RECLAMATION
Managing Water in the West

Supplemental Environmental Assessment

Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas

DRAFT

May 8, 2013

Mission Statements

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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Supplemental Environmental Assessment for the Implementation of Rio Grande Project Operating Procedures

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List of Acronyms and Abbreviations

AAO	Albuquerque Area Office	Flycatcher	Southwestern Willow Flycatcher
1902 Act	Reclamation Act of 1902	FONSI	Finding of No Significant Impact
1905 Project Act	Rio Grande Project Act of 1905	HCCRD1	Hudspeth County Conservation and Reclamation District No. 1
AF/AFY	acre-foot (acre-feet)/acre-feet per year	IBWC	International Boundary and Water Commission, United States Section
CFR	Code of Federal Regulations	ITA	Indian Trust Assets
CFS	cubic feet per second	LRG	Lower Rio Grande in New Mexico
CIR	crop irrigation requirement	NEPA	National Environmental Policy Act
Compact	Rio Grande Compact	NMSP	New Mexico State Parks
Convention	1906 Convention between the United States and Mexico for Equitable Distribution of the Waters of the Rio Grande	NPDES	National Pollution Discharge Elimination System
Corps	US Army Corps of Engineers	OA	Operating Agreement
CWA	Clean Water Act	Project	Rio Grande Project
EA	Environmental Assessment	Reclamation	Bureau of Reclamation
EBID	Elephant Butte Irrigation District	RM	River mile
EIS	Environmental Impact Statement	Service	U.S. Fish and Wildlife Service
EPCWID	El Paso County Water Improvement District #1	Silvery Minnow	Rio Grande silvery minnow
EPWU	El Paso Water Utility	TCEQ	Texas Commission on Environmental Quality
ESA	Endangered Species Act of 1973	TDS	total dissolved solids
FDR	farm delivery requirement	WWCRA	West-Wide Climate Risk Assessment

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1 Summary

The Bureau of Reclamation, Albuquerque Area Office (AAO) proposes to continue implementing operating procedures and an operating agreement (OA), signed in 2008, for the Rio Grande Project (Project) (Proposed Action).

Reclamation initially intended this supplemental Environmental Assessment (EA) to analyze the potential impacts of implementation of the OA on the human environment over the entire remaining period of the OA (through 2050). However, further analysis and review of the potential effects of implementation of the OA revealed two points: 1) for the period 2013-2015, differences in potential impacts between previous operations of the project under the No Action alternative and the projected operations under the OA are projected to be minimal and insignificant, and 2) based on the available data and analytical tools, we can only reasonably predict potential impacts to the human environment over a limited time frame. In light of uncertainties regarding the persistence of drought conditions and the need to improve the analytical tools to detect impacts of the OA, it was determined that analysis of a longer period would be of limited utility at this time.

Consequently, Reclamation believes it should prioritize its review on the short-term, during which the known information will be of the greatest utility to the general public and decision-makers. Reclamation's period of analysis for this supplemental EA is therefore limited to a three year period. During this three year period, Reclamation will voluntarily commence and actively pursue, upon completion of the current NEPA process, the development and refinement of modeling tools to thoroughly analyze the implementation of the OA over its remaining life (through 2050) through an Environmental Impact Statement (EIS). Through this overall approach, Reclamation is providing analysis of short-term impacts in a timely manner while still performing detailed analyses of longer-term impacts in order to assist in the public's consideration of the Proposed Action.

1.1 What is the Rio Grande Project?

The Project includes two dams and reservoirs, Elephant Butte and Caballo, a power generating plant, and five diversion dams (Percha, Leasburg, Mesilla, American, and International) (Figure 1.1). The Project was authorized by Congress under the authority of the Reclamation Act of 1902, and the Rio Grande Project Act of February 25, 1905. The Project provides irrigation water to the Elephant Butte Irrigation District (EBID), which includes 90,640 acres authorized to receive Project water in the Rincon and Mesilla Valleys of New Mexico, and to the El Paso County Water Improvement District No. 1 (EPCWID), which includes 69,010 acres in the Mesilla and El Paso valleys of Texas. The Project serves a total irrigable land comprised of 159,650 acres, 57 percent of which are in New Mexico and 43 percent of which are in Texas. The two districts use Project water to irrigate a variety of crops, including lettuce, chiles, onions, cotton, sorghum, and pecans. The Project also provides water to Mexico under an international

treaty which stipulates that 60,000 acre-feet per year (AFY) will be delivered to the head of the Mexican Canal as a full allocation. The City of El Paso also receives water from the Project under a series of 1920 Act contracts which allow the conversion of irrigation water to municipal and industrial uses. Drainage and tail water from Project lands at the terminus of the Project provides a supplemental water supply to 18,000 acres in Hudspeth County Conservation and Reclamation District No. 1 (HCCRD1) in Texas.

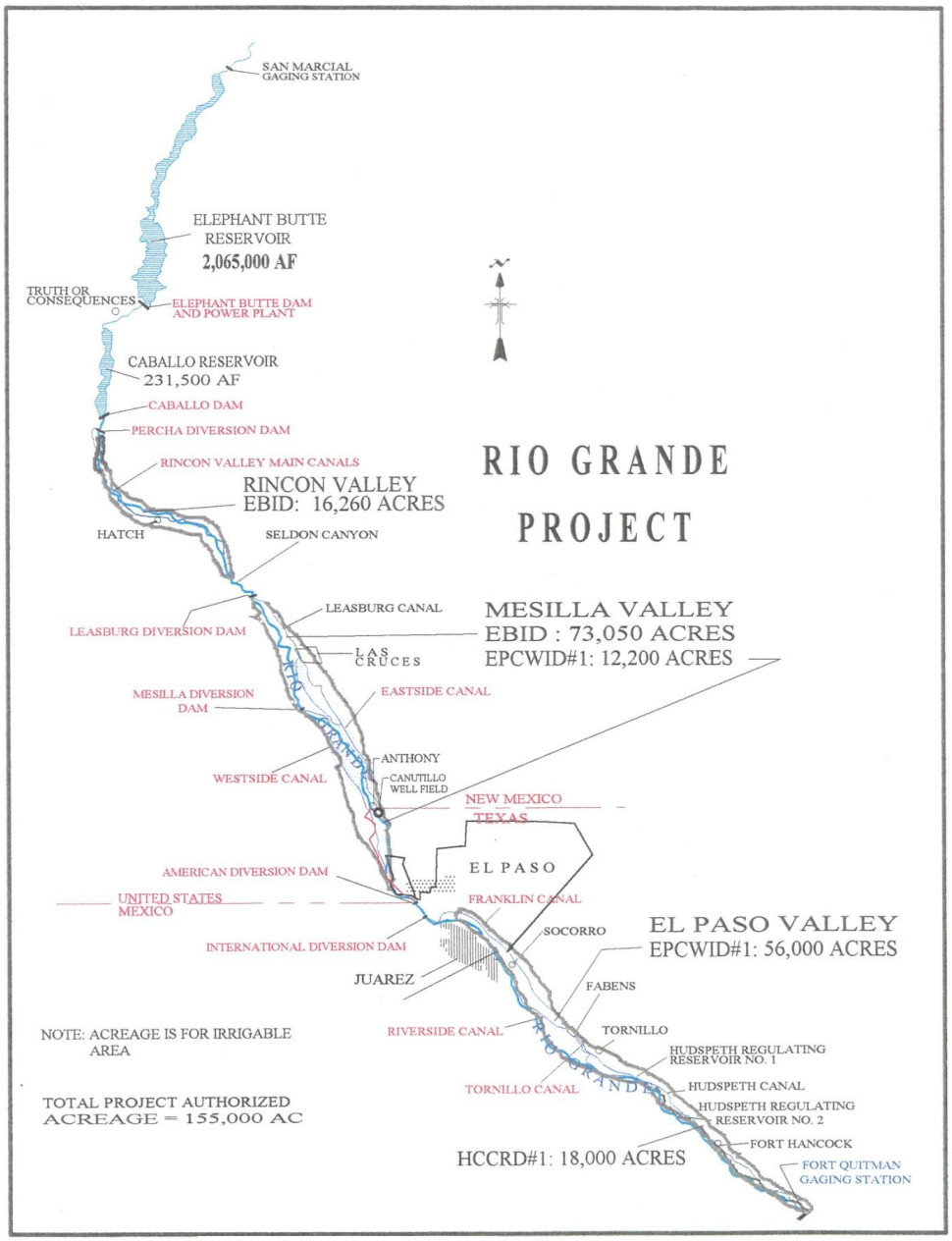

Figure 1.1. Map of Rio Grande Project.

1.2 What is the Rio Grande Project Operating Agreement?

The OA is a written description of how Reclamation allocates Project water to EBID, EPCWID, and Mexico consistent with applicable water rights, state and federal laws, and international treaties. The OA is provided in Appendix A.

The Project and the OA have a long and litigious history as detailed in Appendix C. By way of summary, Reclamation operated the Project itself, until signing contracts with EBID and EPCWID for the transfer of operations and maintenance of particular items of the irrigation delivery and drainage system. In 1979 Reclamation contracted with EBID to assume responsibility for operation and maintenance of Percha, Leasburg, and Mesilla Diversion Dams. In 1980, Reclamation contracted with EPCWID to transfer operation and maintenance responsibilities for Riverside Diversion Dam, and the distribution and drainage system in Texas downstream to HCCRD1. The Riverside Diversion Dam was removed in 2003 in an effort to improve flood control capability. Both contracts required Reclamation and the two districts to create a mutually agreeable "detailed operational plan…setting forth procedures for water delivery and accounting." As detailed in Appendix C, however, a mutually agreeable operating plan was not established until 2007 with the OA. In the absence of established operating procedures, Reclamation imposed ad hoc operating procedures to govern operations. These ad hoc operating procedures were modified by Reclamation as needed between 1980 and 2007. During that time, Reclamation calculated, allocated, and delivered each district's annual diversion allocation, but the methods, equations, and procedures were modified as needed and optimized, according to real-time water conditions. Finally in 2007, after years of litigation and negotiation, the three parties agreed upon operating procedures and in 2008 signed a 50-year OA. A corresponding Operations Manual was established in August 2008. The Operations Manual is reviewed annually and was last updated in May 2012 (Appendix B).

1.3 Principles Underlying the Operating Agreement

The provisions adopted in the OA reflect the parties' interest in the long term sustainability of the Project resources which include both surface water and hydraulically connected ground water in both New Mexico and Texas.

The OA largely reflects historical operation of the Project, with two key changes. First, the OA provides carryover accounting for any unused portion of the annual diversion allocations to EBID and EPCWID. Under the No Action alternative, the unused portion of a district's annual allocation balance contributes to the total amount of usable water available for release during the following year; as a result, a portion of the unused allocation becomes part of the other district's annual allocation the following year (see Section 3.2.2). Under the OA, any unused portion of the annual diversion allocations to EBID and EPCWID is carried over to the district's allocation the following year. The carryover provision of the OA is designed to encourage water conservation within the Project by allowing each district to retain their unused allocation up to a specified limit.

Second, the OA modifies the procedures historically used to allocate Project water to EBID and EPCWID so as to explicitly account for the conjunctive use of surface water and groundwater within EBID and corresponding effects on Project operations, including delivery of Project water to river headings for diversion by EBID, EPCWID, and Mexico. In addition to their allocation of surface water from the Project, EBID irrigators have historically relied on groundwater pumping for supplemental irrigation. Groundwater pumping within EBID draws water primarily from the Rio Grande Alluvial Aquifer and Mesilla Bolson, both of which are shallow unconfined aquifers that are directly hydraulically connected to the Rio Grande, as well as the network of drains that collects and returns water from EBID lands to the Rio Grande. Groundwater pumping within EBID thus directly affects delivery of Project water to EBID, EPCWID, and Mexico due to the hydraulic connection between groundwater and surface water within the Rincon and Mesilla Valleys. The OA was crafted to explicitly acknowledge the dynamic interaction between groundwater and surface water supplies in the Rincon and Mesilla Valleys, as described below, and to account for the effects of conjunctive use of groundwater and surface water within EBID on the allocation and delivery of Project water to EBID, EPCWID, and Mexico.

Figure 1.2 conceptually illustrates the interaction between groundwater and surface water in the Rincon and Mesilla Valleys. 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 towards the channel (Figure 1.2(a)). 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 (Figure 1.2(b)). 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 (Figure 1.2(c)); in this situation, seepage from the channel reaches a maximum rate and is no longer affected by fluctuations in groundwater elevation.

Due to this interaction, any decline in groundwater elevations resulting from groundwater pumping within EBID increases seepage losses and reduces the surface water supply available for downstream diversion by EPCWID or Mexico. Conversely, any increase in groundwater elevations resulting from deep percolation of irrigation and canal seepage, or other sources of recharge within EBID, acts to decrease seepage losses and increase surface water supply available for downstream diversion.

Accounting for these effects in the OA is addressed through implementation of the Project diversion ratio, which is calculated as the ratio of total Project charged diversions from the Rio Grande by EBID, EPCWID, and Mexico to total Project releases from Caballo Dam for a given irrigation season. The diversion ratio has historically been used by Reclamation, EBID, and EPCWID to characterize the effects of groundwater-surface water interactions on Project operations: high groundwater levels in Rincon and Mesilla Valleys result in decreased seepage and/or increased inflows from groundwater discharge

and drain flows, increasing the diversion ratio; conversely, low groundwater levels in the Rincon and Mesilla Valleys result in increased seepage and/or decreased inflows from groundwater discharge and drain flows, decreasing the diversion ratio. Under the OA, annual allocation of Project water to EBID is adjusted to account for groundwater conditions as reflected by the diversion ratio. The success of the OA in appropriately accounting for conjunctive use within EBID is supported by the evaluation of Project allocation and recharge from Project water to EBID's groundwater detailed in Chapter 4.

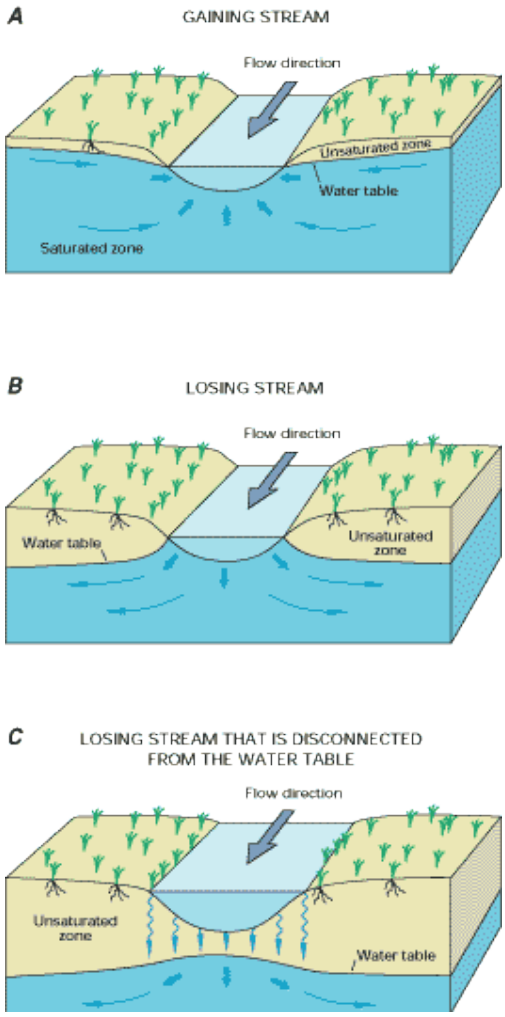

Figure 1.2: Groundwater movement associated with gaining streams, losing streams, and streams disconnected from the groundwater table by an unsaturated zone (USGS 1998). Concepts also apply to stream reaches.

1.4 Why supplement the 2007 Environmental Assessment?

In 2007 in compliance with the National Environmental Policy Act (NEPA) and its implementing regulations at 40 CFR 1500-1508, Reclamation prepared an EA to determine whether implementing the Project operating procedures defined in the OA would significantly affect the quality of the human environment. The EA and the operating procedures were anticipated to be in effect until June 2012. Based on the information, data, and analysis available in 2007, none of the environmental impacts were anticipated to reach a level of significance.[1] In the 2007 EA, Reclamation committed to gather data over the first five years of implementation to support future evaluation of effects on the environment. This supplemental EA fulfills that commitment.

1.5 Topics in this assessment

Based on internal review and external scoping and outreach, the following topics and issues are included for analysis in this EA.

• Water Resources
  ○ Surface Water
  ○ Groundwater
  ○ Water Quality
• Vegetation
• Wildlife
	• Listed Species
	• Cultural Resources
	• Farming and Land Use
	• Parks and Recreation
	• Environmental Justice
	• Indian Trust Assets

[1] In defining "significantly" the Council on Environmental Quality's regulations require consideration of context and intensity of the environmental effects of an action. An EIS must be prepared when the effect of an action is considered significant.

2 Purpose and Need to Implement Operating Procedures

The need for the operating procedures and OA remains as described in the 2007 EA. Since 1979 and 1980, Reclamation, EBID and EPCWID have had contractual obligations to agree upon a detailed operational plan setting forth procedures for allocation, delivery, and accounting of Project water. This need was finally satisfied in 2008 when the three parties entered into a Compromise and Settlement Agreement (2008 Settlement), which required implementation of the OA and Operations Manual, and resolved decades of litigation, as described in Appendix C.

The purpose of the Proposed Action is to meet contractual obligations to provide EBID and EPCWID with a written set of procedures defining the allocation of Project water to both districts consistent with their rights under applicable law, with which both districts agree, and which can be changed only with the unanimous consent of the districts and Reclamation.

Also, the Proposed Action allows each district to carryover the unused portion of its annual diversion allocation, up to a specified limit, rather than the unused portion contributing to the total usable water available for allocation the following year. The Proposed Action considers adjustments to annual diversion allocations in response to changes in the ability of the Rio Grande to convey Project water from Caballo Dam to points of diversion, as represented by the diversion ratio.

Outside of these operational elements, the operation of the Project would proceed unchanged.

3 Alternatives

3.1 Introduction

Two alternatives were evaluated in 2007 and remain the same for this supplemental EA:

- No Action; and
- Proposed Action: Continued implementation of OA.

3.2 No Action

The operation of the Project has consisted of four functions, all of which would remain unchanged under the No Action alternative:

- Storing Project water;
- Allocating the stored Project water to EBID and EPCWID and Mexico primarily by applying the D-2 and D-1 allocation relationships, respectively (with annual adjustments as agreed-upon to optimize operations);
- Releasing the Project water to satisfy orders from the two districts and the International Boundary and Water Commission, United States Section (IBWC) on behalf of Mexico to deliver the allocations; and
- Diverting Project water at the diversion dams and distributing that water through the irrigation and drainage system to individual farmers. (Since 1980, this has been a function of the districts.)

Implementation of the No Action alternative would not completely satisfy the stated purpose and need for action as requested by the parties to the contracts as these contracts require the development of operating procedures to govern the operations of the Project. Implementation of the No Action alternative would also result in the breach of a settlement agreement among the United States, EBID, and EPCWID (W.D. Tex. 2007). The No Action alternative would continue Project operations according to pre-OA conditions.

3.2.1 Storing Project Water

Under the No Action alternative, Reclamation stores Project water in Elephant Butte and Caballo Reservoirs. The total conservation storage capacity is 2,249,520 acre-feet (AF). The most recent sedimentation survey of Elephant Butte Reservoir (Ferrari 2008) determined that the reservoir capacity is currently 2,024,586 AF. Caballo Reservoir has a total capacity of 324,934 AF, comprising 224,934 AF of storage and 100,000 AF of flood control space. Presently under a 1996 court order, Reclamation is restricted to storing no more than 50,000 AF in Caballo Reservoir during the non-irrigation season[2].

[2] According to Court Order No. CIV-90-95- HB/WWD of October 17, 1996, which resulted from a negotiated settlement with the U.S. irrigation districts, the Caballo Reservoir storage level is targeted not to exceed 50,000 AF (elevation 4,146.11 ft) from October 1 to January 31 of each year, unless flood control operations, storage of water for conservation purposes, regulation of releases from Elephant Butte Dam, safety of dams purposes, emergency operations, or any other purpose authorized by Federal law, except non-emergency power generation, dictate otherwise. Significant variation above 50,000 AF during the

At the beginning of the calendar year (water year) and prior to the onset of the irrigation season, Reclamation would calculate the existing total water in storage. Total storage would include annual Rio Grande Compact (Compact) deliveries, which are comprised of any accumulated inflows, less evaporative losses. From this total quantity of water, non-Project storage (San Juan – Chama Project Water[3] and Compact Credit Water) would be subtracted and the resultant amount would be the total usable Project storage.

In years when the irrigation season would begin with less water than what is needed for a full allocation, Reclamation would update the Project storage calculations each month during the irrigation season until a final allocation is made. Updates would be based on inflows and releases during the month, and include the amount of water from the previous end-of-month Project storage and contractually and legally available for release.

The contractually and legally available water supply is water which the Project has in storage, plus all inflow to the Rio Grande downstream of Caballo Dam to International Dam, that may be used to comply with the terms of the 1906 Convention with Mexico, the Rio Grande Compact, irrigation delivery commitments with EBID and EPCWID, and contracts with San Juan Chama water owners. The legally available water for release is that which remains after accounting for Rio Grande Compact Credit accounts and San Juan Chama accounts.

3.2.2 Allocating Project Water

Under the No Action alternative, annual diversion allocations would be comprised of Project water stored in the reservoirs that is contractually and legally available for release, tributary inflows and return flows such that a full average annual release of 790,000 AF from the reservoirs results in a total of approximately 930,000 AF of water available for diversion from the Rio Grande by the two irrigation districts in the United States portion of the Project and Mexico at their respective canal headings. As discussed in Section 1.3 and Chapter 4, the amount of water available for diversion is greater than the amount of water released from Project storage because return flows recaptured through the system drains are returned to the river and are available for diversion downstream. All water reaching the bed of the Rio Grande within the Project area is captured and used for Project deliveries.

Annual allocations would be adjusted throughout the irrigation season to reflect inflows to Project storage and as needed to optimize Project operations consistent with applicable water rights, state and federal laws, and international treaties. Initial diversion allocations

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winter months of October through January requires collaboration and consultation between the districts and Reclamation.

[3] The San Juan – Chama Project was authorized in 1962 (PL 87-483) to allow diversion of Colorado River basin water into the Rio Grande basin of New Mexico. Subsequent authorizations under PL 97-140 allowed for the Cities of Albuquerque and Santa Fe to enter into agreements with Reclamation to store 50,000 and 25,000 AF, respectively, in Elephant Butte Reservoir.

would be announced at the beginning of each water year; if initial allocations are below the full allocation of approximately 930,000 AF, Reclamation would update allocations each month or as needed based on inflows to the reservoir during the irrigation season.

3.2.2.1 Allocation to Mexico

Under the No Action alternative, in accordance with the Convention of 1906 between the United States and Mexico regarding equitable distribution of waters of the Rio Grande (Convention), up to 60,000 AF of water would be provided annually to Mexico. The water is delivered to the bed of the Rio Grande, measured at the Acequia Madre heading, and the delivery carried out in cooperation with the IBWC.

In 1980, in light of the change from deliveries being made to Project lands of the United States at the districts' diversion headings, Reclamation and IBWC developed an equation, referred to as the D-1 curve, to calculate the annual allocation for Mexico when less than a full supply is available.

The D-1 curve is a simple linear regression equation:

$$Y = 0.8260932 * (X) – 102,305;$$

where X is the annual released water (water available for release) in AF per year, and Y is the total delivery to lands in the United States plus the delivery to Mexico at the Acequia Madre heading in AF. The D-1 curve was developed from analysis of historical Project releases and diversions over the period 1951-1978. Diversion allocations based on the D-1 curve reflect Project operations during this period, including conveyance losses and return flows. Annual allocation to Mexico is calculated based on the maximum of 60,000 AF or 11.3486 percent of the annual total delivery calculated from the D-1 curve. Under the Convention, deliveries to Mexico are capped at 60,000 AF.

The Convention specifies that in years of "extraordinary drought or serious accident to the [United States] irrigation system" Mexico's full allocation would be reduced in the same proportion as the water delivered to United States lands. Reclamation would, during times of drought, endeavor to coordinate the releases for each district and Mexico in order to minimize the conveyance losses incurred in making such deliveries.

3.2.2.2 Allocation to EBID and EPCWID

Under the No Action alternative, total annual diversion allocations to EBID and EPCWID would be calculated using the D-2 curve. Similar to the D-1 curve, the D-2 curve is a simple linear regression equation:

$$Y = \min(X,763842)*1.3377994 – 89970 + \max(0,X-763842);$$

where X is the amount of usable water in Project storage that is contractually and legally available for release and Y is the total amount of water available for diversion from the

Rio Grande by EBID, EPCWID, and Mexico at their respective canal headings. Allocations to EBID and EPCWID are calculated by subtracting the D-1 allocation to Mexico from the gross D-2 allocation and then allocating the remaining (net) D-2 to EBID and EPCWID based on the portion of authorized Project lands within each district (57% to EBID, 43% to EPCWID).

Similar to the D-1 curve, the D-2 curve was developed from analysis of historical Project releases and diversions over the period 1951-1978. Diversion allocations based on the D-2 curve reflect Project operations during this period, including conveyance losses and return flows. As discussed in Section 1.3, conveyance losses and return flows depend on conditions within the Project, including cropping patterns, irrigation practices and efficiency, operation and maintenance of canals, laterals, and drains, and groundwater pumping within the Project and surrounding areas. Diversion allocations based on the D-2 curve therefore reflect conditions within the Project during the period 1951-1978 and do not account for changes in conditions within the Project since 1978 that may affect Project operations, conveyance losses, and return flows. It should be noted that for a given amount of Project water released from storage, the D-2 curve is used to calculate the amount of water that can be delivered to river headings for diversion by EBID, EPCWID, and Mexico, whereas the D-1 curve is used to calculate the amount of water that can be delivered to Project lands within the United States and to the heading of the Acequia Madre for diversion by Mexico. Mexico's allocation is proportional to the amount of water that is delivered to lands in the Rio Grande Project.

Under the No Action alternative, the unused portion of both district's annual diversion allocation, if any, minus evaporative losses, would contribute to usable water in Project storage at the start of the following year, which is then allocated according to the D-2 curve. As a result, 43% of any unused EBID allocation (minus evaporative losses) is allocated to EPCWID the following year and 57% of any unused portion of EPCWID allocation (minus evaporative losses) is allocated to EBID the following year.

During wet periods when conservation is typically less critical, the districts are likely to call for accumulated carryover waters for increased crop production incentives, to recharge groundwater aquifers, or to flush naturally occurring salts from the irrigated fields. During very dry periods, the districts are likely to call for accumulated carryover waters to make use of all available water. Historically, EPCWID has had considerably more uncalled for (and therefore carried over) allocated water than EBID, which under No Action operations was re-allocated in the following year. Historically, EBID has usually called for all available water. EBID's degree of certainty of water for irrigation in times of drought lies in the practice of supplementing surface water supplies with groundwater pumping.

3.2.3 Releasing Project Water

As the districts and Mexico call for water, Reclamation would adjust releases based on the current system efficiency of delivering water from Caballo Dam to the respective

diversion gates[4]. The volume of water in the river system would depend on the amount of water released from the reservoirs and hydrologic conditions throughout the Project, including bank storage and groundwater elevations adjacent to the Rio Grande and drain networks within the Project, soil moisture storage and deep percolation from farmlands, flow and water levels in canals and laterals, and municipal effluent reaching the Rio Grande between Caballo Dam and American Diversion Dam. All of these factors affect conveyance losses from and return flows to the Rio Grande between Caballo Dam and Project diversions. Under normal and wet conditions, water released from Caballo Reservoir would be less than the amount of water delivered at the headgates due to the availability of return flows, groundwater discharge, and municipal effluent for downstream diversion.

3.2.3.1 Releases from Elephant Butte Dam

Under the No Action alternative, releases from Elephant Butte Dam would be provided to ensure capacity in Caballo Reservoir is available to meet delivery requirements. Releases would be scheduled on a monthly and hourly basis to ensure adequate water for Project deliveries, and may represent an increase from initially announced releases as more water becomes available. Releases from Elephant Butte Dam would be based on allocations to Mexico, EBID, and EPCWID and are restricted by other factors. These factors include the capacity of the hydropower turbines of the Elephant Butte powerplant; the flood control flow capacity of the channel downstream, as maintained by Reclamation (under separate permit with Corps), at 5000 CFS for protection of communities including Williamsburg and Truth or Consequences, New Mexico; and the limits of storage in Caballo Reservoir. When possible, releases would be made through the power plant. The three turbines of the powerplant are limited to approximately 600 to 700 CFS each, limiting releases to no more than 2100 CFS at a given time. There would be no changes in releases from Elephant Butte Dam to satisfy power generation during the irrigation season, and no water would be released under normal (non-flood) circumstances during the non-irrigation season. Reclamation retains some discretion regarding the timing of releases from Elephant Butte into Caballo Reservoir, to maintain sufficient water in Caballo for irrigation demands.

3.2.3.2 Releases from Caballo Dam

Under the No Action alternative, releases from Caballo Dam would be made when the districts and Mexico call for water, and would be a function of meeting irrigation delivery requirements. During normal non-flood Project operation, there would be no other releases from Caballo Dam. Flood control is an authorized function of Caballo Dam. Adjustments to releases from Caballo Reservoir would be made throughout the irrigation season, sometimes on an hourly basis as needed.

3.2.4 Diverting Project Water and Delivering Water to Users

Pursuant to law and contract, the fourth stated function of the Project - diversion and distribution - was delegated to the two districts in 1979 and 1980. Under the No Action

[4] System delivery efficiency is defined as the ability of the river to transport water released from Project storage to the diversion dams, accounting for losses from evaporation and seepage.

alternative, diversions would still be measured at the delivery gates, and deliveries to irrigated lands would still be a function of the districts.

3.3 Proposed Action (Continued Implementation of OA)

Despite the size and complexity of the Project and the long history of events leading up to the OA, only two activities comprise the difference between the No Action alternative and the Proposed Action: 1) new provisions for carryover water accounting for any unused portion of the annual diversion allocations to EBID and EPCWID, and 2) modified procedures for allocating Project water to both districts so as to account for the conjunctive use of surface water and groundwater within EBID, and the corresponding effects on Project allocations and deliveries to the districts and Mexico.

Under both the Proposed Action and the No Action alternative, Reclamation would continue to store, allocate and release Project irrigation water. Under the Proposed Action, diversion allocations to Mexico and EPCWID would be calculated by the D-1 and D-2 curves, respectively, and releases would be scheduled and managed to meet Project demands, as under the No Action alternative. The allocation to EBID would be made using the D-3 adjustment as detailed in the OA and summarized below.

3.3.1 The Operating Agreement

While the term of the OA is January 1, 2008 to December 31, 2050, Reclamation determined the duration of analysis for this EA should only be for another three years. (Section 1.0). Methods, equations, and procedures are detailed within the OA and the 2012 Operations Manual, as revised from 2008 and optimized based on water conditions each year. The Operations Manual is reviewed annually at the beginning of the year by EBID, EPCWID, and Reclamation (including representation from IBWC under the auspice of Reclamation) and updated as necessary.

Under the OA, Reclamation would determine the total amount of contractually and legally available Project water supply in storage at the beginning of each water year and during each month thereafter. The OA specifies the procedures by which EBID's and EPCWID's annual diversion allocations will be derived based on each district's respective proportion of the contractually and legally available water supply, in accordance with the Operations Manual and in consultation with those two parties. Additionally, the OA requires that Reclamation ensure the water order matches the actual diversion at each designated delivery metering station. This would be accomplished by close monitoring of releases, diversions, and return flows along the Rio Grande.

Diversion allocations to EBID would be made using a new method (D-3 adjustment) originally proposed by EBID, which provides Mexico and EPCWID water deliveries as stated above as the D-1 and D-2 curves, respectively, and forgoes a calculated proportion of EBID's allotment to make up for any decrease in river system delivery performance which may have been caused by changes in hydrologic conditions in New Mexico. The D-3 adjustment is a change from the D-2 allocation to EBID which would either deduct from or add to their allocation depending on daily delivery efficiencies. Declines or increases in groundwater table elevations resulting from EBID's surface and groundwater

irrigation practices will affect downstream deliveries, and the D-3 methodology is designed to reflect this. The D-3 adjustment basically provides EBID the water remaining after the allocations to EPCWID and Mexico are made, and adjusted for the diversion ratio.

The D-3 adjustment is discussed in more detail below in Section 3.3.3. This calculation would be a change to the D-2 method of determining the allocation for EBID, designed to take into account the effects of groundwater pumping and the river system delivery performance. This is an accounting change that would not impact the amount of water utilized by the Project from storage overall.

3.3.2 Carryover Water

While that portion of unused annual diversion allocation that consisted of water in the reservoir was always physically carried over to the next year, the OA includes a measure to encourage water conservation. Specifically, instead of any unused annual diversion allocation being re-allocated between the districts as Project water, the OA provides each district the right to conserve and bank a portion of their annual diversion allocation from one year, then "carry over" the credit for that allocation to be delivered in a subsequent year. Accumulation as carryover of up to 60% of a full-year water allocation is allowed under the OA. This amount is 305,918 AF for EBID and 232,915 AF for EPCWID. The OA provides that any excess carryover amount over that limit is transferred to the carryover account of the other district unless both districts' carryover limits are exceeded. In this case, both districts receive maximum carryover balances and the amount of carryover water available above the limits for each district reverts to the Project. The ability for EPCWID to have access to all of the water that it had previously conserved, instead of only 43 percent of it, provides the district with a degree of certainty of at least that much water in times of drought will be available.

Under the Proposed Action in years with less than a full Project supply, EBID's diversion allocation would be calculated from the D-3 adjustment (described below in Section 3.3.3) using total contractually and legally available Project water, less Mexico and EPCWID's allocations, and less the amounts of water on account for both districts as carryover. EBID's carryover would then be added back in on top of their diversion allocation.

Calculation of the annual diversion allocation for Mexico would proceed as under the No Action alternative, with any carryover water called for release by the districts being included as total Project water for the D-1 equation. Calculation of diversion allocations for EPCWID would also proceed as under the No Action alternative, with any carryover on account for EPCWID being added on top of its calculated (D-2) diversion allocation and made available for release when needed. Carryover water that is not called for in a given year would be added to the annual diversion allocation for the conserving district in the following year. Water not called for from that total would constitute the carryover for that year.

3.3.3 Offsets[5] for Water Conveyance Efficiencies

The OA includes a major provision that deliveries to the diversion points for EPCWID and Mexico, as predicted by the D-2 curve, would be maintained at the negotiated baseline delivery efficiencies, or the D-2 levels. This provision requires that a portion of EBID's annual diversion allocation (surface water) be utilized to maintain those negotiated baseline delivery efficiencies. This positive or negative offset for transportation efficiency is achieved through a calculation determined by the D-3 adjustment.

Under the Proposed Action, and in accordance with the 2008 Settlement, both districts would be accountable for offset losses in river efficiency within their respective states. When El Paso Water Utility (EPWU), a water user of EPCWID, pumps groundwater from the Canutillo well field[6], a portion of the actual pumped water would be charged against EPCWID's diversion allocation. In addition, water pumped by EPCWID for use in the Mesilla Valley in Texas would also be directly charged against their allocation. To account for groundwater pumping in EBID, that district would forgo a portion of its annual diversion allocation (calculated by D-3), using this portion to account for changes in river system efficiency.

The D-3 calculation is an adjustment to the D-2 diversion allocation to EBID which either deducts or adds to their allocation depending on daily delivery efficiencies. D-3 calculates the water remaining for EBID after allocations to EPCWID and Mexico are made as follows:

> (Water available for allocation) minus (EPCWID and Mexico allocations) minus (water needed to offset the change in delivery efficiency) = EBID diversion allocation.

The diversion ratio would be calculated every time the allocation is updated. If the ratio is less than 1 (typically in times of drought and therefore affected by groundwater pumping), then EBID would use a portion of their allocation to make up for the loss. If the ratio is greater than 1 (typically in times of full water allocations and reduced groundwater pumping) then EBID would receive an annual allocation further augmented by drain and irrigation return flows plus any other water reaching the bed of the Rio Grande.

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[5] Offset is defined as the amount of water from storage that is needed to supplement the river to achieve historical delivery ratios between the water released from Caballo Reservoir to all points of diversion.
[6] The Canutillo well field is located in northern El Paso County, Texas and overlies the Mesilla Bolson – an aquifer also tapped for groundwater pumping in southern New Mexico.

4 Environmental Consequences

This section discusses the potential or anticipated impacts of the Proposed Action and No Action alternative. Direct impacts are caused by the action, and occur at the same time and place as the action. Indirect impacts are caused by the action, and occur later in time or more geographically removed, but are still reasonable and foreseeable. Cumulative effects, or impacts, are the effects on the environment that may result from the incremental effects of the alternatives when added to other past, present, or reasonably foreseeable actions regardless of what agency or person undertakes such actions (40 CFR 1508.7; 43 CFR 46.115).

The following Natural, Cultural, and Socioeconomic Resources and Indian Trust Assets sections discuss the potential or anticipated direct and indirect impacts of the implementation of the Proposed Action on resources or elements of the environment.

4.1 Related Projects and Actions

This EA is tiered from several previous NEPA analyses and references other related analyses, including;

- IBWC's Flood Control Project Final EIS (USIBWC 2004a);
- Rio Grande Canalization Project Brief and Final EIS (USIBWC 2004b);
- El Paso-Las Cruces Regional Sustainable Water Project EIS (USIBWC 2001);
- Reclamation's Elephant Butte and Caballo Reservoirs Resource Management Plan and EIS (Reclamation 2003);
- Phreatophyte management at Elephant Butte/Caballo Reservoirs (Reclamation 2004);
- Elephant Butte Lake State Park management Development and Management Plan (Reclamation 2006); and
- El Paso Water Utilities; Desalination process at the Umbenhauer Plant to treat and use water in the American Canal during the non-irrigation season (EPWU 2013)

4.2 Natural Resources

4.2.1 Basis of Significance

As stated, in part, in the 2007 assessment, a significant effect on natural resources would:

1. contribute to an environmental violation, or cause the Project to not conform to applicable federal, state, or local law, regulation, or standard, such as a federal water quality standard, or
2. result in the permanent degradation or loss of native vegetation communities, jurisdictional wetlands, or important wildlife habitat, or
3. jeopardize the continued existence of a listed species or adversely modify designated critical habitat under the Endangered Species Act (ESA) of 1973, or
4. result in a predicted substantial deviation from historic water quantities or qualities, as evidenced by marked changes in Project supplies, allocations, releases or quality of regulated water such as drinking water.

4.2.2 Water Resources

4.2.2.1 Introduction

Much of the discussion on the potential impacts of the Proposed Action on water resources coincides with numerous factors influencing surface and groundwater in the Project area, including improvements in irrigation efficiency within EBID; changes in cropping patterns; changes in groundwater administration by the State of New Mexico, including the allocation of groundwater pumping rights and amounts as part of the State's adjudication of water rights; urbanization of Project lands; and onset of severe and sustained drought conditions since 2003 that continue to the present. It should be noted that analysis of recent trends cannot attribute observed trends to any particular driver.

The Rio Grande basin in southern New Mexico has experienced recent drought conditions characterized both by low local summer monsoon precipitation and by low surface water runoff from the upper Rio Grande, relative to both the instrumental record and to the paleoclimatic record from 1658-2008 (Woodhouse et. al. 2013). The paleoclimatic record further demonstrates that years with low runoff followed by a dry monsoon are common throughout the history of the basin, with periods of shared seasonal droughts occurring as early in the record as the 1660s and as recently as the 1950s (Figure 4.1; Woodhouse et. al. 2013).

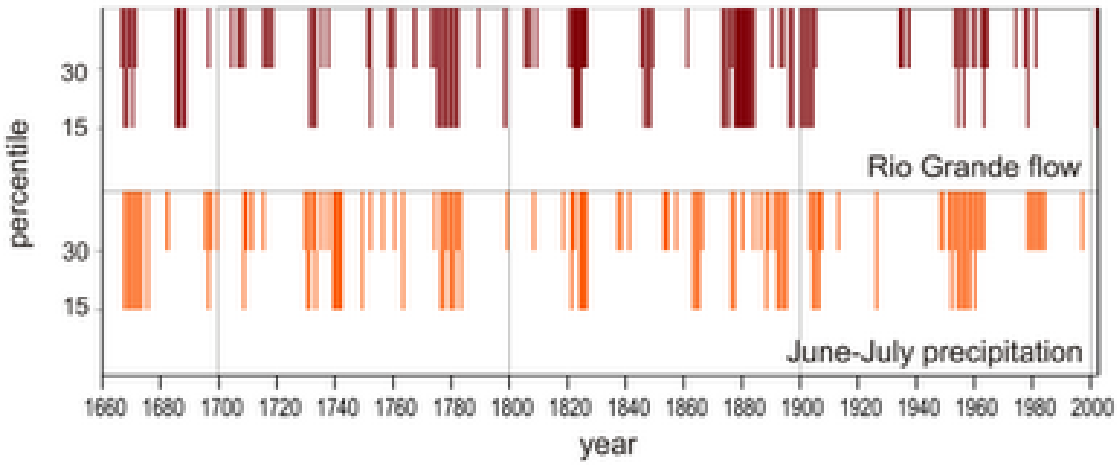

Figure 4.1. Upper Rio Grande runoff (top) and basin summer monsoon precipitation (bottom), 1659-2008, based on dendochronology (Woodhouse et. al. 2013). Bars denote years in which the chance of non-exceedance of flows was in the 15- or 30-percentile range (i.e., dry conditions). Clusters of bars indicate the persistence of drier conditions over multiple years.

4.2.2.2 Surface Water

Introduction

Through the 2007 EA, Reclamation committed to gather data over the first five years of operating under the OA in order to assess potential effects of the agreement on the

environment. This supplemental EA therefore evaluates potential effects of the proposed action based on two separate analyses. First, effects are evaluated by comparing actual Project operations during the first five years of the OA (2008-2012) to estimated Project operations that would have occurred during this period under the No Action alternative, i.e., under Prior Operating Practices that were in place during the period 1980-2007. In addition, a probabilistic analysis was conducted to evaluate potential effects of the OA over the three year period from the start of the 2013 irrigation season to the end of the 2015 irrigation season.

The analysis detailed in the section titled "What is the status of surface water?" assesses the results of the first five years of implementing the OA. The analysis detailed in the section titled "How does the Proposed Action affect surface water?" describes the potential future effect of the Proposed Action on surface water resources.

As discussed below, conditions since 2008 have been substantially affected by severe and sustained drought conditions. While the ongoing drought is comparable in magnitude and duration to the drought of the 1950s, conditions during 2008-2012 are not representative of the range of hydrologic conditions within the basin over the past several decades.

Methodology

Historical annual Project operations data and annual allocation models were used to evaluate the potential effects of the OA on Project operations during the first five years under the OA (2008-2012) and during the subsequent three irrigation seasons (2013-2015). Project data and annual allocation models were used to estimate effects of the OA on annual Project allocations to EBID, EPCWID, and Mexico; total annual releases from Project storage; total annual diversions by EBID, EPCWID, and Mexico; and total Project storage at the start and end of irrigation season (March 1 and October 31 of each year, respectively). See Appendix E for definitions of allocation components used in the OA and in following analyses for both the OA and Prior Operating Practices.

The Council on Environmental Quality (40 CFR 1502.22) states that NEPA analyses should consider reasonably foreseeable environmental impacts and not a worst case analysis with a low probability of occurrence. It is common for hydrologic analyses to use exceedance/non-exceedance curves to display projected future hydrologic scenarios for NEPA impact analysis. In this context, it is common to use the 20th and 80th percentiles to frame the reasonably foreseeable hydrologic conditions that may occur. Low non-exceedance probabilities are associated with drier conditions and high non-exceedance probabilities are associated with wetter conditions. The conditions outside of the 20th and 80th percentiles represent conditions with a low probability of occurrence. The analyses in the following sections predominantly use the 20th (drier) and 80th (wetter) percentiles of non-exceedance curves to define the reasonably foreseeable future conditions. Considering the analysis of reservoir elevation for example, 80% of the time will be drier and reservoir levels will be lower than the 80th percentile data presented. The analyses also present the 50th percentile as the condition most likely to occur.

While there is considerable uncertainty in the projections of future hydrology, by using the same hydrologic data for each alternative, differences between the alternatives can be isolated and compared. It must be noted that the hydrology presented are not predictions of future conditions; rather, they are projections of what might occur under the alternatives based on past performance.

What is the status of surface water?

Water flows into Elephant Butte Reservoir from the Rio Grande, tributary inflow and the low flow conveyance channel. The low flow conveyance channel is a manmade channel located alongside the river, designed to convey water from San Acacia Diversion Dam to Elephant Butte Reservoir.

The natural inflow to Elephant Butte Reservoir is highly variable, as indicated in Figure 4.2, ranging from less than 20,000 to over 1,500,000 AF per year from 1950 to the present. Notably, inflows have been substantially below average much of the last ten years. New Mexico is currently experiencing severe to extreme drought conditions statewide (USGS 2013; http://droughtmonitor.unl.edu) which follows three years of below normal precipitation and runoff. Records for the Rio Grande Floodway at San Marcial gage (USGS #08358400) indicate that the average inflow of 269,000 AFY from this source over water years 2010, 2011, and 2012 was less than 52% of the long-term average of 522,000 AFY recorded from 1964 through the present. While inflow measured at the San Marcial gage is an informative representation of overall system variability, flow measurements at San Marcial are highly uncertain due to the nature of the channel (wide and shallow with very dynamic sandy bed). Because of this, San Marcial gage records are not used in the analyses, which are instead based on total net inflow, calculated from the change in storage plus reservoir releases over a given period.

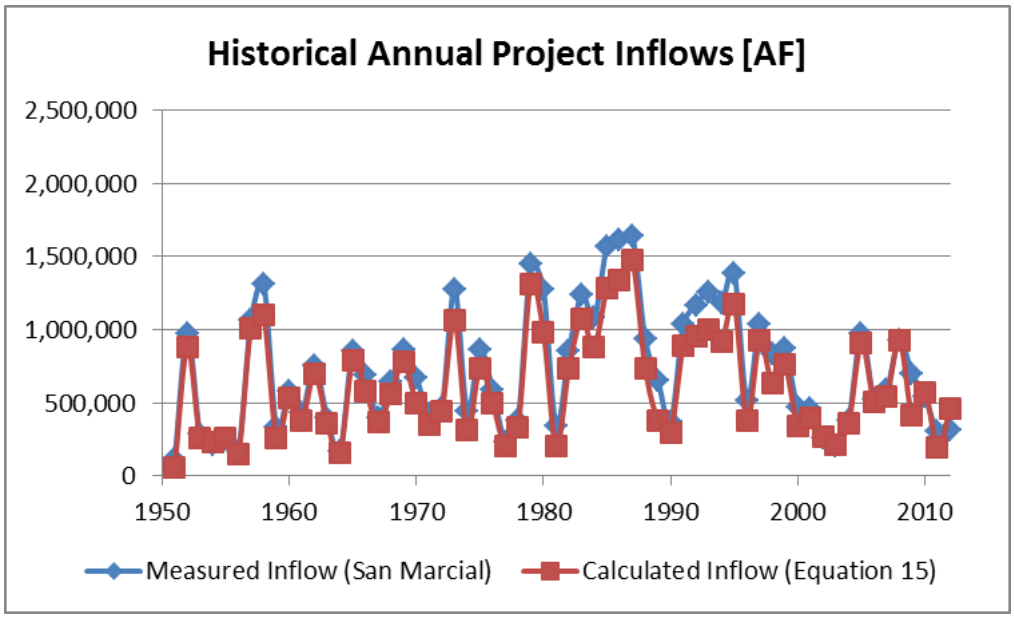

Figure 4.2. Historical annual Project inflows for the period, 1951-2012 calculated from historical Project storage and releases.

Figure 4.3, below, depicts the historic exceedance curve for Elephant Butte Reservoir elevations since 1916, demonstrating the percent of years that exceed specific elevations. This figure shows that, during this time period, there was an 80% chance of the reservoir level exceeding elevation 4,323 feet relative to the USBR datum (which corresponds to a reservoir storage of 394,180 AF), and a 20% chance of the reservoir levels exceeding 4,398 feet (which corresponds to a reservoir storage of 1,722,190 AF). The range in between the 20% and 80% chance of exceedance represent the most frequent range of reservoir elevations and storage throughout the Project history.

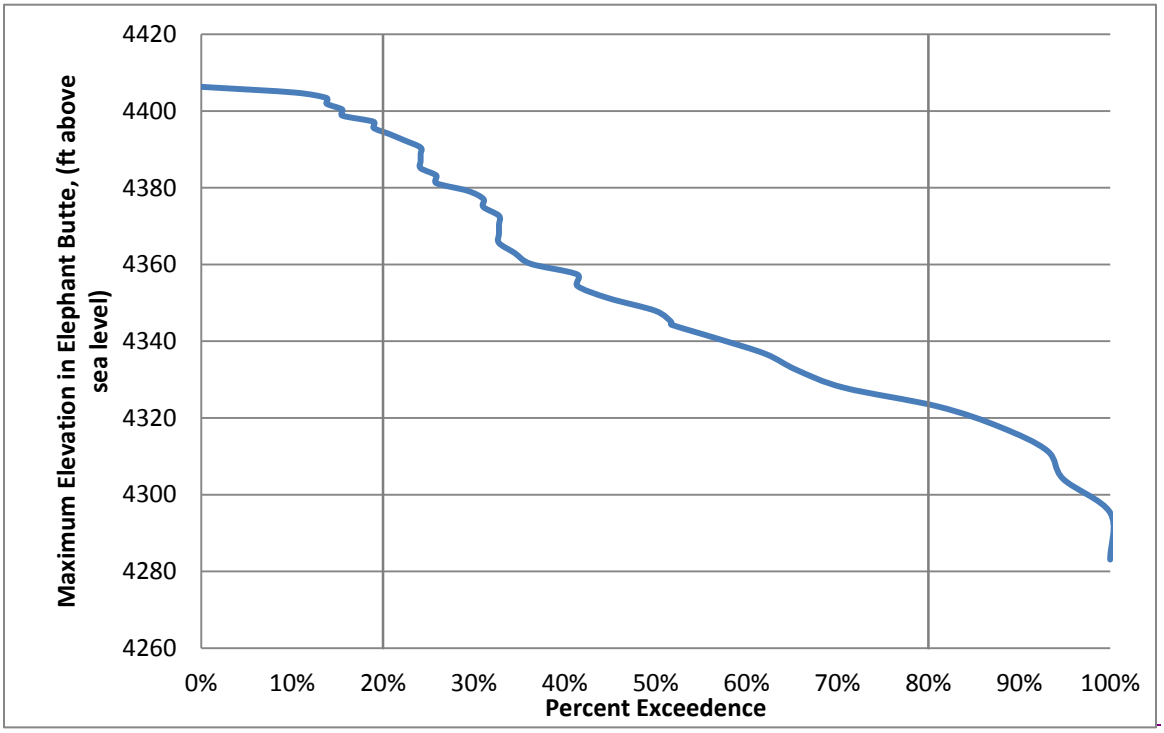

Figure 4.3. Elevation Exceedance Curve for Elephant Butte Reservoir, 1916 - 2011

Review of First Five Years of Operating Agreement: 2008-2012

The potential effects of Project operations on surface water supplies during the first five years of the OA (2008-2012) were compared to the simulated effects that would have occurred during this period under No Action alternative, i.e., under Prior Operating Practices that were in place during the period 1980-2007.

The Proposed Action has no effect on inflows to Project storage or surface runoff within the Project, and therefore has no effect on the total available surface water supply. Analysis was limited to consideration of potential effects of the Proposed Action on management of the available surface water supply, including Project allocations to EBID, EPCWID, and Mexico; releases from Project storage; and total contractually and legally available Project storage at the start and end of the irrigation season (March 1 and October 31 of each year, respectively).

Surface Water Allocations

For the period 2008-2012, the average amount of new water allocated per year (Annual Allocated Water) for EPCWID was 46,279 AF/yr greater under the OA than it is estimated it would have been, on average, under the No Action alternative; the average Annual Allocated Water for EBID was 21,822 AF/yr less under the OA than it is estimated it would have been under the No Action alternative.

The Total Project Allocation to each district for any given year is the total amount of water available for release to that district, and consists of the Annual Allocated Water plus any accrued Carryover Water from prior years. The average Total Project Allocation to EPCWID during this period was 182,738 AF/yr greater under the OA while the average total allocation to EBID was 46,105 AF/yr less under the OA than it is estimated it would have been under the No Action alternative. Results indicate that the change in Total Project Allocation to EPCWID is primarily driven by differences in the district's accrued Carryover Water (i.e., most of it is water that is not newly allocated to the district), whereas the change in Total Project Allocation to EBID is attributable to both differences in Annual Allocated Water and differences in Carryover Water, in comparable amounts.

In accordance with the 1906 Treaty with Mexico, in years when extraordinary drought does not exist, such as full allocation years, the allocation to Mexico is 60,000 acre-feet. During years with extraordinary drought the allocation is "*diminished in the same proportion as the water delivered to lands under said irrigation system in the United States.*" The average total allocation to Mexico for the period 2008-2012 is 43,032 AF/yr under the OA and 38,170 AF/yr under the No Action alternative, indicating an increase in the average total allocation to Mexico of 4,862 AF/yr under the OA during this period, relative to the No Action alternative. The procedure used to determine the allocation to Mexico is based on the total release of Project water each year and both the OA and the No Action Alternative procedures are consistent with the requirements of the 1906 Treaty and use the same method to determine allocations Mexico. The estimated difference in allocation to Mexico is due to the fact that, under certain conditions, Mexico receives a benefit from carryover allocation by the districts in the year in which carryover is released.

The following tables (Tables 4.1 a, b, and c) summarize allocations to EBID and EPCWID, including Annual Allocated Water, Carryover Water, and Total Allocation to each district over the period 2008-2012.

Table 4.1. Annual Allocated Water, Carry-Over Water Accrued to Date, and Total Allocation Available each year to EBID, EPCWID, and Mexico, 2008-2012.

Table 4.1a: EBID Allocation Summary, 2008-2012

EBID	OA (Actual)			Prior Operations (Estimated)			Difference		
	Annual Allocated Water	Carryover Water accrued to date	Total Allocation available	Annual Allocated Water	Carryover Water accrued to date	Total Allocation available	Annual Allocated Water	Carryover Water accrued to date	Total Allocatio availabl
2008	324,990	0	324,990	495,013	0	495,013	-170,023	0	-170,02
2009	345,817	-4,304	345,817	193,828	191,966	385,795	151,989	-196,270	-39,978
2010	255,257	40,343	305,871	292,949	0	292,961	-37,692	40,343	12,910
2011	57,089	20,015	77,104	93,733	0	93,768	-36,644	20,015	-16,664
2012	135,633	17,333	135,633	152,374	0	152,405	-16,741	17,333	-16,772
Average	223,757	14,677	237,883	245,579	38,393	283,988	-21,822	-23,716	-46,10

Table 4.1b: EPCWID Allocation Summary, 2008-2012

EPCWID	OA (Actual)			Prior Operations (Estimated)			Difference		
	Annual Allocated Water	Carryover Water accrued to date	Total Allocation available	Annual Allocated Water	Carryover Water accrued to date	Total Allocation available	Annual Allocated Water	Carryover Water accrued to date	Total Allocation available
2008	388,192	106,982	517,455	376,885	0	376,885	11,307	106,982	140,570
2009	320,105	232,882	552,987	147,574	146,156	293,730	172,531	86,726	259,257
2010	281,634	232,915	514,549	223,050	0	223,050	58,584	232,915	291,499
2011	43,466	224,348	267,814	71,392	0	71,392	-27,926	224,348	196,422
2012	132,935	9,042	141,977	116,035	0	116,035	16,900	9,042	25,942
Average	**233,266**	**161,234**	**398,956**	**186,987**	**29,231**	**216,218**	**46,279**	**132,003**	**182,738**

Table 4.1c: Mexico Allocation Summary, 2008-2012

Mexico	OA (Actual)			Prior Operations (Estimated)			Difference		
	Annual Allocated Water	Carryover Water accrued to date	Total Allocation available	Annual Allocated Water	Carryover Water accrued to date	Total Allocation available	Annual Allocated Water	Carryover Water accrued to date	Total Allocation available
2008	60,000	0	60,000	60,000	0	60,000	0	0	0
2009	56,082	0	56,082	58,597	0	58,597	-2,515	0	-2,515
2010	50,235	0	50,235	42,046	0	42,046	8,189	0	8,189
2011	25,649	0	25,649	7,006	0	7,006	18,643	0	18,643
2012	23,196	0	23,196	23,202	0	23,202	-6	0	-6
Average	**43,032**	**0**	**43,032**	**38,170**	**0**	**38,170**	**4,862**	**0**	**4,862**

The estimated decrease in average annual allocation to EBID during the first five years of the OA primarily reflects the diversion ratio provision of the agreement. The diversion ratio provision adjusts annual Project allocations to account for the effects of conjunctive use of groundwater and surface water within EBID on Project deliveries to downstream points of diversion, including effects of groundwater pumping on drain flows as well as groundwater discharge (baseflow), and seepage losses along the Rio Grande. In general, the diversion ratio provision reduces the annual allocation to EBID when the Project diversion ratio is low, which occurs when seepage losses are large and return flows are small (e.g., when Project releases exceed Project charges). Conversely, the diversion ratio provision increases the annual allocation to EBID when the Project diversion ratio is high, which occurs when return flows are large and seepage losses are small (e.g., when Project charges exceed Project releases). The decrease in average annual allocation to EBID under the OA during the period 2008-2012 compared to the estimated average annual allocation under the prior operating practices reflects the low Project diversion ratio during this period.

Low values of the Project diversion ratio during the period 2008-2012 are indicative of high losses within the Project during this period. Examination of gross water delivery efficiencies before and after the implementation of the OA shows that the decline in efficiency coincides with the start of the most recent drought period and not with the initial implementation of the OA. Since the baseline for determining the required offset by each district was negotiated based on the years 1951 to 1978, no attempt was made in this analysis to discern the amount of offset required for ground water pumping from the offset required as a result of factors beyond the Project's control that also affect Project conveyance efficiencies, including drought, changed cropping patterns, and changes in farm practices. Present available data indicates that drought and supplemental pumping needed to satisfy crop demand not met by surface water supplies is the major influence on Project water delivery efficiency.

During the first five years of operations under the OA, average annual Project releases were approximately 65,500 AF/year greater than average annual Project charges to the two districts, indicating that losses within the Project exceeded inflows from groundwater discharge, drain flows, and other return flows. Previous studies indicate that the majority of losses within the Project occur as seepage, and that a large portion of seepage losses within the Project contribute to recharge of unconfined shallow groundwater aquifers within the Rincon and Mesilla Valleys, which in turn contributes to the groundwater supply available to EBID farmers (Tom Maddock, 2012 Affidavit, 2012 pers. comm.; Peggy Barroll 2012 pers. comm.). However, EBID operates the surface water delivery system and the surface water delivered from the Rio Grande Project, therefore seepage losses are lost to the surface water delivery ability of EBID. Results therefore suggest that under drought conditions the surface water supply to EBID was reduced under the OA relative to what it would have been under prior operations.

EBID Surface Water Allocations, 2008-2012

Annual Project allocations to EBID during the first five years of the OA (2008-2012) are shown in Figure 4.4 along with estimated annual Project allocations to EBID during the same period under the No Action alternative. As noted above, the average annual Project allocation to EBID under the OA during this period is approximately 46,105 AF/year less than the estimated average annual allocation to EBID under the No Action alternative. The estimated difference in allocation to EBID is due to two differences in allocation procedures between the OA and the No Action alternative:

1. Carryover provision of the OA (see Section 1.3): During the period 2008-2012, carryover of unused allocation balance by EPCWID was far greater than carryover by EBID. Deduction of EPCWID's unused allocation balance reduced the total usable water available for allocation each year, therefore reducing the current-year allocation to EBID in all years and most notably in 2008 and 2009.
2. Diversion ratio provision of the OA (see Section 1.3): The diversion ratio is less than 1.0 in all years considered. This results in a negative value of the diversion ratio adjustment, which in turn reduces the EBID Diversion Ratio Allocation and subsequently the Total EBID Diversion Allocation.

As noted above, the estimated difference in annual Project allocation to EBID is similar in magnitude to the estimated recharge to EBID groundwater supplies due to seepage from the Rio Grande during the period considered here. This result therefore indicates that the overall conjunctive supply of surface and groundwater available to EBID was not adversely affected during the first five years of the OA.

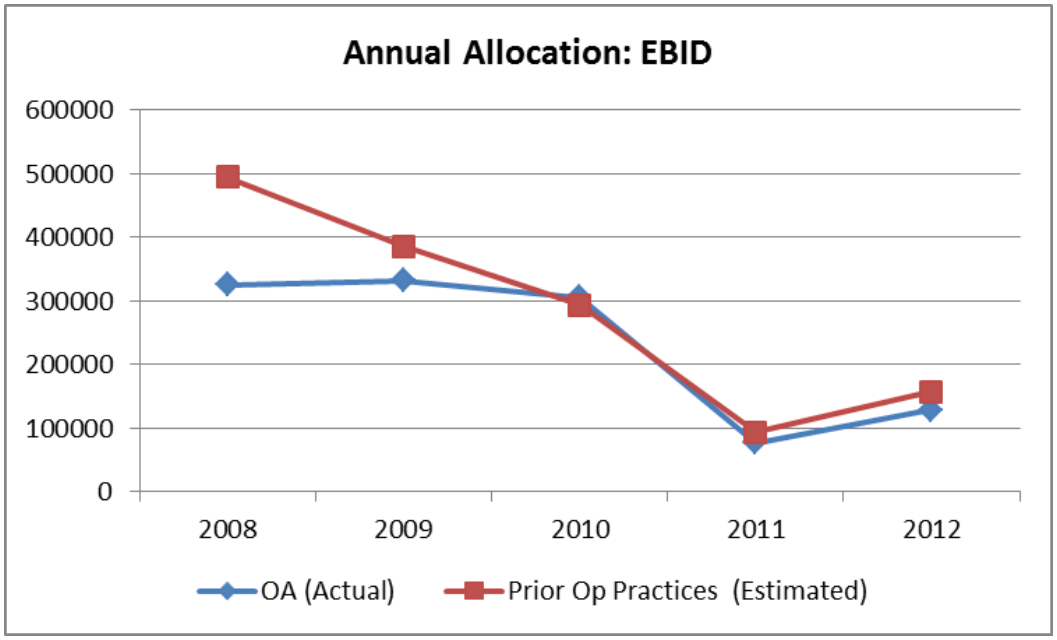

Figure 4.4. Annual Project allocations to EBID (AF) under actual OA operations, 2008-2012, versus calculated allocations that would have occurred under the No Action.

EPCWID Surface Water Allocations, 2008-2012

Annual Project allocations to EPCWID during the first five years of the OA (2008-2012) are shown in Figure 4.5 along with estimated annual Project allocations to EPCWID during the same period under the No Action alternative. The average annual Project allocation to EPCWID under the OA during this period is approximately 182,738 AF/year greater than the estimated average annual allocation to EPCWID under the No Action alternative. The estimated increase in allocation to EPCWID is primarily due to the inclusion of unused prior year allocation balance (i.e., carryover) in the following year's allocation under the carryover provision of the OA. In addition, inclusions of American Canal Extension (ACE) Conservation Credits contributed to increased allocations to EPCWID in 2008 and 2009; the difference between the EBID Diversion Ratio Allocation and D2 Diversion Allocation contributed to the EPCWID Diversion Allocation in 2011. It should also be noted that in 2009 and 2010, EPCWID carryover exceeded the maximum carryover allowed under Section 1.10 of the OA; in each of these years, excess carryover balance was transferred to EBID's diversion allocation as per Section 1.11 of the OA.

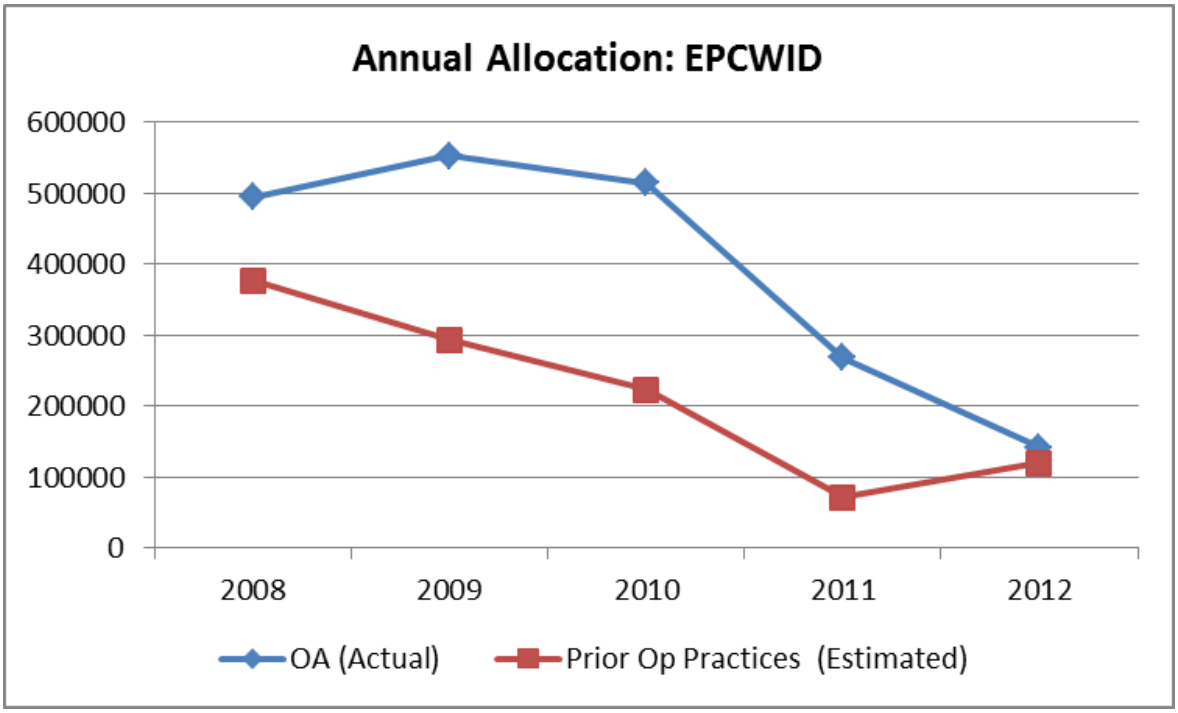

Figure 4.5. Annual Project allocations to EPCWID (AF) under actual OA operations, 2008-2012, versus calculated allocations that would have occurred under the No Action.

Mexico Surface Water Allocations, 2008-2012

Annual allocations to Mexico during the first five years of the OA (2008-2012) are shown in Figure 4.6 along with estimated annual allocations to Mexico during the same period under No Action. The average annual allocation to Mexico under the OA during

this period is approximately 4,862 AF/year greater than the estimated average annual allocation under the No Action alternative. The estimated increase in allocation to Mexico results from an increase in the annual estimated release of current usable water, which in turn results from an increase in total Project storage due to the carryover of unused EPCWID allocation.

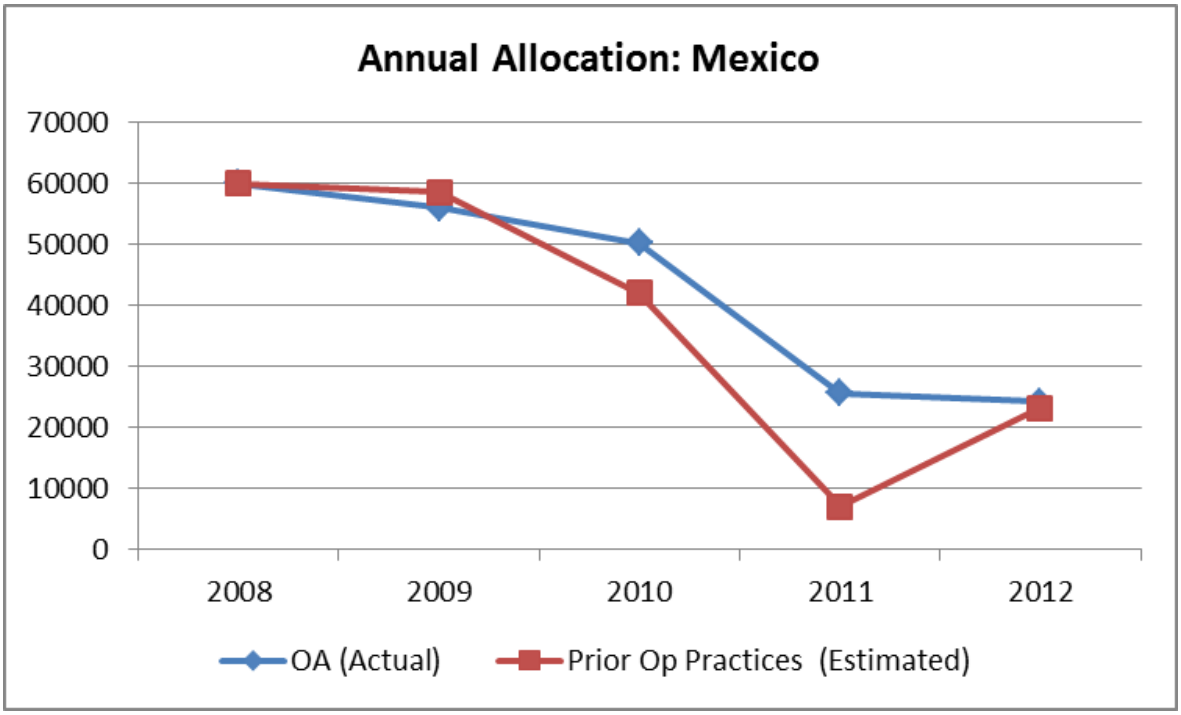

Figure 4.6. Annual Project allocations to Mexico (AF) under actual OA operations, 2008-2012, versus calculated allocations that would have occurred under the No Action.

Annual Release from Project Storage

Actual total annual releases from Project storage under the OA and estimated releases under No Action are illustrated in Figure 4.7 and annual release values are provided in Table 4.2. Average annual release under the OA (actual) is 559,829 AF/year; average release under prior operating practices (estimated) is 549,108 AF/year. The OA thus results in an estimated increase of 10,720 AF/year in the average annual release from Project storage. Given that the OA has no effect on inflows to Project storage and that total usable Project water is effectively depleted at the end of the 2012 irrigation season under both operations, the difference in total Project release over the period 2008-2012 is expected to be zero. The estimated average difference of 10,720 AF/year therefore reflects uncertainties that are not directly accounted for in this analysis, including uncertainties in the Project data used in this analysis.

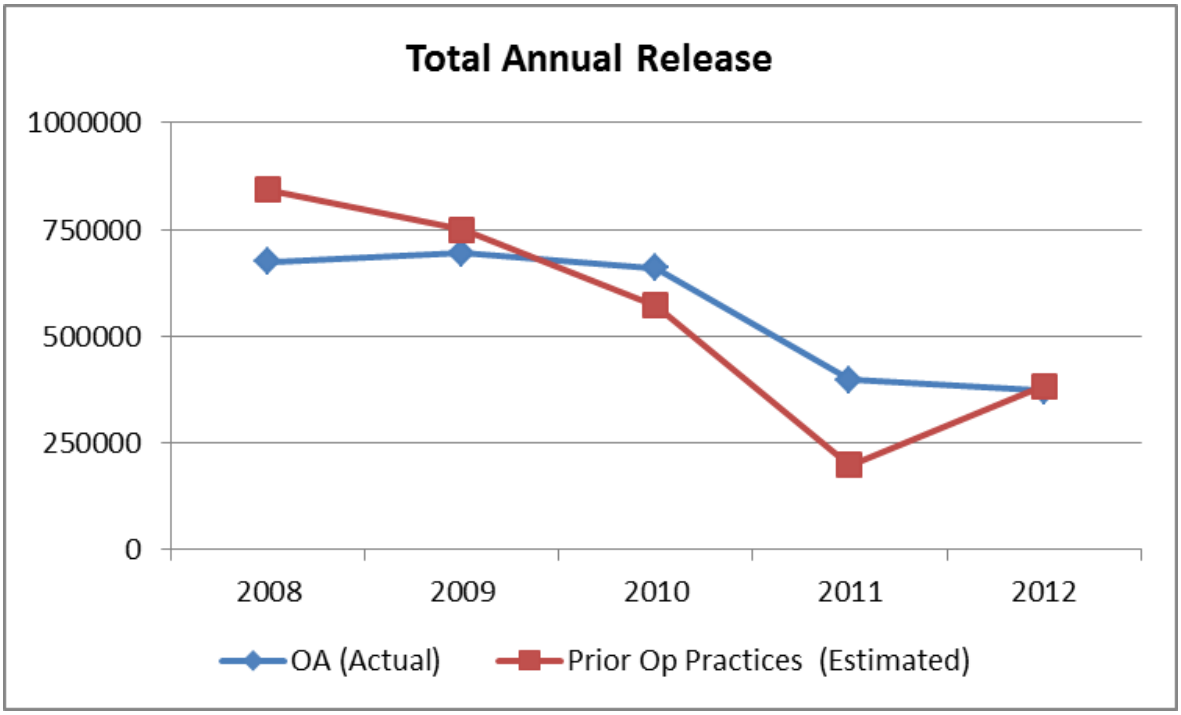

Figure 4.7: Historical (actual) total annual releases from Caballo Dam ($R_{Caballo}$) under the OA and calculated annual releases under prior operating practices for the period 2008-2012.

Table 4.2: Total Annual Releases from Caballo Dam (2008-2012).

	Annual Release OA (Actual)	Annual Release Prior Operations (Estimated)
2008	675,170	843,545
2009	694,199	748,859
2010	660,300	572,270
2011	396,876	198,518
2012	372,600	382,347
Average	559,829	549,108

Total Project Storage

Figures 4.8 and 4.9 show the historical (actual) total Project storage at the start and end of irrigation season for the period 2008-2012 and the corresponding estimated storage under prior operating practices. For the purposes of this analysis, the start of irrigation season is taken as March 1 of each year, the end of irrigation season is taken as October 31, and releases from Project storage between November 1 and February 28 of each year are considered negligible.

Project storage at the start and end of the irrigation season under the OA was estimated from actual values used in the final annual allocation worksheet for each year. Project storage at the start of each irrigation season was estimated from the total usable water in Project storage available for release. Total usable water available for release is calculated by deducting non-Project water (i.e., San Juan-Chama Waters and Rio Grande Compact Credit Waters) from the total water in Project storage. Project storage at the end of each irrigation season was calculated as the total usable storage available for release minus the annual total Project release as measured below Caballo Dam. Project storage at the start and end of the irrigation season under prior operating practices was similarly estimated from the total usable water available for release and total annual release calculated under prior operations.

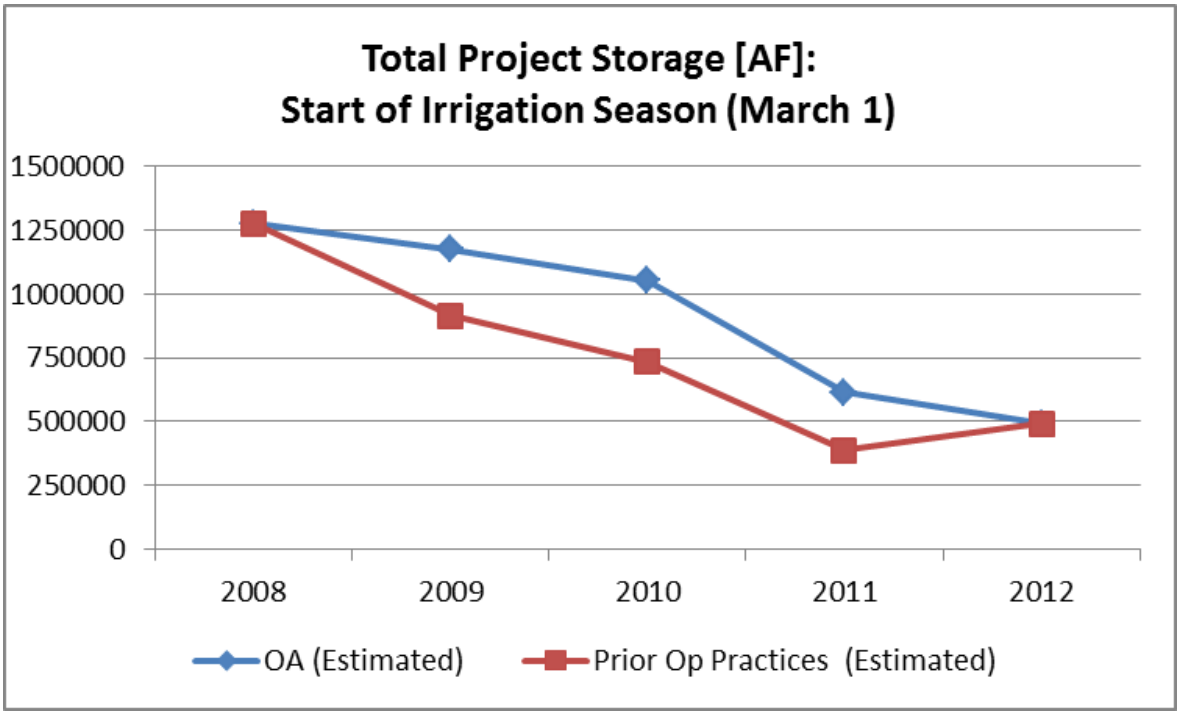

Figure 4.8: Historical (actual) total Project storage at the start of irrigation season under the OA (blue) and the corresponding estimated total Project storage under prior operating practices (red) for the period 2008-2012.

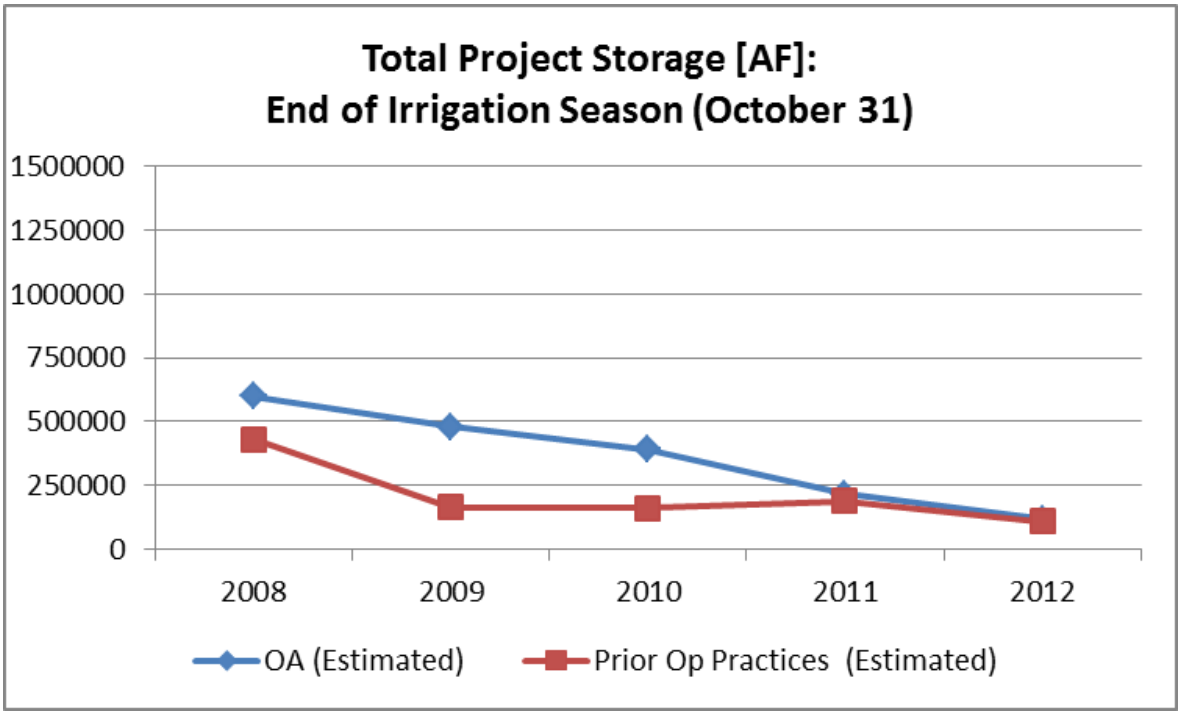

Figure 4.9: Historical (actual) total Project storage at the end of irrigation season under the OA (blue) and the corresponding estimated total Project storage under prior operating practices (red) for the period 2008-2012.

Elephant Butte Reservoir Elevation

Figure 4.10 shows the historical (actual) estimated maximum reservoir surface elevation in Elephant Butte Reservoir and the estimated reservoir surface elevation under prior operating practices for the period 2008-2012. The maximum reservoir surface elevation is taken as the reservoir elevation corresponding to the estimated storage in Elephant Butte Reservoir at the start of irrigation season, prior to release of water to meet Project deliveries.

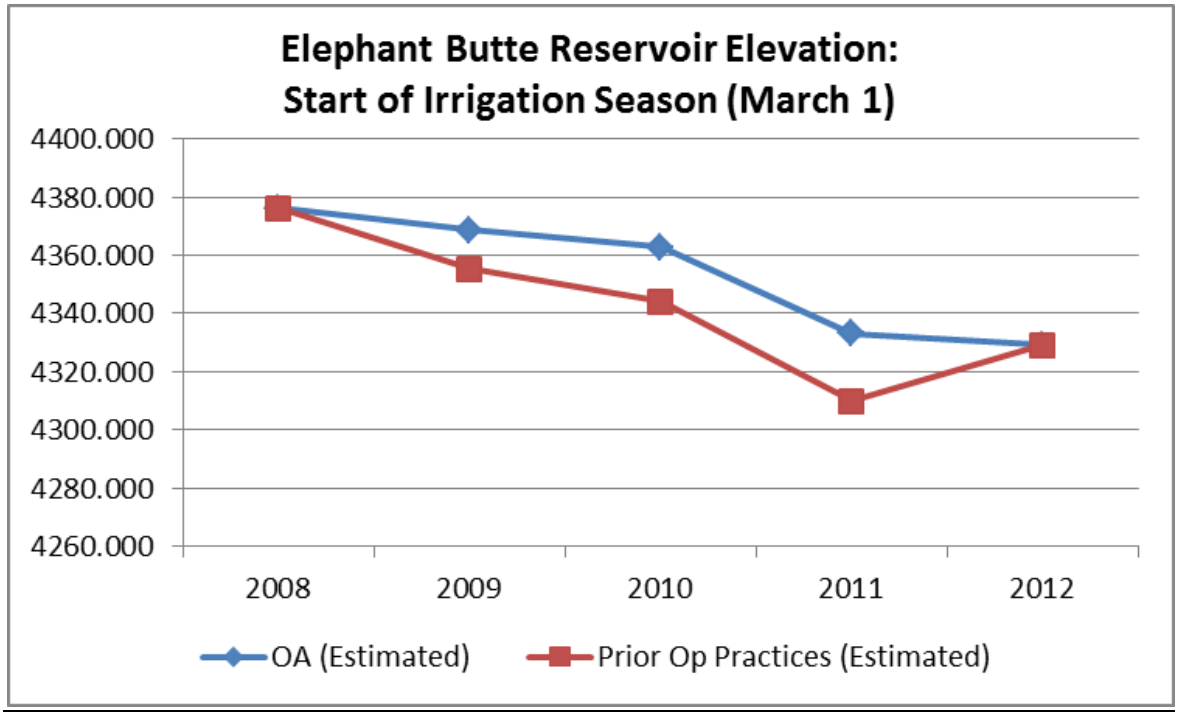

Figure 4.10: Historical (actual) Elephant Butte Reservoir elevation relative to USBR datum at the start of irrigation season under the OA and calculated reservoir surface elevation under prior operating practices for the period 2008-2012.

<u>How would the Proposed Action affect surface water (2013-2015)?</u>
This section describes the potential future effect of the Proposed Action on surface water resources during the period of analysis, which extends through the end of the 2015 irrigation season. Potential future effects of the Proposed Action are evaluated by comparing projected Project operations under the No Action and Proposed Action alternatives as described below.

Methodology

A Project annual allocation model was developed to evaluate Project operations under the anticipated range of water supply and demand conditions within the Project during the 2013-2015 irrigation seasons. The model calculates annual Project operations, including annual allocations, releases, and storage, based on annual inflows to Project storage. The effects of groundwater-surface water interaction on Project operations are accounted for based on the estimated diversion ratio. The model calculates total Project storage on March 1 and October 31 of each year, which under normal conditions correspond to the start and end of irrigation season, respectively. Initial conditions in the model are based on actual Project conditions at the end of the 2012 irrigation season. From that point forward, the model simulated conditions for year 2013 through year 2015. Thus, conditions in the model for the beginning of year 2013 are representative of but not the same as actual conditions. Reservoir surface elevation in Elephant Butte Reservoir is subsequently estimated based on the most recent Elephant Butte Area-Capacity table.

The annual allocation model incorporates two sets of operations, one that is fully consistent with Project operations under the No Action alternative and one that is fully consistent with Project operations under the Proposed Action. Potential effects of the Proposed Action are evaluated by comparing projected Project operations under the Proposed Action to those under the No Action alternative. Model results also provided the basis for the analysis of the potential effects of the alternatives on other resources.

Effects of the OA on Project operations during the 2013-2015 irrigation seasons will depend on inflows to Project storage and the annual Project diversion ratio during this period, as well delivery orders made by EBID, EPCWID, and Mexico. However, it is not possible to accurately predict inflows, Project diversion ratios, or Project diversions in advance. The potential effects of the OA during the period 2013-2015 were therefore considered using a probabilistic approach.

Because future inflows over the period 2013-2015 are not known, actual annual inflows for the period 1951-2012 were re-sampled to develop probability distributions of Project operations over this period. This was done by calculating and comparing Project operations under the OA and under prior operating practices for each historical three-year inflow trace. For example, the annual allocation models developed for this study were used to calculate Project operations based on historical inflows over the periods 1951-1953, 1952-1954, and so on, for a total of 62 three-year periods. Figure 4.11 shows the non-exceedance curve of annual inflows to Project storage based on historical inflows for the period 1951-2012.

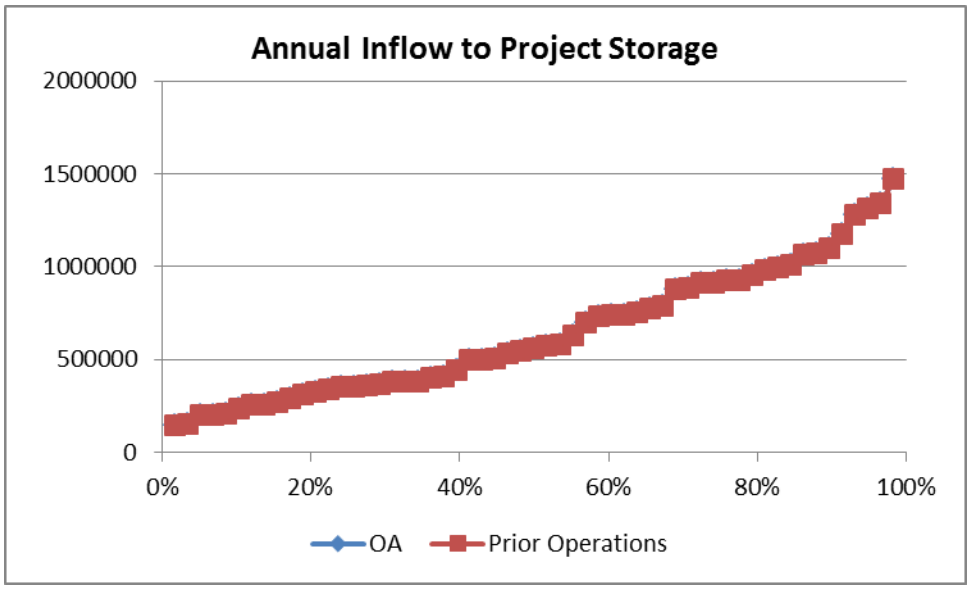

Figure 4.11. Non-exceedance curve of annual inflow to Project storage based on historical inflows for the period 1951-2012.

For each three-year inflow traces, allocation models were initialized based on actual Project storage at the end of the 2012 irrigation season (October 31, 2012), and Project operations were calculated over a three-year period. Results from these 62 scenarios

were then used to develop probability distributions of annual Project allocations, diversions, releases, and storage over the future period 2013-2015. This probabilistic approach assumes that the probability distribution of historical Project inflows is representative of likely inflows over the period 2013-2015.

The estimated annual Project diversion ratio for future years is highly uncertain. The most useful available predictor of annual diversion ratio is the prior year diversion ratio. For the purposes of this analysis, annual Project diversion ratios during the period 2013-2015 were estimated using Equation 22 (Section 2.2.2), a serial regression relationship based on historical Project operations data for the period 1951-2012. This approach provides the best available estimate of the annual diversion ratio in future years.

The effects of climate change were not considered in this modeling due to the limited time horizon of the analysis. Over the three-year period evaluated, any effects attributable to climate change would be negligible in comparison to the substantial range of possible effects associated with existing year-to-year variability in system inflows and other hydrologic drivers.

Surface Water Allocations

Summary

Results shown in Figure 4.12 indicates that for non-exceedance probabilities less than 55%, the calculated annual allocations to EBID for the 2015 irrigation season is slightly greater under the OA than under prior operating practices. However, for non-exceedance probabilities greater than 55%, the 2015 allocation to EBID is up to 155,000 AF greater under prior operating practices. Note that the increase in EBID's annual allocation for non-exceedance probabilities greater than 85% occurs due to the transfer of excess carryover balance from EPCWID under wetter conditions.

For EPCWID, results shown in Figures 4.13 indicate that the district's annual allocation for 2015 is very similar under the OA and prior operating practices under drier conditions (non-exceedance less than 25%). Under wetter conditions, the carryover provision of the OA results in an increase in annual allocation compared to prior operating practices.

Figure 4.14 indicates that annual allocations to Mexico are also similar under the OA and prior operation practices for drier conditions. Under average conditions, the annual allocation to Mexico is up to 15,000 AF/year greater under the OA compared to prior operating practices. Under wetter conditions, the annual allocation to Mexico reaches its maximum of 60,000 AF under both operations.

Figure 4.15 clearly shows that differences in EBID's allocation between the OA and prior operations are generally small under drier conditions (low non-exceedance probabilities) for a wide range of values for the Project diversion ratio. Under wetter conditions (high non-exceedance probabilities), differences become much larger. Importantly, the OA results in a large increase in annual allocation to EBID under wetter conditions when the diversion ratio is greater than 1.2. By contrast, the diversion ratio results in a notable decrease in annual allocation to EBID under wetter conditions when the diversion ratio is

less than 1.1; however, if wet conditions persist, transfer of excess carryover balance from EPCWID to EBID will reduce the decrease in EBID's allocation. For the long-term average diversion ratio of 1.16, differences in annual allocation to EBID under the OA and prior operating practices is generally positive, indicating a small increase in EBID's allocation under most conditions.

Similar to results for EBID, Figure 4.16 shows that differences in annual allocation to EPCWID under drier conditions are generally small and are not strongly sensitive to the Project diversion ratio. Differences are somewhat sensitive to the Project diversion ratio under average conditions, with sensitivity decreasing again under wetter conditions. In general, annual allocation to EPCWID is greater under the OA than under prior operating practices when the diversion ratio is low and slightly less under the OA when the diversion ratio is high.

Analysis

Non-exceedance curves of annual Project allocations to EBID, EPCWID, and Mexico for the 2015 are shown in Figures 4.12-4.14, respectively. Non-exceedance curves of Project allocations are different for each year due to the effects of prior-year operations on current year allocations; however, the general characteristics of non-exceedance curves for 2013 and 2014 are similar to those for 2015. Values of the 20%, 50%, and 80% non-exceedance allocation are provided in Table 4.3-4.5 for years 2013-2015.

Table 4.3. Surface water allocations (AF) for EBID for the 20th, 50th, and 80th non-exceedance percentiles.

	No Action			Proposed Action (OA)		
	20 %	50 %	80 %	20 %	50 %	80 %
2013	122887	334446	495013	123550	167010	231904
2014	156015	366722	495013	171113	231635	296241
2015	166598	388350	495013	192126	320581	339514

Table 4.4. Surface water allocations (AF) in for EPCWID for the 20th, 50th, and 80th non-exceedance percentiles.

	No Action			Proposed Action (OA)		
	20 %	50 %	80 %	20 %	50 %	80 %
2013	120409	254635	376885	109789	259236	392969
2014	153051	279209	376885	195538	366585	471713
2015	163478	295676	376885	219595	441827	538578

Table 4.5. Surface water allocations (AF) for Mexico for the 20th, 50th, and 80th non-exceedance percentiles.

	No Action			Proposed Action (OA)		
	20 %	50 %	80 %	20 %	50 %	80 %
2013	15287	38687	60000	15287	38687	60000
2014	20977	42972	60000	28316	51650	60000
2015	22795	45842	60000	30232	60000	60000

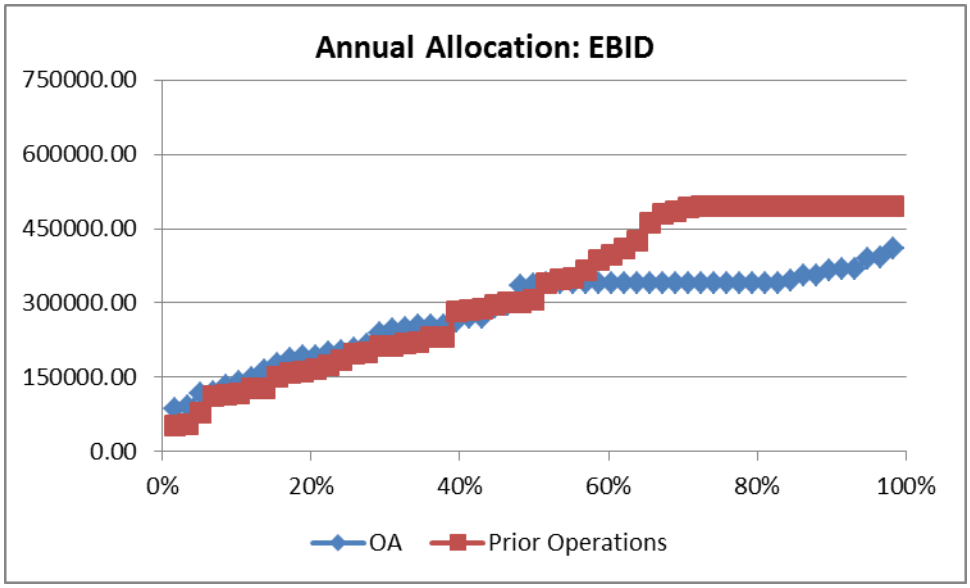

Figure 4.12. 2015 EBID surface water allocation (AF) non-exceedance curve

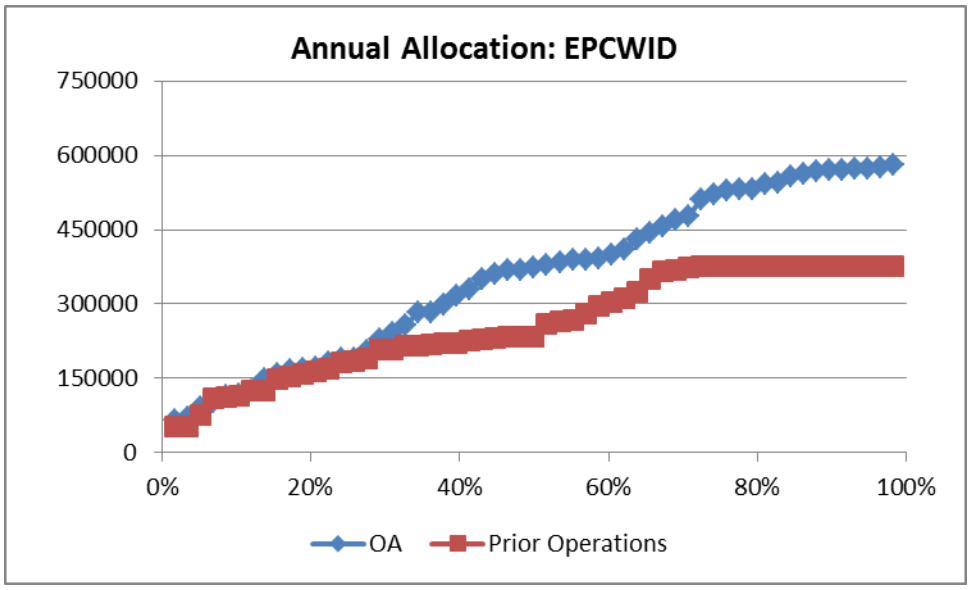

Figure 4.13. 2015 EPCWID surface water allocation (AF) non-exceedance curve

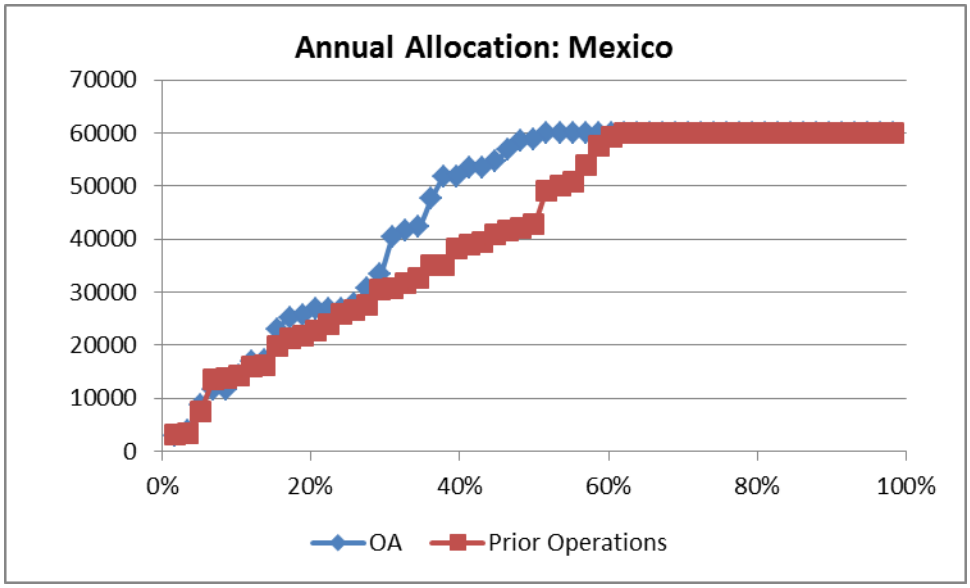

Figure 4.14. 2015 Mexico surface water allocation (AF) non-exceedance curve

The analysis begins with current usable water and carryover allocations, so conditions at the start of 2013 are the same under the Proposed Action and the No Action alternative. Allocations to EBID and EPCWID for 2013, however, are different between the Proposed Action and the No Action alternative. Allocation to Mexico is the same because Mexico's allocation is calculated from the D1 equation, where the D1 equation uses estimated release during 2013. Because the estimated release is based on usable storage at the start of the year, the estimated release and hence allocations to Mexico are the same under Action and No Action for 2013.

Figures 4.15-4.17 show the difference in annual allocation to EBID, EPCWID, and Mexico, respectively, for the 2015 irrigation season as a function of non-exceedance probability. In each of these figures, the thick black line corresponds to differences calculated from the results shown in Figures 4.12-4.14 (i.e., the difference between the red and blue lines in each figure). The gray lines correspond to differences based on Project operations calculated using different values of the Project diversion ratio[7]. For each of the gray lines, Project operations were calculated using the annual allocation models developed for this study; however, fixed (constant) values of the Project diversion ratio were used in place of values estimated using Equation 22 (Section 2.2.2). Thin gray lines with hollow symbols correspond to annual Project diversion ratios ranging from 0.7 to 1.3. The thick gray line with filled gray symbols corresponds to an annual Project diversion ratio of 1.16, which is equal to the long-term average gross diversion ratio; note

[7] As noted under Section 1.3, the Project diversion ratio is defined as the ratio of total Project charged diversions from the Rio Grande by EBID, EPCWID, and Mexico to total Project releases from Caballo Dam for a given irrigation season. Under conditions of high groundwater levels and high inflows in the Project area, the diversion ratio tends to be higher (e.g., greater than 1.0); under conditions of low groundwater levels and reduced inflows, it tends to be lower (e.g., less than 1.0).

that the long-term average Project diversion ratio is not available at this time due to the lack of comprehensive data for Project charges.

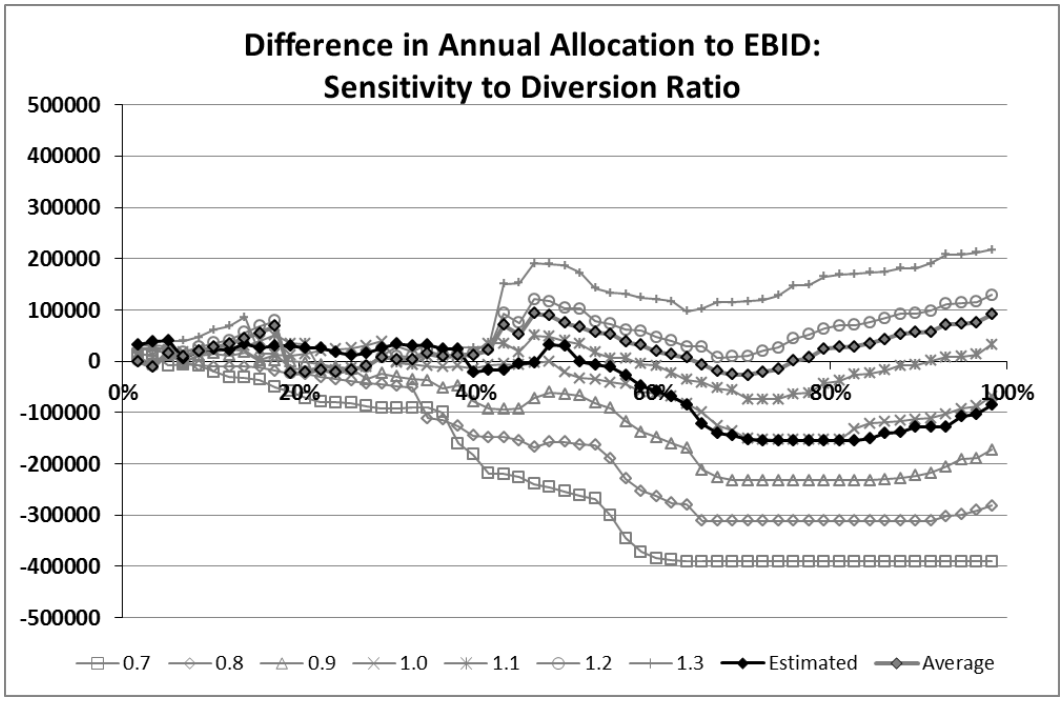

Figure 4.15. Difference in annual allocation (AF) to EBID: sensitivity to diversion ratio.

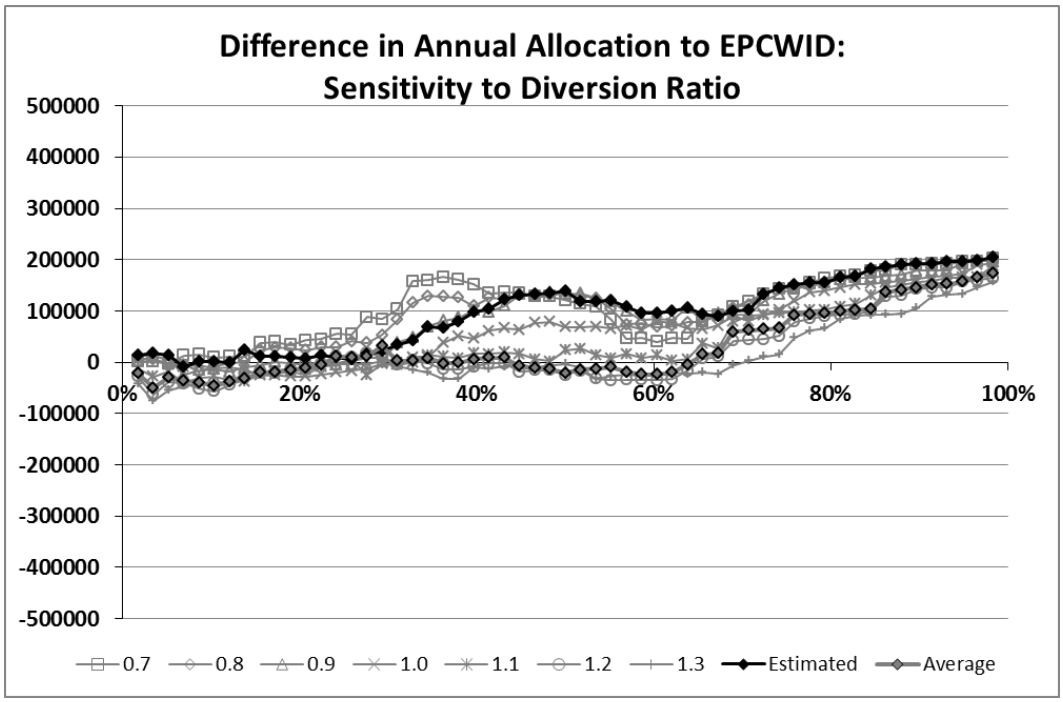

Figure 4.16. Difference in annual allocation (AF) to EPCWID: sensitivity to diversion ratio.

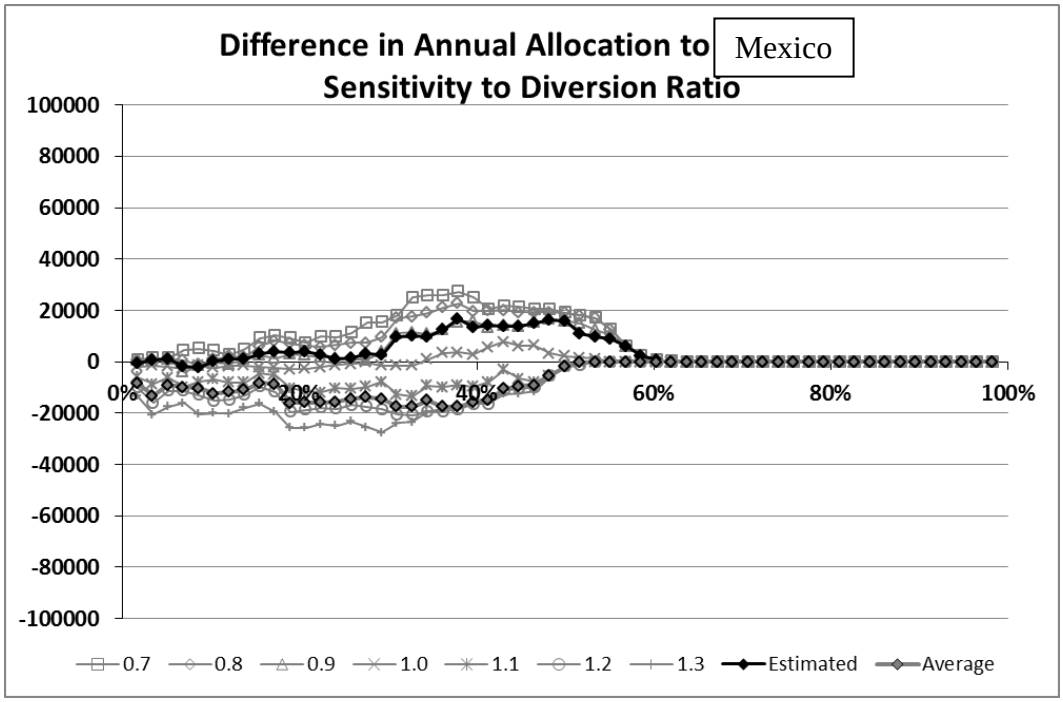

Figure 4.17. Difference in annual allocation (AF) to Mexico: sensitivity to diversion ratio.

Annual Release from Project Storage

Summary

Under drier conditions represented by the 20th percentile and average conditions represented by the 50th percentile nonexceedance, there is not a substantial difference between Caballo Reservoir releases under the Proposed Action in any year when compared with the No Action alternative. A decrease in Caballo Reservoir releases is observed under the wetter 80th percentile nonexceedance for all years due to a concomitant increase in carryover storage due to conservation efforts by each district.

Project releases from Caballo would be expected to be within the range of historic operations.

Analysis

The following non-exceedance curve, Figures 4.18, shows a probabilistic distribution of likely changes in Caballo Reservoir releases for 2015 for both the Proposed Action and the No Action alternative. Non-exceedance curves of Caballo Reservoir releases are different for each year due to the effects of prior-year operations on releases; however, the general characteristics of non-exceedance curves for 2013 and 2014 are similar to those for 2015. Table 4.6 summarizes the releases for the 20th, 50th, and 80th non-exceedance percentiles for 2013 - 2015.

Table 4.6. Releases (AF) from Caballo Reservoir from 2013 – 2015.

	No Action			Proposed Action (OA)		
	20 %	50 %	80 %	20 %	50 %	80 %
2013	236122	536507	958138	236887	458071	668369
2014	290554	582205	903984	355276	574240	701357
2015	296752	612826	854322	353667	659445	712194

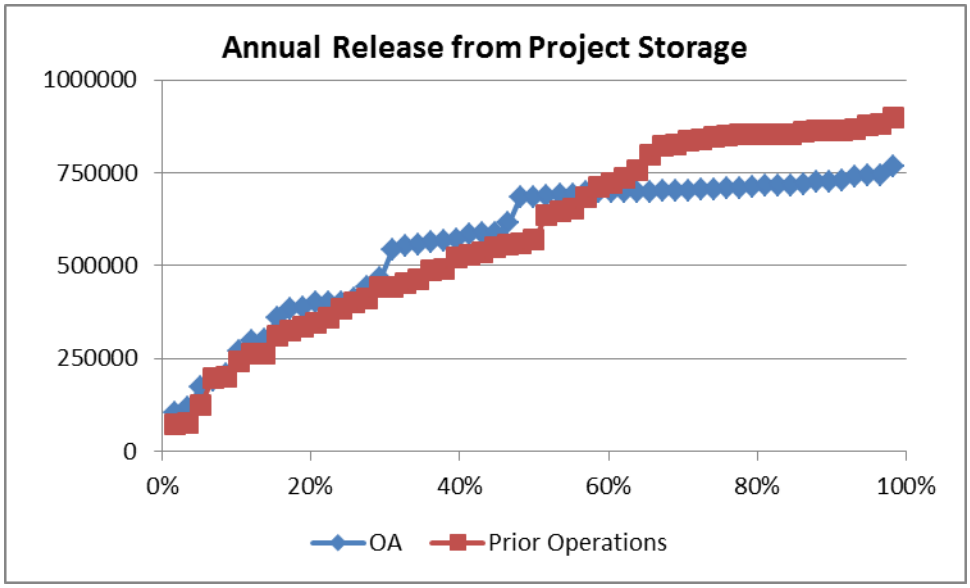

Figure 4.18. 2015 Caballo Reservoir release (AF) non-exceedance curve.

Total Project Storage

Summary

Project storage will fluctuate under any set of operating rules. Total Project storage is higher under the Proposed Action when compared to the No Action alternative. The difference is small under the drier 20th and average 50th percentiles. The increased total Project storage under the wetter 80th percentile non-exceedance is more pronounced due to increased carry-over storage.

Under the Proposed Action, future elevations and water surface area of Elephant Butte are expected to be within the range of historic water surface elevations. Since 1951, when Project allocations were first determined, total storage in the reservoirs has ranged from 77,130 AF in 1957 to 2,383,900 AF in 1988, when the reservoirs last spilled. Based on recent Project data, on average 4.5% of storage is in Caballo and 95.5% is in EB.

Analysis

The following non-exceedance curves, Figures 4.19 and 4.20, show the likely probabilistic distribution of annual total Project storage at the start and end of irrigation season for 2015. Non-exceedance curves of total Project storage are different for each

year due to the effects of prior-year operations on current year storage; however, the general characteristics of non-exceedance curves for 2013 and 2014 are similar to those for 2015. Values of the 20%, 50%, and 80% non-exceedance allocation are provided in Table 4.7 and Table 4.8 for years 2013-2015. Project storage at the start of year 2013 is projected based on actual Project storage and inflows at the end-of-irrigation season 2012 and is identical under the Proposed Action and No Action alternative.

Table 4.7. Projected March 1st storage of water (AF) in Elephant Butte Reservoir from 2013 – 2015.

	No Action			Proposed Action (OA)		
	20 %	50 %	80 %	20 %	50 %	80 %
2013	191020	191020	191020	191020	191020	191020
2014	240980	269405	322830	291584	319416	533008
2015	227800	282998	389695	302331	348627	747251

Table 4.8. Projected October 31st storage of water (AF) in Elephant Butte Reservoir from 2013 – 2015.

	No Action			Proposed Action (OA)		
	20 %	50 %	80 %	20 %	50 %	80 %
2013	143330	171755	225180	193934	221766	435358
2014	143330	198528	305225	217861	264157	662781
2015	143330	215976	354887	232992	329417	769949

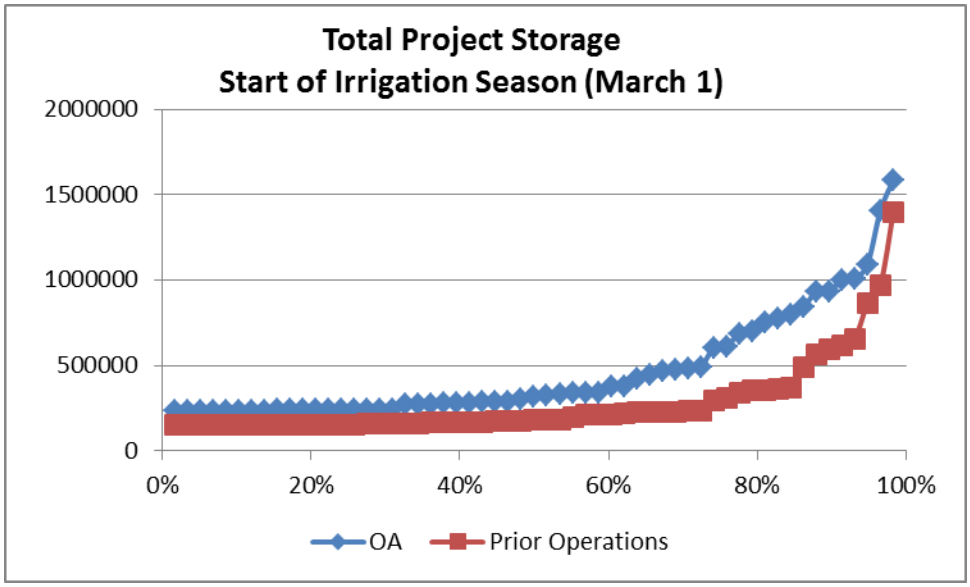

Figure 4.19. 2015 Total Project March 1st storage (AF) non-exceedance curve.

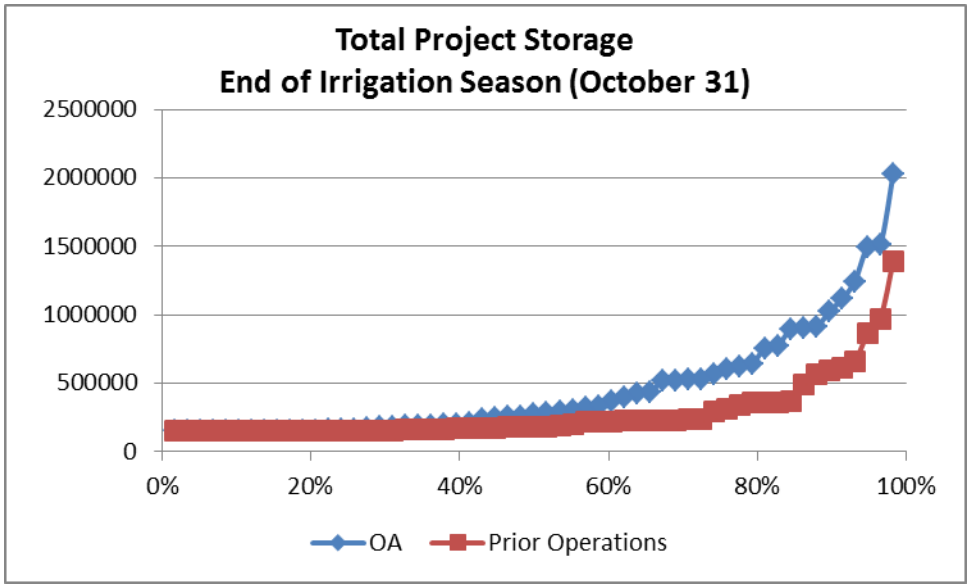

Figure 4.20. 2015 Total Project October 31st storage (AF) non-exceedance curve.

Conclusion

Surface Water Allocations

As described above, surface water allocations to both EPCWID and to Mexico are projected to be greater over the next three years under the Proposed Action alternative than they would have been under the No Action alternative. While the surface water allocations remaining for EBID to divert under the Proposed Action are projected to have a high probability of being reduced over the next three years, 2013–2015, relative to the No Action alternative, the average annual Project releases during the same period, as with the past five years, were greater than the annual Project releases on average. The seepage-induced recharge to groundwater that will become part of the supply available to EBID farmers for use during this period as the result of Project operations is likely to be of similar magnitude to the amount of surface water supply that EBID may relinquish in the form of reduced surface water allocations. For this reason, EBID's overall conjunctive supply of surface and groundwater is not anticipated to be meaningfully affected by the OA.

Annual Release from Project Storage

As described above, Project releases from Caballo Reservoir are expected to be within the range of historic operations under the Proposed Action.

Total Project Storage

As described above, future elevations and water surface areas of Elephant Butte Reservoir are expected to be within the range of historic water surface elevations under the Proposed Action.

How would No Action affect surface water (2013-2015)?

This section describes the potential future effect on surface water resources that would be expected to occur over the next three years as a result of the No Action alternative.

Purpose and Need for the OA

The No Action alternative could impede Reclamation's ability to meets its full contractual obligation to deliver full allocations of Project water to EPCWID and would not comply with the requirements in the transfer contracts with each district to develop an OA. Additionally, the No Action alternative would not meet the purpose and need for the OA, which was designed in response to EPCWID's legal complaint that groundwater pumping in New Mexico was adversely impacting EPCWID's Project deliveries and EBID's complaint of not having consistent and written operating procedures.

Surface Water Allocations

Under drier conditions represented by the 20th percentile nonexceedance, there is not a substantial difference between the allocations for EBID, EPCWID, and Mexico for the three-year period of analysis between the No Action and the Proposed Action alternative. Under the No Action alternative and wetter 80th percentile non-exceedance, allocations to EBID by 2015 would be 155,499 AF higher than the Proposed Action, while allocations to EPCWID would be 161,693 AF less than the Proposed Action by 2015.

Total Project Storage

Total Project storage is lower under the No Action alternative when compared to the Proposed Action. The difference is small under the drier 20th and average 50th percentiles. The decreased total Project storage under the wetter 80th percentile non-exceedance is more pronounced due to a reduction in carry-over storage in the No Action alternative as compared to the Proposed Action.

Caballo Reservoir Releases

Under drier conditions represented by the 20th percentile and average conditions represented by the 50th percentile nonexceedance, there is not a substantial difference between Caballo Reservoir releases under the No Action alternative in any year when compared with the Proposed Action. An increase in Caballo Reservoir releases is observed under the wetter 80th percentile nonexceedance for all years under the No Action alternative due to a concomitant decrease in carryover storage.

4.2.2.3 Groundwater

Groundwater Conditions within the Project and Analysis Approach

The groundwater in the unconfined alluvial aquifers in the Rincon, Mesilla and Hueco Basins of New Mexico and Texas is hydraulically connected to the surface water in the reach of the Rio Grande that flows through the Project. Operation of the reservoirs and surface water system has the ability to impact groundwater resources, and pumping of groundwater has the ability to impact surface flows. Because of this strong hydraulic interconnection, surface water and groundwater can be used conjunctively within the Project, with shortages in surface water supplies being made up for by groundwater pumping and the surface water, in turn, providing recharge to the groundwater system.

This physical connection between the surface water and the shallow ground-water in the Project, as described in Section 1.3, was understood prior to the first Project water deliveries, particularly within the EBID service area. A 1917 supplemental Congressional authorization for the Project recognized this relationship when it specified excavation of drains that would collect shallow groundwater and deliver it to the river, and thereby transport water downstream. Water managers have long known that pumping of shallow groundwater for supplemental use by irrigators did not represent an additional supply in, or new source of water to, the basin, but rather, simply represented a change in the method, time, and place of diversion of available Project water supplies (Conover 1954, 121).

In many basins, the significance of the impact of groundwater pumping is evaluated with respect to the aquifer's firm yield – the aquifer yield that is balanced by groundwater recharge, and therefore does not result in mining of the aquifer. However, due to the strong interdependence between groundwater and surface water systems within the Project, the firm-yield approach is circular in this case. The river and the irrigation canals of the Project have long served as the primary source of recharge to the aquifers in the Project. Pumping of groundwater lowers the water table and increases the loss of river and canal flows to the aquifer, as river flows recharge the aquifers to replenish the water that has been removed (Maddock 2012). Lowering of the water table due to groundwater pumping can also diminish flows in Project drains, which results in decreases in Project surface water supply. Therefore, proposed actions, such as the OA, affect both surface water and groundwater, and the interaction between the two. Further, these impacts occur in concert with a complex variety of factors, including sustained drought, increased irrigation demand due to changes in cropping patterns, increases in on-farm efficiencies, and increased municipal and industrial groundwater use associated with a growing population in the area.

The general state of groundwater resources within the basin can, however, be characterized by evaluating longer-term trends in groundwater levels. In the analysis of the potential impact of the Proposed Action on groundwater supply and use that was performed for this EA, a trend analysis was performed. In this trend analysis, the Mesilla Basin in New Mexico was emphasized, since this is the section of the Project with the largest amount of supplemental pumping, and is the section with the most direct hydraulic connection with the Rio Grande. As of July 2012, EPCWID has been charged for groundwater pumped by District wells in the Mesilla Valley directly out of its diversion allocation; therefore, this pumping should have no net effect on the surface water supply.

The impacts of the OA on groundwater use must be considered in the context of existing groundwater pumping and surface water operations, the general state of groundwater and surface water resources in the basin, and the interaction of groundwater and surface water resources within the basin. Existing groundwater pumping includes municipal pumping, irrigation pumping for lands irrigated with groundwater only, and supplemental irrigation pumping for lands that receive Project water. The volume of change in groundwater pumping caused by the OA can therefore be assessed by comparing the incremental

change in supplemental irrigation pumping, if any, caused by the OA to existing pumping for all purposes. The significance of these changes in pumping volume to the general state of groundwater resources can then be evaluated by comparing the general state of the groundwater resources under prior operating practices to that under the OA, where the general state of the aquifer is characterized as the net balance between recharge and groundwater pumping.

History of Groundwater Allocation and Use

The Project, under full supply, historically allocated to each irrigated acre a farm delivery requirement (FDR) of 3.024 AF per year (AFY). Surface water from the Project was the only water source for irrigated agriculture until the drought of the 1950's, when many wells were drilled to provide a supplemental water source, and groundwater pumping increased. The availability of this unregulated groundwater allowed irrigators to shift beneficial use of their water to high-water-use crops, such as pecans. Unrestricted groundwater development continued in the Rincon and Mesilla Basins in New Mexico, resulting in significant increases in groundwater demand until 1980 when the New Mexico Office of the State Engineer declared the LRG Underground Basin, within which permits would be required for any further groundwater development. Groundwater use that was initiated prior to the declaration of the underground basin was allowed to continue. The amount of water that can be pumped using pre-basin groundwater rights is currently being determined through a basin adjudication process by the State of New Mexico.

In a settlement agreement associated with this ongoing water-rights adjudication, New Mexico allocated an FDR of 5.5 AFY and a consumptive irrigation requirement (CIR) of 4.0 AFY for pecan crops irrigated from a groundwater source established prior to the declaration of the groundwater basin. This amount was authorized for diversion from groundwater, in its full amount at times when there is no Federal surface water supply, with no requirements for offset of the impact of this groundwater pumping on surface water supplies. Surface water allocations under full supply of the Project continue through block allocations to the Districts at rates equivalent to FDR of 3.024 AFY and a CIR of 2.6 AFY. Therefore, even under full surface water supply from the Project, this settlement authorizes 2.476 AFY FDR and 1.4 AFY CIR of groundwater use, with no requirement to offset the impacts of groundwater pumping on surface water supplies.

Groundwater pumping for irrigation use within the Mesilla Basin of New Mexico can be 50,000 to 100,000 AFY in years of full Project surface water supply, and can range between 200,000 and 300,000 AFY in years of low Project surface water supply, depending on crop distributions, available surface water supplies, and weather conditions (Barroll 2005). Additionally, domestic well use has increased, as a result of rural development, and municipalities are using a larger portion of their groundwater pumping rights, in response to municipal and industrial growth. Municipal groundwater pumping in the Mesilla Basin is currently estimated at approximately 30,000 AFY (Erek Fuchs, EBID Groundwater Resources Manager, personal communication, March 25, 2013).

Shortages in surface water supplies, along with greater control over the distribution of water and the timing of application that is available to irrigators using groundwater supplies, have led irrigators in both districts to increase their on-farm efficiencies (i.e., proportion of the water supply used productively for crop uptake). The trends towards greater on-farm efficiency have also contributed to gradual reductions in drain flows and return flows, which further contribute to decreases in the river's delivery efficiency. These trends, exacerbated by drought, have decreased Project deliveries. Under normal Project operations, a portion of the Project water that is applied to lands within EBID is recaptured in drains and is continuously re-diverted and applied to beneficial uses (Maddock 2012). Historically, after several years of full allocation from the Project, drain flows returned water to the river, and Project gross delivery efficiency could approach 120 percent, which represents an augmentation of surface flows by drains and return flows of up to 20%. As shown below in Figure 4-21, Project drain flows have diminished substantially, beginning in the 1950's (Barroll 2005). When the drains are dry, the overall Project supply is reduced, Project delivery losses are high, and Project gross delivery efficiencies (i.e., head gate diversions over Project releases) can be as low as 80-90%.

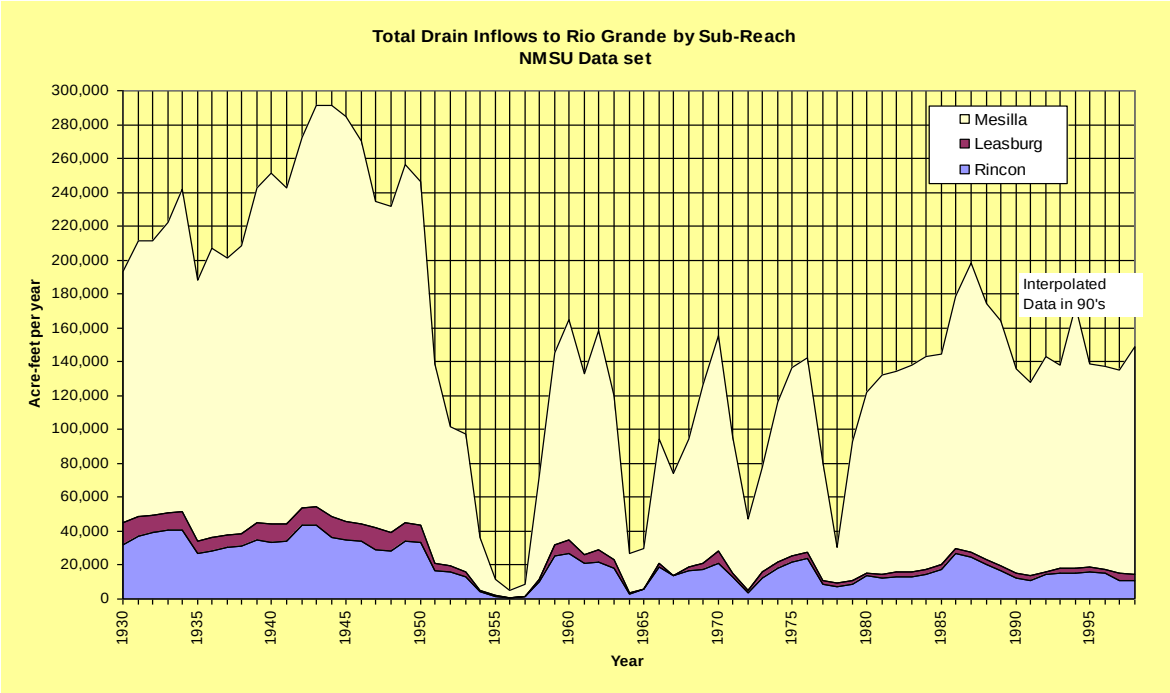

Figure 4.21. Total Drain Inflows to Rio Grande (NM) (Barroll 2005)

Just as the New Mexico Office of the State Engineer acknowledged in the 2000's that groundwater pumping was straining the aquifer, and took steps to more tightly administer pumping, EPCWID acknowledged that the effects of decades of groundwater pumping impacted its portion of Project supply, both in quantity and quality (EPCWID 2007). One objective of the OA was to address apportionment of carry-over water and to

reconcile the hydrologic change caused by increased groundwater pumping with the two districts' contractual rights to a portion of the Project supply.

Historical Trends Leading to the Operating Agreement

At the time that the OA was being negotiated and signed, groundwater elevations in the Project were experiencing a marked decline. In 2003, Project supplies in Elephant Butte and Caballo Reservoirs became insufficient for full Project supply; supplies have remained insufficient for full Project supply for most years since that time. Surface water supply to Project irrigators at levels less than full supply, along with the availability of supplemental groundwater, had led to a significant increase in groundwater use, along with a decrease in surface flows available to recharge the groundwater system. Groundwater pumping was therefore increased to meet the expanded water requirements of high-water-use crops. That increased groundwater pumping resulted in increases in the already-large riverbed losses to groundwater through the Rincon Valley and the New Mexico portion of the Mesilla Valley, as well as a net reduction of the Project's surface return flow, which further decreased available surface water supply. The reduction in surface flows impacted the Project's ability to transport water through the EBID service area to make deliveries to EPCWID.

In response, EPCWID filed a legal complaint that groundwater pumping in New Mexico was adversely impacting EPCWID's Project deliveries. EBID complained of not having consistent and written operating procedures. The OA was negotiated to resolve these complaints (Appendix C). Under the OA, EBID agreed to use a portion of its surface water allocation to offset the reduction in surface flows and return flows via drains caused by groundwater pumping in New Mexico, in order to assure deliveries to EPCWID and Mexico consistent with prior operations. EPCWID accepted direct charges against its diversion allocation to offset the effects to the Project surface supplies caused by withdrawals from the Canutillo well field and other identified pumping in the Texas portion of the Mesilla Valley. In addition, a mechanism for carry-over of each district's allocation was implemented by the OA in order to increase each district's operational flexibility and to promote water conservation.

Current Trends

In the 2007 EA, a commitment was made to monitor wells and gather groundwater data in order to better understand and quantify the interactions between surface and groundwater. For this EA, Reclamation has performed an analysis, based on available well data, of trends in groundwater levels within the Rincon and Mesilla Basins in New Mexico. This analysis indicates that widespread declining groundwater levels since Project inception are confined to the past decade, beginning in 2003. Visual inspection of selected well records confirms this. This period of declining groundwater levels includes the period of operation under the OA. However, changes in groundwater levels during the period covered by the OA are confounded by many other impacts on groundwater levels, including ongoing shortage of surface water supply, changes in cropping patterns and irrigation efficiency, urbanization of Project lands, drilling of new groundwater supply wells, and the allocation of increased groundwater pumping rights and amounts as

part of a state adjudication of water rights. The simple analysis presented here cannot attribute observed trends to any particular driver.

Correlation analysis indicates widespread and statistically significant positive correlation between groundwater elevation and annual river flow below Caballo Dam, as well as between groundwater elevation and total annual Project diversions. Correlations are consistent over periods 1960-1989, 1970-1999, and 1980-present, suggesting that these correlations are robust under both wet and dry conditions. These results are intuitively consistent with conjunctive use of surface water and groundwater within the Project, and reaffirm the strong relationship between the two. 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.

The diversion ratio integrates the hydrologic effects of multiple contributing factors. The greatest direct effect on the diversion ratio is not groundwater levels, but drain flows. Initial analysis made when the D-1 and D-2 equations were developed using Project data from 1951 to 1978 showed a strong correlation between drain flow and Project releases when a nine-month lag was applied. Drain flows are a consequence of shallow groundwater conditions, which in turn correlate to allocations and volumes of water applied to the lands. Correlation of groundwater elevations with diversion ratio is more complicated than for annual flow and diversions. Trend analysis indicates widespread positive correlation between groundwater elevations and diversion ratio over the period 1980-present; however, correlations over the periods 1960-1989 are predominately negative and correlations over 1970-1999 are an approximately even mix of positive and negative. As detailed in Section 4.2, the relationship between groundwater elevation and diversion ratio is affected by prior-year conditions, which results in a complicated relationship between the two variables that is not well represented by simple correlation analysis. These results suggest that the diversion ratio cannot be estimated directly from contemporaneous changes in groundwater elevation (e.g., through regression).

How would the Proposed Action affect groundwater?

Project operations directly impact surface flows, and only indirectly impact groundwater, primarily through their effects on groundwater demand. The Proposed Action impacts surface water allocations within the Project, which in turn affect groundwater demand, since groundwater is used by many irrigators to supplement the Project supply.

Changes in demand are reasonably likely to occur in portions of the Project where groundwater is commonly used to supplement surface water supplies obtained from the Project; these areas occur predominately within EBID. An increase in allocation to EBID under the Proposed Action is therefore reasonably likely to result in decreased groundwater pumping within the Project, whereas a decrease in allocation to EBID is reasonably likely to result in increased groundwater pumping. Increased groundwater pumping within EBID is likely to lower groundwater levels, which in turn reduces baseflows (groundwater inflows to the river), drain flows, and other return flows to the

Rio Grande and increases seepage losses from the Rio Grande to the underlying groundwater system. However, as these conveyance losses increase, the proportion of Project releases that recharge the hydraulically-connected groundwater aquifer also increases. This additional recharge is subsequently available for use within EBID.

This same relationship holds for groundwater pumping within the Mesilla Basin portion of EPCWID. However, the irrigated acreage within the Texas portion of the Mesilla valley is much smaller than the irrigated acreage in the New Mexico portion of the Mesilla valley. Also, the portion of the groundwater pumping that is performed by EBPWID, rather than by individual irrigators, is now directly deducted from the Project's allocation to EPCWID.

As shown schematically in Figure 4.22, the OA would have relatively small effect on EBID's surface water allocation during times when the usable Project water available for allocation is low. When usable Project water is low and the diversion ratio is low, the OA results in a decrease in allocation to EBID that is generally less than 10% of EBID's historical full allocation; when usable water is low and diversion ratio is high, the OA results in an increase in allocation to EBID that is also generally less than 10% of EBID's historical full allocation.

During times when the usable water available for allocation is high (at or near full Project supply), however, annual allocation to EBID under the OA is strongly dependent on the Project diversion ratio. When both usable Project water and the Project diversion ratio are high, the Proposed Action results in a substantial increase in allocation of Project water to EBID compared to No Action, which would tend to reduce the demand for groundwater pumping within the Project. It is only when the usable water available for allocation is high, but the Project diversion Ratio is low, that EBID is likely to experience a significant decrease in allocation. In general, the Project diversion ratio is positively correlated with Project releases; it is therefore unlikely that the Project diversion ratio would be low when usable Project water is high, except in the case that excessive groundwater pumping from the Rincon-Mesilla aquifer in antecedent years with low usable water results in a substantial increase in system losses. Under these conditions, the diversion ratio provision of the OA results in a substantial decrease in annual Project allocation to EBID in order to offset the impacts of groundwater pumping on Project deliveries to downstream points of diversion. Changes in Project allocation to EBID would result in corresponding changes in groundwater pumping for supplemental irrigation.

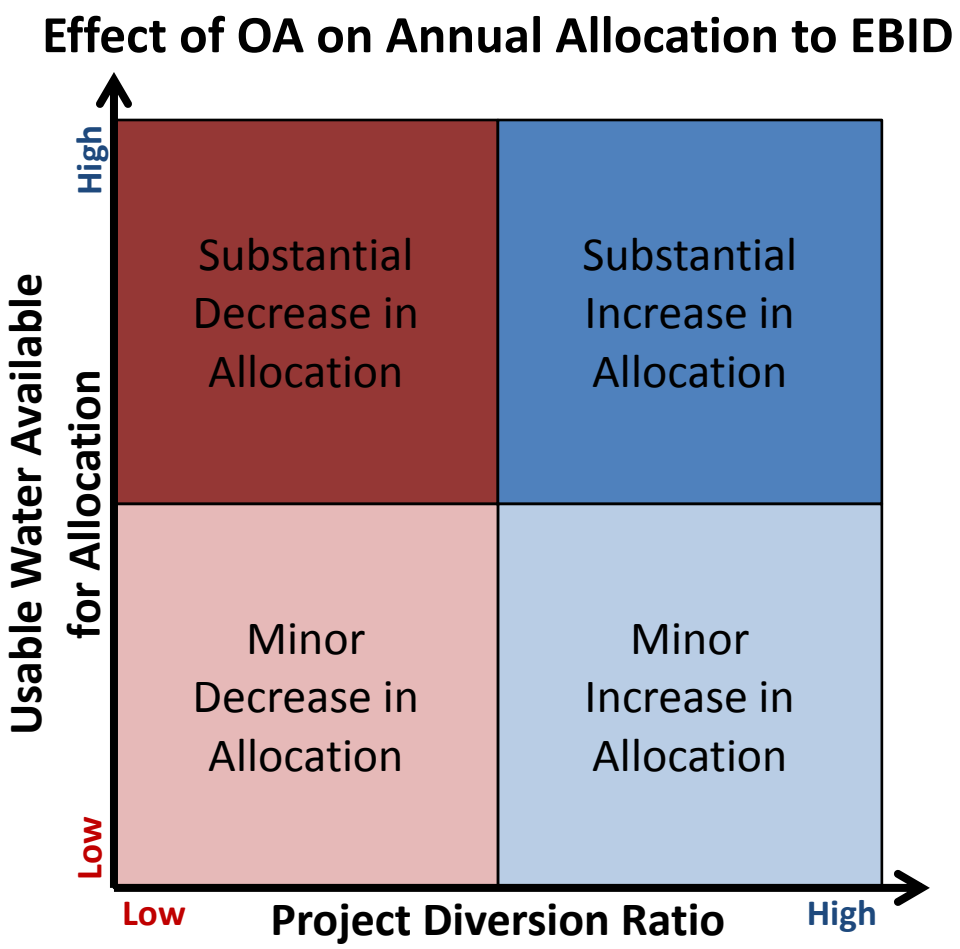

Figure 4.22: Effect of OA on the Annual Project Allocation to EBID.

For the five years in which the OA has been in effect, our analyses indicate an average decrease in EBID's Project allocation of 51,234 AFY. Of the allocated amount, approximately 50% arrives at the farm headgates (James Phillip King, pers. comm. April 2013: note - Reclamation Project allocations prior to 1979 also assume a 50% loss). Therefore, this change in allocation results in a decrease in EBID's supply of about 25,600 AFY. Groundwater pumping from the Rincon-Mesilla Aquifer in New Mexico, as described above, totaled somewhere between 300,000 and 330,000 AFY, including supplemental irrigation pumping and municipal pumping (but not including unmetered domestic well pumping). Therefore, during this period, the OA is estimated to have had an impact on groundwater use in an amount up to 10% of the total pumping from the Rincon-Mesilla Aquifer in New Mexico.

Evaluation of the impact of Reclamation's actions on groundwater is complicated by the fact that a complex web of hydrologic interactions impact the resource, and many of these impacts result from actions beyond Reclamation's jurisdiction or control. For example, within the Project area, irrigators with a right to use groundwater exercise their right pursuant to state law, under rights administered by the states. Reclamation has no

discretion over the district's members' exercise of their groundwater rights, nor over the administration of groundwater rights in New Mexico or Texas.

In general terms, the impact of the Proposed Action on groundwater demand is minimal relative to other factors affecting groundwater use. Over the past five years, this impact has been estimated to average about 25,600 AFY, which is less than 10% of the estimated total groundwater pumping from the Rincon-Mesilla Aquifer in New Mexico. During potential future years in which the diversion ratio is higher, this impact would be even lower. This is because when allocations and water deliveries are reduced as a result of allocations made under the OA, the effect is to increase users' reliance on groundwater pumping from the Rincon-Mesilla Aquifer in New Mexico. This increased groundwater pumping in turn lowers groundwater levels, which reduces return flows to the river via drains, and increase losses from the riverbed into the groundwater system. As these conveyance losses associated with river deliveries increase, the proportion of Project water releases recharging the hydraulically-connected aquifer increases, and this additional groundwater is available for use by all of the groundwater pumpers relying on the Rincon-Mesilla Aquifer in New Mexico, including water-rights holders within EBID, groundwater-only irrigators relying on pre-basin groundwater rights, mutual-domestics, municipalities, and private domestic wells. While groundwater levels in the Project rise or fall in response to a variety variables beyond the control of the Project, described above, as well as by a number of users both within and outside of EBID, the effect of the Proposed Action itself will be for EBID to partially offset declines in groundwater levels associated with all groundwater pumping from the Rincon-Mesilla Aquifer in New Mexico, while also assuring that downstream water users are not impacted by the groundwater pumping. The analysis described in Section 4.2.2.2 verifies that the OA has had this effect over the last five years of Project operations.

As demonstrated above, the estimated impact of the Proposed Action on groundwater demand within the Project and surrounding areas is minimal relative to the total amount of groundwater pumping from the Rincon-Mesilla Aquifer. It is also estimated to be minimal relative to other factors affecting groundwater use in these areas, which are beyond Reclamation's discretion, including.

1. Persistent drought (shortage in usable water available for project allocation);
2. Changes in the administration of groundwater rights by the State of New Mexico;
3. Changes in cropping patterns from low-water-use crops to high-water-use crops;
4. On-farm efficiency improvements that affect drain flows and return flows and therefore influence the diversion ratio;
5. Population growth, increases in domestic well use and municipal pumping, and urbanization of Project farming acreage.

The analysis considered here is not sufficiently detailed to accurately differentiate the potential impacts to groundwater demand and groundwater resources within the Project caused by the Proposed Action from those caused by these other factors.

How would No Action affect groundwater?
The No Action alternative, as a return to prior operating procedures, would have an indirect effect on Project water resources, since pumping of groundwater to supplement Project irrigation supplies in the Mesilla Basin would continue to negatively impact Reclamation's ability to transport water downstream to the Project diversion locations for EPCWID and Mexico. The prior operating practices do not provide a mechanism to offset the effects of groundwater pumping on Project water supply, which would likely result in shortages to the downstream Project users. Groundwater pumping from the Rincon-Mesilla Aquifer in New Mexico, by a variety of users both within and outside of EBID, would likely continue under the prior operating practices at a rate greater than 90% of the rate projected under the Proposed Action.

The No Action alternative could impede Reclamation's ability to meets its contractual obligation to deliver full allocations of Project water to EPCWID and would not comply with the requirements in the transfer contracts with each district to develop an OA. Additionally, the No Action alternative would not meet the purpose and need for the OA, which was designed in response to EPCWID's legal complaint that groundwater pumping in New Mexico was adversely impacting EPCWID's Project deliveries and EBID's complaint of not having consistent and written operating procedures.

4.2.2.3 Water Quality

What is the status of water quality?
This section discusses the effects of the Proposed Action on water quality in comparison with the No Action alternative, and focuses on two parameters of concern, total dissolved solids (TDS) and E. coli bacteria.

Under section 303(d) of the CWA, individual states set water quality standards and maintain lists of impaired waters. The Rio Grande below Caballo Dam has been identified as a 303d impaired water.

In New Mexico, the Water Quality Control Commission is the issuing agency of water-quality standards. In Texas, the Texas Commission on Environmental Quality (TCEQ) is the issuing agency of water-quality standards. The main stem of the Rio Grande from the international boundary with Mexico upstream to one mile below Percha Diversion Dam is currently not meeting New Mexico water quality standards. Standards for E. coli bacteria and total maximum daily loads were approved by the New Mexico Water Quality Control Commission and US Environmental Protection Agency in 2007.

During scoping, compliance with the water quality standards of the Clean Water Act (CWA) was raised as a concern and is summarized as follows. Changes to the critical low-flow period, when reservoir releases are not occurring, should be evaluated to determine if there is a potential for the OA to cause a violation of the State's surface water quality standards. During this past winter, the New Mexico Environment Department has been conducting a water quality survey of the LRG basin and has noted that significant stretches of the Rio Grande within the Project area are dry. A preliminary

analysis of data collected this winter from the Rio Grande at the New Mexico-Texas boundary indicated that it typically exceeds the 126 cfu/100mL *E. Coli* standard for Primary Contact Use.

Michelsen et al (2009) describe spatial and temporal variation of TDS concentrations in river water at various gaging stations in the Project. TDS concentrations increase in a downstream direction and vary widely depending on flow rate and other conditions. The TDS below Caballo Dam, Leasburg, and El Paso is related to releases from the Caballo and Elephant Butte Reservoirs.

TDS is lower during the irrigation season and higher during non-irrigation season, influenced by poor-quality return flows, wastewater effluents and groundwater inflows . During dry periods, levels of TDS in the Rio Grande system below Caballo Reservoir are, on average, more than 50 percent higher than during wet periods (IBWC 2002).

<u>How would the Proposed Action affect water quality?</u>
It is highly likely that any changes occurring in the Rio Grande as the result of the OA will fall within the range of variation measured between the irrigation and non-irrigation seasons.

The levels of TDS measured from 2007-2011 under the Proposed Action are shown in Figure 4.23. The June average (during irrigation season) is within the range of the June average prior to implementation of the OA. However, the December average shows peaks above the prior range in 2003 and 2010. All of these December concentrations are above El Paso's threshold for drinking water purposes.

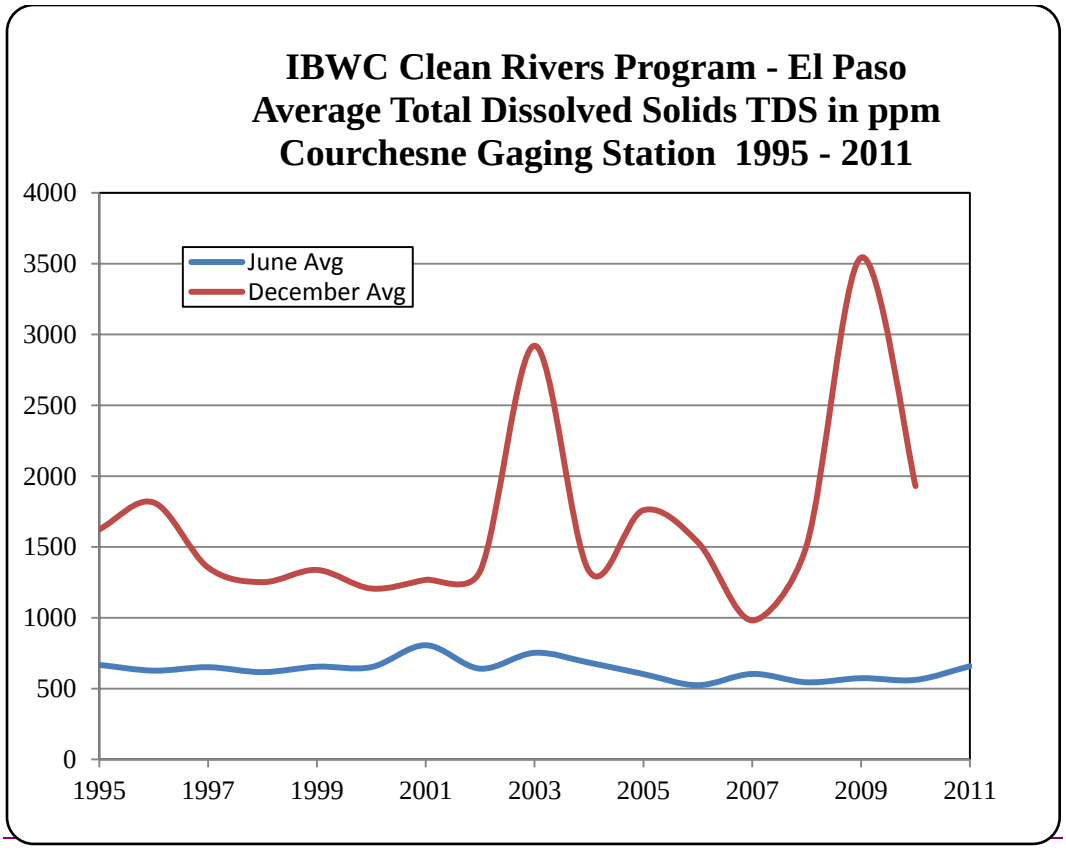

Figure 4.23. Average total dissolved solids (TDS) at the Courchesne Bridge gage, El Paso, Texas, TDS in ppm, from 1995 to 2011 (IBWC 2011).

While the TDS levels in the Rio Grande spiked during the non-irrigation season of 2010, the water held in carry-over allowed for a wetter irrigation season than would have been possible under No Action. As the figure shows, 2011 was wetter compared to 2010 and the additional water released produced an irrigation season in which the TDS levels in June were close to average (658 vs. 637 ppm). In comparison, the 2010 non-irrigation season saw salinity levels rise above 3500 ppm. On the basis of these data, it therefore appears that the proposed action does not contribute to any additional adverse effect to water quality, as compared to the No Action alternative.

<u>How would No Action affect water quality?</u>
Under the No Action alternative, Rio Grande water TDS at El Paso during the irrigation season has varied between 394 and 3,199 mg/L with an average of 834 mg/l and a median of 819 mg/L. During the non-irrigation season, the TDS ranged from 370 to 3,832 mg/L with an average TDS of 1,516 mg/L or 681 mg/L higher than its average TDS during the irrigation season (Michelsen et al. 2009:17). Historically, there is a 10 percent exceedance of TDS over 1,000 mg/L, usually occurring at the beginning or end of the irrigation season. During the non-irrigation season, TDS exceeds the 1,000 mg/L (800 ppm) drinking water secondary limit much of the time. The magnitude and frequency of elevated TDS concentrations would be expected to continue under either the Proposed Action or No Action alternative.

4.2.3 Vegetation

What is the status of vegetation?
The Project area is located in the Chihuahuan Desert with primary vegetation communities that include: Cultivated Cropland, Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub; Chihuahuan Mixed Salt Desert Scrub, and Apacherian-Chihuahuan Mesquite Upland Scrub. The location of species depends on factors such as the soil, elevation, degree of slope and proximity to water. Wetlands and riparian areas are generally limited to the river edges, sand bars, low areas adjacent to the river within the floodplain, and at Elephant Butte and Caballo Reservoirs. Common native wetland or riparian vegetation may include cottonwood, willows, seepwillow, sedges, rushes, cattail, and salt grass. Saltcedar and Russian olive, two salt-tolerant invasive species, are also common and spreading in riparian areas along the river and at the two reservoirs.

Dominant species in the drier terraces and upland areas may include creosote bush, tarbush, apache plume, fourwing saltbush, alkali sacaton, blue grama, sand dropseed, and tobosa. Russian thistle, also known as tumbleweed, is an invasive species that often occupies disturbed areas and may occur within the Project area.

Vegetation at Elephant Butte Reservoir has been described by Reclamation (Ahlers, Reed and Siegle 2003) in the New Mexico State Parks' (NMSP) management plan (NMSP 2006) and in bird surveys (Sogge, et al. 1997). Reclamation has conducted both intensive and reconnaissance-level surveys of the vegetation in these areas as a means of documenting actual or potential habitat for the listed southwestern willow flycatcher (Moore and Ahlers 2012). Vegetation resources in the reach below Caballo Reservoir to El Paso within the Project area are extensively addressed by IBWC (IBWC 2003).

Below Caballo, the river to El Paso is narrow and deep. Most of the farms have allowed a narrow vegetated buffer zone to exist between agricultural areas and the river's bank. There are some areas where the river is adjacent to upland slopes and those areas have no farming and the riparian vegetation is a little wider. The other vegetated areas occur on sand bars in the river channel. Flows in this section of the river rarely allow for overbanking to occur and through the years IBWC has implemented a mowing program along the bank and a dredging program of the river channel.

Methodology
The vegetation within the Project area was considered in terms of composition or plant communities, including both native and non-native riparian vegetation and infestation of invasive weeds; as well as potential for use as wildlife habitat. Hydrologic modeling of inflows and Project releases were used to predict changes in biota. Upland, desert shrub communities further from the river would be unaffected by the Project operations, only the narrow ribbon of riparian vegetation along the river banks and the vegetation that has grown within the reservoir pools could potentially be affected by projected reservoir elevations and releases or groundwater levels.

How would the Proposed Action affect vegetation?

Riverine Area Vegetation under Proposed Action

The river channel between Elephant Butte and Caballo is deep, narrow, with an overall stable channel morphology, and little to no overbank flooding; thus the vegetation on the banks depends on consistent flows from the reservoir and groundwater springs. The Proposed Action would have neither positive nor negative impacts on riparian vegetation between Elephant Butte and Caballo when compared to the No Action alternative.

In the river below Caballo, the river channel is also relatively deep and narrow. For many years IBWC has mowed the buffer zone and dredged the river channel for more efficient delivery of water, and farming has only left a minimal vegetative buffer zone between fields and the river channel. With little to no flows in the river during the non-irrigation season the vegetation along the river's bank is dependent on reservoir releases during the irrigation season, irrigation return flows and local monsoon storm flow during the summer. In addition, as a result of extensive farming occurring adjacent to the river's vegetated bank, these root systems are also likely obtaining water from seepage from the irrigated fields during the irrigation season. Under both alternatives, as long as these flows are present, it is expected that native and non-native vegetation will continue to exist similarly to current conditions.

How would No Action affect vegetation?

Riverine Area Vegetation under No Action

Future low flows in the two river reaches have the greatest likelihood of negatively impacting riparian and marsh vegetation, including riverine wetlands. Under the No Action alternative, any impacts would be minor as predicted low releases remain within the range of annual fluctuation, with the dams not releasing water during the non-irrigation season. Such low flows stress phreatophytes, but would not be expected to cause significant plant die-off. Impacts of low flows and the operations for irrigation purposes would continue to affect obligate phreatophytes such as willow more than facultative phreatophytes such as saltcedar. Thus the long-term trend is to favor continued saltcedar expansion.

From Percha Diversion Dam downstream under the No Action alternative, the long-term trends described by IBWC's various management programs (IBWC 2003) for riverine and wetland vegetation will continue. This includes dredging of the river channel, selective mowing to retain native vegetation and manage salt cedar. The long-term degradation of the channel from Caballo to just north of El Paso will mean that even with high flows (over 2,000 CFS) there is little to no chance of overbanking, and this will mean that vegetation will remain as it is currently. However, the Corps (2007:7.6) has noted that there is about two feet of aggradation that has occurred through El Paso, and higher flows may increase the frequency of over banking. This could create a more dynamic vegetation association in this area, but given the urban nature of this segment, such overbanking through El Paso would likely result in more weeds and disturbance-adapted vegetation.

How would Both Alternatives affect vegetation?

Reservoir Vegetation under Both Alternatives

Vegetation in and adjacent to both Elephant and Caballo Reservoirs is dependent on reservoir fluctuations. Caballo Reservoir's pool level is relatively stable, so vegetation is relatively constant; being dense near the water's edge and gradually reducing in density away from the water line. The vegetation along Caballo's shoreline will not be affected under both alternatives. At Elephant Butte, the vegetation seems to have reached its southern extent at about river mile (RM) 38-39. What currently exists of the reservoir is a deep narrow pool without much vegetation around it. The majority of vegetation at Elephant Butte only occurs at the upper end (delta) where the Rio Grande enters.

Temporary establishment and loss of vegetation and wildlife habitat below the full-pool elevations would occur under both alternatives. When there are higher reservoir elevations, exposed shoreline available for plant colonization would decrease and there would be less opportunity for plant growth. Lower elevations would increase the distance between permanent shoreline vegetation and aquatic habitats, which would increase shoreline available for plant colonization.

Invasive, Non-native Vegetation under Both Alternatives

The potential for invasive weeds to be introduced and spread by future flows or management actions would exist under both alternatives. To avoid or minimize the risk of noxious weed introduction or spread, Reclamation and IBWC have integrated pest management plans and policies that require high pressure washing systems and other methods to ensure that construction equipment, such as that used by IBWC to dredge the channel, would not transmit weeds.

It is predicted that with month-long periods of low to no flow, saltcedar and Russian olive expansion would be favored under both alternatives. Active management by IBWC, the districts, or the City of El Paso would be expected keep saltcedar under control.

4.2.4 Wildlife

What is the status of wildlife?

The Rio Grande, the two reservoirs and the associated riparian vegetation provides habitat for various species of sport fish and wildlife (IBWC, 2003; Bureau of Reclamation 2002 and 2003). The two reservoirs provide lacustrine aquatic habitats and influences of fluvial habitat, where the river enters at the deltas. Common wildlife at both Elephant Butte and Caballo Reservoirs include: deer, coyotes, rabbits, squirrels, chipmunks, raccoons, woodpeckers, egrets, killdeers, quails, great blue herons, and numerous species of waterfowl and shorebirds. Migratory bird species and waterfowl are also present. Previous studies by NMSP (New Mexico State Parks 2000) have documented over 250 species of birds within the region many of which are associated with riparian-wetland habitats.

Riparian areas constitute less than 1% 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 riparian areas are also critical corridors for migratory species, especially birds that are moving from their southern winter grounds to their northern summer areas. When analyzing the river portion of the action area from Caballo to El Paso, IBWC assessed the wildlife habitat in the area to be below average to poor quality (IBWC 2003). There are some riverine wetlands within the river channel that offer high quality habitat, but these are small and far apart. Overall wildlife habitat from Elephant Butte Dam and along the river all the way to El Paso has been impacted through the years from agricultural and urban development. In general, the only remaining high value wildlife habitat occurs at Elephant Butte and Caballo Reservoirs and as a riparian strip adjacent to the river. The dynamic nature of flooding and drying at the upper portions of Elephant Butte have allowed for the establishment of large areas of riparian vegetation to establish which provides important habitat for wildlife.

Methodology

The method of analysis for wildlife assessment involved considering the potential effects of the alternatives to vegetation and water resources to determine whether these would cause changes affecting aquatic and terrestrial wildlife or their the habitats. Predictions of inflows and releases under both alternatives were used to predict changes in biota. Upland, desert shrub communities further from the river would be unaffected by Project operations under either alternative. Only the narrow ribbon of riparian vegetation along the river and the vegetation that has grown within the reservoir pools could potentially be affected by projected reservoir elevations and releases or groundwater levels.

<u>How would the Proposed Action affect wildlife?</u>

At Elephant Butte, modeling indicates that the proposed alternative could allow for slightly higher reservoir levels (from 6 – 25 feet higher beginning in year 2) than No Action. A growing flood pool would be beneficial to aquatic species. In general, lake fish species would be expected to benefit from an increasing reservoir shoreline and flooded vegetation, while riverine fish would have slightly less riverine habitat in the reservoir pool. Modeling is not sensitive enough to predict the actual depth or duration of flooding that will occur. If flooding is of short duration, most native plants are able to handle such events and may in fact benefit from seasonal flooding, in comparison to a flooding event that lasts all summer long and/or beyond. Overall, wildlife are expected to shift to available habitat similarly as with changing reservoir levels in the No Action. In fact, a dynamic rising and lowering of the reservoir over time results in plant community succession, creating a diversity of habitat types and often is beneficial to wildlife and their habitats.

The aquatic habitat in the two river sections (between the reservoirs and downstream from Caballo to El Paso) is not expected to change under either alternative. The river below Caballo will have releases within the range of historical operations. Below Caballo, the entire river channel to El Paso is more directly influenced by the lack of releases during the non-irrigation season and by monsoon rains. During the non – irrigation season the further south on the river, groundwater or secondary arroyos may provide enough water into the river for short sections to keep the river wet.

How would No Action affect wildlife?

At Elephant Butte, modeling indicates that the No Action alternative could allow for slightly lower reservoir levels (from 6 – 25 feet lower beginning in year 2) than the proposed action. A smaller flood pool would result in less habitat for aquatic species. In general, riverine fish species would be expected to benefit from a lower reservoir and a longer river channel into the reservoir. While lake fish would have slightly less lacustrine habitat in the reservoir pool. Modeling is not sensitive to predict the actual depth or duration of flooding that will occur. If flooding is of short duration, most native plants are able to handle such events and may in fact benefit from seasonal flooding, in comparison to a flooding event that lasts all summer long and/or beyond. Overall, wildlife are expected to shift to available habitat similarly as with changing reservoir levels under the No Action alternative.

The aquatic habitat in the two river sections (between the reservoirs and downstream from Caballo to El Paso) is not expected to change under either alternative. The river below Caballo will have releases within the range of historical operations. Below Caballo, the entire river channel to El Paso is more directly influenced by the lack of releases during the non-irrigation season and by monsoon rains. During the non – irrigation season the further south on the river, groundwater or secondary arroyos may provide enough water into the river for short sections to keep the river wet.

How would Both Alternatives affect wildlife?

Wildlife under Both Alternatives

Under both alternatives, wildlife that use the reservoirs and their vegetated shorelines are already affected by and likely accustomed to the fluctuations of these habitats. At Elephant Butte, fluctuations in reservoir levels and releases would occur under both alternatives and result in temporary establishment and loss of vegetation and related wildlife habitat below the full pool elevations. The differences in modeled releases under the 20th and 80th percentiles are well within the monthly and annual release variations of the historical period and the modeled future conditions. When there are lower reservoir elevations, the distance between permanent shoreline vegetation and aquatic habitats would increase, and this would increase the distance wildlife would need to travel between permanent cover and the reservoir edge. Fluctuations would continue into the future, and habitats would continue to be dynamic and change along the shorelines and below the full reservoir pools, as has occurred in the past. At Caballo, since fluctuations are less pronounced, no changes to wildlife are expected under either alternative.

With the signing of the 2009 Record of Decision, the IBWC agreed to enhance 30 sites with native riparian habitat along the portion of the river downstream of Percha Diversion Dam to American Dam. Other agencies like Reclamation and NMSP and ISC, Cities of Las Cruces and El Paso, and non-governmental organizations like The Audubon Society will assist with restoring riparian habitat in this reach.

Aquatic Invasive Species under Both Alternatives

The potential for spread and/or continued presence of invasive mussels will be the same under both alternatives. Invasive zebra and/or quagga mussel DNA has been detected in upstream reservoirs. Under both alternatives, the potential remains for these mussels to become established in Elephant Butte and Caballo Reservoirs; however the slight alternations in reservoir operations or flows in the river reaches does not affect the potential for colonization or infestation of the reservoirs by mussels. Preventative measures to clean boats entering and leaving reservoirs will continue under both alternatives.

4.2.5 Listed Species

What is the status of species listed under the Endangered Species Act?
Based on literature review and field surveys, four threatened or endangered species occur or have been observed within the action area of the EA: the Interior Least Tern (tern), Piping Plover, Southwestern Willow Flycatcher (flycatcher), and Rio Grande silvery minnow (silvery minnow) (Table 4.9). See Appendix D for additional technical information on listed species.

Table 4.9. Four threatened or endangered species in the Project.

Scientific Name	Common Name	ESA Status
Sterna antillarum	Interior Least Tern	Endangered
Charadruis melodus	Piping Plover	Threatened
Empidonax traillii extimus	Southwestern Willow Flycatcher	Endangered
Hybognathus amarus	Rio Grande silvery minnow	Endangered

Critical Habitat

Flycatcher

Critical habitat for the flycatcher was redesignated by the U.S. Fish and Wildlife Service (Service) in January 2013 (78 FR 343-534). The southern boundary of critical habitat along the Rio Grande in New Mexico was extended to about RM 54, or about eight miles into the upper end of the Elephant Butte Reservoir pool. No critical habitat was designated south of this point, including areas within the proposed Project area south of Elephant Butte and Caballo Reservoirs in New Mexico or Texas.

Silvery Minnow

Critical habitat for the silvery minnow was designated in February 2003 and extends from Cochiti Dam downstream to the power lines at RM 62 at the upper-end of Elephant Butte Reservoir. No critical habitat for the silvery minnow occurs within the action area of the proposed action.

Methodology

The method of analysis for Federally listed species first involved determining the potential for occurrence of these species within the action area utilizing information from

on the ground surveys conducted by Reclamation or others and a literature review. If the presence of a listed species or its habitat were documented or suspected, then consideration of the potential effects of the alternatives to vegetation and water resources to determine whether these would cause changes affecting listed species or their the habitats. Predictions of inflows and releases under both alternatives were used to predict changes in biota.

Upland, desert shrub communities further from the river or reservoirs would be unaffected by the Project operations under either alternative, so therefore these areas were not given further consideration. Only the narrow ribbon of riparian vegetation along the river, in-channel riverine habitats (sandbars, islands, banks, etc.), and the vegetation that has grown within the reservoir pools could potentially be affected by projected reservoir elevations and releases or groundwater levels.

How would the Proposed Action affect listed species or critical habitat?

Interior Least Tern

The tern is an unlikely migrant in the proposed Project area and is therefore not expected to occur. According to the Service, the tern can be considered a vagrant on the Middle Rio Grande and no tern nesting has been recently documented (Service 1995). According to the recovery plan from the Service in 1990, the only documented breeding along the Rio Grande takes place in South Texas, and the only documented breeding within the State of New Mexico can be found on the Pecos River (Service 1990), similar conclusions are drawn in the complete rangewide survey collected in 2005 (Lott 2006). Due to the highly unlikely presence of the species in the Project area, the proposed action would have no effect on the tern.

Piping Plover

The Piping Plover is a rare migrant to New Mexico and west Texas, but it has never been documented in the action area. It was sighted at Fort Bliss in Texas once in August (U.S. Geological Survey 2013), and it is possible, although unlikely, that it would be present in the action area as it migrates south. No Piping Plovers have been incidentally recorded during flycatcher surveys within the action area since the mid-1990s, however, it should be noted that these surveys are not generally conducted in habitat suitable for plovers and surveyors are not asked to record other bird observations specifically (Wilber, pers. comm.). Due to the highly unlikely presence of the species in the Project area, the proposed action would have no effect on the Piping Plover.

Southwestern Willow Flycatcher

Within the Project area, flycatchers are only known to breed in Elephant Butte Reservoir above elevation 4345 feet (Reclamation 2013) and along the Rio Grande in the Seldon Canyon area upstream of Percha Diversion Dam (IBWC 2004). These Seldon Canyon birds occur beyond the 100-year floodplain of the Project. The IBWC found that suitable dense vegetation that could be occupied by the birds does not occur south of Percha Diversion Dam.

Elephant Butte Reservoir

Surveys for the flycatchers have been conducted by Reclamation at Elephant Butte Reservoir since the mid-1990s. The following figure (Table 4.10) provides a summary of surveys for flycatchers from 2003-2012.

Table 4.10. Territories occupied by Southwestern willow flycatchers in Elephant Butte Reservoir in 2003-2012 from full pool elevation down to 4345 feet in five foot intervals.

Elevation	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
>=4407	28	26	21	30	34	46	50	41	38	37
4400-4407	54	79	73	83	111	107	130	130	140	112
4395-4400	0	3	5	5	12	12	17	26	27	17
4390-4395	0	0	5	9	19	29	46	44	36	18
4385-4390	0	5	3	6	10	16	35	25	9	6
4380-4385	0	0	0	0	0	5	6	8	14	9
4375-4380	0	0	0	0	0	0	0	0	1	2
4370-4375	0	0	0	0	0	0	0	0	0	2
4365-4370	0	0	0	0	0	0	0	1	2	3
4360-4365	0	0	0	0	0	3	2	0	11	6
4355-4360	0	0	0	1	1	3	4	4	20	18
4350-4355	0	0	0	0	2	7	18	9	6	4
4345-4350	0	0	0	0	0	1	1	3	2	2
Total	**82**	**113**	**107**	**134**	**189**	**229**	**309**	**291**	**306**	**236**

Projected reservoir levels at Elephant Butte Reservoir were modeled for the No Action and Proposed Action using a March 1st forecast. Modeled Project reservoir elevations at the start of start of year 2013 are based on actual Project conditions at the end of the 2012 irrigation season. From that point forward, conditions are simulated for year 2013

through year 2015. Thus, conditions in the model for the beginning of year 2013 are representative of but not the same as actual conditions and are identical under the Proposed Action and No Action alternative. Non-exceedance curves of Elephant Butte Reservoir elevation are different for each year due to the effects of prior-year operations on current year elevation; however, the general characteristics of non-exceedance curves for 2013 and 2014 are similar to those for 2015. For the duration of the proposed action, reservoir elevations are projected to be between 4309 -4322 ft. at the 20th percentile and from 4309-4355 ft. at the 80th percentile (Table 4.11) (Figures 4.24).

Table 4.11. Elevation (ft) of water in Elephant Butte Reservoir from 2013 - 2015.

	No Action			Proposed Action (OA)		
	20 %	50 %	80 %	20 %	50 %	80 %
2013	4309	4309	4309	4309	4309	4309
2014	4315	4318	4324	4321	4324	4341
2015	4314	4320	4330	4322	4326	4355

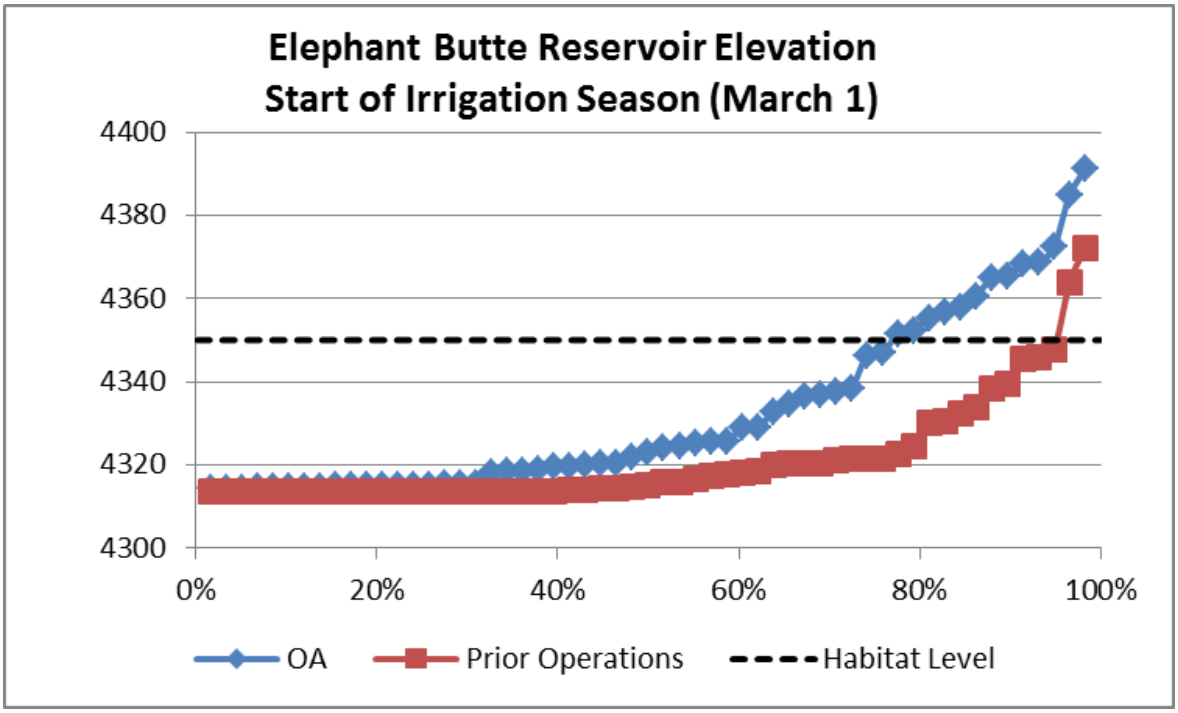

Figure 4.24. 2015 Elephant Butte Reservoir elevation non-exceedance curve.

Conclusion for Elephant Butte Reservoir

The 2007 EA and FONSI resulted in a determination that the proposed OA would have no effect to any proposed or federally listed species or critical habitat during the five years covered in the EA (through 2012). As shown in figure 4.10, reservoir elevations in

2008, 2009, and 2010 were higher than an elevation of 4,355 ft which resulted in inundations of several flycatcher territories in each of those years (Table 4.10). The number of territories at those same elevations increased in 2011 and 2012 suggesting that the extent and timing of the inundation benefited the primary constituent elements of habitat needed by the flycatcher (Appendix D).

This EA evaluates the potential effects for the next three years (2013-2015). To evaluate the potential impact of the Proposed Action on flycatcher nest habitats, projected reservoir elevations were compared to elevations of flycatcher territories identified in 2012 flycatcher surveys at Elephant Butte Reservoir. Based on this comparison, no flycatcher territories are anticipated to be inundated in 2013 or 2014. In 2015, the highest water levels that might occur under the wettest scenario evaluated (80% non-exceedance probability) could reach 4,355 feet in elevation. Under this unlikely scenario (particularly in light of the extremely dry forecast for 2013), up to six territories from the 2012 survey could be inundated; two territories between elevations 4,345 and 4,350 feet and four territories between elevations 4,350 and 4,355 feet. These inundations are most likely to occur prior to the start of flycatcher nesting season. Also, as noted above, the presence of surface water in flycatcher territories during the breeding season is considered important to successful nesting. Eighteen flycatcher territories were located above 4355 ft. (between elevations 4355-4360 ft.) and these territories are not expected to be affected.

Tables 4.7 and 4.8 show that projected Elephant Butte Reservoir storage volumes under the wetter 80% non-exceedance probability were larger at the end of the irrigation season than at the start of the irrigation season. Historically, this occurs about 25% of the time when reservoir inflows during the irrigation season, i.e., inflows after March 1st, are larger than reservoir releases during the same period. Considering the extremely dry forecast for 2013, it is unlikely that this potential for increased inundation, assuming wet conditions in 2014 and 2015, would exceed the elevations discussed above for 2008-2010.

Rio Grande from Caballo Reservoir to El Paso

Reclamation surveyed for flycatchers from Caballo Reservoir to El Paso in areas of suitable flycatcher habitat during the summer of 2012. Twenty-eight total flycatcher territories were observed, which exceeds the recovery goals for this Rio Grande Management Unit of 25 total territories (Reclamation 2013). The riparian and aquatic habitat in the river downstream from Caballo to El Paso is not expected to change under either alternative. The river below Caballo Reservoir is projected to have releases within the range of historical operations over the next three years under the Proposed Action. These releases will support existing and proposed habitat restoration projects within this reach, such as the 30 sites IBWC agreed to enhance with native riparian habitat with the signing of the 2009 Record of Decision. Below Caballo, the entire river channel to El Paso is more directly influenced by the lack of releases during the non-irrigation season and by monsoon rains. During the non – irrigation season the further south on the river, groundwater or secondary arroyos may provide enough water into the river for short sections to keep the river wet.

Conclusion for Rio Grande below Caballo

Based on projected operations of the Proposed Action in the reach below Caballo Reservoir, there would be no effect to the flycatcher. No critical habitat for this species occurs in this reach and therefore there will be no effect to designated critical habitat.

Critical Habitat

The elevation of designated critical habitat within Elephant Butte Reservoir, based on the final designation at RM 54, is about 4375 ft., and water levels are not expected to be higher than 4355 ft. during the period of time evaluated in this EA. Therefore, there will be no effect to designated flycatcher critical habitat.

In summary, we have determined that the proposed action will have no effect to the flycatcher or designated critical habitat under this supplemental EA. Reclamation will be monitoring the location of flycatcher territories and actual reservoir levels during the 2013 – 2015 breeding seasons. If information indicates that there could be potential for adverse impacts to flycatchers, we would coordinate and consult with the Service pursuant to the requirements of Section 7 of the ESA. We will also update the Service regularly with current hydrological and biological data.

Rio Grande Silvery Minnow

In 2010 and 2011, silvery minnow were collected within the temporary channel in Elephant Butte Reservoir between RM 45.8 and 54.5. In general, silvery minnow were more abundant at sites above RM 50. No sampling occurred downstream of RM 45.8 due to accessibility issues. In 2012, no silvery minnow were found (Table 4.12). The fish has been extirpated from the rest of the action area.

Table 4.12. Fish species collected during September sampling in the temporary channel within Elephant Butte Reservoir pool from 2010 – 2012.

	2010		2011		2012	
	#	#/100 m²	#	#/100 m²	#	#/100 m²
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

Adult silvery minnow are strong swimmers capable of moving upstream substantial distances (25km) (Bestgen et al. 2010). As the reservoir fills, silvery minnow can move upstream into suitable habitat. The Rio Grande Silvery Minnow Recovery Plan (Service 2010) states that adults, eggs and larvae are transported downstream to Elephant Butte Reservoir but it is believed that none of these fish survive because of poor habitat and predation from reservoir fishes. As mentioned above, no critical habitat for the silvery minnow occurs within the action area of the proposed action.

The silvery minnow does not have critical habitat within the Project area. The full pool of Elephant Butte Reservoir is influenced by Project operations, but provides poor quality habitat. There is a relatively low abundance of silvery minnow within the associated temporary channel, and fish within this reach have the ability to move upstream. Therefore, it is concluded that the Proposed Action would have no effect on the silvery minnow.

How would No Action affect listed species?

Interior Least Tern

Due to the highly unlikely presence of the species in the Project area, we have determined the No Action alternative would have no effect on the tern.

Piping Plover

Due to the highly unlikely presence of the species in the Project area, we have determined the No Action alternative would have no effect on the Piping Plover.

Southwestern Willow Flycatcher

Elephant Butte Reservoir

Under the No Action alternative, during the next 3 years, reservoir elevations at Elephant Butte are projected to be between 4309 - 4314 ft. at the 20th percentile and from 4309-4330 ft. at the 80th percentile (Figure 4.24). Based on the elevations of flycatcher territories identified in 2012 at Elephant Butte Reservoir (the lowest territories are between elevations 4345-4350 ft.), modeling of the no action indicates that no flycatcher territories would be impacted by water levels during the next 3 years. As indicated previously, critical habitat is estimated to be at elevation 4375 ft. Therefore, the No Action alternative would have no effect to flycatchers or its designated critical habitat.

Rio Grande from Caballo to El Paso

In the reach of the Rio Grande between Caballo Reservoir and El Paso, operations under the No Action have not shown to adversely affect the flycatchers near Seldon Canyon. The riparian and aquatic habitat in the river downstream from Caballo to El Paso is not expected to change under either alternative. The river below Caballo will have releases within the range of historical operations. Below Caballo, the entire river channel to El Paso is more directly influenced by the lack of releases during the non-irrigation season and by monsoon rains. During the non – irrigation season the further south on the river, groundwater or secondary arroyos may provide enough water into the river for short

sections to keep the river wet. Therefore, the No Action alternative would have no effect on flycatchers or its designated critical habitat.

Rio Grande Silvery Minnow

The silvery minnow does not have critical habitat within the Project area. The full pool of Elephant Butte Reservoir is influenced by Project operations, but provides poor quality habitat. There is a relatively low abundance of silvery minnow within the associated temporary channel, and fish within this reach have the ability to move upstream. Therefore, it is concluded that the No Action alternative would have no effect on the silvery minnow.

4.3 Cultural Resources

4.3.1 Basis of Significance

As stated in the 2007 assessment, a significant impact to a cultural resource would be an adverse effect that would alter the characteristics of an historic property that would qualify it for the National Register of Historic Places. A significant effect to an Indian sacred site would prohibit access or result in physical damage or destruction. While consulting for this supplemental EA, an additional tribal resource of concern was identified, i.e., native plants growing along the irrigation canals. A significant effect to such a resource would have to be identified by the concerned tribe during the consultation process.

4.3.2 What is the status of cultural resources?

Historic properties listed on the National Register of Historic Places are present within the area of potential effects of this undertaking. Elephant Butte Dam and the diversion dams and the Franklin Canal are listed on the National Register of Historic Places as an historic district. Other historic properties include the Garfield Lateral (LA-111726), Pittsburg Placer Mine (LA-13557), a Mogollon pithouse site (LA-2806), and an Apache battle site (LA-132559). In a follow up conversation in response to a Reclamation scoping letter, the Mescalero Apache Tribe had concerns with native plants growing along the irrigation canals in the service areas of the EBID and EPCWID. The Mescalero Tribe collects plant material for cultural purposes.

4.3.3 How would Both Alternatives affect cultural resources?

The method for assessing adverse effects to historic properties is whether changes would occur to alter the character-defining characteristics, and if so, whether a contemporary from the period of significance would recognize the property today. Neither the Proposed Action nor the No Action alternative would visually impact Elephant Butte Dam or contributing elements to the historic district, so there would be no adverse effects to these listed properties. No Indian sacred sites have been identified within the Project area, so there would be no effects to this type of cultural resource. The culturally important plant resources growing along Project canals would not be affected by either alternative because Project water will continue to flow in these canals and allow the growth (and harvesting) of plants valued by the Mescalero Apache Tribe.

Elephant Butte Reservoir has been receding to a size that only the southern pool remains inundated. The current lake boundaries are well within the high water mark, and what is above water is a steep highly eroded slope of the reservoir from high water to current conditions. Under both alternatives the fluctuation, and any wave action, of the reservoir will not affect undisturbed land around the perimeter of the reservoir. Under the No Action, the Elephant Butte Reservoir is projected to fluctuate 21 feet and under the Proposed Action the model assesses that the reservoir will fluctuate 56 feet in year 3, all within the existing normal high water mark level. Caballo Reservoir fluctuation will not change. The alternatives do not modify the high pool elevation at either reservoir. A Class III archeological survey of Elephant Butte and Caballo Reservoirs was conducted in 1998 and 1999. Since then several site assessments have been conducted. In sum, the proposed alternatives will not modify the fluctuation of the reservoirs and there will be no new impacts to cultural resources.

The two sections of the Rio Grande that are covered by the alternatives will maintain historic flows. Aside from the diversion dams, which will have no operational or physical changes, there is no Reclamation-owned land along the river. The two districts farm the entire floodplain and farm as close to the bankline as possible. Flows in the river channel are not projected to be higher than historic flows as a result of the alternatives, nor is overbanking projected to occur. There will be no impacts to cultural resources from either alternative at the river sections between Elephant Butte and Caballo Reservoirs and from Caballo Reservoir to El Paso.

4.4 Socioeconomic Resources

The analysis of social and economic conditions addresses the relationships between the Proposed Action and communities it may affect. The study area for socioeconomic analysis is based mostly on county-level data from Sierra, Dona Ana, El Paso and Hudspeth counties. While the northern end of Elephant Butte Reservoir is in Socorro County, it is excluded because there is no acreage in the county irrigated by the Project.

4.4.1 Basis of Significance

As stated in the 2007 EA, a significant socioeconomic effect would negatively affect public health, alter regional economics or recreational opportunities, or result in a disproportionately high and adverse human health or environmental effect on low-income or minority populations.

4.4.2 Farming and Land Use

<u>What is the status of farming and land use?</u>

Limiting factors for agricultural producers in EBID and EPCWID include surface and groundwater, land, labor and capital, technological constraints such as crop varieties, and weather conditions that influence crop yields (Ward et al. 2001:111). There are 90,640 acres of land within EBID that have authorized water rights, with an estimated 7,900 water users (DeMouche 2004). There are 69,010 acres within EPCWID. According to Ward et al. (2001:106), under a full-supply of both surface and groundwater, there are generally 82,680 planted acres within EBID and for EPCWID. There are generally

53,300 acres planted under a full supply of surface water. There is no significant groundwater development by EPCWID. Table 4.13 shows the acres planted in EBID during the full allocation year of 2002 and the less-than-full-allocation year of 2003.

For both districts, three types of crops are grown: vegetable crops, row crops, and pecans. Vegetable crops include lettuce, chilies, and onions, which are generally grown under contract with a constant amount of land devoted to these crops from one year to the next. Profitability is high for these crops, but can vary widely. Row crops such as cotton or grain sorghum are generally less profitable, but have more stable returns than vegetables.

Acreage grown varies as national prices for row crops vary (Ward et al. 2001:112). Pecans are a major and highly profitable crop for EBID and EPCWID, but with a high initial investment cost (Ward et al. 2001:112). Producers will go to great lengths to protect their investment in pecan orchards. Several EBID growers have drilled wells 500 feet deep or more to help insure dependable supplies of water for this valuable crop.

Table 4.13. Acreage by Crop Type, EBID, 2002 to 2003. (Ward, et al. (2005)

	Year	
Acres/Crop	2002	2003
Vegetable	19,347	18,373
Row	16,710	15,253
Pecans	3,287	2,961
Total Acres	39,344	36,587

The economic value per AF to the districts is highly variable, ranging from $30 to $155. The marginal value of an AF under a drought can rise to $213 per AF for surface water (Ward et al. 2001). For this analysis, the value of an AF is set at $100 (cf. Ward, et al. 2006).

How would Both Alternatives affect farming and land use?

The effect to both districts of the Proposed Action is that it reduces water use in wet years, when its economic value at the margin is small, leaving some water in storage. In dry years, the accumulated water would be available for beneficial use, when its economic value at the margin is higher due to its greater scarcity (Hooper and Ward 2006). Land may be fallowed or type of crops shifted to try and maximize farm income, but this would occur under either alternative. To approximate the effects of the Proposed Action, releases from Caballo Reservoir associated with the 50th percentile nonexceedance probability were multiplied by the value of $100 per AF. As shown in Table 4.14, for these years, income under the Proposed Action is projected to be higher than that under the No Action alternative in 2015, about the same in 2014, and lower in 2013. As mentioned in Section 4.2.2.3, changes in surface water supply must be considered in the context of existing groundwater pumping and surface water operations, the general state of groundwater and surface water resources in the basin, and the interaction of groundwater and surface water resources within the basin. This simple analysis does not fully consider the groundwater available to EBID farmers for supplemental irrigation

Table 4.14. Hypothetical Farm Income under Alternatives.

Year	OA AF	No Action AF	Income under OA	Income under No Action
2013	458,071	536,507	$45,807,100	$53,650,700
2014	574,240	582,205	$57,424,000	$58,220,500
2015	659,445	612,826	$65,944,500	$61,282,600

4.4.3 Parks and Recreation

<u>What is the status of parks and recreation?</u>
Elephant Butte Reservoir is the largest, most heavily visited reservoir in the region (Booker et al. 2005). It is managed for its reservoir-based recreational values by NMSP under contract with Reclamation, along with Caballo Lake State Park, Percha State Park, and Leasburg Park. From 2000 to 2011, Elephant Butte averaged 1,205,279 visitors a year and Caballo Reservoir averaged 216,219 visitors per year (NMSP data). Boating is the primary recreational use at the parks with sport fishing secondary.

<u>How would Both Alternatives affect parks and recreation?</u>
A regional travel cost model developed by Booker et al. (2005) and Ward et al. (2001) is applied to estimate differences in economic value between the alternatives. The model is based on telephone surveys of water-based visitor use patterns from 1988 to 1989, updated by total visitor use counts in 2000. This was a wet period, but annual reservoir fluctuations resulted in the following equations which can be applied to projected Elephant Butte Reservoir storage water:

$$\text{Annual Economic Benefits} = \lambda_0 \,(\text{Reservoir volume})^{\lambda 1}$$

Where $\lambda_0 = 172.43$ is in thousand dollars per year and $\lambda 1 = 0.51$, and reservoir volume is in thousand AF. The equation applied to the 50th percentile estimated volume of Elephant Butte Reservoir for future years is shown in Table 4.15 by year and alternative.

Table 4.15. Travel Cost Model Applied to Elephant Butte Recreation.

Year	OA AF	No Action AF	OA AF	No Action AF
2013	191	191	2,511.54	2,511.54
2014	319	269	3,262.47	2,990.79
2015	348	282	3,410.50	3,063.66

For example, if average annual volume at Elephant Butte is 348 (thousand) AF in 2015 under the Proposed Action, annual visits are predicted to be (172.43 x (348) raised to the 0.51 power = 3410 (thousand) dollars in benefits per year or $3,410,500. This same projected year under No Action would result in $3,063,660. On average, the first three years under the Proposed Action would result in a mean benefit of $3,061,500 under action and $2,855,330 under no action.

4.4.4 Environmental Justice

What is the status of environmental justice communities?
Federal agencies are directed by Executive Order 12898 to identify and address disproportionally high and adverse effects of their projects on the health or environment of minority or low-income populations. A minority population is defined as African American, Hispanic, Asian American, American Indian, and Native Hawaiian. Low-income is defined by the Office of Management and Budget's Directive 14 as varying by family size. If the affected area has a minority or low-income population more than 20 percent higher than the reference area, further analysis is necessary to determine if these populations would receive a disproportionally higher share of adverse Project impacts.

Table 4.16 shows that 78 percent of the four counties that receive Project water is Hispanic, compared to 46 percent of New Mexico and 37 percent of Texas. Thus, for purposes of environmental justice, the four Project counties have minority populations higher than that of New Mexico and Texas so the counties qualify as environmental justice minority communities.

Table 4.16. Minority Population of the Four Rio Grande Project Counties, 2011 (U.S. Department of Commerce. 2012)

	Dona Ana, NM	Sierra, NM	El Paso, TX	Hudspeth, TX	New Mexico	Texas
Total Population	205,637	11,925	787,410	3,433	2,037,136	24,774,187
Hispanic or Latino	134,659	3,231	644,844	2,754	934,301	9,216,240
White alone	62,379	8,234	105,697	551	832,435	11,349,192
African American alone	2,982	25	20,854	87	35,602	2,856,383
American Indian alone	1,699	139	1,754	0	175,904	69,329
Asian alone	2,255	0	7,790	41	25,595	927,023
Native Hawaiian alone	22	0	596	0	941	17,758
Some other race	267	0	1,033	0	3,907	40,018
Two or more races	1,374	296	4,842	0	28,451	298,244
Percent of Total						
Hispanic or Latino	65.5	27.1	81.9	80.2	45.9	37.2
White alone	30.3	69.0	13.4	16.1	40.9	48.8
African American alone	1.5	0.2	2.6	2.5	1.7	11.5
American Indian alone	0.8	1.2	0.2	0.0	8.6	0.3
Asian alone	1.1	0.0	1.0	1.2	1.3	3.7
Native Hawaiian alone	0.0	0.0	0.1	0.0	0.0	0.1
Some other race	0.1	0.0	0.1	0.0	0.2	0.2
Two or more races	0.7	2.5	0.6	0.0	1.4	1.2

Figure 4.25 shows that Hudspeth County qualifies as a low-income community for environmental justice analysis having 44.7 percent of individuals living in poverty compared to 14.3 percent for the United States or 17.0 percent for Texas.

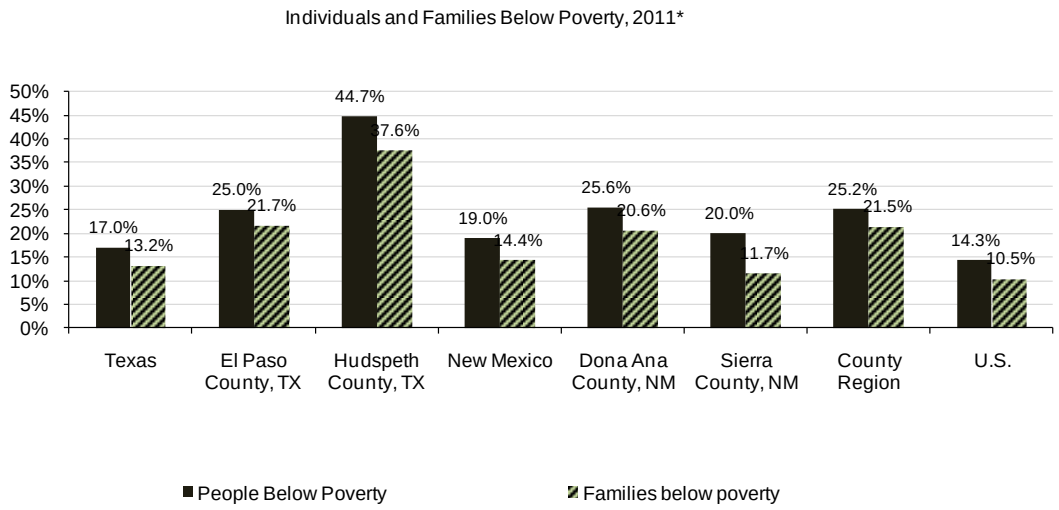

Figure 4.25 Distribution of low-income people and families in Project counties, 2011.

<u>How would Both Alternatives affect environmental justice communities?</u>
A disproportionately high and adverse effect on an environmental justice community means the adverse effect would be predominately borne by that community or would be appreciable more severe or greater in magnitude on the environment justice community than the effect on the overall population within the Project area. For the Project, the counties are predominately Hispanic compared to the rest of New Mexico and Texas, but the greatest concern lies with the two Texas counties of El Paso (82 percent Hispanic) and Hudspeth (81 percent Hispanic). As mentioned above, Hudspeth County is also a low-income county for environmental justice.

Looking at the water quality results, the two Texas counties have worse water quality than the upstream counties; however, El Paso has mitigated for this effect through its water treatment facilities. Further, neither of the alternatives would result in a significant impact. For socioeconomic purposes, the travel cost model and the extrapolation to farming incomes was not divided by counties, and so an estimate of disproportionate effects cannot be made. However, as in the 2007 EA and FONSI, Reclamation is committed to monitoring the effects of its selected alternative and committed to obtaining data about biophysical processes and their effects on the human environment. As a result, the Proposed Action will not have a disproportionately high or adverse effect on an environmental justice community.

4.5 Indian Trust Assets

<u>What is the status of Indian trust assets?</u>
Indian trust assets (ITA) are legal interests in property held in trust by the United States for Indian tribes or individuals. Reclamation consulted with the Mescalero Apache, the Indian tribe whose aboriginal territory is located within the current Project area, but they did not identify any ITAs that could be affected by either alternative.

5 Consultation and Coordination

5.1 Lead and Cooperating Agencies

Reclamation is the lead agency in preparing this supplemental EA and was assisted in the process by five cooperating agencies: IBWC, Corps, EPCWID, EBID, and the Texas Rio Grande Compact Commission. Reclamation consulted with and obtained the comments of these agencies due to their jurisdiction by law or special expertise with respect to potential environmental effects of the proposed action.

5.2 Public Involvement and the Scoping Process

Scoping is the phase in the NEPA process whereby the initial scope of issues to be analyzed is determined. This phase occurs early in the process and is intended to obtain the views of the public, agencies, Indian tribes, and other interested parties regarding the scope of the analysis.

Reclamation mailed scoping letters to potentially interested parties in January and April, 2012 and hosted two public scoping meetings in El Paso, Texas and Las Cruces, New Mexico. These meetings were held on April 25, and 26, 2012, respectively. The purpose of these meetings was to solicit input from the public regarding the format, content and analysis to be considered during the NEPA process. Meetings were announced in local newspapers and in a "Drought Watch on the Rio Grande." The outcome of this public input process was a decision by the AAO Area Manager to supplement the 2007 EA.

One of the concerns raised during scoping was the duration of the analysis. The 2007 EA projected effects over a five-year period; i.e., through December of 2012. In 2008, the OA was signed with a 50-year duration. Some commentors wanted an analysis covering the full period of the agreement. As discussed in Section 1.0, the period of analysis for this supplemental EA is an initial three year period. During this three year period, Reclamation will voluntarily commence and actively pursue, upon completion of the current NEPA process, the development and refinement of the existing modeling tools to thoroughly analyze the implementation of the OA over its remaining life (i.e., for the period through 2050) through an EIS. Through this overall approach, Reclamation is prioritizing resources for both the immediate future and the extended future to ensure that such information is completed in a timely manner to assist in the public's consideration of the Proposed Action.

5.3 Tribal Consultation

In January 2012 and again in April 2012, Reclamation mailed potentially interested and affected Indian tribes a letter notifying them of the Proposed Action and inquiring whether they wanted government-to-government consultation. The letters were followed up with emails or phone calls. The Mescalero Apache Tribe was the only tribe offering comments. The following tribes were sent the mailing, but had no comments or concerns or did not respond: Apache Tribe of Oklahoma, Comanche Nation, Kiowa Tribe of Oklahoma, Hopi Tribe, Navajo Nation, Pueblo of Isleta, Pueblo of Acoma, White Mountain Apache Tribe, and Ysleta del Sur Pueblo.

5.4 Contributors

The following organizations or persons provided information that assisted in the preparation of this document (it does not include those who commented during scoping).

5.4.1 Federal

U.S. Army Corps of Engineers
U.S. Fish and Wildlife Service, New Mexico Ecological Services
U.S. Section of the International Boundary and Water Commission

5.4.2 State Agencies

El Paso County Water Improvement District No. 1
Elephant Butte Irrigation District
New Mexico State Historic Preservation Officer
Texas Rio Grande Compact Commission

5.4.3 Reclamation Contributors or Reviewers

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Nancy Coulam, Environmental Protection Specialist, Upper Colorado Region
Catherine Cunningham, Environmental Specialist, Policy and Administration, Denver
Jim Wilber, Program Manager, AAO

6 References

Affidavit of Dr. Thomas Maddock III. CV-96-888 (Third Judicial District, Dona Ana County New Mexico, June 21, 2012).

Ahlers, D, G Reed, and R Siegle. *Browsing Analysis of Riparian Vegetation, Elephant Butte Project Lands.* Denver Technical Service Center, Denver, CO: Bureau of Reclamation, 2003.

Banner, J L, et al. "Climate Change Impacts on Texas Water: A White Paper Assessment of the Past, Present and Future and Recommendations for Action." *Texas Water Journal*, 2010: 1-19.

Barroll, Peggy. "Active Water Resource Management in the Lower Rio Grande – Tools for A New Era in Water Management." Oral Presentation to the Lower Rio Grande Water Users Association, New Mexico Office of the State Engineer, New Mexico, 2005.

Booker, James F., Ari M. Michelsen, Frank A. Ward. 2005. Economic Impact of Alternative Policy Responses to Prolonged and Severe Drought in the Rio Grande Basin, Water Resources Research 41:1-15.

Bureau of Reclamation. "Elephant Butte and Caballo Reserviors Resource Management Plan and Final Environmental Impact Statement." 2002.

Bureau of Reclamation. *Elephant Butte and Caballo Reservoirs Resource Management Plan.* Deparment of the Interior, Bureau of Reclamation, Albuquerque, NM: Albuquerque Area Office, 2003.

Bureau of Reclamation. *Elephant Butte And Caballo Reservoirs Resource Management Plan Final Environmental Impact Statement.* Department of the Interior, Bureau of Reclamation, Albuquerque, NM: Albuquerque Area Office, 2002.

Bureau of Reclamation. 2012, Southwestern Willow Flycatcher Management Plan.

Bureau of Reclamation. 2013. 2012 Southwestern Willow Flycatcher Study Results. Department of the Interior, Bureau of Reclamation, Denver Technical Services Center.

Caroom, Douglas G, and Susan M Maxwell. "Overview of Texas Water Rights and Development." *2009 Texas Water Law Institue.* Austin, TX: The University of Texas Law School, 2009.

Conover, C S. *Ground-water Conditions in the Rincon and Mesilla Valleys and Adjacent Areas in New Mexico.* U.S. Geological Survey, Washington, DC: US GPO, 1954.

Council on Environmental Quality. "Environmental Justice Guidanced Under The National Environmental Policy Act." *Environmental Justice and NEPA.* http://ceq.hss.doe.gov/nepa/regs/ej/justice.pdf (accessed October 24, 2012).

DeMouche, L. *Interpreting the Elephant Butte Irrigation District for Water Users.* New Mexico State University Cooperative Extension Service, Las Cruces, NM: College of Agriculture and Home Economics, 2004.

El Paso Public Utilities Board. *El Paso Public Utilities Board.* 2007. http://www.epwu.org/water/water_resources.html (accessed October 12, 2012).

El Paso Water Utilities. 2013 http://www.epwu.org/water/desal_info.html (accessed March 8, 2013)

El Paso County Water Improvement District v Elephant Butte Irrigation District and the United States of America, Department of the Interior, Bureau of Reclamation, Cause No. EP07CA0027, Western Dis. of Texas. (2007)

Ferrari, Ronald L. *Caballo Reservoir 2007 Sedimentation Survey.* Water and Environmental Resources Division, Technical Service Center, Denver, CO: US Bureau of Reclamation, 2008.

Ferrari, Ronald L. *Elephant Butte Reservoir 2007 Sedimentation Survey.* Water and Environmental Resources Division, US Bureau of Reclamation, Denver, CO: Technical Service Center, 2008.

Gangopadhyay, Subhrendu, and Tom Pruitt. *West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections.* Water and Environmental Resoruces Division, Technical Service Center, Denver, CO: Bureau of Reclamation, 2011.

Hall, B M. *Letter to the Territorial Irrigation Engineer.* Carlsbad, NM: United States Geological Survey, 1906.

Hechler, Rolf. *Elephant Butte Lake State Park Managment and Development Plan.* Elephant Butte, NM: New Mexico State Parks Division, 2000.

Hooper, Bruce P. and Frank A. Ward. 2006. River Basin Indicators: a Framework for Evaluation in the Rio Grande. Western Economics Forum, Spring 2006.

Hunt, R R. *Physiography of the United States.* San Francisco:W.H.Freeman & Co., 1967.

IBWC. "Draft EIS River Management Alterntaives for the Rio Grande Canalization Project." Draft Environmental Impact Statement, International Boundary and Water Commission, 2003.

IBWC. *El Paso - Las Cruces Regional Sustainable Water Project.* Final Environmental Impact Statement, El Paso, TX: International Boundary and Water Commission, 2002.

Littlefield, Douglas Robert. *Interstate Water Conflicts, Compromises and Compacts: The Rio Grando 1880-1938.* Unpublished Disseration, University of California, Los Angeles: University of California.

Michelsen, Ari M, et al. *Rio Grande Salinity Management Program: Preliminary Economic Impact Assessment.* Rio Grande Salinity Management Coalitiion, 2009.

Moore, D, and D Ahlers. *Southwestern Willow Flycatcher Study Results.* Denver Technical Service Center, Bureau of Reclamation, 2012.

Natural Resources Conservation Service. *Land Resource Regions and Major Land Resour Areas ofthe United States, the Caribbean, and the Pacific Basin.* United States Department of Agriculture, 2006.

New Mexico State Parks Divsion. *Elephant Butte State Park Final Plan.* New Mexico State Parks, 2006.

New Mexico State Parks. *Elephant Butte Lake State Park Management and Development Plan.* New Mexico State Parks, 2000.

Seaber, P R, F P Kapinos, and G L Knapp. *U.S Geological Survey Water Supply Paper* . U.S. Geological Survey, 1987.

Secretary of the Interior. *Orders and Regulations of the Interior Department Touching the Use, Appropriation, or Dispostion for Irrigation WAters of the Rio Grande and Its Tributaries in Colorado and New Mexico.* Letter from the Secretary of the Interior by Direction of the President, Washington DC: 62nd Congress, 1911, 2.

Sogge, M K, R M Marshall, S J Sferra, and T J Tibbits. *A Southwestern Willow Flycatcher natural history summary and survey protocol.* National Park Service, 1997.

Stangle, Karen. *2009 - 2011 Annual Report.* Interstate Stream Commission, Santa Fe, NM: Office of the State Engineer, 2011.

Stephens, John H. *El Paso Dam and Elephant Butte Dam.* Hearing Report, Subcommittee, Committee on Foreign Affairs, House of Representatives, Washington, DC: Government Publishing Office, 1900, 11-12.

TCEQ. *Texas Surface Water Quailty Monitoring and Assessment Strategy.* Surface Water Quality Monitoring Program, Water Quailty Planning Division, Austin, TX: Texas Council on Enviromental Quailty, 2012.

Tetra Tech. 2012. Draft Report providedby EPCWID.

The Adjudication of Water Rights In The Upper Rio Grande Segment of the Rio Grande Basin. (327th Judicial District Court of El Paso County, Texas, October 30, 2006).

Turney, Thomas C. *Mesilla Valley Administrative Area Guidelines for Review of Water Right Applications.* Santa Fe, NM: Office of the New Mexico State Engineer, 1999.

US Department of Agriculture. *Census of Agriculture.* Washington, DC: National Agricultural Statistics Service, 2009.

U.S. Department of Commerce. 2012. Census Bureau, American Community Survey Office, Washington, D.C.; U.S. Department of Commerce. 2000. Census Bureau, Systems Support Division, Washington, D.C.

U.S. Fish and Wildlife Service, Biological Opinion and Biological Assessment for the 2009 IBWC River Management Alternatives for the Rio Grande Canalization Project.

U.S. Fish and Wildlife Service. 2010. Rio Grande silvery Minnow Recovery Plan.210 pp.

U.S. Fish and Wildlife Service, Biological and conference opinion on the effects of the 2012 IBWC proposed action of an Integrated Land Management Alternative for Long-Term Management of the Rio Grande Canalization Project in Sierra County and Doña County, New Mexico, and El Paso County, Texas.

U.S. Geological Survey. Northern Prairie Wildlife Research Center. Bird Checklists of the United States, Fort Bliss, TX. USGS Website 2013.

U.S. Geological Survey (USGS), 1998. Ground Water and Surface Water: A Single Resource. USGS Circular 1139, Denver, Colorado. 79 pp.

Ward, Frank A., Ari Michelsen, and Leeann DeMouche. 2005. Institutional Barriers to Water Conservation in the Rio Grande Basin: Challenges and Opportunities. New Mexico Water Resources Research Institute: New Mexico Water, Past, Present, and Future or Guns, Lawyers, and Money. October:57-70.

Ward, Frank A., James F. Booker, and Ari M. Michelsen. 2006. Integrated Economic, Hydrologic, and Institutional Analysis of Policy Responses to Mitigate Drought Impacts in Rio Grande Basin. Journal of Water Resources Planning and Management Nov/Dec 2006:488-502).

WaterBank. "Landmark Pleadings and Other Documents in New Mexico Water Law Cases." *http://www.waterbank.com/index.html.* August 29, 2008.

Woodhouse Connie A., David M. Meko, Daniel Griffin, and Christopher L. Castro. 2013. Tree rings reveal multi-season drought variability in the lower Rio Grand basin, USA. Water Resources Research, DOI: 10.1002/wrcr.20098

Appendix A – 2008 Operating Agreement

Appendix A

2008 Operating Agreement for the Rio Grande Project
Dated March 10, 2008

United States Department of the Interior

BUREAU OF RECLAMATION

El Paso Field Division
10737 Gateway West, Suite 350
El Paso, Texas 79935

IN REPLY REFER TO:

EP-100
PRJ-1.10

MAR 10 2008

Mr. Gary Esslinger
Manager-Treasurer
Elephant Butte Irrigation District
P.O Drawer 1509
Las Cruces, NM 88004-1509

Subject: Signed Rio Grande Project Operating Agreement

Dear Mr. Esslinger,

It is with extreme pleasure that I enclose for your files a signed Operating Agreement for the Rio Grande Project dated March 10, 2008. I offer my appreciation and congratulations to the Elephant Butte Irrigation District in helping to make the Operating Agreement possible.

Sincerely,

Filiberto Cortez
Manager

Enclosure

cc: Mr. Patrick R. Gordon
Commissioner
Rio Grande Compact Commission for Texas
P.O Box 1917
El Paso, TX 79950-1917

Mr. Lee Leininger
US Department of Justice
Environment and Natural Resources Division
1961 Stout Street, Suite 800
Denver, CO 80294

Mr. Jesus Reyes
General Manager
El Paso County Water Improvement District No. 1
294 Candelaria
El Paso, TX 79907-5599

Mr. Chris Rich
Office of the Solicitor
125 South State Street, Rm 6201
Salt Lake City, UT 84138

United States Department of the Interior
BUREAU OF RECLAMATION
El Paso Field Division
10737 Gateway West, Suite 350
El Paso, Texas 79935

IN REPLY REFER TO:
EP-100
PRJ-1.10

MAR 10 2008

Mr. Jesus Reyes
General Manager
El Paso County Water Improvement District No. 1
294 Candelaria
El Paso, TX 79907-5599

Subject: Signed Rio Grande Project Operating Agreement

Dear Mr. Reyes,

It is with extreme pleasure that I enclose for your files a signed Operating Agreement for the Rio Grande Project dated March 10, 2008. I offer my appreciation and congratulations to the El Paso County Water Improvement District #1 in helping to make the Operating Agreement possible.

Sincerely,

Filiberto Cortez
Manager

Enclosure

cc: Mr. Gary Esslinger
Manager-Treasurer
Elephant Butte Irrigation District
P.O Drawer 1509
Las Cruces, NM 88004-1509

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Salt Lake City, UT 84138

OPERATING AGREEMENT

FOR THE RIO GRANDE PROJECT

THIS OPERATING AGREEMENT (" Agreement ") is entered into this 10th day of March, 2008, by and among the United States of America, by and through the Bureau of Reclamation (" United States " or " Reclamation " or " USA ") acting pursuant to the Reclamation Act of June 17, 1902, 32 Stat. 390, as amended and supplemented; the Elephant Butte Irrigation District (" EBID "), an irrigation district and a quasi municipal corporation in the State of New Mexico, incorporated and organized under New Mexico law, N.M.S.A. 1978, § 73 10 1 et seq. (1985 Repl. Pamp.); and the El Paso County Water Improvement District No. 1 (" EPCWID "), a political subdivision of the State of Texas, under Art. XVI, § 59 of the Texas Constitution (collectively, " the Parties " to this Agreement).

NOW THEREFORE, the Parties recognize the following terms and conditions to constitute an operational plan for the Rio Grande Project and the Parties agree as follows:

1 DEFINITIONS

When used in this Agreement, unless otherwise distinctly expressed or manifestly incompatible with the intent hereof, the following definitions shall apply:

1.1. Normal Annual Release

A Normal Annual Release from Project Storage for all authorized uses is 790,000 acre-feet as measured at the first gauging station downstream of Caballo Dam. It is possible that during any Water Year the aggregate quantity of water released for EBID and EPCWID, and for the United States (pursuant to the Convention of 1906), including release of Carryover Water for EBID and EPCWID, may be more or less than the Normal Annual Release from Project Storage of 790,000 acre-feet.

1.2. Project-Authorized Acreage

There are 159,650 authorized acres within the Project. Of the Project Authorized Acreage, 90,640 acres are within EBID and 69,010 acres are within EPCWID.

1.3. Project Storage

Elephant Butte Reservoir, Caballo Reservoir, and such additional storage facilities (less flood control space) as may be authorized by Congress or provided for pursuant to the Rio Grande Compact (Act of May 31, 1939, 53 Stat.785).

1.4. Rio Grande Project

The Project was authorized by an Act of Congress on February 25, 1905, 33 Stat. 814, pursuant to the Reclamation Act of 1902, 32 Stat. 390. The Project includes facilities and works with their appurtenant lands authorized by the Act of February 25, 1905, as amended and supplemented, particularly Elephant Butte Dam and Reservoir, Caballo Dam and Reservoir, a power generating plant, and six diversion dams (Percha, Leasburg, Mesilla, American, International, and Riverside) on the Rio Grande in New Mexico and Texas, and includes the Project lands and service area authorized for water delivery pursuant to the Rio Grande Project Act of February 25, 1905, as amended and supplemented and the Reclamation Act of 1902 as amended and supplemented.

1.5. Water Year

The water year shall be a calendar year beginning on the first day of January and ending on the thirty-first day of December.

1.6. Project Water

Project Water, as used herein, shall mean: 1) usable water in Project Storage; 2) all water required by the Rio Grande Compact of 1938 to be delivered into Elephant Butte Reservoir; and 3) all water released from Project Storage and all inflows reaching the bed of the Rio Grande between Caballo Dam, New Mexico and Fort Quitman, Texas.

1.7. Annual Allocated Water

Annual Allocated Water is the quantity of Project Water that is determined by United States, in accordance with this Agreement, the Operations Manual, and in consultation with EBID and EPCWID, to be allocated each Water Year for delivery to EBID and EPCWID, and to the United States (pursuant to the Convention of 1906).

1.8. Carryover Water

Carryover Water is the Annual Allocated Water allotment balance remaining on the water account for each district at the end of a given Water Year. EBID and EPCWID shall have the right to carry over any amount of their respective Annual Allocated Water subject to provisions of Section 1.10 herein.

1.9. Actual Carryover Water

Actual carryover water is the increase in a district's allocation due to applying carryover water amounts for each district in the allocation calculations.

1.10 Carryover Limit

Actual carryover water may be accumulated in an account for each district to a maximum of sixty percent (60%) of each district's respective full yearly allocation or an amount of actual carryover water equal to 232,915 acre-feet for EPCWID and 305,918 acre-feet for EBID.

1.11 Excess Carryover Balance

At the end of the water year, either district's carryover balance in excess of its respective carryover limit shall be transferred to the carryover account of the other district. If both districts' carryover limits are exceeded, each district's carryover balance shall be equal to its respective limit.

1.12 Rio Grande Project Water Accounting and Operations Manual (Operations Manual)

The United States, EBID, and EPCWID shall produce an Operations Manual. The Operations Manual shall contain detailed information regarding the methods, equations, and procedures used by EBID, EPCWID, and the United States to account for all water charges and operating procedures for the Rio Grande Project. This Agreement shall be effective upon execution regardless of the status of the Operations Manual.

1.13 Non-Allocated Water

Project Water is available for diversion from the Rio Grande by EBID or EPCWID that is not charged by the United States against any allocation account. Non-Allocated water is typically available only during periods when no water is being released from storage or during flood events.

2. ALLOCATION OF PROJECT WATER

2.1. Use of Project Water

All Project Water in Project Storage, including any actual Carryover Water shall be used for the authorized purposes set forth in the Reclamation Act of June 17, 1902, 32 Stat. 390, and the Rio Grande Project Act of February 25, 1905, 33 Stat. 814, as amended and supplemented.

2.2. Determination of Project Water in Project Storage

At the beginning of each Water Year and during each month of the Water Year, The United States shall determine the total quantity of Project Water in Project Storage.

2.3. Determination of Annual Allocation to Mexico, EBID, and EPCWID

The United States shall determine the quantity of Annual Allocated Water to Mexico, EBID, and EPCWID by the first of December for the following Water Year utilizing the Project Water in storage amounts and Carryover Water amounts for each district. The United States may reconsider the Annual Allocated Water each month during a Water Year and adjust it as necessary in consultation with EBID and EPCWID in accordance with this Agreement.

2.4. Annual Allocation for United States for delivery to Mexico

The portion of the Annual Allocated Water which shall be allocated for the United States to meet its obligations pursuant to the Convention of 1906 shall be 11.3486 percent (11.3486%) of the sum of the quantity of Project Water delivered to lands in the United States plus the quantity of Project Water delivered to the head works of the Acequia Madre in acre-feet per Water Year as set forth in equation 2-1 and Table 1 that follow:

$$Y = 0.8260932\,(X) - 102{,}305 \qquad (2\text{-}1)$$

where X =Annual Released Water (in acre-feet per Water Year), and Y = sum of the quantity of Project Water delivered to lands in the United States plus the quantity of Project Water delivered to the head works of the Acequia Madre (in acre-feet per Water Year).

Table 1

Annual Amount of Water Released from Caballo Reservoir (ac-ft/acre)	Sum of the quantity of Project Water delivered to lands in the United States plus the quantity of Project Water delivered to the head works of the Acequia Madre (in acre-feet per Water Year).	Quantity of Project Water delivered to the head works of the Acequia Madre (in acre-feet per Water Year).
790,000	550,309	60,000
763,842	528,700	60,000
700,000	475,960	54,015
650,000	434,656	49,327
600,000	393,351	44,640
550,000	352,046	39,952
500,000	310,742	35,265
450,000	269,437	30,577
400,000	228,132	25,890
350,000	186,828	21,202
300,000	145,523	16,515
250,000	104,218	11,827
200,000	62,914	7,140

The United States shall be entitled to release all or such portion of the Annual Allocated Water which has been allocated for the United States as it deems necessary to meet the

requirement of the Convention of 1906 to deliver water in the bed of the Rio Grande at the head works of the Acequia Madre.

2.5. Annual Allocation for EBID and EPCWID

EBID's and EPCWID's portions of the quantity of Annual Allocated Water, exclusive of the United States' portion of Annual Allocated Water pursuant to the Convention of 1906, shall be determined by the process described in Table 2 for a full allocation condition and Table 3 when there is less than a full water supply available. EBID 's and EPCWID 's yearly allocation shall be determined using the empirically derived linear regression analysis equation (D-2). Equation D-2 was derived using historical Rio Grande Project data correlating releases from Rio Grande Project storage and corresponding yearly deliveries to Rio Grande Project diversions from the Rio Grande for EBID, EPCWID and Mexico during the Water Years 1951 to 1978 inclusive. The amount of Annual Allocated Water shall be determined using the D-2 equation for EPCWID, using equation 2-1 for the United States (pursuant to the Convention of 1906), and using the diversion ratio (ratio of the amount of water Charged to the amount of water Released) for EBID and in accordance with Tables 1 through 4 herein.

Table 2 – Rio Grande Project Hypothetical Example of Full Allocation

1	Rio Grande Project Diversion Allocations	ac-ft
2	Elephant Butte Reservoir Storage	1,000,000
3	Caballo Reservoir Storage	44,005
4	Total Rio Grande Project Storage	1,044,005
5	Estimated Rio Grande Compact Credit Waters	(196,000)
6	Estimated San Juan-Chama Water	(4,553)
7	Water Released from Storage	-
8	Total Usable Water Available for Release	843,452
9	Carryover Obligation using Estimated Diversion Ratio	14,854
10	Total Usable Water Available for Current Year Allocation	790,000
11	EBID Allocation Balance (Previous Year)	10,000
12	EPCWID Allocation Balance (Previous Year)	5,000
13	EBID Estimated Allocation Balance (End-of-Year)	-
14	EPCWID Estimated Allocation Balance (End-of-Year)	-
15	Storage for EBID and EPCWID Estimated Allocation Balance (End-of-Year)	-
16	Estimated Release of Current Usable Water	804,654
17	Estimated End-of-Year Release for Diversion Ratio	781,208
18	D1 Delivery	562,414
19	Mexico's Current Diversion Allocation	60,000
20	Gross D2 Diversion Allocation	972,709
21	EPCWID ACE Conservation Credit	-
22	Net D2 Diversion Allocation for EBID and EPCWID	912,709
23	D2 Diversion Allocation for EPCWID	394,526
24	EPCWID Diversion Allocation (w/o Conservation Credit)	399,526
25	EPCWID Diversion (w/o Conservation Credit or 67/155ths of Row 30)	399,526
26	Diversion Ratio	1.023633
27	Diversion Ratio Adjustment	19,017
28	Sum of Release and Diversion Ratio Adjustment	823,670
29	EBID D2 Diversion Allocation	518,183
30	Difference between EBID Diversion Ratio Allocation and D2 Diversion Allocation	-
31	EBID Diversion Ratio Allocation	354,144
32	EBID Diversion Allocation	354,144
33	Total EBID Diversion Allocation (includes 88/155th of Value in Row 30)	384,144
34	Total EPCWID Allocation (includes Row 21 and 67/155th of Value in Row 30)	399,526
35	Total EBID, EPCWID, and Mexico Allocation	823,670

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Table 3 – Rio Grande Project Hypothetical Example of Less than Full Allocation

1	Rio Grande Project Diversion Allocations	ac-ft
2	Elephant Butte Reservoir Storage	408,773
3	Caballo Reservoir Storage	23,772
4	Total Rio Grande Project Storage	432,545
5	Estimated Rio Grande Compact Credit Waters	(187,800)
6	Estimated San Juan-Chama Water	(4,053)
7	Water Released from Storage	-
8	Total Usable Water Available for Release	240,692
9	Carryover Obligation using Estimated Diversion Ratio	112,931
10	Total Usable Water Available for Current Year Allocation	127,761
11	EBID Allocation Balance (Previous Year)	-
12	EPCWID Allocation Balance (Previous Year)	106,882
13	EBID Estimated Allocation Balance (End-of-Year)	-
14	EPCWID Estimated Allocation Balance (End-of-Year)	-
15	Storage for EBID and EPCWID Estimated Allocation Balance (End-of-Year)	-
16	Estimated Release of Current Usable Water	240,692
17	Estimated End-of-Year Release for Diversion Ratio	600,000
18	D1 Delivery	96,529
19	Mexico's Current Diversion Allocation	10,955
20	Gross D2 Diversion Allocation	80,948
21	EPCWID ACE Conservation Credit	-
22	Net D2 Diversion Allocation for EBID and EPCWID	69,994
23	D2 Diversion Allocation for EPCWID	30,256
24	EPCWID Diversion Allocation (w/o Conservation Credit)	137,237
25	EPCWID Diversion (w/o Conservation Credit or 67/155ths of Row 30)	137,237
26	Diversion Ratio	0.947320
27	Diversion Ratio Adjustment	(12,680)
28	Sum of Release and Diversion Ratio Adjustment	228,012
29	EBID D2 Diversion Allocation	39,738
30	Difference between EBID Diversion Ratio Allocation and D2 Diversion Allocation	40,082
31	EBID Diversion Ratio Allocation	79,820
32	EBID Diversion Allocation	39,738
33	Total EBID Diversion Allocation (includes 88/155th of Value in Row 30)	62,495
34	Total EPCWID Allocation (includes Row 21 and 67/155th of Value in Row 30)	154,563
35	Total EBID, EPCWID, and Mexico Allocation	228,012

Table 4 Description of Values and Calculations Tables 2 and 3

Row	Description	Source of Value	Equation
1	Rio Grande Project Diversion Allocations	NA	NA
2	Elephant Butte Reservoir Storage	USBR	NA
3	Caballo Reservoir Storage	USBR	NA
4	Total Rio Grande Project Storage	Calculated	[2]+[3]
5	Estimated Rio Grande Compact Credit Waters	USBR	NA
6	Estimated San Juan-Chama Water	USBR	NA
7	Water Released from Storage	USBR	NA
8	Total Usable Water Available for Release	Calculated	[4] + [5] + [6] + [7]
9	Carryover Obligation using Estimated Diversion Ratio	Calculated	([11] + [12]) / [26]
10	Total Usable Water Available for Current Year Allocation	Calculated	MIN(790000,[8] - [9])
11	EBID Allocation Balance (Previous Year)	EPCWID, EBID, USBR	NA
12	EPCWID Allocation Balance (Previous Year)	USBR	NA
13	EBID Estimated Allocation Balance (End-of-Year)	EBID	NA
14	EPCWID Estimated Allocation Balance (End-of-Year)	EPCWID	NA
15	Storage for EBID and EPCWID Estimated Allocation Balance (End-of-Year)	Calculated	([14]+[13]) / [26]
16	Estimated Release of Current Usable Water	USBR	[10] + [9] - [15]
17	Estimated End-of-Year Release for Diversion Ratio	USBR	NA
18	D1 Delivery	Calculated	MAX(0,([16]*0.8260932) - 102305)
19	Mexico's Current Diversion Allocation	Calculated	MIN(60000,[16]*0.113486)
20	Gross D2 Diversion Allocation	Calculated	MIN(763842,[10])*1.3377994-89970+MAX(0,[16]-763842)
21	EPCWID ACE Conservation Credit	USBR	NA
22	Net D2 Diversion Allocation for EBID and EPCWID	Calculated	[20] - [19]
23	D2 Diversion Allocation for EPCWID	Calculated	[22] * 67 / 155
24	EPCWID Diversion Allocation (w/o Conservation Credit)	Calculated	[23] + [12]
25	EPCWID Diversion (w/o Conservation Credit or 67/155ths of Row 30)	Calculated	[24] - [14]
26	Diversion Ratio	Calculated	0.00000042113634*[17]+0.6946382
27	Diversion Ratio Adjustment	Calculated	([26] - 1) * [16]
28	Sum of Release and Diversion Ratio Adjustment	Calculated	[16] + [27]
29	EBID D2 Diversion Allocation	Calculated	[22] * 88 / 155
30	Difference between EBID Diversion Ratio Allocation and D2 Diversion Allocation	Calculated	IF([16]<600000,MAX(0,[31]-[29]),0)
31	EBID Diversion Ratio Allocation	Calculated	[28] - [25] - [19] - [11] - [21]
32	EBID Diversion Allocation	Calculated	IF([16]<600000,MIN([29],[31]),[31])
33	Total EBID Diversion Allocation (Includes 88/155th of Value in Row 30)	Calculated	[32]+[11]+88/155*[30]
34	Total EPCWID Allocation (Includes Row 21 and 67/155th of Value in Row 30)	Calculated	[24]+[30]*67/155+[21]
35	Total EBID, EPCWID, and Mexico Allocation	Calculated	[34]+[33]+[19]

3. RELEASE FROM STORAGE

3.1. Orders for Release of Rio Grande Project Water from Storage

EBID and EPCWID may order releases from Project storage to meet their respective delivery requirements of Annual Allocated Water or Carryover Water at their river headings during the Water Year at such times and in such quantities as they respectively elect. Water orders shall be delivered by the United States to their respective diversion and delivery points as prescribed by agreed to travel times, or as described in the Operations Manual when completed. EBID shall not order changes more frequently than four times per week. EPCWID shall not order changes more frequently than twice per week.

EBID and EPCWID shall determine the amount of water to be released from Caballo Reservoir necessary to meet the diversion orders at the time and days requested by EBID, EPCWID, and the United States (pursuant to the Convention of 1906). If EBID and EPCWID cannot agree on the amount or timing of release, then the United States shall make such determinations.

The parties shall develop a schedule of order changes that will best meet the needs of each party at their respective delivery points.

The United States shall only release Project Water ordered by EBID when EBID has Annual Allocated Water or Carryover Water remaining in their allocation. The United States shall only release Project Water ordered by EPCWID when EPCWID has Annual Allocated Water or Carryover Water remaining in their allocation.

The Parties may make non-scheduled order changes to adjust for rainfall/runoff or flood events, accident to the delivery system, or for public safety.

The United States may make releases from storage in such quantities as necessary to meet the requirements of the Convention of 1906 and according to the schedule determined by the United States under the authority of the Convention of 1906.

4. DELIVERIES

4.1. Operation of Release and Diversion Structures

The United States shall operate Elephant Butte Reservoir so as to provide for sufficient quantities of water to be available for released from Caballo Reservoir to the Parties, as outlined in Section 3.1 herein. The United States or its designee shall operate Percha, Leasburg, and Mesilla diversion dams so as to provide sufficient flows for the districts'

diversions on the Rio Grande. The United States shall operate the American and International diversion dams and make the diversions into the American Canal.

4.2. Obligations to Deliver Project Water

Within a reasonable amount of time from the time requested for the release by EBID and EPCWID, or as defined in the Operations Manual when completed, the United States shall release from project storage those quantities of Project Water which will meet the individual requirements of each district as communicated in their water order to the United States to be delivered at the Arrey Canal Heading, Leasburg Canal Heading, Eastside Canal Heading, Westside Canal Heading, Del Rio Lateral Heading and any additional authorized points of delivery for EBID, and to be delivered to the Franklin Canal Heading, the Riverside Canal Heading, the City of El Paso 's water treatment plants and any additional authorized points of delivery for EPCWID. Within a reasonable of amount time from the time requested for the delivery, or as defined in the Operations Manual when completed, the United States shall deliver those quantities of Project Water in the Rio Grande at the head works of the Acequia Madre in accordance with the orders designated by the United States.

5. FLOW REQUIREMENTS

5.1. Order

An " Order " is a request to the United States by a Party to deliver a quantity of Project Water to each district's delivery and accounting stations at a specific flow rate (cubic feet per second) and at specified delivery time and day.

5.2. Release

A " Release " is a flow rate (cubic feet per second) of Project Water released from Project Storage.

5.3. Delivered Flow

A " Delivered Flow " is a flow rate (cubic feet per second) of Project Water that meets the conditions required to meet the delivery requirement for each district and Mexico at their designated delivery point or metering stations (stations) and at specified delivery time and day.

5.4. Charge

A " Charge " is a quantity of Project Water (acre-feet) that is deducted from (i.e. charged against) a Party's Annual Allocated or actual Carryover Water account.

5.5. Charge Against EBID's and EPCWID's Annual Allocated Water including Carryover Water

EBID 's and EPCWID 's remaining Annual Allocated Water shall be computed by subtracting a Charge which shall be equal to EBID 's or EPCWID 's respective delivery at main canal headings and any other designated and authorized metering stations at the Rio Grande diversion dams against their respective remaining portion of Annual Allocated Water including carryover water.

Allocation charges for water diverted by EPCWID, EBID, and Mexico shall be made as follows, or in accordance with the procedures and methods contained in the Operations Manual when completed.

1. EBID and EPCWID shall report to the United States the flow records for their respective diversion and water delivery stations for each month by the 5th day of the following month.
2. The reports may be transmitted electronically by any party to the other parties.
3. The United States shall report to EBID and EPCWID the previous month's Allocation Charges and the cumulative year-to-date Allocation Charges for EBID, EPCWID, and the United States by the 10th day of the month.

A hypothetical example of summary tables of the Allocation Charges for EBID and EPCWID is contained in Appendix A attached here to.

Water diverted from the Rio Grande by EBID may be returned (bypassed) to the Rio Grande for credit to their water allocation account at one designated location each within the Leasburg, Eastside, and Westside canal system, and two designated locations within the Arrey Canal system. Water diverted from the Rio Grande by EPCWID may be returned (bypassed) to the Rio Grande for credit to their water allocation account at one designated location on the La Union East Canal. Such credits shall be the smaller of the amount of water declared for bypass by the respective district or the actual amount of water that was measured and returned to the Rio Grande.

The United States shall make every effort to match the delivery and the order for each district at all designated metering and delivery stations in order to minimize spill water and meet the order at any given time.

5.6. Charge Against United States' Annual Allocated Water for Delivery to Mexico

United States' remaining quantity of Annual Allocated Water shall be equal to United States' previous allocation of Annual Allocated Water during the current Water Year minus the water delivered to Mexico at their diversion point on the Rio Grande at the Acequia Madre during the Water Year. The United States will maintain the gates at the International Dam so as to minimize the leakage to the greatest extent practical.

5.7. Compliance with Delivery of Project Water to Mexico at the Acequia Madre

If the flow at the first metering station above International Diversion Dam does not meet the Acequia Madre delivery requirement, the United States will adjust the gates at American Diversion Dam to reduce the flow to meet the corresponding delivery requirement for that day. The United States will give notice to EBID and EPCWID of such action except when such flow is due to storm runoff or flood events, short term debris clearing or sluicing operations. Any time the United States manually adjusts the flow at the American Diversion Dam by more than 25 cfs, for any reason, or at anytime the flow diverted at the American Diversion Dam into the American Canal exceeds the capacity of the American Canal, United States shall notify EPCWID as soon as possible.

5.8. Diversion Points

The diversion points used for EBID are as follows: Percha Lateral, Arrey Canal, Leasburg Canal, California Extension, various designated river pumps, Del Rio Lateral, East Side Canal, and West Side Canal. The diversion points used for the EPCWID are as follows: the New Mexico/Texas state line crossings for the La Union East Lateral, Three Saints Lateral, and La Union West lateral in the Mesilla Valley. In the El Paso Valley, deliveries to EPCWID will be made at the Robertson/Umbenhauer Water Treatment Plant, Franklin Canal, Jonathan Rogers Water Treatment Plant, and Riverside Canal.

5.9. Compliance with Delivery of Project Water to EBID and EPCWID

The United States shall closely match the order and diversion at each designated delivery metering station through close monitoring of releases from Project Storage and river accretions or losses. Close coordination and daily communication shall be maintained between EBID, EPCWID, and the United States in order to make adjustments to releases

from Project Storage such that water deliveries match water order amounts as closely as possible at each delivery point in the Project.

6. GENERAL PROVISIONS

6.1. Compliance with Federal Law

The terms of this Agreement are subject to applicable federal law. All Parties will cooperate to comply with all federal law prior to and during implementation of this Agreement.

6.2. Other Agreements

This Agreement is not intended to conflict with terms of any prior agreements or contracts between the EBID and EPCWID, or EBID and the United States, or EPCWID and the United States, or among all of the Parties; however, the Agreement represents the current conditions and present understanding that future operations shall be as provided for herein unless further modified upon having reached unanimous consent of the Parties.

6.3. Required Continuous Flow Metering Stations

A list of required continuous flow metering stations is attached to this Agreement as Appendix B. Each Party shall distribute and exchange copies of all flow records for all flow metering stations for which it is responsible, as listed in Appendix B, among the other Parties at least monthly with a goal of real time data exchanges.

6.4. Regulating Reservoirs Downstream of Caballo Dam

Nothing in this Agreement shall be interpreted to prohibit the construction and/or operation of an off-channel regulating reservoir, providing however that no such reservoir shall affect the water order or delivery requirements of the Parties under this Agreement.

6.5. Emergency Conditions (Force Majeure)

If any Party through no fault of its own is rendered unable, wholly or in part, by Force Majeure to carry out its obligations under this Agreement, then the obligations of such Party, so far as they are affected by such Force Majeure, shall be suspended during the time reasonably necessary to remedy such inability, but for no longer period. The term "Force Majeure" shall mean acts of God, wars, terrorism, vandalism, insurrections, riots, epidemics, landslides, lightning, earthquakes, fires, storms, floods, hazardous spills, or explosions.

6.6. Term of Agreement

This Agreement shall be in effect from January 1, 2008 until December 31, 2050.

6.7. Modification of Agreement

The Parties may modify any provisions of this Agreement upon having reached unanimous consent.

6.8. Assignment Limited - Successors and Assigns Obligated

The provisions of this Agreement shall apply to and bind the successors and assigns of the Parties hereto. No assignment of any right or obligation shall be made by any Party without first obtaining written approval by the other Parties.

6.9. Obligations to Indian Tribes Not Affected

Nothing in this Agreement shall be construed as affecting the obligations of the United States of America to the Indian Tribes, or as impairing the rights of the Indian Tribes.

6.10. Obligations to Mexico Not Affected

Nothing in this Agreement shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties.

6.11. Amendment of Agreement

This Agreement shall be reviewed for improvement of operations at least on an annual basis or as agreed to by the majority of the parties. Any of the parties may submit a written request to the other parties for review of this Agreement at any time.

6.12. Rio Grande Compact

Nothing herein is intended to alter, amend, repeal, modify, or be in conflict with the provisions of the Rio Grande Compact.

APPENDIX A – Hypothetical Example of Allocation Charges for EBID and EPCWID

The tables below are hypothetical examples of summary tables of Allocation Charges for EBID and EPCWID. The Operations Manual, when completed, shall contain detailed information regarding the methods, equations, and procedures used by EBID, EPCWID, and the United States to account for all water charges and operating procedures for the Rio Grande Project.

EPCWID Diversion Allocation Charges

Diversion Location	Metered Volume	Adjustment for Conveyance Losses for NM Deliveries	Diversion Allocation Charges for Month	Beginning-of-Month Totals	End-of-Month Totals
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
L U E Canal - TX	2,395	95%	2,275	17,065	19,340
L U W Canal - TX	947	95%	900	6,620	7,520
Three Saints Lateral	134	100%	134	1,426	1,560
Total Mesilla Valley (Texas)			3,309	25,112	28,420
Umbenhauer/Robertson Water Treatment Plant	3,345	100%	3,345	16,701	20,046
Franklin Canal	7,400	100%	7,400	39,293	46,694
United States - Ysleta del Sur Agreement	0	100%	0	200	200
United States Section - IBWC (Construction Water)	1	100%	1	22	23
Jonathan W. Rogers Water Treatment Plant	4,666	100%	4,666	27,747	32,413
Riverside Canal	20,079	100%	20,079	125,831	145,910
Haskell R. Street WWTP Effluent	-1,599	100%	-1,599	-8,180	-9,779
Credit for Diversions greater than Orders (EP Valley)	-2,790	100%	-2,790	-3,233	-6,023
Total Allotment Diversions Charges			34,411	223,493	257,904
Diversion Allocation				382,486	390,105
Est. Annual Conservation Credit Diversion Allocation					18,742
Accrued Conservation Credit Diversion Allocation					12,390
Total Diversion Allocation				382,486	402,495
District Allotment Balance				158,993	144,591
2006 Carryover Balance					36,200

ELEPHANT BUTTE IRRIGATION DISTRICT

WATER ALLOTMENT CHARGES

SUBJECT TO REVISION

	GROSS DIVERSIONS (AC-FT)		DIVERTED TO TEXAS (AC-FT)		NET DIVERSIONS (AC-FT)	
		TO DATE		TO DATE		TO DATE
ARREY CANAL	9775	63725			9775	63725
PERCHA LATERAL	93	508			93	508
LEASBURG CANAL	8739	67663			8739	67663
CALIFORNIA EXTENTION	0	353			0	353
EASTSIDE CANAL	7295	48677	311	1920	6984	46757
DEL RIO LATERAL	476	2989			476	2989
WESTSIDE CANAL	18793	135991	5267	41097	13526	94894
PUMPED FROM RIVER**	0	56			0	56
GROSS TOTAL	45171	319962	5578	43017	39593	276945

	NET DIVERSION	TO DATE
TOTAL CHARGES (AC-FT)	39593	276945
CREDIT AT ARREY (-)	1216	3882
CREDIT AT LEASBURG (-)	0	233
NET ALLOTMENT CHARGE	38,377	272,830
DISTRICT ALLOTMENT		311,517
DISTRICT BALANCE		38,687

** GREENWOOD AND DURAN RIVER PUMPS (EBID DATA)

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APPENDIX B – Required Flow Metering Stations

In order to assure accurate metering of allocated water deliveries to EBID, EPCWID and Mexico, the following metering stations will be maintained by the described agencies. The letter prefix before each metering station indicates the valley in which the metering station is located (R for Rincon, M for Mesilla, and E for El Paso).

The following continuous stage recorders shall be maintained by the United States:

R1 – Rio Grande Below Caballo – located on the east side of the river and approximately 0.8 mile downstream of Caballo Dam.

M2 - Rio Grande at Leasburg Canal – located approximately 1.5 miles downstream of Leasburg Diversion Dam on the river channel just downstream of Leasburg Wasteway No. 1.

Miscellaneous Sites: Any location, not identified herein, at which water from Rio Grande downstream of Elephant Butte Dam and upstream of the Ft. Quitman, Texas, is diverted by the United States, including without limitation, diversions for the Bonita Lateral.

The following continuous stage recorders shall be maintained by EBID:

R2 – Arrey Canal – The metering bridge is located just downstream of the canal heading and the CMP shelter and recorder are located just downstream of the Percha State Park bridge crossing.

R3 – Percha Lateral – The lateral water flow is measured just downstream of the lateral heading and the CMP shelter with recorder are located downstream of the metering RC Box culvert.

R4 – Wasteway No. 5 at Hatch Siphon – This wasteway is located upstream of the Hatch Siphon at the Rio Grande.

R5 – Garfield Drain – located north of the US Hwy 85 bridge, 3 miles north of Hatch, New Mexico, and west of the highway on the drain channel.

R6 – Rio Grande at Hatch – located approximately 3 miles north Hatch, New Mexico, and west of the US Hwy 85 bridge on the right side of the river channel.

R7 – Wasteway No. 16 at Rincon Siphon – located downstream on the river channel from the A.T. & S. F. Railroad crossing the Rio Grande approximately 2 miles east of Hatch, New Mexico.

R8 – Hatch Drain – located on the drain upstream of UW Hwy 85 approximately 2.5 miles east of Hatch, New Mexico.

R9 – Wasteway No. 18 from Rincon Lateral – located approximately 8 miles east of Hatch, New Mexico, north of the US Hwy 85, and on the left side of the Rio Grande.

R10 – Rio Grand at Hayner Bridge – located approximately 8 miles east of Hatch, New Mexico on the Rio Grande just upstream of the Tonuco River crossing.

R11 – Rincon Drain – located approximately 8 miles east of Hatch, New Mexico, 1 mile north of the Tonuco River crossing, and downstream of the intersection of the Rincon Lateral and Rincon Drain.

M1 – Leasburg Canal – located approximately 1.5 miles form the canal heading and approximately 0.5 miles east from the intersection of Fort Selden Road (from US I-25) and US Hwy 85.

M3 – Selden Drain – located approximately 3.5 miles south of Radium Springs, New Mexico and just east of U.S. Hwy 85, immediately upstream of the intersection of Kerr Lateral with the drain.

M4 – Wasteway No. 5 – located approximately 5 miles north of Las Cruces, New Mexico and one mile south of the intersection of NM Hwy 430 and US Hwy 85, on the left side of the river channel.

M5 – Wasteway No. 8 – located approximately 3 miles north of Las Cruces, New Mexico on the left side of the river approximately 2 miles west of US Hwy 85.

M6 – Picacho Drain – located approximately 2.0 miles northwest from Mesilla Diversion Dam, west of the Rio Grande, and just downstream from the Nusbaum Lateral inflow into the Picacho Drain.

M8 – West Side Canal – located west off the Mesilla Diversion Dam. Station is located approximately 0.5 miles downstream of the canal heading and contains a metering bridge and CMP shelter with recorder.

M9 – East Side Canal – located east off the Mesilla Diversion Dam. The Station is located approximately 0.25 miles downstream of the canal heading and contains a metering bridge and CMP shelter with recorder.

M10 – Del Rio Lateral – located east off the Mesilla Diversion Dam. Station is located approximately 0.5 miles downstream of the lateral heading and contains a metering bridge and CMP shelter with recorder.

M11 – Rio Grande Below Mesilla – located approximately 0.75 miles downstream of Mesilla Diversion Dam on the Rio Grande.

M12 – Wasteway No. 15 – located approximately 200 feet upstream of the left (east) of the river levee and 1.6 miles downstream from the New Mexico State Hwy No. 28 bridge crossing of the Rio Grande.

M13 – Santo Tomas River Drain – located approximately 3.4 miles downstream of the New Mexico State Hwy No. 28 bridge crossing and 0.8 miles upstream of the Mesquite-San Miguel Road bridge crossing the Rio Grande. The station is on the west side of the river on the Santo Tomas River Drain upstream of the culvert through the levee.

M14 – Wasteway No. 25 – located approximately 3.5 miles downstream of the New Mexico State Hwy No. 28 bridge crossing and 0.7 mile upstream of the Mesquite-San Miguel Road Bridge crossing the Rio Grande. The station is on the west side of the river on the tail end of the Santo Tomas River Lateral on the river side of the lateral embankment.

M15 – Wasteway No. 26 – located approximately 1.5 miles west of Mesquite, New Mexico on the right side of the river off the Upper Chamberino Lateral and just downstream of the river crossing the Mesquite-San Miguel state road.

M16 – Brazito River Lateral Wasteway – located on the east side and 0.7 mile downstream of the Mesquite-San Miguel Road bridge crossing the Rio Grande. The station is on the tail end of the Brazito River Lateral and is downstream o f the river levee.

M17 – Wasteway No. 18 – located approximately 1.5 miles northwest from Vado, New Mexico on the left (east) side of the river. This station is just upstream where the wasteway crosses Del Rio Drain and downstream of the railroad tracks.

M19 – Del Rio Drain – located approximately 3 miles south of Mesquite, New Mexico and north of Vado, New Mexico. Station is just west off US Hwy 85 and 125 feet downstream of the Vado Mesquite Road Crossing Del Rio Drain.

M20 – Wasteway No. 19 – located between a fork formed by the river on the west and the A.T. & S.F. railroad and approximately 2.0 miles northwesterly from Berino, New Mexico. The wasteway station is approximately 500 feet from the Three Saints Lateral and wastes this lateral into the Rio Grande.

M21 – Wasteway No. 30 – located downstream of the New Mexico State Road 226 from Berino, and downstream of the river levee between the Chamberino East Lateral and the Rio Grande.

M22- La Mesa Drain – located approximately 2 .5 miles west of Berino, New Mexico, west of the river, and ½ mile from wasteway No. 31.

M23 – Wasteway No. 31 – located approximately 2.5 miles southwest of Berino, New Mexico, west of the river, and 3 miles downstream from the intersection of the river with State Hwy 226 (Berino to Chamberino).

M24 – Wasteway No. 20 – located on the east side of the Rio Grande and wastes the Three Saints West Lateral. This wasteway is approximately 1.6 miles upstream of the Anthony bridge crossing the Rio Grande.

M25 – Wasteway No. 31B – located approximately 0.5 mile upstream of the Anthony bridge crossing and on the west side of the Rio Grande. This wasteway is on the tail end of the Jimenez Lateral and is upstream of the river levee.

M26 – Wasteway No. 21 – located approximately 0.5 mile upstream and on the east side of the Rio Grande. This wasteway is on the tail end of the Three Saints West Lateral and is 300 feet upstream of the river levee.

M27 – La Union West Canal – located approximately 3 miles west of Anthony, New Mexico just downstream of the canal heading.

Miscellaneous Sites: Any location where diversion of water from the Rio Grande occurs in New Mexico downstream of Caballo Dam and upstream of the upstream of the American Diversion Dam, including but not limited to the California Lateral Extension and various river pumps.

The following continuous stage recorders shall be maintained by EPCWID:

M28 – La Union East Canal – located approximately 3 miles west of Anthony, New Mexico just downstream of the canal heading.

M29 – Three Saints East – located approximately 0.3 mile upstream of the intersection of the Three Saints Lateral and FM1905 from Anthony.

M30 – Wasteway No. 32 – located approximately 2 miles west of Anthony, New Mexico, on the right side of the river, and just downstream of New Mexico State Hwy 225.

M32 – East Drain – located approximately 2 miles south of Anthony, New Mexico and west of US Hwy 80A.

M33- Wasteway No. 32A – located 2 miles upstream of the Anthony bridge crossing and on the west side of the Rio Grande. This wasteway is on the tail end of the Rowley Lateral and just upstream of the river levee.

M35 – Wasteway No. 32B – located west and downstream of the Vinton bridge crossing the Rio Grande. Station is on the tail end of the Vinton Cutoff Lateral and just downstream of the river levee.

M36 – Wasteway No. 34 – located just downstream of the Montoya Siphon and is on the tail end of the Canutillo Lateral.

M37 – Wasteway No. 34A – located approximately 0.6 mile upstream of the Combined La Union Lateral and on the west side of the Rio Grande.

M38 – Wasteway No. 35 – located 3.5 miles downstream from Canutillo, Texas on the right side (west) of the Rio Grande.

M39 – Wasteway No. 35C – located just downstream and on the west side of the Rio Grande. Station is on the tail end of the Schutz Lateral and upstream of the river levee.

M40 – Wasteway No. 36 - located at the tail end of the Montoya Lateral A and on the east side of the Rio Grande.

M41 – Montoya Drain – located in the Upper Valley, Texas, approximately two miles downstream of Country Club Road on the Montoya Drain.

M42 – Wasteway No. 38 – located just down stream of the Sunland Park Road on the Montoya Main Lateral.

M45 – Rio Grande at Canutillo – located approximately 1.0 mile north of Canutillo, Texas and on the right and west side of the Rio Grande.

E1 – American Canal – located off Paisano Drive on canal concrete lined channel just downstream of the Paisano Siphon and ASARCO plant.

E2 – Robertson/Umbenhauer Water Treatment Plant – located adjacent to the American Canal Extension near Canal Street in downtown El Paso.

E3 – Franklin Canal – located downstream of heading of the Franklin Canal near the 2nd Street Check on the American Canal Extension.

E4 – Jonathan Rogers Water Treatment Plant - located adjacent to the Riverside Canal immediately upstream of the E5 metering station

E5 – Riverside Canal – located on the right side (south) and approximately 800 feet downstream of the canal heading.

E6 – Riverside Canal Wasteway No. 1 – located on the right side of the canal just south of the Bosque Park. Wasteway is from Riverside Canal to the Rio Grande.

E7 – Riverside Canal Wasteway No. 2 – located downstream from Riverside Canal Wasteway No. 1, at a point where the canal channel departs from the river levee, approximately 2.5 miles northwest of Cuadrilla, Texas.

E8 – Fabens Waste Drain – located on the Waste Drain Channel just west of U.S. Hwy 20 at Fabens, Texas.

E9 – Fabens Waste Channel – located southeast of Fabens, Texas, downstream on the waste channel from the Tornillo Canal Heading and the Cook-Schultz Lateral inlet intersection.

E10 – Waste Channel Below Tornillo Wasteway No. 1 – located on the Fabens Waste Channel below the Tornillo Canal Wasteway and the Tornillo-Caseta Road.

E12 – Hudspeth Feeder Canal – located on the Hudspeth Feeder Canal approximately six miles downstream from the Guadalupe-Caseta Road and International Bridge in to Caseta, Mexico.

E13 – Tornillo Canal Wasteway No. 2 – located approximately 1 mile east of Alamo Alto, Texas on the canal channel adjacent to U.S. Hwy 20 Alternate.

E14 – Tornillo Drain – located on drain channel just downstream and 800 feet from the Alamo Alto Drain inlet, approximately 0.5 miles southeast of Alamo Alto, Texas.

Miscellaneous Sites: Any location where diversion of water from the Rio Grande occurs in Texas downstream of Mesilla Dam and upstream of the former location of Riverside Diversion Dam.

IN WITNESS WHEREOF, the Parties have executed this Agreement as of the 10th day of March, 2008.

Attest: ELEPHANT BUTTE IRRIGATION DISTRICT

Willie Koenig
Secretary

By: James Salopek
President

Attest: EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1

Indar Singh
Secretary

By: Johnny P. Stubbs
President of the Board of Directors

Attest: UNITED STATES OF AMERICA

For: Field Solicitor
Regional

By: Regional Director
Upper Colorado Region
Bureau of Reclamation

Appendix B – 2012 Operations Manual

RECEIVED
MAY 18 2012

Recommendation of Changes to Rio Grande Project Operation Manual Proposed on May 8, 2012

_____ Date: 5/16/12
Dr. James Phillip King, Allocation Committee Member representing EBID

_____ Date: 5/20/12
Dr. A. W. Blair, Allocation Committee Member representing EPCWID

_____ Date: 5-18-12
Filiberto Cortez, Allocation Committee Member representing USA

Approval of Changes to Rio Grande Project Operation Manual Proposed on May 8, 2012

Elephant Butte Irrigation District (EBID)

_____ Date: 5/16/12
Gary Esslinger, General Manager and Treasurer
(Approved at EBID's May __, 2012 Board Meeting)

El Paso County Water Improvement District No. 1 (EPCWID)

_____ Date: 5-7-12
Jesus Reyes, General Manager
(Approved at EPCWID's May 14, 2012 Board Meeting)

United States of America

_____ Date: 5/25/2012
Larry Wakoviak, Director
Upper Colorado Region, Bureau of Reclamation

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MAY 18 2012

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Jesus Reyes, General Manager
(Approved at EPCWID's May 14, 2012 Board Meeting)

United States of America

_____ Date: 5/25/2012
Larry Wakoviak, Director
Upper Colorado Region, Bureau of Reclamation

Revision of January 12, 2010

RIO GRANDE PROJECT - OPERATIONS MANUAL

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D – Flow Regulation Calibration at Caballo Dam

Exhibits

1 – CD-ROM of Ordering and Allocation Spreadsheets

1. Disclaimer

This Rio Grande Project Water Accounting and Operations Manual (Operations Manual) contains detailed information regarding the methods, equations and procedures used by the United States Bureau of Reclamation (Reclamation), El Paso County Water Improvement District No. 1 (EPCWID), and Elephant Butte Irrigation District (EBID) to operate the Rio Grande Project and account for all water charges under the Rio Grande Project Operating Agreement This Operations Manual is an addendum to the Rio Grande Project Operating Agreement and is intended to be consistent with the Project Storage, release and delivery and allocation provisions in the Rio Grande Project Operating Agreement; nothing in the Operations Manual modifies or changes the language and requirements set forth in the Operating Agreement. To the extent any provisions in this Operations Manual are inconsistent or incompatible with the Operating Agreement, such inconsistencies are superseded by the Operating Agreement and/or are null and void.

2. Definitions

Allocated Water: that portion of the project water supply, as defined in the Operating Agreement, which is determined to be available for diversion and use by EBID, EPCWID and the United States for delivery to Mexico during the primary irrigation season. Accounting of allocated water is subject to the time that it takes water to travel from Caballo Dam to each district's respective diversion points.

Primary Irrigation Season: the primary irrigation season is defined as that period of a year when water is being released from Caballo Reservoir for irrigation purposes.

Allocation Charge: the debit applied to EBID's, EPCWID's or Mexico's respective amount of allocated Allocation Water.

Non-Allocated Water: water in the Rio Grande, during non-irrigation season and after the closing of the Caballo Dam release gates and prior to opening of the Caballo Dam release gates for the subsequent primary irrigation season, which originates from drain flows and other sources which may be diverted by the irrigation districts for application to irrigable land area within their boundaries. All diversions made by the Districts during the non-irrigation season utilizing return flow waters shall not be charged against the District's respective allocations.

Operating Agreement: Agreement executed on March 10, 2008 between the United States, EBID and EPCWID.

3. Allocation of Project Water

3.1. EBID and EPCWID

The U.S. Bureau of Reclamation (Reclamation) shall, prior to the 2nd Tuesday of each month of the year, allocate Rio Grande Project water in accordance to the Operating Agreement to EBID, EPCWID, and the United States for delivery to Mexico. The final allocation for the year shall include storage and allocation accounting data through the month of October of such year.

3.2. Bonita Private Irrigation Canal

The Reclamation shall each month inform EBID, EPCWID, and US-IBWC of the amount of water diverted from Caballo Reservoir into the Bonita Private Irrigation Canal by the United States for use in New Mexico.

3.3. United States for Delivery to the Republic of Mexico

Reclamation shall advise US-IBWC based on the storage conditions at the end of November whether the project waters available for release from Project Storage for the following year are sufficient for a full allocation or whether a proportionally reduced allocation will be made. The initial allocation letter provided by the U.S. Bureau of Reclamation to the US-IBWC is received mid-December of each year, with projected storage conditions in Elephant Butte and Caballo reservoirs through the end of the year.

During drought years when proportionally reduced allotments are made, regular monthly meeting are held at the US-IBWC headquarters. Monthly updates based on the end of previous month reservoir storage conditions and allocation projections for the remainder of the year are presented by Reclamation to the US-IBWC, CILA, EBID, EPCWID and CONAGUA, Juarez irrigation district.

3.4. Diversion of Flood Water in Excess of Project Water Orders

Reclamation may declare that flood flows, in a specific amount and duration, entering the Rio Grande downstream of Caballo Dam and in amount in excess of Project Water Orders to be Non-Allocated Water and available for diversion by EBID and EPCWID.

4. Water Delivery and Accounting

4.1. Ordering of Water by the Districts

Figure 1 below shows the order forms to be completed by EPCWID and EBID for review by Reclamation. The amount of flow ordered for delivery to Mexico shall be specified by US-

IBWC. The data fields in Figure 1 shall be entered by EBID and EPCWID each order day during the primary irrigation season by 10:00 am. Based on the information entered into to Figure 1 and the "Flow Regulation Calibration at Caballo Dam" report contained in Appendix D, Prior to 11:00 am each order day, the low level gates at Caballo Dam shall be set to the opening values calculated in Figure 1. The official record of releases of Project Water from Caballo Reservoir shall be calculated by Reclamation and shall be based on the flows recorded by the metering station immediately downstream of Caballo Dam and operated by Reclamation. The amount of opening of the low-level gates shall not be changed if the difference in the amount of the gate opening is ± 0.02 feet from the prior gate setting. Reclamation will perform a flow measurement at the river station below Caballo Dam whenever there is a change in the release from Caballo Dam of ± 100 cfs.

Figure 1 – Internet-Based Order Forms

RIO GRANDE PROJECT ORDER

Ord:1124	Effective Date: 7/8/2008		Prior:1123	Effective Date: 7/7/2008	
BOR	Date/Time Received: 07/08/08 15:36	Received By: IO	BOR	Date/Time Received: 07/07/08 15:09	Received By: IO
EPCWID #1	Date/Time Entered: 07/08/08 08:39	Approved By: RR	EPCWID #1	Date/Time Entered: 07/07/08 09:49	Approved By: RR
EBID	Date/Time Entered: 07/08/08 08:49	Approved By: MJN	EBID	Date/Time Entered: 07/07/08 09:51	Approved By: MJN

Upper Valley From: 7/8/2008 To: 7/9/2008

Location	Current	Prior	Change
Arrey Canal	140	140	0
(-) Bypass	0	0	0
River Pumps	0	0	0
Leasburg Canal	170	230	-60
(-) Bypass	0	0	0
California Ext.	0	0	0
Del Rio Lateral	0	0	0
Eastside Canal	110	140	-30
Westside Canal	380	400	-20
(-) Bypass WW32	-30	-70	40
Total Upper Valley	770	840	-70

State Line From: 7/8/2008 To: 7/9/2008

Location	Current	Prior	Change
La Union West TX	20	30	-10
La Union West NM	20	30	-10

Gate Settings	Current	Prior	Change
East Gate Recommended	3.98	4.41	-0.43
West Gate Recommended	3.98	4.41	-0.43

EBID Comments

-

SUMMARY

	Current	Prior	Change
RIVER BOOST	50	0	50

River Reaches/Stations	Current	Prior	Change
Caballo Release	1683	1873	-190
Flow below Percha Dam	1543	1733	-190
Gain/Loss (+/-) above Leasburg	50	0	50
Flow at Leasburg Cable	1423	1503	-80
Gain/Loss (+/-) Leasburg/Mesilla	0	0	0
Flow below Mesilla Dam	933	963	-30
Gain/Loss (+/-) Mesilla-American	0	0	0
Flow at American Dam	963	1033	-70

District Totals	Current	Prior	Change
Total for EBID	690	780	-90
Total for EPCWID #1	866	916	-50
Total for Both Districts	1556	1696	-140

Project Totals	Current	Prior	Change
Total Gains/Loss	50	0	50
Total EBID, EPCWID, Mexico	1733	1873	-140
Release	1683	1873	-190

State Line From: 7/10/2008 To: 7/12/2008

Location	Current	Prior	Change
La Union East TX	60	30	30
La Union East NM	30	20	10
3 Saints East TX	0	0	0
3 Saints East NM	0	0	0
Total State Line	130	110	20

Lower Valley From: 7/11/2008 To: 7/13/2008

Location	Current	Prior	Change
UR-WTP	56	56	0
Franklin Canal	160	130	30
JR-WTP	85	85	0
Riverside Canal	485	585	-100
Total Lower Valley	786	856	-70

Comments - EPCWID

-

Mexico From: 7/11/2008 To: 7/13/2008

Location	Current	Prior	Change
Mexico	177	177	0
Total Mexico	177	177	0

Comments - Mexico

-

Reclamation Order # 1124

Caballo Elevation	Current	Prior	Change
USBR Elevation (ft)	4148.58	4148.44	0.14
Recommended River Boost (cfs)	0.00	0.00	0
Accretions (cfs)	50.00	0.00	50

Gate Settings	Current	Prior	Change
East Gate (ft)	3.98	4.41	-0.43
West Gate (ft)	3.98	4.41	-0.43

Recommended Flow Setting	Current	Prior	Change
CFS	1683	1873	-190

Scheduled Time of Change	10:00

USBR River Measurement	Date	Time	Flow
Measured Flow (cfs)	7/8/2008	13:15	1756

USBOR Confirmation of Mexico Order	Yes

Comments

BOR recom. gate settings @ 3.86 ea.=1683 Dist. recom. gate settings @ 3.98 ea.=1735

Date/Time Received: 07/08/08 15:36	Received By: IO

4.2. Estimate of the Time Required for Water Released from Caballo Reservoir to Travel in the Rio Grande to Diversion Dams

Project Water is released from Caballo Reservoir is diverted at the Percha, Leasburg, Mesilla, and American diversion dams located downstream of Caballo Dam on the Rio Grande. The time required for water released from Caballo Reservoir to travel to each of these dams varies with the amount of water in the Rio Grande, the amount of water released, the amount of change in the amount of water released (both magnitude and sign), the amount of water being diverted at each diversion point, and other considerations. As water released from Caballo travels from Caballo Dam towards American Dam in the Rio Grande it does such as a wave that is attenuated and modified with distance. For example, if the amount of flow released from Caballo Dam is changes from 1,000 cfs to 1,500 cfs, the 500 cfs increase occurs almost instantly, but assuming no water is lost or gained between Caballo Dam and American Dam, the arrival of the change-in-release would be gradual. Figure 2 below show the measured hydrographs during the initial release of water from Caballo Dam in 2007 at various locations on the Rio Grande downstream of Caballo Dam. Because the change-in-release is modified as it flows downstream, the estimated travel times are based on the time that 90% of the anticipated change arrives at the given diversion dam. For the above example of a 500 cfs change at Caballo with no loss or gain of water, the travel time would be that when 450 cfs of the change arrived at given location. Table 1 below lists the distance and average travel time for the Rio Grande Project diversion dams on the Rio Grande.

Figure 2 – Hydrographs for Initial Release of Water from Caballo Dam in 2007

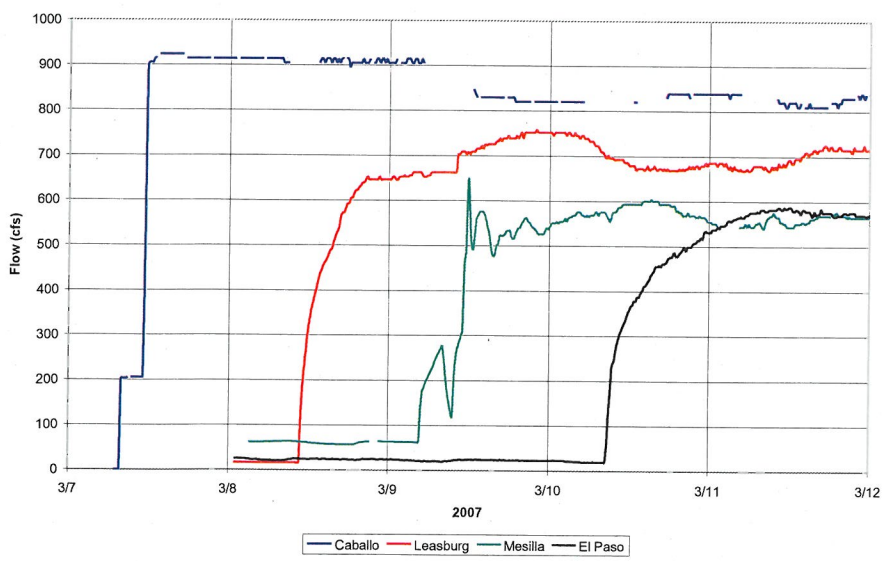

Table 1 Average Travel Times from Caballo Dam to Various Diversion Dams

River Location / Reach	River Miles from Caballo Dam	River Reach Miles	Travel Velocity	Cumulative Travel Time in Hours	Travel Time per River Reach in Hours	Example Day of Week	Example Hour of Day
Rio Grande at Caballo Dam	0	-		0	0	Monday	11:00 AM
Percha Diversion Dam	1.2	1.2	0.6	2	2	Monday	1:00 PM
Leasburg Diversion Dam	44.8	43.6	2.4	20	18	Tuesday	7:00 AM
Mesilla Diversion Dam	67.5	22.7	2.3	30	10	Tuesday	5:00 PM
American Diversion Dam	106.8	39.3	1.1	66	36	Thursday	5:00 AM
International Diversion Dam	108.9	2.1	1.1	68	2	Thursday	7:00 AM

4.3. Sharing of Storages

Flows at American Canal Heading occasionally drop below the order of the EPCWID. At times when the actual flow at EPCWID delivery points is 100 CFS or more below the EPCWID's order, and at EPCWID option, the following method of sharing the shortage between EBID and EPCWID shall be implemented:

> EBID shall release additional water through wasteways equal to one half of the amount of shortage at Riverside Canal Heading. EBID and EPCWID shall adjust the order for release from Caballo Reservoir to correct for such shortage. EBID shall receive credit against their allocation charge for the amount of additional water released through their wasteways because of such shortage.

4.4. Water Flow Measurement Stations

Each party shall maintain and operate the water flow measurement (metering) stations as listed in the Operating Agreement. Each station used in accounting of delivery of allocated water and listed in sections 4.5.2 and 4.5.3 shall be equipped with a Steven's Type F recorder and the water levels shall be continuously recorded on paper charts. A digital copy of the charts shall be made available by the party maintaining the metering station upon request by any other party.

4.5. Measurement of Flow and Volume

Water flow and volume measurement shall generally following procedures as outlined in USGS Water Supply Paper 2175. Rating tables for metering stations shall be determined at least annually by the party maintaining the station using previous flow measurements.

4.5.1. United States Section of the International Boundary and Water Commission (US-IBWC)

The US-IBWC measures twice a week at the Below American Dam gaging station and twice weekly at the headworks of the Acequia Madre, preferably on Mondays and Fridays each week

during the primary irrigation season. CILA measures the amount of water flowing in Acequia Madre at its headworks three times a week, usually on Mondays, Wednesdays and Fridays. All information regarding measurements are exchanged between the two sections. Based upon the latest US measurements, the US-IBWC determines the appropriate gage height setting at the metering station immediately downstream of American Dam on the Rio Grande and the corresponding gate setting at American Dam to deliver the requested flow rate into the Acequia Madre.

The water delivered to Mexico in the Rio Grande at the headworks of the Acequia Madre pursuant to the 1906 Convention is computed by subtracting 1) computed losses in the reach between Below American Dam gauging station and the Acequia Madre headworks and 2) estimated leakage through International Dam from the computed flows at the Below American Dam gauging station.

4.5.2. EBID

Figure 3 –Example of EBID's Monthly Water Allotment Charges Report

ELEPHANT BUTTE IRRIGATION DISTRICT
WATER ALLOTMENT CHARGES (acre-feet)
for Month of April 2008
SUBJECT TO REVISION

	Gross Diversions		Diverted to Texas		Net Diversion	
	Month	Year to Date	Month	Year to Date	Month	Year to Date
ARREY CANAL	12,091	22,237			12,091	22,237
PERCHA LATERAL	67	71			67	71
LEASBURG CANAL	11,439	18,710			11,439	18,710
CALIFORNIA EXTENTION	0	0			0	0
EASTSIDE CANAL	7,771	11,954	-353	-514	7,418	11,441
DEL RIO LATERAL	466	823			466	823
WESTSIDE CANAL	20,594	38,029	-6,248	-13,019	14,347	25,010
PUMPED FROM RIVER**	0	0			0	0
GROSS TOTAL	52,429	91,824	6,601	13,533	45,828	78,292
TOTAL CHARGES					45,828	78,292
CREDIT AT ARREY (-)					-692	-763
CREDIT AT LEASBURG (-)					-87	-87
NET ALLOTMENT CHARGE					45,049	77,442
DISTRICT ALLOTMENT						198,384
DISTRICT BALANCE						120,942

** GREENWOOD AND DURAN RIVER PUMPS (EBID DATA)

Charges to EBID are made using the following diversion points:

a) Arrey Canal,

b) Percha Lateral,

c) Irrigations from Leasburg Canal above gauging station,

d) Leasburg Canal,

e) California Lateral,

f) West Side Canal (NM portion),

g) East Side Canal (NM portion),

h) Del Rio Lateral, and

i) the Greenwood, Duran, Roundtree, Dulin, Dorser, and Thurston pumps located in the Rincon Valley.

4.5.3. EPCWID

Figure 4 –Example of EPCWID's Monthly Water Allotment Charges Report

EPCWID Diversion Allocation Charges for Mar 2008

Diversion Location	Metered Volume	Adjustment for Conveyance Losses for NM Deliveries	Diversion Allocation Charges for Month	Beginning-of-Month Totals	End-of-Month Totals
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
L U E Canal - TX	3,092	95%	2,937	0	2,937
L U W Canal - TX	1,096	95%	1,041	0	1,041
Three Saints Lateral	133	100%	133	0	133
Total Mesilla Valley (Texas)			4,112	0	4,112
Umbenhauer/Robertson Water Treatment Plant	1,820	100%	1,820	61	1,881
Franklin Canal	6,246	100%	6,246	256	6,502
United States - Ysleta del Sur Agreement	0	100%	0	0	0
United States Section - IBWC (Construction Water)	0	100%	0	0	0
Jonathan W. Rogers Water Treatment Plant	2,539	100%	2,539	0	2,539
Riverside Canal	21,751	100%	21,751	1,680	23,431
Haskell R. Street WWTP Effluent	-1,461	100%	-1,461	-239	-1,700
Credit for Diversions greater than Orders (El Paso Valley)	-200	100%	-200	0	-200
Total Allotment Diversions Charges			**34,806**	**3,132**	**36,565**
Diversion Allocation				232,339	257,951
Est. Annual Conservation Credit Diversion Allocation					16,207
Accrued Conservation Credit Diversion Allocation					2,297
Total Diversion Allocation				232,339	260,248
District Allotment Balance				**229,207**	**223,684**

Charges to EPCWID are made using the following diversion points:

a) East Side Canal (Texas portion)

b) La Union East Canal (Texas portion)

c) La Union West Canal (Texas portion)

d) Franklin Canal

e) City of El Paso Water Treatment Plants

f) American Canal Extension for the United States (Ysleta del Sur and US-IBWC)

g) Riverside Canal

4.6. Water Order by Only One District

4.6.1 At the start of the Primary Irrigation Season and when one District orders water for diversion prior to the other, allocation charges to that District shall start on the date and time that water arrives to the delivery point and shall equal the greater of the amount of water ordered for diversion or the amount of water released from Caballo Dam. Any charges based on the amount of water released from Caballo Dam shall be discontinued upon the other district or Mexico ordering water for delivery.

4.6.2 During years with less than a full allocation and diversion have been discontinued for only one district because of insufficient diversion allocation balance and during the time prior to the termination of release of water from Caballo Dam at the end of the Primary Irrigation Season (when only one District orders water for diversion), the allocation charges shall equal the greater of the amount of diversion charges made in accordance with Appendices A, B, and C of this manual or the amount of water released from Caballo Dam.

4.7. End of Primary Irrigation Season

Except when Section 4.6.2 is in effect and after the gates at Caballo Dam have been closed, allocated water will be charged to the Districts until such time as the stored water is no longer available at their respective headings or the estimated travel times listed in Section 4.2 above have elapsed, whichever is less. If Section 4.6.2 is in effect, allocation charges for either district shall end at the date and time the gates at Caballo Dam are closed.

4.8. Emergency Conditions

Each Party shall be allowed to make changes to the water order in response to emergencies such as ditch breaks, flood flows, excessive arroyo inflows, or other accidents to the system. Reclamation shall make the change in the release from Caballo Reservoir as soon as possible.

The order change for accounting purposes, at the respective diversion point, shall take effect as per the travel times in Section 4.2.

In the event of a total closing of the release gates from Caballo due to an emergency, accounting of delivered allocated water shall be in accordance with Section 6.5 Emergency Conditions (Force Majeure) of the Operating Agreement. Documentation of the changes in orders shall be completed utilizing the process in Section 4.1 as soon as possible and verified by each party.

4.9. Accounting Mistakes Regarding Mexico's Allocation

During an extraordinary drought or serious accident to the irrigation system in the United States, Mexico's delivery allocation (that has been diminished in the same proportion as the water delivered to lands in the irrigation districts in the United States) shall not be decreased during the calendar year except in the situation where an accounting or measurement mistake has been made resulting in an allocation to Mexico in an amount greater than would have been made if such error had not been made.

In November of each year, if under any situation Mexico's allocation is greater than the same proportion as the water delivered to lands in the irrigation districts in the United States, then the difference in the amount greater than the proportion as the water delivered to lands in the irrigation districts in the United States shall be charged against the delivery allocation of the irrigation districts in amounts proportional to their respective irrigable acres.

4.10. Correction of D2 – Linear Regression Equation During Multi-Year Extreme Drought

The D2 Linear Regression Equation fails to accurately predict the measured amount of water that was diverted from the Rio Grande during consecutive calendar years when the total amount of water released from Caballo Reservoir is less than 400,000 acre-feet. For example during the years 1954 through 1957 the amount of water released from Caballo Reservoir was less than 400,000 acre-feet, and the amount of measured diversions was 88%, 78%, and 75% of the amount predicted by the D2 Linear Regression Equation for the years 1955, 1956, and 1957, respectively.

During the 2nd consecutive year when the amount of water released from Caballo Reservoir is less than 400,000 acres feet the "Corrected D2 Linear Regression Equation" shall equal the value predicted by the D2 Linear Regression Equation multiplied by 0.88.

During the 3rd consecutive year when the amount of water released from Caballo Reservoir is less than 400,000 acres feet the "Corrected D2 Linear Regression Equation" shall equal the value predicted by the D2 Linear Regression Equation multiplied by 0.78.

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During the 4th and all following consecutive years when the amount of water released from Caballo Reservoir is less than 400,000 acres feet the "Corrected D2 Linear Regression Equation" shall equal the value predicted by the D2 Linear Regression Equation multiplied by 0.75.

If the measured diversion ratio for a consecutive drought year in which the correction to the D2 Linear Regression Equation is applied~~,~~ is higher than the diversion ratio predicted by the Corrected D2 Linear Regression Equation ~~defined in this section~~, the measured diversion ratio shall be used for allocation purposes.

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5. Exchange of Information

5.1. Allocation Water Charges

Reclamation will provide the EBID and the EPCWID written notification of allocation water charges by the 10th of each following month.

5.2. Communications

Reclamation will provide timely information on any unusual circumstances which could affect the water deliveries to the Districts or Mexico. EBID and EPCWID will immediately notify Reclamation concerning ditch breaks, unusual operating conditions, climatic conditions, or other major disruptions to orderly irrigation operations.

Reclamation will provide river status information daily to the Districts. Additional information or assistance may be requested at any time during Reclamation's operation hours. Any requests for information or assistance during non-operating hours should be limited to emergencies and not routine items. Reclamation's project water operations office and field operating hours during the irrigation season will be as follows:

	Office	Field
Weekdays	6:00 am to 4:30 pm	NM: 6:00 am to 6:00 pm
		TX: 6:00 am to 2:30 pm
Weekends	(none)	NM: 6:00 am to 2:30 pm
		TX: 6:00 am to 2:30 pm

A current roster of contact numbers for EBID, EPCWID, US-IBWC and Reclamation shall be distributed by each of the above entities to EBID, EPCWID, US-IBWC, and Reclamation. The roster shall be updated as necessary.

5.3. Information Provided to Reclamation

EBID and EPCWID shall provide to Reclamation and the other district the following:

a) Water orders by 10:00 am on order days

b) Average flow data (cfs) for all metering station listed in the Operating Agreement by the 2nd Monday of each month following the month in which the data was measured.

c) Crop report information by January 15, each year.

d) Water charges to the farms by January 15, each year.

Reclamation shall obtain the following from US-IBWC:

a) Water orders by 10:00 am on order days.

b) Preliminary average flow data (cfs) for the Acequia Madre listed in the Operating Agreement by the 2nd Monday of each month following the month in which the data was measured.

c) Final average flow data (cfs) by the last day of each month following the month in which the data was measured.

5.4. Information Provided by Reclamation

Reclamation shall provide to EBID, EPCWID, and US-IBWC the following information by the 2nd Tuesday of each month.

a. Amount of water stored in Elephant Butte and Caballo Reservoirs

b. Amount of non-project water storage

c. Amounts of project water stored above Elephant Butte in the Upper Rio Grande Basin

d. Cumulative annual amount of water released from Elephant Butte and Caballo Reservoir

e. Current inflow to Elephant Butte and Caballo Reservoir

In addition to the above information, Reclamation shall, by January 15 of each year, provide to all parties documentation of compliance, during the previous year, by the City of El Paso with terms of "Exhibit C – Determination of Underflow of the Rio Grande Captured by the City of El Paso's Groundwater Withdrawal" of the contract among the City of El Paso, EPCWID, the United States numbered 01-WC-40-6760 (2001 Implementing Contract).

6. Updating of Operations Manual

EBID, EPCWID, and Reclamation (including representation from US-IBWC under the auspice of Reclamation) will meet once a year in January, or more frequently if requested by one of the three parties, to review this operating manual. The Parties may modify any provisions of this manual upon having reached unanimous consent. No unilateral departure from this manual is allowed. Proposals for updates shall be submitted to all parties by January 1st of each year for review during the January meeting. The proposal shall consist of a detailed description of the proposed update with a justification for the update. Adoption of the update shall be by unanimous consent for the start of the irrigation season agreed to by the parties. At any time during the year any party may submit proposal for updating this manual. The proposal shall consist of a detailed description of the proposed update with a justification for the update. Adoption of the update shall be by unanimous consent on the date agreed to by the parties. Consent of adoption of the update shall communicated by letter to each party. The Bureau of Reclamation shall make the updated manual available to the general public upon implementation. No unilateral departure from this manual is allowed.

7. Record of Changes Made to This Operating Manual

August 13, 2008	Original Manual
January 15, 2009	No changes made.
January 12, 2010	Deletions, additions, revisions, and changes made to sections 3.1, 3.3, 4.1, 4.5.1, 4.6,1, 4.6.2, 4.7, 4.9, 5.2, 5.3, and 6. as shown in the redline version dated January 12, 2010. No changes made to appendices.
May 8, 2012	Section

Appendix C - Comprehensive Background

Origins of the Rio Grande Project

The origins of the Rio Grande Project (Project) date to the 1880s, when extensive farming in the San Luis Valley in Colorado and along the Middle Rio Grande Valley in the Albuquerque region created serious water shortages along the lower Rio Grande in the New Mexico territory and in the El Paso, Texas and Ciudad Juarez area (Littlefield 1987). The Rio Grande Compact (Compact) arose from conflicts between Colorado, New Mexico and Texas in the United States and Mexico over the use and development of the waters of the Rio Grande. These conflicts were reported to the federal government and both the Department of the Interior and the Department of State began trying to find a long-term solution. In the 1890's, the United States Congress began investigations for what would become the Project by ordering studies of storage and irrigation systems in the area by the United States Geological Survey (USGS) and the United States Army Corps of Engineers (Corps).

The eventual decision resulting from those and other studies was to build storage works on the Rio Grande in the area of Elephant Butte and deliver water from that storage, along with flows accruing downstream, to irrigate lands in New Mexico, Texas and Mexico.

Federal Authorization

Under the authority of the Rio Grande Project Act of 1905 (1905 Project Act), the Project was authorized to provide agricultural irrigation water to the water districts now known as Elephant Butte Irrigation District (EBID) and El Paso County Water Improvement District #1 (EPCWID).

Congress also took action to settle the conflict with Mexico over how much water would be delivered to Mexico. Under the 1906 Convention between the United States and Mexico regarding equitable distribution of waters of the Rio Grande (Convention), the United States is obligated to deliver up to 60,000 acre-feet (AF) of water annually in a full allocation year; otherwise, the water allocation to Mexico is reduced by the same percentage as is the water allocated to the irrigated Project lands in the United States.

The Reclamation Act of 1902 (1902 Act) provides that Reclamation shall proceed in conformity with State or Territory laws relating to the control, appropriation, use, or distribution of water used in irrigation, or any vested right to water acquired under such laws. Section 8 of the 1902 Act also provides that "…nothing herein shall in any way affect any right of any State or of the Federal Government or of any landowner, appropriator, or use of water in, to, or from any interstate stream or the waters thereof…". Consistent with this mandate, after passage of the 1905 Rio Grande Project Act, the

United States filed notices in 1906 and in 1908 alerting the Territory of New Mexico of federal ownership of specified waters of the Rio Grande.[8] The 1906 filing notified the Territorial Irrigation Engineer that the United States intended to utilize "730,000 AF per year requiring a maximum diversion or storage of 2,000,000 miner's inches said water to be diverted or stored from the Rio Grande River" near Engle, New Mexico, and diversion dams near Palomas, Rincon, Mesilla, and El Paso Valleys in New Mexico and Texas (Hall 1906). In April 1908, the Reclamation Service provided a second notice of its intent "to utilize ...all of the waters of the Rio Grande and its tributaries, said water to be diverted or stored from the Rio Grande River at [Elephant Butte] ...and diversion points below in Palomas, Rincon, Mesilla and El Paso Valleys in New Mexico and Texas" for the Project (WaterBank 2008).

In 1907, Congress appropriated $1,000,000 to pay for the portion of the Project necessary to provide storage of water for fulfillment of the 1906 Convention with Mexico. (Act of March 4, 1907, 34 Stat. 1357.) As for funding the rest of the Project, under the 1902 Act, Congress intended that water projects would be self-supporting; each would generate sufficient revenues to approximately cover costs of construction and operation and maintenance, and the total estimated Project costs would be equitably borne by Project beneficiaries.[9] Therefore, EBID and EPCWID were required to enter into contracts with Reclamation under which they would cover these costs in the future. The 1902 Act further states that the right to use Project 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 U.S.C. §§ 372, 383.) The contracts with EBID and EPCWID establish the allocation of water between the two districts based on the irrigable acreage within each district.

In the 1920’s and 1930’s, pursuant to the 1902 Act, Reclamation constructed a series of drains that provided a means by which Project water used on fields and seeped underground would get back to the river as return flow. These drains assured that the lands would remain irrigable and ensured that the Project could appropriate or re-claim these return flows which became an integral part of the total Project water supply. Additionally, during construction of the Project, Reclamation purchased essentially all the existing canals in the Project area and either re-built or replaced them. These canals, which had priority dates from the 1840s, would be used to deliver Project water.

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[8] The filing was made in compliance with a notification provision of the Act Creating the Office of Territorial Irrigation Engineer, to Promote Irrigation Development and Conserve the Waters of New Mexico for the Irrigation of Lands and Other Purposes, March 16, 1905. See also Territorial Act of March 19, 1907, chap. 49, § 40 (1907).

[9] *See* Reclamation Act of 1902, § 4, 43 U.S.C. §§ 419, 461 (“The said charges shall be determined with a view of returning to the reclamation fund the estimated costs of construction of the project, and shall be apportioned equitably.”); *Swigart v. Baker*, 229 U.S. 187, 193-94 (1913)

Rio Grande Compact

The Project could only succeed if the upstream areas in New Mexico and Colorado agreed to deliver sufficient water to keep it viable. Recognizing this, the three Rio Grande basin states negotiated an agreement to establish minimum delivery requirements by Colorado and New Mexico. In 1939 Congress ratified the Rio Grande Compact, as a tri-state agreement between Colorado, New Mexico, and Texas to ensure an equitable apportionment of the waters of the Rio Grande. The Compact sets delivery requirements to states based upon flows at specific measurement stations; and delivery of water to the Project at Elephant Butte Reservoir. The Compact specifies an obligation for New Mexico and Colorado to deliver water to Texas and sets limits on the accumulation of over-deliveries (credits) and under-deliveries (debits). Under the Compact, New Mexico and Colorado are required to ensure that the Project receives a sufficient water supply each year to have the ability to release 790,000 AF (on average) from Project storage to meet the United States' treaty and contractual obligations.

State Water Laws

Beginning with the drought of the 1950's, farmers in New Mexico began to install pumps to supplement their surface supply from the Project with groundwater. The wells also provided district water users the opportunity to supplement their full Project allocations when the drought ended and when full diversion allocations from the Project were again available. The availability of this additional water supply led to a large-scale change in cropping patterns as irrigators began a shift to plant high-value crops such as pecans, which also have higher water requirements than crops historically planted.

The New Mexico Office of the State Engineer (NMOSE) is responsible for regulating groundwater within the state. In 1980, NMOSE declared the Lower Rio Grande (LRG) underground basin, and imposed a permit system on well drilling. Prior to this declaration, there were no restrictions upon well drilling. Under Texas state law, groundwater is managed as groundwater conservation districts within Groundwater Management Areas (GMA). Groundwater conservation districts are local government organizations authorized by the Texas Legislature and ratified by local populations to manage and protect groundwater resources.[10]

On January 5, 1999, in an effort to further protect existing water rights from impairment caused by groundwater pumping, the NMOSE published the Mesilla Valley Administrative Area Guidelines (Turney 1999). The Guidelines' objectives state: "The primary aquifer within the Mesilla Valley Administrative Area is recognized as a stream-

[10] The right of an irrigator to pump groundwater is regulated by the state. The federal government has no legal authority or discretion to allow or disallow groundwater pumping within the Project area. New Mexico law provides that the State Engineer's jurisdiction extends to "underground streams, channels, artesian basins, reservoirs or lakes, having reasonable ascertainable boundaries," once they are "declared to be public waters and to belong to the public and to be subject to appropriation for beneficial use." (NMSA 1978, § 72-12-1).

connected system in which groundwater withdrawals will ultimately result in depletions of surface-water sources." The Guidelines created strict criteria for evaluating applications for new appropriations, applications for supplemental wells, and applications to change point of diversion, or place or purpose of use, and provided "Administrative standards which quantify allowable surface water depletions and water level declines."

Beginning in 2004, due to "a water shortage crisis" caused by drought and "to ensure protection of existing water rights in [EBID] from impairment", the NMOSE further enhanced its efforts to administer water rights in the LRG area (Order of the State Engineer, December 3, 2004.) By two separate orders, the NMOSE created the Lower Rio Grande Water Master District and imposed metering requirements on wells within the District (Metering Order) (amended December 20, 2005). The Metering Order required "that all wells in the LRG Water Master District be metered by March 1, 2006, except for those wells that serve one household or livestock" and provided a grace period for enforcement until November 1, 2006. According to its 2009-2011 Annual Report, (Stangle 2011) NMOSE water master staff has conducted meter installation field checks on 827 wells and red-tagged 123 wells, which led to 19 compliance orders being issued for non-compliance. Additionally, water master staff has acquired meter readings for about 90 to 93 percent of the actively metered wells in the area.

Lower Rio Grande Adjudication

In 1997, the NMOSE filed a complaint with the Third Judicial District Court of Doña Ana County to begin the adjudication of water rights in the LRG, which will establish the quantity, place and purpose of use, and the priority date of each and every water right in the area.

Over the last few years, the NMOSE has entered into several settlement agreements involving the legal limits of surface use and groundwater pumping, which were approved by the adjudication court in the Final Judgment of Stream System Issue 101 filed on August 22, 2011. In February 2008, the NMOSE entered into a Settlement Agreement with the New Mexico Pecan Growers, which granted pecan growers a farm delivery requirement[11] (FDR) of 5.5 acre-feet per year (AFY) and a consumptive irrigation requirement[12] (CIR), which is transferable to non-irrigation uses, of 4.0 AFY. The agreement provides that pecan growers can use groundwater to irrigate their trees so long as they fully use their surface allocation. In June 2011, the NMOSE entered into a Settlement Agreement with the Pecan Growers and the Southern Rio Grande Diversified Crop Farmers Association, which granted the following:

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[11] The farm delivery requirement (FDR) is the consumptive irrigation requirement (defined below) plus farm losses due to evaporation, deep percolation, surface waste, and nonproductive consumption. The losses are measured by the Farm Irrigation Efficiency, which is the percent of farm-delivered water that remains in the root zone and is available for crop growth.

[12] The consumptive irrigation requirement (CIR) is the quantity of irrigation water, exclusive of precipitation, stored soil moisture, or ground water that is required consumptively for crop production.

- surface water right owners an FDR of 3.024 AFY or greater and a CIR of 2.6 AFY;
- groundwater right owners an FDR of 4.5 AFY, and a CIR of 2.6 AFY; and
- Allowing a water right owner to prove an FDR up to 5.5 AFY.[13]

In the LRG adjudication, the United States has claimed enough water to fulfill its obligations under contracts with Project beneficiaries in New Mexico and Texas and under the Convention with Mexico. The United States' claim is based upon the statutory authorizations of Congress following investigations that began in the 1890s, the purchase of older canals and associated water rights, and the filings made in accordance with New Mexico Territorial law at the time the Project was authorized.

Texas Water Law and Administration

In 1913, the Texas legislature enacted an irrigation act that centralized the licensing process by limiting the permitting authority to the Texas Board of Water Engineers. Another act replaced this act in 1967, which established a procedure to adjudicate a water rights claim. In Texas, individuals do not own surface water but acquire a right to use it under state law; however, recent case law has declared an overlying landowner owns groundwater under its lands. The Texas Commission on Environmental Quality (TCEQ) evaluates all claims of water rights to state water, except for domestic or livestock purposes, for each stream in Texas. That evaluation is subject to judicial review and confirmation.

Texas Groundwater Administration

Texas is a "rule of capture" state in which groundwater is property of the owner of the surface estate. Texas law distinguishes between percolating groundwater and underflow, with a presumption that underground water is percolating groundwater (Caroom and Maxwell 2009) .

Under the Texas state law, groundwater is managed as groundwater conservation districts within GMAs. Groundwater conservation districts are local government organizations authorized by the Texas Legislature and ratified by local populations to manage and protect groundwater resources. There are no groundwater conservation districts within the Project area, which is GMA #5.

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[13] By comparison, just due east, in the adjudication of the Carlsbad Project located in the Lower Pecos River Basin, the NMOSE granted and the court approved an FDR of just 3.697 AFY and a CIR of 2.218 AFY for surface water and/or supplemental groundwater irrigation in the Carlsbad Irrigation District. The Carlsbad Project has lower water use requirements than the Rio Grande Project because the NMOSE began declaring portions of the Carlsbad underground basin as early as 1947 and water users did not establish high water use crops. In both areas, groundwater pumping was originally used to supplement surface supply, but only in the Rio Grande did groundwater use become a primary source. In the Roswell area, just north of Carlsbad, the OSE declared the main section of the underground basin in 1931, and the FDR is just 3.0 AFY and the CIR is 2.1 AFY. There, farmers must acquire additional water rights and stack them on their land if their crops need additional water.

Adjudication of Water Rights in the Upper Rio Grande Segment of the Rio Grande Basin

In 1993, EPCWID filed application for a permit for use of Project water in Texas. In 2006, the United States and EPCWID obtained a court-decreed right to specified Project water (Honorable Linda Chew 2006). Under Section 11.307 of this decree, EPCWID is authorized to divert and use 376,000 AF of water per year for irrigation, municipal, industrial, mining and recreational use. In addition EPCWID is authorized any measurable surface water-based effluent, groundwater-based effluent, or groundwater discharged into the Rio Grande pursuant to contracts between EPCWID and Reclamation, and an average of 1,899 AF averaged over any five years from tributary inflows to the Rio Grande between the Texas/New Mexico state line and the (former) location of the Riverside Dam. The latest priority date of this filing is January 1, 1918.

Reclamation's Contractual Obligations

Amended Repayment Contracts

Under the authority of the 1905 Rio Grande Project Act, as well as the Sale of Water for Miscellaneous Purposes Act of 1920 (43 USC §521), Reclamation entered into contracts with EBID and EPCWID for the repayment of construction costs and the delivery of irrigation water. 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 upon an established irrigated acreage in each district: 56.7742 percent to EBID and 43.2258 percent to EPCWID. In 1938, subsequent amendments to these contracts added a three percent buffer to the authorized amount of land that could be irrigated with Project water. Today, the Project irrigates 159,650 (original 155,000 plus three percent) total acres within the United States: 69,010 acres of land within EPCWID and 90,640 acres of land within EBID with Project-water rights.

The districts' amended repayment contracts required three changes to occur in historic operations.

1. When the two districts had repaid the total reimbursable costs for the Project, they were required to take over the day-to-day responsibility for operation and maintenance of the irrigation delivery and drainage system, including 141 miles of canals, 462 miles of laterals, and 457 miles of drains.
2. Once this transfer of operation and maintenance occurred, Reclamation and the two districts were required to agree to and formalize a set of operating procedures that would govern the operations of those transferred Project works.
3. Upon that transfer, Reclamation would no longer calculate, allocate, and deliver water to Project land but rather would deliver an annual water allocation—an "annual diversion allocation"—to each district in an amount that corresponded to the percentage of Project land within their boundaries: 57 percent of the legally-available Project water supply to EBID and 43 percent to EPCWID. These

diversion allocations continue to govern the division of Project water between the districts except as provided in the OA.

In 1979 and 1980, when the districts fulfilled their repayment obligations as established in 1937 and 1938, they and Reclamation entered into contracts that transferred the day-to-day responsibility for operation and maintenance of the irrigation delivery and drainage systems to each district[14]. These contracts required the districts and Reclamation to develop operating procedures to govern the operations of the Project. Because the districts and Reclamation could not agree on a formalized set of operating procedures, the transfer occurred but the Secretary, through Reclamation's El Paso office, imposed *ad hoc* operating procedures to govern Project operations in the interim. These *ad hoc* operating procedures were modified by Reclamation as needed between 1980 and 2007. During that time Reclamation calculated, allocated, and delivered each district's annual diversion allocation (e.g., the district's proportion of the legally-available water supply) but the methods, equations, and procedures used were modified as needed and optimized, according to real-time water conditions. The period of 1979 thru 2002 were full allocation years; however decreased inflows to the Project began in 1996. Accumulated Project storage carried over from previous years provided full allocations until 2002. The first reduced allocation year was in 2003. . .

Contracts with City of El Paso

The City of El Paso diverts its Project water from the American Canal and Riverside Canal. Under a 1941 contract between Reclamation and the city (Contract No. Il6r-1541), the city, as El Paso Water Utilities (EPWU), was able to acquire up to 2,000 acres of EPCWID's irrigated Project lands, and therefore receives its diversion as a water-user member of EPCWID. Subsequent contracts have increased the amount of acreage that the city is allowed to acquire for the conversion of water. Rio Grande water is only available during the irrigation season. (Caroom and Maxwell 2009)

Contract with HCCRD1

In 1924, the Hudspeth County Conservation and Reclamation District No. 1 (HCCRD1) was organized to consolidate several ditches that had been built in and around 1915 and were diverting water from the Rio Grande at various points between the Project boundary and Guayuco Arroyo into one canal system. Under a Warren Act contract between Hudspeth County and the United States, HCCRD1 has been diverting drainage and wastewaters from the Project since 1925. The contract extends only to the return water as it occurs in the normal operation of the Project and puts no obligation upon the Project or Reclamation for delivery of any specific amounts of water.

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[14] Title to the easements, ditches, laterals, canals, drains and other rights-of-way was transferred to the districts in 1996, under the authority of PL 102-575, Title 33, as documented in Reclamation's 1996 *Final EA and FONSI for the Transfer of Lands and Irrigation Facilities, Rio Grande Project to Elephant Butte Irritation District and El Paso County Water Improvement District No. 1.*

Litigation History

Starting in the 1980's, legal complaints arose over how the functions remaining under Reclamation's control were handled. EPCWID complained that due to the conservation efforts of the district's farmers, they were not using their full annual diversion allocation in many years. EPCWID asserted that it was, in effect, leaving a portion of its annual diversion allocation in Elephant Butte Reservoir each year. EPCWID further asserted that as EPCWID had repaid 43 percent of the reimbursable costs, it had a property right in its 43 percent of the annual diversion allocation, and Reclamation was treating it unfairly when the unused portion of EPCWID's annual diversion allocation was re-divided each year through the allocation process, which resulted in EBID receiving 57 percent of the water conserved by EPCWID.

EPCWID also protested that groundwater pumping in New Mexico was causing the Texas district to receive less water than the 43 percent to which it was entitled. EPCWID stated that it lost a portion of its water share because: 1) surface water transfers to groundwater pumped by EBID, essentially increasing the overall supply available to EBID, because they could obtain water through both Project deliveries as well as through groundwater pumping; and 2) the water released to make deliveries to EPCWID was lost in conveyance as the Rio Grande became less efficient due to losses of water from groundwater pumping.

EBID also complained that the ad hoc procedures and other operational choices by Reclamation were depriving them of entitlements. In 1990, EBID filed suit against the Secretary challenging, among other things: 1) operational decisions on reservoir management made under the ad hoc criteria; 2) crediting miscellaneous revenues from Project lands; 3) charges to the districts for operation and maintenance functions performed by Reclamation, and 4) the validity of the recreational leases at Elephant Butte and Caballo Reservoirs. EPCWID also joined as a plaintiff, first in an involuntary capacity and later as a voluntary plaintiff.

Following the conclusion of the earlier cases, in 2007, EBID and EPCWID filed new separate actions in the federal courts of New Mexico and Texas, respectively, seeking declaratory judgments confirming and validating the rights and obligations of each party, based upon their individual repayment contracts with the United States. Among other things, EPCWID asserted that it was being deprived of its 43 percent of the legally available annual diversion allocation by both the re-allocation of its unused allocation, and by increased conveyance losses caused by groundwater pumping in New Mexico. EBID's demands included an operating agreement and both complaints asserted the United States must implement a set of operating procedures based upon the district's respective interpretations of the United States' contractual obligations rather than continue the ad hoc administration of Project operations.

The 2007 lawsuits were dismissed by EBID and EPCWID when the parties, in conjunction with Reclamation, agreed to execute and implement an operating agreement in 2008, as a settlement of the pending litigation. The term of the resulting 2008 OA is from January 1, 2008, until December 31, 2050.

Timeline

1890	Congress orders investigations of irrigation and storage by USGS and the Corps.
1902	Reclamation Act—authorizing irrigation project to “reclaim” the arid West.
1905	Congress authorized the construction of a dam and reservoir on the Rio Grande in New Mexico, for the impounding of flood waters of said river for the purposes of irrigation.
1906	Convention Between The United States and Mexico
1908	Leasburg Dam and Canal completed.
1917	El Paso Valley Water Users Association dissolved and reorganized as EPCWID, with 69,010 irrigable acres located in the Mesilla and El Paso valleys of Texas.
1924	HCCRD1 organized. United States enters into Warren Act contract for return flows.
1936	Rio Grande Canalization Project Act (49 Stat. 1463).
1937	Elephant Butte Water Users Association dissolved and reorganized into EBID, with 102,000 irrigable acres in Rincon and Mesilla valleys.
1937	Congress authorized the execution of amended repayment contracts with EBID and EPCWID.
1938	Rio Grande Compact entered into between Colorado, New Mexico and Texas, which becomes the institutional mechanism for interstate water allocation.
1938	Caballo Dam completed.
1939	Congress ratifies Rio Grande Compact (53 Stat. 785).
1940	Elephant Butte Powerplant becomes operational.
1951	Onset of drought requires Reclamation to develop allocation strategy in order to be in compliance with Convention of 1906 with Mexico and the irrigated acreage in the U.S. portion of the Project.
1974	Title XIV of the Reclamation Development Act of 1974 (88 Stat. 1498) authorizes the storage of San Juan Chama water in Elephant Butte Reservoir to establish a recreational pool.
1979/80	Districts fulfill their repayment obligations and enter into contracts with Reclamation to transfer operation and maintenance of facilities.
1992	Public Law (PL) 102-575, Title XXXIII authorizes transfer of the title to

	easements, ditches, laterals, canals, drains, and other rights-of-way, but not storage or diversion structures, which the United States had acquired on behalf of the Project.
1993	EPCWID filed application for a permit for use of Project water in Texas.
1995	Southwestern willow flycatcher (*Empidonax traillii extimus;* flycatcher) listed as endangered by Service. (Critical habitat designated on 10/19/2005.)
1996	Final Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for the Transfer of Lands and Irrigation Facilities, Rio Grande Project to EBID and EPCWID
1996	Court Order—restricting storage at Caballo (paragraph in “Storage” below)
2006	The United States and EPCWID obtained a court-decreed right to 376,000 AFY of Project water
2007	Reclamation EA/FONSI
2008	Reclamation and districts entered into OA
2011	Final Judgment for New Mexico Stream Issue 101, August 2011
2012	Preparation of Supplemental EA

Appendix D - Listed Species Technical Information

Species Identified for Analysis

Based on literature review and field surveys, four threatened or endangered species occur or have been observed within the action area of the environmental assessment (EA): the Interior Least Tern, Piping Plover, Southwestern Willow Flycatcher (flycatcher), and Rio Grande silvery minnow (silvery minnow) (Table D.1).

Table D.1. Four threatened or endangered species in the action area including listing status.

Scientific Name	Common Name	ESA Status
Sterna antillarum	Interior Least Tern	Endangered
Charadruis melodus	Piping Plover	Threatened
Empidonax traillii extimus	Southwestern Willow Flycatcher	Endangered
Hybognathus amarus	Rio Grande silvery minnow	Endangered

The only critical habitat contained within the action area is for the flycatcher. This designation was revised by the U.S. Fish and Wildlife Service (Service) in January 2013 (78 FR 343-534). The southern boundary of critical habitat along the Rio Grande in New Mexico was extended to about river mile (RM) 54, or about eight miles into the upper end of the Elephant Butte Reservoir pool (Figure D.1). No critical habitat was designated south of this point, including proposed areas south of Elephant Butte and Caballo Reservoirs.

Action Area

For analysis purposes, there are four segments of the action area that vary in degree and type of effects. These geographical segments include:

- Elephant Butte Reservoir, New Mexico
- Rio Grande downstream from Elephant Butte Dam to the inflow to Caballo Reservoir
- Caballo Reservoir
- Rio Grande from Caballo Dam to the El Paso-Hudspeth County line in Texas.

The International Boundary and Water Commission (IBWC) has already consulted on effects of its operations from Percha Diversion Dam to the southerly international boundary with Mexico. The issued biological opinion (BiOp) committed IBWC to maintain at least 53.5 acres of dense riparian habitat for flycatchers and implement a flycatcher management plan by 2015 (Service 2012). Reclamation has reviewed the proposed action in the EA and concluded that the range of operations under the proposal was fully covered by IBWC in their consultation.

Interior Least Tern (Sterna antillarum)

Status and Distribution

The Service stated in the 2003 BiOp (consultation #2-22-03-F-0129) that "the interior least tern occurs as a vagrant along the Middle Rio Grande, and no nesting has been recently documented. Therefore, effects from the proposed action are likely to be insignificant or discountable."

The Interior Least Tern (*Sternula antillarum athalassos*, tern) was listed as endangered by the Service in 1985 (50 CFR 21784). This subspecies historically bred along the Colorado (in Texas), Red, Rio Grande (in Texas), Arkansas, Missouri, Ohio, and Mississippi River systems and has been found on braided rivers of southwestern Kansas, northwestern Oklahoma, and southeastern New Mexico (American Ornithologists' Union 1957). In New Mexico, the tern was first recorded (including nesting) at Bitter Lake National Wildlife Refuge (NWR) in 1949; and since then, it remained present essentially annually (Marlatt 1984, New Mexico Department of Game and Fish 2008). The species also occurs as an occasional breeder in Eddy County, New Mexico (Moore 2011). The tern has been observed as a 'vagrant' or 'highly unusual' species among the 377 avian species detected on the Bosque del Apache NWR since 1940 (Service 1995). In 2005, a rangewide survey of terns was completed, and the Rio Grande/Pecos River systems collectively made up 0.8% of the population (Lott 2006). Historically, tern nesting has been confirmed on six reservoirs along the Rio Grande/Pecos reach at Bitter Lake NWR, Brantley Lake, and Imperial Reservoir on the Pecos; and Lake Casa Blanca, Amistad Reservoir, and Falcon Reservoir on the Rio Grande in Texas (Lott 2006) (Figure 9).

Life History and Ecology

Terns nest colonially on bare or sparsely vegetated sand along rivers, lakes, or reservoirs and along mudflats along coasts and rivers. Nesting occurs from late April to August. Sand is the dominant nesting substrate (New Mexico Avian Conservation Partners 2012). Chicks leave the nest a few days after hatching, but parental attention continues until migration in early September. Terns' diet consists of small fish and invertebrates. At the Bitter Lake NWR, the terms are reported to fly at least 3 kilometers (km) from nesting colonies to foraging areas (Johnson et al. 1997).

Breeding habitat requirements for this species include the presence of bare or nearly bare ground on alluvial islands, shorelines, or sandbars for nesting, the availability of food (primarily small fish), and the existence of favorable water levels during the nesting season so nests remain above water (Ducey 1981). Breeding colonies contain from 5–75 nests. Although most nesting occurs along river banks and reservoirs, the tern also nests on barren flats of saline lakes and ponds. Nests are constructed by scraping a depression within the sand.

Habitat Description

From late April to August, terns use sparsely vegetated beaches and sandbars along rivers or lake or reservoir shorelines. Wide river channels with scattered sand bars are the preferred habitat, but terns use sand and gravel pits. Their nest is a shallow depression in

an open area, above high water levels and safe from ground predators; thus islands are favored habitats (Thompson et. al.1997).

Threats

The primary threat to the tern is loss and degradation of habitat. Dams and other alterations to river systems have reduced their preferred sandbar nesting habitat. Fluctuating water levels in streams may cause scouring of sandbars or high flows that wash away chicks and nests. Recreational use of beaches and sandbars results in reduced use of such areas by the tern.

Presence-Absence within the Action Area

Altered flows and channelization of the Rio Grande have eliminated suitable nesting habitat; however, terns may use the river corridor for feeding or resting during migration and as mentioned above, they have been documented as present south of the action area. At least one tern was observed in the southern portion of the action area by IBWC during fall surveys in September 2000, presumably in the process of migrating south. The U.S. Geological Survey (USGS) reports no tern at Fort Bliss in El Paso County (USGS 2013) (Table D.2). In short, it would be extremely unlikely for this species to be found in the action area. No tern have been incidentally recorded during flycatcher surveys within the action area since the mid-1990s, however, it should be noted that these surveys are not generally conducted in habitat suitable for terns and surveyors are not asked to record other bird observations specifically (Wilber, pers. comm.).

Table D.2. Bird occurrence at Fort Bliss, Texas by month.

	Month											
Common Name	J	F	M	A	M	J	J	A	S	O	N	D
Interior Least Tern												
Piping Plover								--6				
Willow Flycatcher				-4	444		--4	333	445			
Yellow-Billed Cuckoo					--4	444	444	444	44-			

Source: USGS 2013. Legend: 1=abundant; 2=common; 3=fairly common; 4=uncommon; 5=rare/irruptive; 6=very rare.

As previously mentioned in the Status and Distribution section of this analysis, the tern can be considered a vagrant on the middle Rio Grande and no tern nesting has been recently documented (Service 1995). According to the recovery plan from the Service in 1990, the only documented breeding along the Rio Grande takes place in Texas, and the only documented breeding within the state of New Mexico can be found on the Pecos River (Service 1990), similar conclusions are drawn in the complete rangewide survey collected in 2005 (Lott 2006).

Piping Plover (Charadruis melodus)

Status and Distribution

In 1986, the Great Lakes population of Piping Plover (*Charadruis melodus)* was listed as endangered and the species is threatened in the northern Great Plains and Atlantic coast. A recovery plan was published by the Service in 2003. In the spring and summer they breed in the U.S. and Canada. Piping Plovers are migratory birds. In the spring and summer they breed in the northern United States and Canada. In the fall, they migrate south to winter along the Gulf of Mexico and more southerly locations. The Piping Plover has been documented in the Bosque del Apache NWR in New Mexico north of the action area (IBWC 2004) and at Fort Bliss, Texas (USGS 2013).

Life History and Ecology

The Piping Plover arrives on northern or coastal breeding grounds from early to mid-March. They often nest with a colony of terns. The young leave the nest shortly after hatching and by early September most have departed for their wintering areas. The Piping Plover diet consists of marine worms, fly larvae, beetles, crustaceans, mollusks, and other small animals and their eggs. Food is obtained by foraging on beaches, dunes and in tidal wrack.

Site Specific Habitat or Critical Habitat

Piping Plovers use wide, flat, open, sandy beaches with little vegetation. Nesting territories include beaches and sand flats along creeks and wetlands. Most adults return to their previous nesting sites. They also nest in riverine sand or gravel bars.

Threats

Habitat loss or degradation and poor breeding success are major reasons for the population decline. Construction of reservoirs on the rivers and channelization has resulted in a loss of sandbar habitat. Too much water in the spring floods nests and vegetation growth on nesting beaches makes sites unsuitable for nesting. Piping Plovers are sensitive to nest disturbance and the presence of people.

Presence-Absence within the Action Area

The Piping Plover is a rare migrant to New Mexico and Texas and it has never been documented in the action area. It was sighted at Fort Bliss once in August (USGS 2013) (Table D.2), and it is possible, although unlikely, that it would be present in the action area as it migrates south. No Piping Plovers have been incidentally recorded during flycatcher surveys within the action area since the mid-1990s, however, it should be noted that these surveys are not generally conducted in habitat suitable for plovers and surveyors are not asked to record other bird observations specifically (Wilber, pers. comm.).

Southwestern Willow Flycatcher (Empidonax traillii extimus)

Status and Distribution

The southwestern subspecies of the flycatcher (*Empidonax traillii extimus*) was listed as endangered in 1995 (Service 1995; 60 FR 10694). A final recovery plan was completed in August 2002 (Service 2002). Background information on the flycatcher is found in the critical habitat rule published in 2005 (Service 2005; 70 FR 60886). A revised critical habitat designation was published on January 3, 2013 (78 FR 343-534).

The flycatcher is a neotropical migrant that breeds in the southwestern United States and winters in Mexico, Central and South America. Migration flyways include major river corridors and tributaries including the Rio Grande (Service 2005, Sogge et al. 1997, 2003).

Life History and Ecology

The flycatcher is a late spring breeder, typically arriving in the action area in early May. Nest construction, breeding, incubation, and hatching of eggs occur from mid-May to mid-July in dense patches of cottonwood, willow, and tamarisk (Sogge and Marshall 2000). The bird is highly territorial, with territories clustered rather than spread out (Service 2002). Territory sizes vary from 0.1 hectare (ha) to 2.3 ha, with most territories being between 0.2 and 0.5 ha. Average clutch size is three to four eggs. The time from egg laying to fledging is about 28 days with juveniles fledged through mid-August. They depart for their winter range in mid-September (Service 2002).

Habitat Description

The recovery plan (Service 2002) divide the range of the flycatcher into six recovery units representing major river drainages. Each recovery unit is subdivided into smaller management units. The action area is located within the Rio Grande Recovery Unit and in the Middle Rio Grande Management Unit and Lower Rio Grande Management Unit. Flycatchers breed in dense riparian vegetation near lentic water, such as river backwaters, oxbows, or marshy areas or saturated soil (Service 2002, 2005; Sogge and Marshall 2000). In the middle Rio Grande, Smith and Johnson (2007) found most nests are constructed over standing water or wet soil. Flycatchers no longer breed in Texas (Service 2002).

The Service revised the designation of critical habitat in January 2013 (78 FR 343-534). The southern boundary of critical habitat along the Rio Grande in New Mexico was extended to about RM 54, or about eight miles into the upper end of the Elephant Butte Reservoir pool (Figure D.1) with the lateral extent including the riparian areas and streams that occur within the 100-year floodplain or flood-prone areas. No critical habitat was designated south of this point, including proposed areas south of Elephant Butte and Caballo Reservoirs, i.e. the area that the IBWC has consulted on with its Rio Grande Canalization Project, 46.1 miles (74.2 km) from Percha to American Diversion Dam.

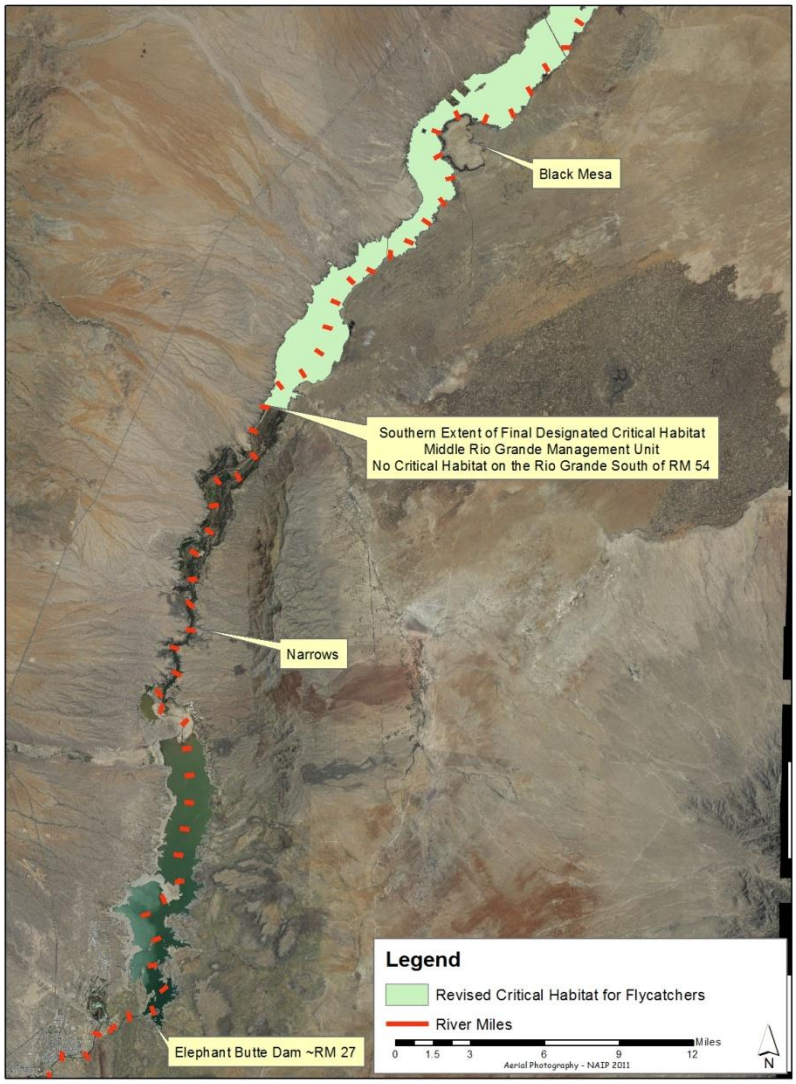

Figure D.1. Revised critical habitat for Southwestern Willow Flycatcher.

The Service has determined that the primary constituent elements of habitat needed by the flycatcher are:

1. Riparian vegetation in a dynamic river or lakeside, natural or manmade successional environment that is comprised of trees and shrubs and some combination of:
   a) Dense riparian vegetation with thickets of trees and shrubs; and/or
   b) Areas of dense riparian foliage at least from the ground level up to approximately 4 to 8 m (13 ft) above ground; and/or
   c) Sites for nesting that contain a dense (about 50 percent to 100 percent) tree or shrub canopy; and/or
   d) Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation.

2. A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments.

Threats

The primary threat to the flycatcher is the loss, alteration, and fragmentation of their breeding habitat (Service 2002, Sogge et al. 1997). Factors contributing to habitat loss include water management, including surface water diversion, impoundment and channelization, groundwater pumping, livestock grazing, phreatophyte control, and increased recreation and urbanization. Any hydrological changes, whether natural or human-caused, can reduce the quality and amount of breeding habitat. Fire and nest parasitism by the brown-headed cowbird (*Molothrus ater*) are also factors in the decline of flycatcher populations ((New Mexico Avian Conservation Partners 2012; Service 2002). The replacement of native vegetation by exotics is a potential threat, though breeding occurs regularly in non-native vegetation, especially salt cedar (Moore and Ahlers 2006, Sogge et al. 2003).

Presence-Absence within the Action Area

Surveys for the flycatchers have been conducted at Elephant Butte Reservoir since the 1990s. The surveys show the birds now occupy the reservoir from full pool elevation at 4407 feet down to 4345 feet (Table D.3).

Table D.3. Territories occupied by Southwestern Willow Flycatchers in Elephant Butte Reservoir in 2003-2012 from full pool elevation down to 4345 feet in five foot intervals.

Elevation	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
>=4407	28	26	21	30	34	46	50	41	38	37
4400-4407	54	79	73	83	111	107	130	130	140	112
4395-4400	0	3	5	5	12	12	17	26	27	17
4390-4395	0		5	9	19	29	46	44	36	18
4385-4390	0	5	3	6	10	16	35	25	9	6
4380-4385	0	0	0	0	0	5	6	8	14	9
4375-4380	0	0	0	0	0	0	0	0	1	2
4370-4375	0	0	0	0	0	0	0	0	0	2

4365-4370	0	0	0	0	0	0	0	1	2	3
4360-4365	0	0	0	0	0	3	2	0	11	6
4355-4360	0	0	0	1	1	3	4	4	20	18
4350-4355	0	0	0	0	2	7	18	9	6	4
4345-4350	0	0	0	0	0	1	1	3	2	2
Total	**82**	**113**	**107**	**134**	**189**	**229**	**309**	**291**	**306**	**236**

Reclamation surveyed for flycatchers from Caballo to El Paso in areas of suitable flycatcher habitat during the summer of 2012. Twenty-eight total flycatcher territories were observed, which exceeds the recovery goals for this Rio Grande Management Unit of 25 total territories. The IBWC has also surveyed for the birds (2004) and documented the birds in the Seldon Canyon region of the Rio Grande (IBWC 2004). These Seldon Canyon birds occur beyond the 100-year floodplain of the Rio Grande Project—not in the action area for this EA. The IBWC found that suitable dense vegetation that would be occupied by the birds does not occur south of Percha Diversion Dam. Although salt cedar does exist along the river banks, these shrubs and trees do not meet the minimum patch size and density requirements for the flycatcher.

As mentioned above, the IBWC committed to a restoration plan in their 2011 consultation on the Rio Grande canalization project. The restoration plan includes up to 30 riparian restoration sites, of which about 8 are specifically designed to create flycatcher habitat on at least 21 hectares (53 acres) and as many as 42 hectares (105 acres), and to include management of saltcedar that is intermixed with cottonwood, willow, mesquite, and arrowweed to maximize potential value for nesting or migratory flycatchers. These sites are to be restored by 2019. The restoration plan also calls for discontinuing mowing willows along the river for the benefit of flycatchers and planting willows in other areas where hydrological conditions are favorable. Restoration efforts will also physically reconnect old river channels and lower incised banks to the main river channel where appropriate. These efforts should result in additional flycatcher habitat beyond the minimum restoration sites. The restoration plan has established collaborative relationships between the EBID, EP#1, IBWC, Audubon Society, Reclamation, and Service to benefit the flycatcher, including monitoring for flycatcher presence and habitat condition throughout the reach.

Rio Grande Silvery Minnow (Hybognathus amarus)

Status and Distribution

The silvery minnow was once one of the most abundant and widespread fishes in the Rio Grande Basin. Historically, silvery minnow occurred in the Rio Grande from Española,

NM, to the gulf coast of Texas and in larger tributaries including the Pecos River encompassing more than 1,500 river miles. Today, silvery minnow are restricted to the reach of the Rio Grande in New Mexico from the vicinity of Bernalillo downstream to the headwaters of Elephant Butte Reservoir. The occupied distance is approximately 10% of its presumed historic range (approximately 150 river miles).

Catch rates at sites in the middle Rio Grande upstream of Elephant Butte Reservoir were highest in 2005, and were similar in 2004, 2006, 2010, and 2011. During October 2012, silvery minnow was not present in any of the seine hauls that yielded fish, as compared with four of the seine hauls that yielded fish during September 2012. Silvery minnow were present in 79 of the seine hauls that yielded fish during December 2012 (Dudley and Platania, 2012).

Impacts of the severe drought in New Mexico are reflected in the 2012 silvery minnow population monitoring results. It should be noted that population monitoring results are an indicator of relative and not absolute abundance. The lack of silvery minnow in the October 2012 density data does not mean there are no silvery minnow in the river but, instead, indicates that the species is near its lowest numbers since monitoring began in 1993.

Life History and Ecology

Silvery minnow are pelagic spawners producing numerous semi-buoyant, nonadhesive eggs and generally spawn in the spring, from late April through June (Platania and Dudley 1999–2010). Peak egg production typically occurs in mid- to late-May, coinciding with high spring discharge produced by snowmelt runoff. Each female produces several clutches of eggs during spawning, ranging from 2,000–3,000 (Age 1) to 5,000+ eggs (Age 2) per female (Platania and Altenbach 1996). Adult silvery minnow are strong swimmers capable of moving upstream during high flow events (Bestgen et al. 2010). However, studies conducted tracking hatchery fish indicate that there is not likely a population wide migration behavior for silvery minnow. It appears that movement is somewhat random with a net downstream trend for marked individuals though a few individuals moved upstream substantial distances (25 km).

Age determination for museum specimens collected in 1874 based on scales (Cowley et al. 2006) indicated silvery minnows may live up to 5 years. However, more recent analysis of the same museum material and contemporary specimens indicate a maximum age of 3 (Horwitz et al. 2011). The majority of the population captured by population monitoring during prespawn seining surveys is comprised of Age 1 fish (1 year old) with older, larger fish (Age 2+) constituting less than 10% of the spawning population (Platania and Altenbach 1996, Horwitz et al. 2011).

Habitat

Critical habitat was designated for silvery minnow in 1999 (64 FR 36274-36290), with revisions published February 19, 2003 (68 FR 8088-8135). Designated critical habitat in the Rio Grande extends through Sandoval, Bernalillo, Valencia, and Socorro Counties, New Mexico, generally beginning at Cochiti Dam downstream to the utility line crossing

the Rio Grande at the upstream end of the Elephant Butte Reservoir full pool. The reservoir and the Rio Grande Project are acknowledged to have led to the extirpation of the species from this area.

Both juvenile and adult silvery minnow primarily used mesohabitats with moderate depths (15–40 centimeters), low water velocities (4–9 centimeters per second) and silt/sand substrates. Young-of-year silvery minnow are generally found in shallower and lower velocity
habitats than adult individuals. During winter months, silvery minnow become less active and seek habitats with cover such as debris piles and low water velocities. During spring sampling, large concentrations of reproductively mature silvery minnow are often collected on inundated lateral overbank habitats (Hatch and Gonzales 2008, LL Study). Further hypothesis testing to determine if silvery minnow exhibit preferential use of lateral habitat (including overbank) for spawning is underway. Surveys of inundated overbank habitats often capture large numbers of gravid females (Gonzales and Hatch 2009).

Threats

The original listing of the species as endangered (58 FR 11823) cited the presence of mainstream dams; growth of agriculture and cities in the Rio Grande Valley; overutilization for commercial, recreational, scientific, or educational purposes; disease or predation, particularly during periods of low or no flow; inadequacy of existing regulatory mechanisms including the lack of recognition that instream flows are a beneficial use of State waters; dewatering of a large percentage of its habitat, including dewatering downstream from San Acacia.

Presence-Absence Analysis within the Action Area

In 2010, silvery minnow were the most abundant fish collected within the temporary channel. Silvery minnow were captured in a variety of habitat types. Four sites were selected based on accessibility between RM 45.8 and 51.3. Mean density of silvery minnow was significantly higher in habitats less than 0.25 meters deep. In 2011, silvery minnow was the second most abundant fish collected, however, overall fish densities were much lower than those observed in 2010. Five sites were selected between RM 46.5 and 54.5.

Sampling for 2012 was conducted on October 10th and 11th. Four sites between RM 46 to 52 were selected. A total of seven different fish species were captured during the sampling. No silvery minnows were captured during any of the samplings on either day. Two samplings at two different sites produced “no fish” and there were no sites dry. Western mosquitofish were the most abundant and red shiners were the second most abundant. Red shiners were distributed fairly evenly from top to bottom throughout the sites and the mosquitofish were a little more plentiful in the lower sites.

Refer to Table D.4 for a summary of the species collected during sampling in the temporary channel over the past three years. In general, silvery minnow were more abundant at sites above RM 50. No sampling occurred downstream of RM 45.8. The fish has been extirpated from the rest of the action area.

Table D.4. Fish species collected during September sampling in the temporary channel within Elephant Butte Reservoir pool from 2010 – 2012.

	2010		2011		2012	
	#	#/100 m²	#	#/100 m²	#	#/100 m²
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

Appendix E

Definition of Allocation Components: OA

- **Accrued Carryover Balance**
  - Balance on district's Project water account on January 1 of the current year
  - Reflects all prior-year charges and any transfer of excess carryover at the end of the prior year
  - Term corresponds to Actual Carryover Water as defined in OA.
- **Annual Allocated Water**
  - District's Project water account balance between January 1 of the current year and the end of the current-year irrigation season
  - For the purposes of this analysis, it is assumed that the final Annual Allocated Water for the current year is determined on or before the end of the current-year irrigation season.
  - Term corresponds to Annual Allocated Water as defined in OA.
- **Transfer of Excess Carryover Balance**
  - Change in district's Project water account between the end of the current-year irrigation season and the end of the current Water Year (December 31) due to transfer of excess carryover per Section 1.11 of the OA
  - Transfer is negative if water is transferred from district account, positive if water is transferred to district account
  - For the purposes of this analysis, it is assumed that no charges or credits are accrued between the end of irrigation season and the end of the Water Year, and that the only change in a district's water account during this period is due to transfer of excess carryover
  - Term corresponds to Excess Carryover Balance as defined in OA.
- **Total Diversion Allocation**
  - Total allocation allotment on district's Project Water Account for the current year
  - Total Diversion Allocation for the current year is the sum of the district's Accrued Carryover Water, Annual Allocated Water, and Transfer of Excess Carryover Water for the current year
  - No corresponding term explicitly defined in OA.
- **Total Allocation Charges**
  - Sum of a district's gross diversions of Project water minus the sum of the district's allocation credits between January 1 of the current year and the end of the current-year irrigation season
  - Gross diversions of Project water correspond to diversions of Delivered Flow as defined in Section 5.3 of OA; allocation credits correspond to credits applied to a

district's Project water account for bypassed (returned) flows as defined in Section 5.5 of OA plus credit for unused diversions which exceed the order.
  - For the purposes of this analysis, it is assumed that no charges or credits are accrued between the end of irrigation season and the end of the Water Year.
- **Unused Allocation Balance**
  - Difference between Total Diversion Allocation and Total Allocation Charges at the end of the current-year Water Year
  - It should be noted that current-year Accrued Carryover Balance is equal to prior-year Unused Allocation Balance

Definition of Allocation Components: Prior Operations

- **Implicit Accrued Carryover Balance**
  - Carryover accounting did not exist under prior operating practices; this term is defined here for comparison purposes only.
  - Implicit Carryover Balance is defined here as the balance on a district's Project water account on December 31 of the prior water year, after all charges and transfers have been enacted (see below)
- **Annual Allocated Water**
  - Carryover accounting did not exist under prior operating practices; this term is defined here for comparison purposes only.
  - Increase in district's Project water account balance between January 1 of the current year and the end of the current-year irrigation season (assumed to be October 31)
  - For the purposes of this analysis, it is assumed that the final Annual Allocated Water for the current year is determined on or before the end of the current-year irrigation season.
- **Implicit Transfer of Carryover Balance**
  - Carryover accounting did not exist under prior operating practices; this term is defined here for comparison purposes only.
  - Under prior operating practices, the unused balance on each district's Project water account at the end of each Water Year was effectively relinquished. Accrued Carryover Balance was not considered under prior operating practices.
  - This relinquishment constituted an implicit transfer of Accrued Carryover Balance between districts—EBID effectively transferred 43% of its balance to EPCWID, and EPWCID effectively transferred 57% of its balance to EBID.
  - For the purposes of this analysis, this implicit transfer of unused allocation balance between districts is considered comparable to the transfer of excess carryover under the OA.

  - EBID's implicit transfer of carryover balance is the sum of 57% of EBID's allocation balance at the end of the current-year irrigation season (taken as negative) and 57% of EPCWID's allocation balance at the end of the current-year irrigation season (taken as positive)
  - EPCWID's implicit transfer is the sum of 43% of EBID's allocation balance at the end of the current-year irrigation season (taken as positive) and 43% of EPCWID's allocation balance at the end of the current-year irrigation season (taken as negative)
  - For the purposes of this analysis, it is assumed that no charges or credits are accrued between the end of irrigation season and the end of the Water Year, and that the only change in a district's water account during this period is due to transfer of excess carryover
- **Total Diversion Allocation**
  - Total allocation allotment on district's Project Water Account for the current year
  - Total Diversion Allocation for the current year is the sum of the district's Accrued Carryover Water, Annual Allocated Water, and Transfer of Excess Carryover Water for the current year
- **Total Allocation Charges**
  - Sum of a district's gross diversions of Project water minus the sum of the district's allocation credits between January 1 of the current year and the end of the current-year irrigation season
  - For the purposes of this analysis, it is assumed that no charges or credits are accrued between the end of irrigation season and the end of the Water Year.
- **Unused Allocation Balance**
  - Difference between Total Diversion Allocation and Total Allocation Charges at the end of the current Water Year
  - It should be noted that current-year Accrued Carryover Balance is equal to prior-year Unused Allocation Balance