

4.19.4.2.1.*1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative*

Under Alternative 1, the agricultural production value is estimated to increase by $1.7 million (shown in Table 4-18) compared to Alternative 5 (No Action). This increase in value has a positive impact on the regional economy in terms of job, labor income, and output as shown in Table 4-29.

4.19.4.2.1.2 Alternative 2: No San Juan–Chama Project

As shown in Table 4-29, Alternative 2 would be the same as Alternative 1 in terms of job, labor income, and output as shown in Table 4-29.

4.19.4.2.1.3 Alternative 3: No Carryover Provision

Under Alternative 3, the agricultural production value is estimated to increase by $1.1 million (shown in Table 4-18) compared to Alternative 5 (No Action). This increase in value has a positive impact on the regional economy in terms of job, labor income, and output as shown in Table 4-29.

4.19.4.2.1.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the agricultural production value is estimated to increase by $0.3 million (shown in Table 4-18) compared to Alternative 5 (No Action). This increase in value has a positive impact on the regional economy in terms of job, labor income, and output as shown in Table 4-29.

4.19.4.2.1.5 Alternative 5: Prior Operating Practices, No Action Alternative

The regional economic impacts are measured based on incremental changes from Alternative 5 conditions; therefore, the total regional impacts associated with Alternative 5 (No Action) were not measured.

4.19.4.2.2 Mesilla Valley Agricultural Use

The estimated change in economic benefits or direct impacts are unchanged for all alternatives relative to Alternative 5 (No Action) as shown in Table 4-20.

4.19.4.2.3 EPCWID Urban Use

The regional impacts stemming from El Paso Valley urban water use are based a change in the change in economic value or direct impacts as shown in Table 4-22.

Table 4-30 EPCWID, El Paso Valley urban regional impacts under the central tendency climate change scenario by alternative (incremental to Alternative 5)

	Alternative				
EPCWID M&I, El Paso	1	2	3	4	5
Employment	15	15	8	7	No Action
Labor Income	1,041,396	1,041,396	545,493	557,497	No Action
Output	3,603,279	3,603,279	1,887,432	857,923	No Action

4.19.4.2.3.1 Alternative 1: Continued OA and San Juan–Chama Storage, Preferred Alternative

Under Alternative 1, the value of urban water use is estimated to increase by $2.1 million (shown in Table 4-22) compared to Alternative 5 (No Action). This increase in value has a positive impact on the regional economy in terms of job, labor income, and output as shown in Table 4-30.

4.19.4.2.3.2 Alternative 2: No San Juan–Chama Project

As shown in Tables 4-22 and 4-30, Alternative 2 would be the same as Alternative 1 in terms of job, labor income, and output.

4.19.4.2.3.3 Alternative 3: No Carryover Provision

Under Alternative 3, the value of urban water use is estimated to increase by $1.1 million (shown in Table 4-22) compared to Alternative 5 (No Action). This increase in value has a positive impact on the regional economy in terms of job, labor income, and output as shown in Table 4-30.

4.19.4.2.3.4 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, the value of urban water use is estimated to increase by $0.5 million (shown in Table 4-22) compared to Alternative 5 (No Action). This increase in value has a positive impact on the regional economy in terms of job, labor income, and output as shown in Table 4-30.

4.19.4.2.3.5 Alternative 5: Prior Operating Practices, No Action Alternative

The regional economic impacts are measured based on incremental changes from Alternative 5 conditions; therefore, the total regional impacts associated with Alternative 5 (No Action) were not measured.

4.19.4.3 Hydropower

The regional impacts are not affected by hydropower production at Elephant Butte.

4.19.4.4 Recreation

The differences in Elephant Butte Reservoir storage for all action alternatives compared to Alternative 5 (No Action) are small and would not result in significant differences in regional economic impacts.

4.19.5 Summary Conclusions

The average annual economic benefits under the central tendency climate scenario for each alternative and water use category are summarized in Table 4-31. Generally, Alternatives 1 to 4 would increase the total benefits compared to Alternative 5 (No Action). The economic benefits estimated for EBID would decrease compared to Alternative 5 for all of the alternatives except Alternative 4, while the benefits estimated for EPCWID would increase compared to Alternative 5.

The regional impacts under the central tendency climate scenario estimated for each alternative and water use category are summarized in Table 4-32. Generally, the regional impacts in the New Mexico study area (Doña Ana and Sierra Counties, New Mexico) where EBID is located decrease compared to Alternative 5 for all action alternatives.

The regional impacts in the Texas study area (El Paso and Hudspeth Counties) where EPCWID is located increase for all action alternatives compared to Alternative 5. Compared to the overall region, these changes (positive and negative) are small compared to the entire regional economies of the New Mexico and Texas study areas.

Table 4-31 Summary of economic benefits (millions of dollars) by alternative under the central tendency climate scenario

	Alternative				
Valley & Resource	1	2	3	4	5
Rincon Agriculture	-0.20	-0.20	-0.20	0.00	No Action
Mesilla Agriculture	-0.70	-0.70	-0.40	0.00	No Action
EPCWID El Paso Ag.	1.70	1.70	1.10	0.30	No Action
EPCWID Mesilla Ag.	0.00	0.00	0.00	0.00	No Action
EPCWID El Paso M&I	2.10	2.10	1.10	0.50	No Action
Hydropower	0.20	0.20	0.10	0.00	No Action
Recreation	0.00	0.00	0.00	0.00	No Action
Total	3.10	3.10	1.70	0.80	No Action

Table 4-32 Regional impacts summary (jobs, dollars) by alternative under the central tendency climate scenario

	Alternative				
Valley/Resource	1	2	3	4	5
EBID Agriculture					
Employment	-5	-5	-4	0	No action
Labor Income	(185,947)	(185,947)	(123,965)	0	No action
Output	(599,166)	(599,166)	(399,444)	0	No action
EPCWID El Paso Valley Agriculture					
Employment	45	45	29	8	No action
Labor Income	1,107,627	1,107,627	716,700	195,463	No action
Output	3,194,525	3,194,525	2,067,046	563,740	No action
EPCWID Mesilla Valley -Ag	No Change	No Change	No Change	No Change	No action
EPCWID El Paso – M&I (Urban)					
Employment	15	15	8	7	No action
Labor Income	1,041,396	1,041,396	545,493	557.497	No action
Output	3,603,279	3,603,279	857,923	563,740	No action

4.20 Environmental Justice

4.20.1 Analysis Methods and Assumptions

As informed by the Federal Interagency Working Group on Environmental Justice and NEPA Committee (2016), a disproportionately high and adverse impact on minority or low-income populations is based on a comparison of the adverse impacts on the environmental justice community relative to the impacts on the overall population of the study area, based on the particular resource analyzed in the NEPA document. As described in Section 3.15 of Chapter 3, Doña Ana, El Paso, and Hudspeth Counties are environmental justice communities, while Sierra County is not an environmental justice community. However, because the economic analysis combined Sierra County with Doña Ana County as the New Mexico study area, this combination is retained here.

4.20.2 Employment

From 1970 to 2014, employment in the four counties grew from 179,838 to 515,740 jobs, a 187 percent increase (Commerce, Bureau of Economic Analysis 2015). Tables 4-28 and 4-32 project a potential loss of 4 or 5 farm jobs in the non-environmental justice communities (Doña Ana and Sierra Counties, New Mexico study area) under the action alternatives compared to Alternative 5 (No Action). Tables 4-29 and 4-32 show that the environmental justice communities (El Paso and Hudspeth Counties, Texas study area) would experience a slight positive benefit: a potential increase of 8 to 45 farm jobs compared to Alternative 5 (No Action). Relative to 515,740 total jobs in the study area during 2014, 4 to 45 jobs is insignificant. This means there is neither a high nor disproportionate effect on environmental justice communities.

4.20.3 Income

From 1970 to 2014, personal income grew from $8,820.3 million to $33,568.8 million, a 281 percent increase across the four-counties (Commerce, Bureau of Economic Analysis 2015). Tables 4-28 and 4-32 project a potential maximum decrease in labor income in the non-environmental justice communities (Doña Ana and Sierra Counties, New Mexico study area) of $185,947. Tables 4-29 and 4-32 indicate there would be a potential maximum increase of $1,107,627 in the environmental justice communities (El Paso and Hudspeth Counties, Texas study area), an insignificant effect relative to the $34 million incomes in the counties.

5 Cumulative Effects and Other NEPA Considerations

This chapter discusses the cumulative effects of the alternatives within the context of other past, present, and reasonably foreseeable future actions. It also presents other NEPA considerations from 40 CFR 1502.16 including adverse effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses and long-term productivity, and any irreversible and irretrievable commitments of resources involved in the proposal should it be implemented.

5.1 Regulatory Framework

CEQ regulations require consideration of cumulative impacts defined as:

> "…the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." [40 CFR 1508.7]

Following CEQ guidance, the cumulative impact study area for identifying these actions is expanded beyond the immediate project area to include actions that might affect the same water resources, biological, cultural and socioeconomic resources of the environment as those described in Chapters 3 and 4. Cumulative actions that could result in cumulative impacts are listed below.

5.2 Reasonably Foreseeable Future Actions

Actions which have the potential to create ongoing or additive effects to those of the alternatives are summarized in chronological order with the most recent documents first

5.2.1 Far West Texas Water Development Board Plan (2016) and El Paso Water Plan (2013)

The 2016 Far West Texas Water Plan prepared by the Texas Water Development Board (2016) recognizes that current and future water demand and supply sources are constantly changing and indicates water plans need to be updated every 5 years. The plans recognize the City of El Paso as one of the fastest growing cities in Texas and that throughout Far West Texas (a larger area than the study are for this FEIS), the largest category of water use is irrigated agriculture. The 2016 Far West Texas Water Plan states that irrigation water shortages have occurred in El Paso and Hudspeth Counties due to insufficient water in the Rio Grande during the recent drought and those farmers in these counties have generally reduced irrigated acreage, changed types of crops planted, or not planted crops.

El Paso Water is the largest supplier of municipal water in Far West Texas and the utility has implemented a water conservation program that has significantly reduced per capita water demand. The City of El Paso has historically received about 50 percent of its M&I supply from surface water and 50 percent from groundwater in the Hueco Bolson and the Mesilla Bolson.

According to Hutchison (2006), historic pumping in the Mesilla Bolson has not resulted in significant changes in groundwater levels or groundwater quality, but pumping up to 1979 in the Hueco Bolson lowered groundwater levels and led to brackish groundwater intrusion. In the 1980s, El Paso reduced its groundwater pumping in the Hueco Bolson to about 80,000 AFY by increasing surface water diversion from the Rio Grande, increasing conservation efforts, and increasing reclaimed water use. By 2002, El Paso Water pumping in the Hueco Bolson dropped below 40,000 AFY and has since remained at these levels (Hutchison 2006). Reclamation, 2014a. River Maintenance Program-Delta Channel Maintenance Project Environmental Assessment The Delta Channel Maintenance Project maintains the existing, constructed Delta Channel to facilitate efficient delivery of Rio Grande water to the Elephant Butte Reservoir pool. It involves such activities as channel sediment removals, berm repair, site access, and staging area maintenance. River maintenance is conducted along 20.8 miles of the Delta Channel. Project-related road and staging area maintenance would be conducted within an approximately 293-square mile study area boundary in Socorro and Sierra Counties, New Mexico.

5.2.2 Reclamation River Maintenance Program-Delta Channel Maintenance Project Environmental Assessment and Finding of No Significant Impact

The Delta Channel Maintenance Project maintains the existing constructed delta channel to facilitate efficient delivery of Rio Grande water to Elephant Butte Reservoir. It involves activities such as channel sediment removal, berm repair, site access, etc. River maintenance is conducted along a 20.8 miles in Socorro and Sierra Counties, New Mexico. The project includes a suite of conservation measures to minimize or avoid adverse impacts on water quality, vegetation, species habitat, and wildlife. In addition, Reclamation is implementing recovery actions identified in the flycatcher and Rio Grande silvery minnow recovery plans.

5.2.2 USIBWC River Management Alternatives for the Rio Grande Canalization Project, River Management Plan, FEIS and Record of Decision (2014, 2012, 2009)

The USIBWC completed an evaluation of river management alternatives for the Rio Grande Canalization Project. This project affects a 105.4-mile long river reach from Percha Dam to the international boundary at El Paso and Cuidad Juarez, Chihuahua. The status is that the USIBWC is in the second phase of implementation of their 2009 Record of Decision on the River Management Alternatives for the Rio Grande Canalization Project and complying with the Service’s (2012) biological opinion. The project, as proposed, would include ongoing channel maintenance and floodplain management, including levee improvements, vegetation management, habitat restoration work, and conservation of endangered birds following a flycatcher management plan. The USIBWC committed to establish flycatcher habitat and no-mow zones to enhance riparian vegetation.

5.2.3 Corps FLO-2D Model Development, Caballo Reservoir Flood Release and Court Order No. CIV-90-95 HB/WWD (2013, 2005)

As part of USIBWC’s Rio Grande Canalization Project, USIBWC contracted with the Corps of Engineers who subcontracted with Tetra Tech to update the calculations of design storms affecting Caballo Dam releases. While the report is not an “action” per se, in conjunction with Reclamation and USIBWC management of Caballo flood releases, the cumulative action with cumulative effects is that there is statistically almost no chance of a 5,000 cubic feet per second (cfs) release for flood control, although historically, there have been greater than 5,000 cfs flows at the USIBWC’s gage below Caballo Dam. The peak discharge is approximately 2,990 cfs, which essentially precludes overbank flooding below Caballo.

5.2.4 Corps of Engineers and CH2MHill (2012) and Rio Grande Salinity Management Program (2012)

The Corps and others have formed a coalition to reduce salinity from San Acacia to Fort Quitman. The project consists of four phases: salinity assessment, salinity management alternatives analysis, feasibility and pilot control project testing, expanded scale salinity control project and evaluation of project effectiveness. Effects of this ongoing project may result in improvements (decreases) in salinity and other contaminants in the Rio Grande through the study area for this FEIS.

5.2.5 City of Las Cruces Wastewater System Master Plan Update (CDM 2008) and 40-Year Water Development Plan (2007)

The City of Las Cruces has had a water and wastewater plan in place since 1995. In 2007, it prepared a 40-year water development plan. In 2008, the City updated their water and wastewater plan which projected that by 2025, with low growth demand it would need a total of 20,549 acre-feet per year; with high growth demand it would need a total of 33,307 acre-feet per year (CDM 2008:6-4). As of 2008, the City's water supply is groundwater from wells in the Mesilla and Jornada groundwater basins. The City's plans include three elements: conjunctive use of surface and groundwater, water conservation, and reclaimed water use. The City anticipates that some but not all of any increase in groundwater pumping would require offsets. The City's director of utilities (Garcia 2008) indicated that they have been acquiring and leasing some surface water rights through EBID with verification from the NMOSE. The City's strategy is to concentrate on surface water supply. Working with EBID, they have implemented a Special Water Users Association. The City of Las Cruces has not contracted with EBID and Reclamation for conversion of irrigation water to municipal and industrial uses.

5.2.6 New Mexico State Parks, Elephant Butte Lake State Park Management Plan (2006)

This is a resource management plan guiding recreation and the management of public recreational opportunities at Elephant Butte Lake State Park. NM State Parks also manages recreational areas at Caballo, Percha, and Leasburg Diversion Dams.

5.2.7 New Mexico Lower Rio Grande Regional Water Plan (2004)

This plan, with a revision currently in progress, provides population projections through 2040 for three different rates of regional growth to provide a high estimate, a medium-range estimate, and a low range estimate. Projected public water supply requirements for the area are made through the year 2040 for the low, medium and high growth scenarios. This plan includes other public water supply systems located within the planning area with relevant estimates of the population served and the total amount of water provided by these systems.

5.2.8 NMOSE Active Water Resource Management Initiative (2004)

This project of the NMOSE, initiated in 2004, could have ongoing effects in the cumulative impact study region. Under this initiative, the NMOSE declared the Lower Rio Grande a "priority basin" (NMAC 19.25.13). The objective is to supervise the physical distribution of water to protect senior water right owners, to assure compliance with interstate stream compacts and to prevent calls by senior water rights holders for administration of water rights. In addition, these rules fulfill the mandates of Section 72-2-9.1 NMSA, requiring the state engineer to adopt rules for priority administration based on appropriate hydrological models and facilitate marketing within water master districts subject to priority administration.

5.2.9 Reclamation Elephant Butte and Caballo Reservoirs Resource Management Plan, Record of Decision and FEIS (2003, 2002)

This is Reclamation's resource management plan designed to guide Reclamation and other Federal, state, local, and participating agencies in managing, allocating, and appropriately using Elephant Butte and Caballo Reservoirs' land and water resources. The RMP was also designed to assist Reclamation in making decisions regarding the management of recreation resources.

5.3 Cumulative Impacts by Resource

This section projects cumulative impacts of the reasonably foreseeable future actions listed in Section 5.2 on resources described in Chapters 3 and 4 of the FEIS.

5.3.1 Water Resources including Reservoir Storage, Elephant Butte Reservoir Elevations, Allocations, Releases, Diversions, Farm Surface Water Deliveries

Effects of the Federal actions listed above were included in the modeling of the effects of the alternatives, so there would be no additional cumulative effects to water resources. While water management plans of the Cities of Las Cruces and El Paso and of Far West Texas (Texas Water Development Board 2016) are listed as cumulative actions above, due to uncertainties, future effects of these municipal plans have only partially been incorporated in Chapter 4 water resource analyses. The original 1920 Act contracts with the City of El Paso were done in 1940 which allowed the city to purchase 2,000 acres of irrigated farmland for conversion of the water allocated to that land to M&I supply. By the 1950s (President's Commission 1950), El Paso and Albuquerque had experienced water shortages. Back then, El Paso began buying additional lands from landowners within the RGP to obtain rights to water under arrangements with EPCWID. These effects were part of the modeling of water resources analyses in Chapter 4 (Sections 4.1 to 4.12). The City of Las Cruces, through its 40-Year Water Plan, is considering a similar strategy of acquiring or leasing surface water rights through EBID. While their plan is considered a cumulative action, there are not enough data or details to model how this might occur.

5.3.2 Groundwater

The assumption of the Chapter 4 groundwater analyses (Sections 4.9 to 4.11) is that irrigation water requirements that are not satisfied by RGP surface water deliveries are met through supplemental groundwater pumping. For groundwater elevations, the model projects that the differences that would be caused by implementing one or another of the alternatives would be less than the differences that might arise due to future climatic conditions.

Increases in future groundwater pumping by the Cities of Las Cruces or El Paso were not modeled, but could be anticipated to result in lower groundwater levels in the future unless offset by decreases in pumping in other parts of the aquifer. No data or models are presently available to Reclamation to quantify groundwater effects of the cities' future actions related to groundwater uses.

5.3.3 Water Quality

Since the 1950s, quality of surface water in the Rio Grande has been documented as degrading from the San Luis Valley to Fort Quitman (President's Commission 1950), although in the latest 303d report of New Mexico (NMED 2016: 175-178), water quality has improved in Elephant Butte Reservoir. When the effects of the alternatives are added to those ongoing effects from Reclamation's Delta Channel Maintenance Project and low flow conveyance channel, water quality in the reservoir is expected to be within the ranges historically documented with possible impairments due to mercury, nutrients and polychlorinated biphenyls. Likewise, cumulative impacts to water quality in Caballo Reservoir are expected to fluctuate over time with the quantity of water in storage, but with ongoing impairments due to high nutrient levels.

Downstream of Caballo Reservoir in the USIBWC Rio Grande Canalization Project, water quality should improve over time when the effects of the alternatives are added to those of USIBWC's Record of Decision implementation (2012, 2009), which includes more efficient water delivery, soil erosion prevention, and habitat restoration, water quality should improve slightly over time. Also, the Corps' Salinity Management Program and work of El Paso Water should result in cumulative improvements to water quality.

5.3.4 Vegetation and Weeds

As described in Sections 3.6 and 4.13, the existence of the reservoirs, combined with USIBWC's Rio Grande Canalization Projects downstream of Caballo Reservoir has led to the present status of vegetation communities across the cumulative impact study area. At the inflow area to Elephant Butte Reservoir, ongoing effects of Reclamation's Delta Channel Maintenance Project would continue to help moderate potential impacts from inundating vegetation and vegetation loss or degradation in Elephant Butte Reservoir.

The reservoir pool elevations would continue to fluctuate under all alternatives and these fluctuations would continue to affect individual plants throughout the reservoir area. Although given the low probabilities of the reservoir surface water remaining at one elevation for a prolonged period, it is unlikely that whole patches of vegetation would be affected or that there would be a net loss of habitat for nesting birds.

Downstream of the RGP reservoirs, the Rio Grande was canalized between 1938 and 1943, and the vegetation in most areas is managed by the USIBWC and monitored as part of USIBWC's and Reclamation's ESA commitments. There are sections of the downstream environment where some native vegetation is being managed by USIBWC to improve wildlife habitat and there are ongoing beneficial effects due to their non-native plant control program (USIBWC 2012). These beneficial effects are expected to continue into the future.

While there is some potential for noxious weeds to grow or increase in the short-term, however as a cumulative impact of management by both the USIBWC and Reclamation noxious weeds are managed under an integrated pest management framework. As a result, no increase in cumulative impacts to weeds is expected.

5.3.5 Wetlands and Floodplains

No additional cumulative impacts to wetlands and floodplains would be anticipated based on the cumulative actions listed in Section 5.2. There are patches of emergent marsh plants in the sediment delta inflow area to Elephant Butte Reservoir, but these patches are not expected to become jurisdictional wetlands due to the repeated cycles of wetting and drying: the fluctuations are unlikely to support the development of hydric soils.

For floodplains in the cumulative impact study region, between the USIBWC's and Reclamation's ongoing actions of managing releases from Elephant Butte and Caballo Dams and actively managing the river segments, there would be no change in base floodplains and no construction proposed in the 100- or 500-year floodplains that has not undergone prior NEPA analysis.

As stated by the USIBWC (2007, 2009a, b), the Rio Grande floodplain was enclosed by a levee system and dredged river channel beginning in 1938 and completed in 1943. The canalization extends some 105.4 miles along the Rio Grande from below Percha Dam in Sierra County, New Mexico to American Dam in El Paso, Texas, and along the river to Fort Quitman, Texas. The USIBWC increased flood containment capacity as a result of raising levees between 4 – 12 feet in height and dredging the river channel in a series of past actions; and these effects of managing the floodplains to meet Federal Emergency Management Agency certification requirements would continue into the future (USIBWC 2007, 2009b).

5.3.6 Wildlife and Special Status Species

The potential cumulative impacts to terrestrial wildlife (defined by NEPA, not ESA) and special status wildlife species are essentially the same as the projected effects for vegetation. As described in Section 4.14, the flycatcher and the cuckoo are seasonally present in Elephant Butte Reservoir and their habitats may be degraded, expanded, or enhanced depending on the duration at which the water surface elevations remain at a particular elevation. None of the actions listed in Section 5.2 would create cumulative impacts on wildlife or special status species that have not been included in the Section 4.14 analysis or the consultation with the Service.

Along the Rio Grande below Caballo Dam, cumulative impacts to wildlife from the actions of the USIBWC have been described in a series of environmental assessments, environmental impact statements, and consultations (USIBWC 2007, 2009a, b; 2012, 2014a). The USIBWC committed to work on restoring riparian shrub communities suitable for breeding flycatchers in this reach. When Reclamation’s action of releasing water from Caballo Dam is added to the actions of the USIBWC, there should be no cumulative impacts to vegetation, wildlife or special status species that have not already been consulted upon.

5.3.7 Aquatic Resources and Special Status Fish Species

The existence of the RGP dams and reservoirs led to the extirpation of native fish, as discussed in Sections 3.8 and 4.15, but dam existence is in the baseline and cumulative effects are restricted to Reclamation’s Delta Channel Maintenance Project that extends the river into Elephant Butte Reservoir and provides additional occupied habitat for riverine species, including the endangered Rio Grande silvery minnow. Conservation measures included in the project provide habitat features in the channel to support the minnow’s life stages and avoid harming the fish during construction and maintenance. No other cumulative effects to aquatic resources and special status fish are expected to occur through 2050.

Similar to the other biological resources, the range of releases to the Rio Grande from the alternatives is within the range of historical operations. When all the actions listed above are added to the potential effects of the alternatives, no additional cumulative effects to aquatic resources and special status fish species are expected to occur through 2050.

5.3.8 Cultural Resources

Management of historic properties within the cumulative impact study areas is being conducted by Reclamation and the USIBWC as part of their respective Section 110 compliance responsibilities. No other undertakings are reasonably foreseeable that have not undergone Section 106 or 110 compliance; thus, no cumulative effects to historic properties are expected to occur through 2050.

No adverse impacts to Indian sacred sites or resources of tribal concern would be anticipated from the alternatives (as described in Section 4.17); therefore, no cumulative effects would apply to these resources.

5.3.9 Indian Trust Assets

The Rio Grande is recognized as aboriginal territory of the Apache and the Pueblo of Ysleta del Sur has interests in the area around El Paso, but no ITAs have been identified in the cumulative impact study area. As a result, there would be no adverse impacts of the alternatives to ITAs and no cumulative effects on ITAs. The Federal agencies are committed to government-to-government consultation with these Indian tribes, going into the future.

5.3.10 Socioeconomics, Including Farmland

The primary purpose of the RGP is irrigated agriculture and maintaining the water supply for this purpose would continue into the future under all the alternatives. When the cumulative impacts of the actions of the USIBWC are added to those in this FEIS, there are no anticipated changes to farmland in production. As noted by the USIBWC (2009), measures associated with their Integrated Land Management Alternative were selected and are being implemented to minimize the conversion of farmland to non-agricultural uses. As the USIBWC found, no significant impacts on prime farmland are anticipated.

Simulation and analysis of project operations was carried out to evaluate relative changes in the storage, release, and delivery of project water to diversion points for EBID, EPCWID, and Mexico from the five alternatives under future possible climate and hydrologic conditions within the project area, but with the assumption that future M&I demands would be consistent with recent demands. This assumption allows for analysis of changes in project operations because of alternatives, without confounding effects of changes in M&I demand or uses.

The modelling for the FEIS assumes that future pumping for M&I uses would be consistent with recent pumping and there would be no reasonably foreseeable change into future. This assumption is consistent with water plans of the cities in the study area, as cited above.

5.4 Unavoidable Adverse Effects

As described in Chapters 4 and 5, implementation of any of the alternatives, combined with climate change, could result in adverse impacts to birds listed under the ESA and on designated or proposed critical habitat. However, with careful monitoring and reservoir management, and coordination with the Service, adverse effects to birds or their habitat should be avoided or reduced below the level of significance. No other significant adverse effects to resources are projected by the FEIS.

5.5 Relationship between Short-term Uses of the Environment and Maintenance and Enhancement of Long-term Productivity

To assess the relationship between short-term uses and maintenance of long-term productivity, Reclamation considers the period through 2050 to be short-term when compared with the long history of the RGP or the indefinite period beyond 2050 when the RGP continues to be operated and maintained. Within this short-term time frame, Reclamation's implementation of the OA would result in increased certainty to the RGP water users, given the increased flexibility afforded by carryover allocation and adjustments for project efficiency projected by the diversion ratio. With this FEIS, the RGP water users should have a better understanding of how the system would operate in the future under climate change. There will be times when the districts experience a smaller allocation of surface water which would translate into a smaller surface allocation of water to farms and possible future M&I users, which would be supplemented by groundwater at the discretion of each farmer. Conversely, during wetter climatic conditions, the districts would receive larger surface water allocations resulting in more water to farms and possible future M&I users, which would translate to less groundwater use, all water use dependent on crop types and population.

5.6 Irreversible and Irretrievable Commitments of Resources

The CEQ's regulations at 40 CFR 1502.16 require consideration of irreversible and irretrievable commitments of resources. This is interpreted to mean decisions affecting non-renewable resources such as land, or causing a species to become extinct, or a resource to be destroyed or removed. The term irreversible also describes the loss of future options.

None of the alternatives has or would result in an irreversible or irretrievable commitment of resources. The proposed action would ensure that the RGP water would continue to be managed consistently and efficiently with respect to the RGP authorization, the districts' rights, the 1906 treaty, and other applicable laws, court decrees, agreements, and contracts.

6 Preparers, Consultation and Coordination

This chapter details the consultation and coordination among Reclamation and other Federal, state and local agencies, American Indian tribes, and the public in preparing this FEIS. The public scoping process was described in Section 1.9 of the FEIS. This chapter also includes the list of preparers.

6.1 Cooperating Agency Involvement

Reclamation invited nine agencies to cooperate in the NEPA process. Three agencies either declined or did not respond to the request: HCCRD, the New Mexico Interstate Stream Commission, and ABCWUA. Six agencies signed a memorandum of understanding with Reclamation to become cooperating agencies. In October 2015, the City of Santa Fe Water Division ended its role as a cooperating agency. The five agencies cooperating throughout the process are:

- Colorado Division of Water Resources
- Elephant Butte Irrigation District of New Mexico
- El Paso County Water Improvement District No. 1
- Texas Rio Grande Compact Commissioner
- U.S. Section, International Boundary and Water Commission

Reclamation hosted periodic cooperating agency meetings throughout the preparation of this FEIS to ensure that the agencies were informed of and involved in the process based on their legal jurisdiction or special expertise.

6.2 Tribal Consultation

Following Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, Reclamation sent letters on June 24, 2014, asking the two tribes with potential interests in the RGP: Ysleta del Sur Pueblo of Texas and the Mescalero Apache Tribe of the Mescalero Reservation, New Mexico, if they wished to be consulted or had issues or concerns with the proposed action. In October 2015, Reclamation reached out to the tribes via phone call and follow-up e-mail. To date, no response has been received from either tribe.

During the preparation of the SEA covering the OA from 2013 to 2015, the Mescalero Apache Tribe, whose aboriginal territory lies within the project area, expressed concerns about native plants growing along the irrigation canals in the service areas of EBID and EPCWID. Tribal members collect plant material for cultural purposes. This is identified as a resource of tribal concern in the cultural resources analysis (Section 4.17.2).

6.3 Other Consultations and Coordination

6.3.1 U.S. Fish and Wildlife Service

To comply with ESA Section 7(a)(2), Reclamation submitted a biological assessment to the Service on August 20, 2015. Reclamation's finding was that Alternative 1 "may affect, but is not likely to adversely affect" the Rio Grande silvery minnow (*Hybognathus amarus*). The finding was that Alternative 1 "may affect, and is likely to adversely affect" the flycatcher, the cuckoo, and "may affect, is likely to adversely modify proposed or designated critical habitat" for the birds. The finding for the mouse was no effect, because the species is not present in the action area. On May 25, 2016, the Service issued its biological opinion.

6.3.2 Consultation with the Government of Mexico

The USIBWC served as a cooperating agency and assisted Reclamation in conforming to the requirements of Executive Order 12114 regarding effects of proposed Federal actions in other countries. This FEIS describes water deliveries to Mexico, but the modeling assumptions or descriptions in this FEIS are not intended to constitute an interpretation or application of the Treaty with Mexico or to represent current U.S. policy or a determination of future U.S. policy regarding deliveries to Mexico.

6.3.3 New Mexico State Historic Preservation Officer

To comply with the NHPA, Reclamation consulted with the New Mexico Historic Preservation Officer on October 29, 2015, requesting concurrence on the determination of "no historic properties affected." Reclamation received concurrence on November 25, 2015 (see Appendix D).

6.4 Final EIS Distribution

The notice of availability of this FEIS was sent to area libraries, other Federal, state and local agencies, American Indian tribes, and the public. All parties listed in Table 6-1 received a CD or electronic version of the FEIS. Copies may be reviewed at the locations listed below:

- Reclamation, Albuquerque Area Office, 555 Broadway NE, Albuquerque, NM 87102
- Reclamation, El Paso Office, 10737 Gateway West, Suite 350, El Paso, TX 79935
- Natural Resources Library, U.S. Department of the Interior, 1849 C Street NW, Main Interior Building, Washington D.C. 20240-0001
- Elephant Butte Irrigation District, 530 South Melendres Street, Las Cruces, NM 88005
- El Paso County Water Improvement District No. 1, 13247 Alameda Avenue, Clint, TX 79836

A copy of the FEIS is available on Reclamation's website at:
http://www.usbr.gov/uc/envdocs/eis.html

Table 6-1 Distribution list

Affiliation	Name
Federal:	
US Environmental Protection Agency	Houston, Robert
U.S. International Boundary and Water Commission	Anaya, Gilbert
U.S. Fish and Wildlife Service	Tuggle, Benjamin
State or Quasi-state:	
Colorado Division of Water Resources	Sullivan, Mike
Colorado Attorney General	Wallace, Chad M.
Colorado Compact Commissioner	Wolfe, Dick
Colorado Department of Law	Wallace, Chad M.
Counsel for EPCWID	Speer Jr., James M.
El Paso Water Control and Improvement District, No. 1	Stubbs, Johnny
Elephant Butte Irrigation District of New Mexico	Salopek, James
New Mexico Attorney General	Balderas, Hector
New Mexico Department of Game & Fish	Wunder, Matt
New Mexico Environment Department	Flynn, Ryan
New Mexico Interstate Stream Commission	Dixon, Deborah K.
New Mexico Office of the State Engineer	Verhines, Scott
New Mexico State Historic Preservation Office	Pappas, Jeff
New Mexico State Parks	Tafoya, Christy
Texas Rio Grande Compact Commissioner	Gordon, Pat
Local Agencies:	
Albuquerque Bernalillo County Water Utility Authority	Sanchez, Mark
City of Las Cruces	Miyagishima, Ken
Stein & Brockman for the City of Las Cruces	Stein, Jay F.
American Indian/Tribal:	
Mescalero Apache	Chino, Frederick
Ysleta del Sur	Paiz, Frank
Libraries:	
New Mexico State University Library	Carter, Stephanie
University of Texas at El Paso	Gaunce, Charles
Organizations and Individuals:	
Audubon New Mexico	Bardwell, Beth
Individual	Welsh, Heidi
New Mexico B.A.S.S. Nation	Earl Conway
Paso del Norte Watershed Council	Keyes, Conrad
Southwest Environmental Center	Bixby, Kevin
Wild Earth Guardians	Pelz, Jen

6.5 List of Preparers

This FEIS was prepared by Reclamation's Upper Colorado Region, Albuquerque Area Office, with contributions from the Denver Policy Office, with assistance from Environmental Management and Planning Solutions, Inc. (EMPSi), Santa Fe, New Mexico. The names of persons who prepared various sections, provided information, or participated to a significant degree in reviewing the document are listed in Table 6-2.

Table 6-2 List of preparers

Name and Title	EIS Responsibility
Reclamation Preparers:	
Cortez, Filiberto, special assistant	Technical coordination, water resources
Coulam, Nancy, environmental protection specialist	Technical coordination, environmental justice
Coykenall, Arthur, biologist	ESA policy and biology review
Cunningham, Catherine, environmental protection specialist	NEPA policy and review
Engel, Paula, economist	Socioeconomics
Ferguson, Ian, civil engineer	Hydrology, climate change, water resources
Garcia, Hector, environmental protection specialist	Technical coordination, quality control
Graham, Rhea, special project officer	Project manager
Heffernan, Beverly, division manager	NEPA policy and review
Llewellyn, Dagmar, hydrologist	Hydrology, climate change, water resources
Painter, M. Jeff, resource management specialist	Technical coordination, quality control
Environmental Management and Planning Solutions, Inc. (EMPSi):	
Batts, David, principal-in-charge	Technical coordination, quality control
Cordle, Amy, administrative planner	Quality control, editing
Crump, Sarah, administrative	Document and administrative record support
Doyle, Kevin, project manager	Technical coordination, cultural resources
Estep, Melissa, engineer	Water resources
Gahli, Zoe, environmental planner	Socioeconomics, environmental justice
McCarter, Molly, environmental planner	Administrative record support
Parker, Nicholas, environmental planner	Technical coordination, quality control
Patterson, Katie, legal reviewer	Legal sufficiency
Prohaska, Holly, environmental planner	Quality control
Rice, Kevin, biologist	Biological resources
Rickey, Marcia, GIS specialist	Maps, figures
Ricklefs, Chad, environmental planner	Cumulative effects, quality control
Schad, Cindy, administrative	508 compliance, formatting
Vankat, Drew, planner	Cumulative, consultation and coordination
Varney, Randy, technical editor	Document editing

Tetra Tech, Inc.:	
Barna, Jeff B., ecologist	Biological resources
Marcus, Mike, biologist	Biological resources
Martz, Merri, biologist	Biological resources
Pershall, Alaina, environmental scientist	Biological resources
Precision Water Resources Engineering, Inc. (PWRE):	
Coors, Shane, engineer	Water resources
Erkman, Caleb, engineer	Water resources
Gacek, Heather, engineer	Water resources
Powell, Anthony, engineer	Water resources
Winchester, John, engineer	Water resources

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8 Index